9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an environmental assessment (EIAR) of the effects of the operation and decommissioning of the Cleanrath Wind Farm site, grid connection and junction accommodation works (the “Cleanrath wind farm development”)on water aspects (hydrology and hydrogeology) of the receiving environment. A detailed assessment of the effects of the construction phase of the Cleanrath wind far development with respect to hydrology and hydrogeology is included in the Remedial EIAR (rEIAR) which accompanies this application.

The objectives of the assessment are:

- Characterise the baseline water environment (surface water and groundwater) in the area of the Cleanrath wind farm development and associated works;
- Identify significant effects of the Cleanrath wind farm development on surface water and groundwater during the operational and decommissioning phases of the development (a summary of the significant effects during the construction phase is also provided in the chapter);
- Where required, appropriate remedial mitigation measures that were employed or that may need to be employed are described. The residual effects of the Cleanrath wind farm development are then presented; and,
- Assess cumulative effects of the development and other local developments.

9.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist 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 upland hydrology and wind farm 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 and David Broderick.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 18 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/EIAR for Meenbog WF, Shehymore WF, and Carrigarierk WF, Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

David Broderick (BSc, H. Dip Env Eng, MSc) is a hydrogeologist with over 13 years’ experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments including Meenbog WF, Shehymore WF, and Carrigarierk WF, Oweninny WF, and Yellow River WF.

9.1.3 Scoping and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the List of Consultees is outlined in Section 2.4 of this EIAR. 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
Irish Water (IW)	• A generic response was provided with respect potential impacts in terms of any local groundwater and surface water abstractions	Local groundwater and surface water assessments addressed at Section 9.3.21
Geological Survey of Ireland (Groundwater Section)	• A generic response was provided with respect potential impacts on groundwater resources/sources	Groundwater resources assessment addressed at Sections 9.3.14 and 9.3.21
Health Services Executive	• A generic response was provided with respect potential impacts on surface water and groundwater quality	Local groundwater and surface water quality assessments addressed at Section 9.5

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 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1994, S.I. No. 101 of 1996, S.I. No. 351 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001, S.I. 134 of 2013 and the Minerals Development Act 2017), the Planning and Development Act, and S.I. 600 of 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;
- S.I. No 296 of 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 of 1988: European Communities (Quality of Salmonid Waters) Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;

- 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) and S.I. No. 722 of 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 of 2003);
- S.I. No. 684 of 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 of 2007: European Communities (Drinking Water) Regulations 2007and S.I. No. 122 of 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 of 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 of 2009: The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (as amended by S.I. No. 355 of 2018).

9.1.5 Relevant Guidance

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

- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Department of Environment, Heritage and Local Government (2006): Wind Energy Development Guidelines for Planning Authorities;
- 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;
- 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, 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).

9.2 Methodology

9.2.1 Desk Study

A desk study of the site and the surrounding area was completed in advance of construction of the development and this data was reviewed and updated where relevant in the preparation of this EIAR.

This involved collecting all relevant geological data for the site and surrounding area. This included consultation with the following data sources:

- The CEMP for the Cleanrath wind farm development updated as part of condition compliance for the 2017 Permission for the construction phase;
- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks and Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 21 (Geology of Cork-Kerry). Geological Survey of Ireland (GSI, 2003);
- Geological Survey of Ireland (2003) – Groundwater Body Initial Characterization Reports,
- OPW Indicative Flood Maps (www.floodinfo.ie);
- Environmental Protection Agency – "Hydrotool" Map Viewer (www.epa.ie);
- CFRAM Flood Risk Assessment maps (www.cfram.ie); and,
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie).

9.2.2 Pre-Construction Monitoring and Site Investigation Data

A hydrological walkover survey, including detailed drainage mapping and baseline monitoring, was undertaken by HES at the site and along sections of the grid connection during the pre-construction phase.

Investigations undertaken during the pre-construction included the following:

- Walkover surveys and hydrological mapping of the proposed site, grid connection route and the surrounding area were undertaken whereby water flow directions and drainage patterns were recorded;
- A total of over 225 no. peat probe depths were carried out by Fehily Timoney and Company - FT (formerly called AGEC Ltd) to determine the depths and geomorphology of the peat at the site; and,
- A Peat Stability Assessment was undertaken by FT (December, 2015).

9.2.3 Construction and Operational Phase Monitoring/Audit Data

In preparation of this EIAR, walkover surveys and detailed geological mapping of the built development site were undertaken by HES during December 2019 and May 2020. A drone survey of the built development footprint was undertaken by MKO on 27th February 2020.

In addition, monitoring/audit data recorded during the construction phase and operational phase was also compiled and reviewed to address the Water Section of the EIAR. This data includes the following:

- Ionic Consulting Ltd. construction phase records (quantity, volumes etc);
- ECoW (MKO) audit reports;
- HES construction phase site audits;
- Monthly surface water monitoring/sampling results;
- Automated surface water turbidity monitoring results; and
- Results from automated surface water flow/level monitoring in the Toon River and the River Lee.

9.2.4 Impact Assessment Methodology

The guideline criteria (EPA, August 2017) for the assessment of significant effects require that effects are described with respect to their extent, magnitude, type (i.e. negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). The descriptors used in this EIAR are those set out in the EPA (2017) Glossary of effects as shown in Chapter 1 of this EIAR.

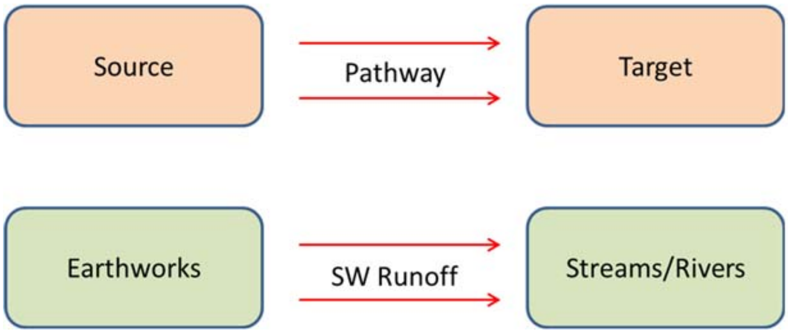
In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 9-2 are used to assess the potential effect that the Cleanrath wind farm development may have on them.

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

9.2.5 Overview of Impact Assessment Process

The conventional source-pathway-target model (see below, top) was applied to assess the impacts on downstream environmental receptors (see below, bottom as an example) as a result of the Cleanrath wind farm development.



Where potential impacts 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):

- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003); and,
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002).

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 9.6), we have firstly presented below a summary guide that 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 wind farm construction and operation activities 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.

9.3 Receiving Environment

9.3.1 Site Description and Topography

The Cleanrath wind farm development site is located approximately 13km to the southwest of Macroom, Co. Cork. The total site area is approximately 67ha. The landscape character of the region listed in the Cork County Development Plan is "Composite Middle Valley of Rugged scrub and Marginal Land". While the landscape character type is entitled "Ridged and Peaked Upland".

Access to the site is from local road at Gortanaddan and Cloontycarthy townlands which is located 1.5km east of Reananerree village. The 9 turbines and associated infrastructure are positioned around a distinct conical shaped hill feature (referred to as Derrineanig on the OSI mapping) which is located approximately 3.5km to the southwest of the site entrance. Turbines T6, T7, T9 and T10 are located on the steadily sloping western side of Derrineanig Hill (peak at 300m OD) where the ground elevation at the turbine locations varies between approximately 220m and 260m OD. Turbines T1, T3, T4, T5 and T8 are located on the more moderately sloping eastern side of Derrineanig Hill where the ground elevation at the turbine locations varies between approximately 190 and 220m OD. The total development footprint area is approximately 10ha.

Bedrock is at the surface over much of the site, particularly on the western slopes of the site, with pockets of soils or peat that are confined to small local dips/valleys between ridged outcrops of bedrock. Landuse locally comprises rough pasture or forestry where a soil and subsoil has formed. For the majority of the site where rock outcrops this precludes any use other than patchy grazing.

The Cleanrath wind farm development comprises a grid route connection route that consists of a electricity cabling (33kV) from Turbine no. 7 within cable ducting along the permitted Operational Access/Inspection Road (Pl Ref. 18/04458) southwest of Turbine no. 7 and on to the local public road until it turns onto the access track of the constructed Derragh Wind Farm development and connects to the constructed 38kV electricity substation, located approximately 3km west of the Cleanrath wind farm development in the townland of Rathgaskig. The grid connection is approximately c15km in length. The cabling loops back out of the Derragh Wind Farm Substation (38kV) and runs mainly within the public road corridor on to the 110kV Coomataggart substation located in the townland of Grousemount, Co. Kerry. The final 1.5km of the cable route within Co. Cork and the 2km of the cabling in Co. Kerry is located on existing private access tracks. There are 126 no. watercourse crossings along the grid connection route, and this includes 13 no. main existing bridge/culvert crossings (natural watercourses) and 113 no. existing smaller culvert crossings (manmade drain crossings).

9.3.2 Rainfall and Recharge

Long term rainfall and evaporation data was sourced from Met Éireann. The 30-year standard annual average rainfall (SAAR: 1981 - 2010) recorded at Ballyvourney (Cloontycarthy), 0.6km north of the site, are presented in Table 9-4. This is the closest station which is most similar to the elevation of the development site.

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

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Ballyvourney		110700		235200		101		1963		N/A		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
201	150.5	138	102	102.5	91.5	85	102	119.5	186	177	189.5	1645

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Cork Airport, approximately 60km east of the site. The long-term average PE for this station is 540mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 513mm/yr (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

= 1644 mm/yr – 513mm/yr

ER = 1,131mm/yr

Based on groundwater recharge coefficient estimates from the GSI (www.gsi.ie) an estimate of between 51 – 200mm/year average annual recharge is given for the site due to its sloping nature. As a conservative measure the lower estimate is used in this study. This means that the hydrology of the study area is characterised by high surface water runoff rates and low groundwater recharge rates. Therefore, conservative annual recharge and runoff rates for the site are estimated to be 51mm/yr and 1,080mm/yr respectively.

9.3.3 Regional Hydrology

Regionally the Cleanrath wind farm development site is located in the River Lee surface water catchment. The grid connection route which is approximately 15km in length is located in both the River Lee (~12.6km) and the Roughty River (~2.4km) surface water catchments. All of the 9 no. constructed turbines and access roads etc are located in the River Lee Catchment.

The River Lee is located in (Hydrometric Area 19 of the South Western River Basin District) and flows in an easterly direction approximately 2.7km to the south of the development site via Lough Allua. The Roughty River catchment, which exists ~9km to the west of the development site, is also located in the South Western River Basin District.

A regional hydrology map is shown as Figure 9-1.

9.3.4 Local Hydrology

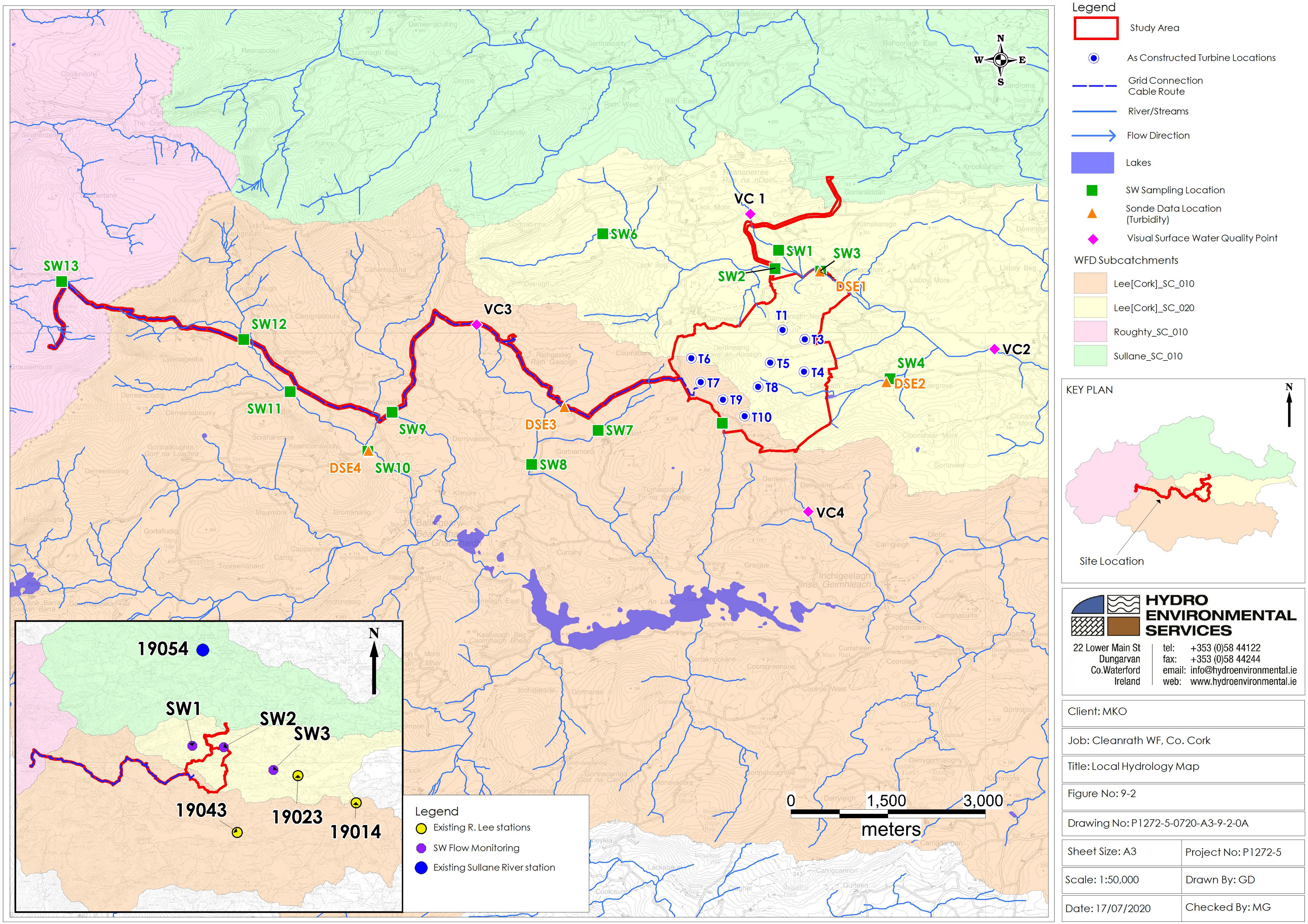
The western section of the wind farm site drains into Lough Allua (i.e. turbines T7 to T10) which exists on the River Lee. The eastern section of the wind farm site (i.e. turbines T1, T3, T4, T5, and T8) drains to the Toon River which is a tributary to the River Lee. The wind farm site entrance and approximately 0.8km of access road is located in the Sullane Beg River which is also a tributary of the River Lee.

The length of the grid connection route within the River Lee catchment drains into Lough Allua. The remaining section of grid route within the Roughty River catchment drains directly into the Roughty River via minor upland streams.

A local hydrology map is shown as Figure 9-2.

9.3.5 Wind Farm Site Natural Drainage

The topography at the wind farm site is locally undulating with the Hill of Derrineanig being the dominant feature. The ridges running below this peak slope gently off into five main sub-catchments. Two sub-catchments drain to Lough Allua and three of the sub-catchments drain to the Toon River.



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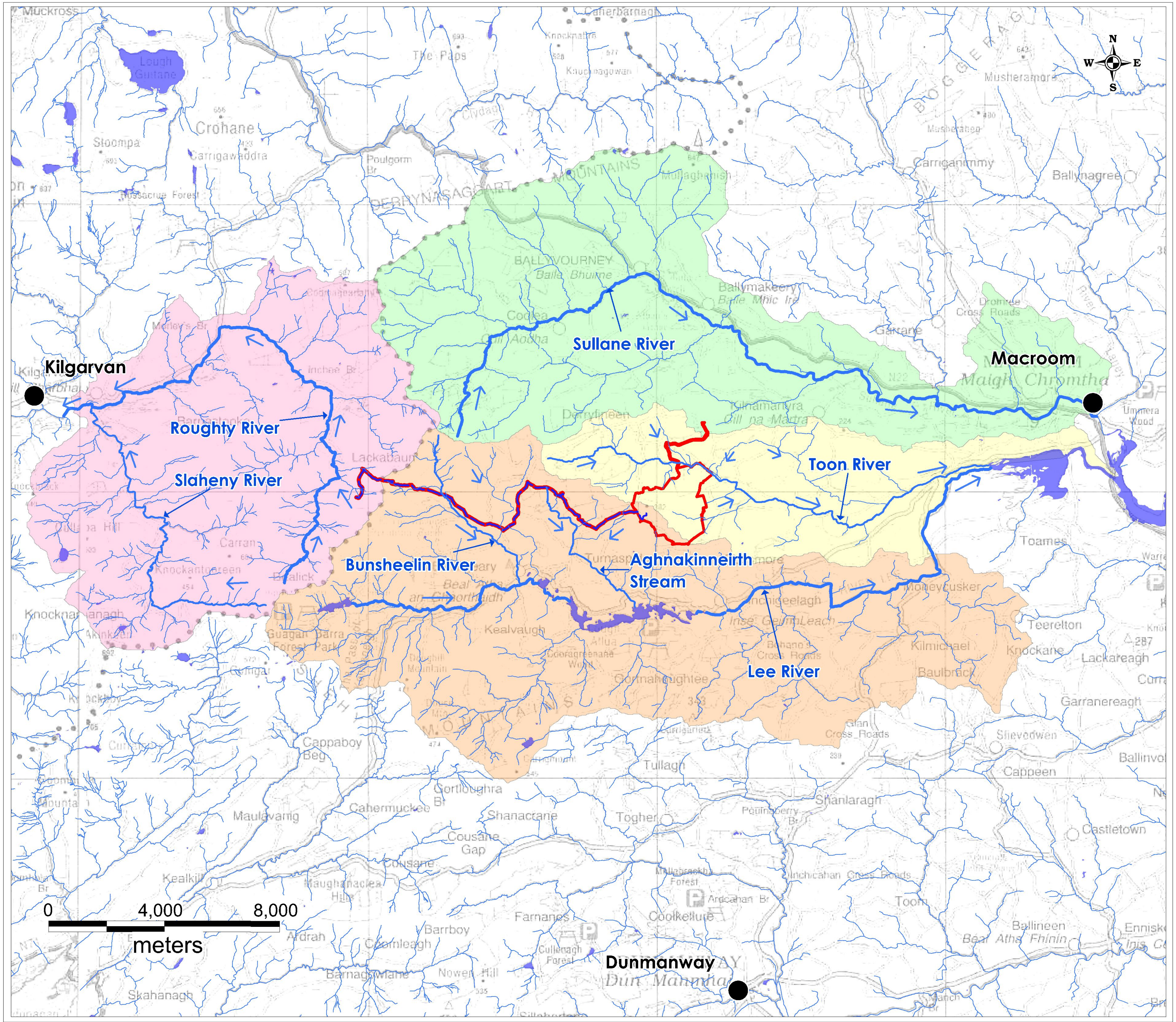
Client: MKO	
Job: Cleanrath WF, Co. Cork	
Title: Local Hydrology Map	
Figure No: 9-2	
Drawing No: P1272-5-0720-A3-9-2-0A	
Sheet Size: A3	Project No: P1272-5
Scale: 1:50,000	Drawn By: GD
Date: 17/07/2020	Checked By: MG



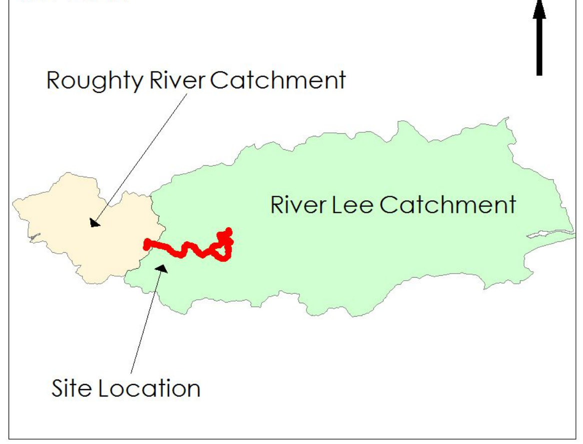
Legend

- Study Area
- Grid Connection Cable Route
- River/Streams
- Flow Direction
- Lakes

WFD Subcatchments

- Lee[Cork]_SC_010
- Lee[Cork]_SC_020
- Roughty_SC_010
- Sullane_SC_010

KEY PLAN



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Client: MKO	
Job: Cleanrath WF, Co. Cork	
Title: Regional Hydrology Map	
Figure No: 9-1	
Drawing No: P1272-5-0720-A3-9-1-0A	
Sheet Size: A3	Project No: P1272-5
Scale: 1:125,000	Drawn By: GD
Date: 17/07/2020	Checked By: MG

The topography of the Hill of Derrineanig is characterised by rocky ridgelines which have a westerly / south-westerly orientation. The natural channels/valleys formed between the ridgelines means surface water runoff is constrained within these channels/valleys. The wind farm access roads intercept these channels at numerous locations across the wind farm site, particularly on the western portion of the wind farm site. The surface water flows within these natural channels have led to the formation of some local acid flushes (discussed in Section 9.3.6 below).

The eastern section of the wind farm site has existing forestry drains and man-made drains at roads and forest track side. The conifer plantation has itself got a well-developed drainage network which drains sections of the wind farm site. The main wind farm site entrance road passes through a significant area of forestry and in some instances the existing forestry tracks have been upgraded.

The installed wind farm drainage is discussed in Section 9.4.1 below.

A wind farm site drainage map is shown as Figure 9-3.

9.3.6 Flush Hydrology

This section discusses acid flush habitats that are present in the area of T9 and T4.

The topography of the area around turbine T9 is characterised by rocky ridgelines which have a westerly / south-westerly orientation. The natural channels/valleys formed between the ridgelines means surface water runoff is constrained within these channels/valleys and hence the increased surface water flows have led to the formation of local acid flushes. These acid flushes (including the ones in the area of T9) are formed solely by surface water flows and not groundwater flows. The hydrochemistry of these flush areas, which is dealt with further below, suggest that they are solely rainwater fed (meteoric in origin), hence the very low mineral content and the acidic hydrochemistry. If they were groundwater fed the hydrochemistry would indicate much higher mineral content in the water within the flushes.

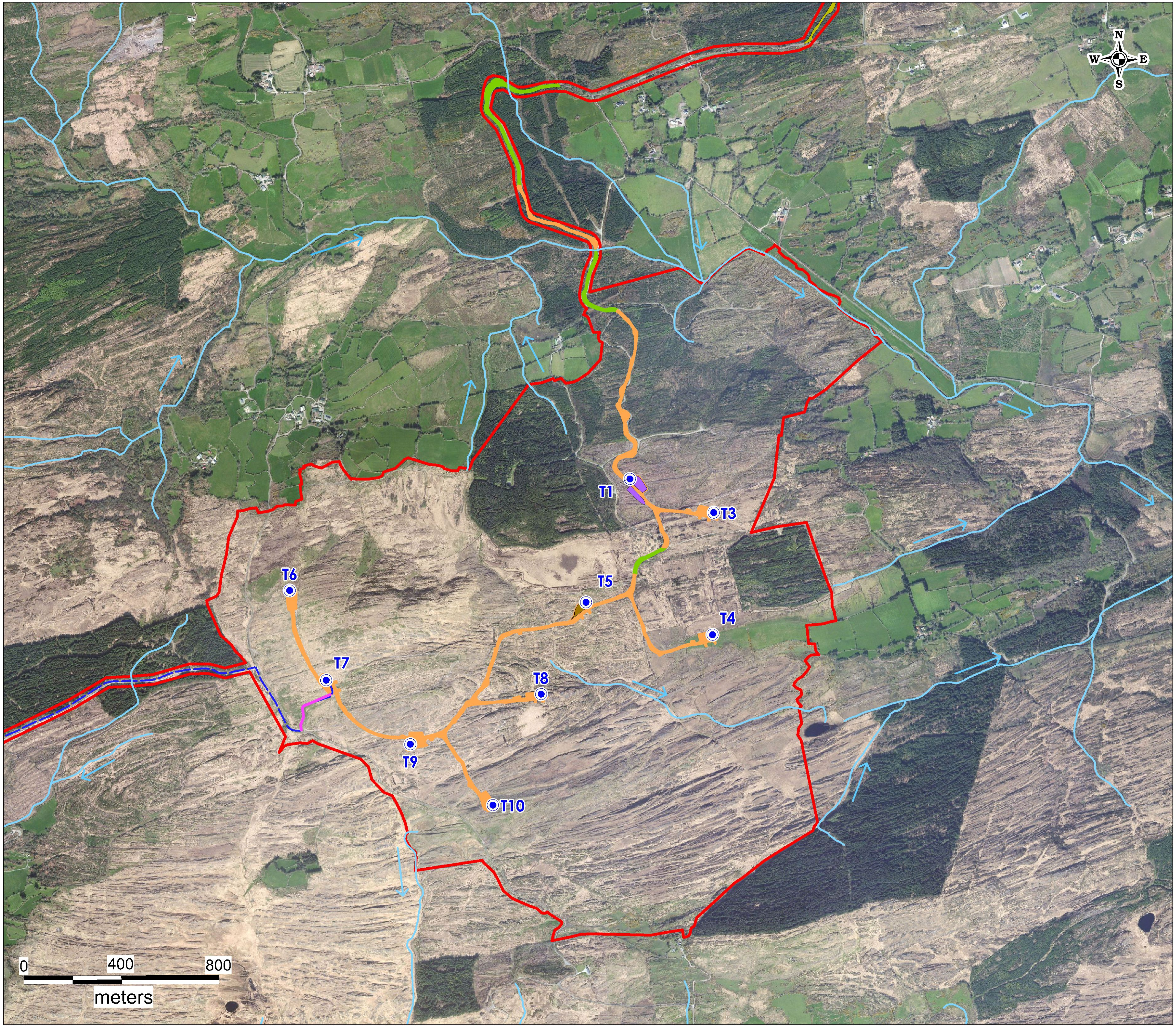
Turbine T9 and its related access road are located in a localised valley (created by the rock ridgelines), which extends up-gradient of the turbine location in a predominately easterly / north-easterly upslope direction. In addition to the turbine T9 base and hardstanding area, there is approximately 200m of access roads within the catchment area to the flushes.

There are a number acid flush areas located in the vicinity of T9 and its access road that rely on surface water flows within this valley.

Gouge coring undertaken within the T9 flush catchment area indicate local peat depths in the range of 0 – 0.4m. The peat was found to rest directly on top of bedrock with an absence of mineral subsoils beneath the peat. Measurement of flush water hydrochemistry (i.e. pH and Electrical Conductivity – EC) indicate pH values in the 6.6 – 6.8 range and EC values less than 90µS/cm. These values confirm that the flushes are maintained by rainfall, and not more mineralised groundwater seepages.

The predominant surface water flow path direction within the T9 flush area surface water catchment is in a south-westerly direction. Typically, surface water flows were concentrated on the vegetated valley / channel floors. Surface water flows from the T9 flush area catchment collects at a low point approximately 50m to the south of the turbine T9 location where a manmade channel appears to have been created to help drain the upstream area.

Construction drainage at T9 includes a cross-drain at the access road and an interceptor drain along the western boundary of the T9 hardstand to direct any water around the turbine and towards the flush type habitat to the south. The flush habitat is predominantly located down gradient (south) of T9 and some flow arises from the area around T9 over exposed rock towards the lower flush habitat.



Legend

- Study Area
- As Constructed Turbine Locations
- Grid Connection Cable Route
- Borrow Pit Area
- Area used as aTemporary Construction Compound
- Turbine Delivery Accomodation Areas
- Newly Constructed Roads
- Exisitng Roads Upgraded
- Operational Access/Inspection Road with underground cabling permitted under PL ref. 18/04458
- Rivers/Streams

KEY PLAN

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Sheet Size: A3	Project No: P1272-5
Scale: 1:15,000	Drawn By: GD
Date: 17/07/2020	Checked By: MG

The topography of the area around T4 and its local access roads is gently gentle sloping to the southeast. Surface water flow through the flush area is generally evenly distributed diffuse flow on the bog surface. The peat depth in the area of the flush habitat is measured between 0.1 and 0.8m and is underlain directly by bedrock.

The wind farm access road in the vicinity of T4 does not intercept any PF2 habitat but it does pass up-gradient of flush areas to the northwest of the turbine location. Also, the spur road leading to the T4 location intercepts some PB3-PF2 habitat to the west of the turbine location.

Along the access track to T4, the low point at these locations (old drains/semi-natural watercourses) are piped and large stone fill material is placed on top, before finer stone was used to grade the road.

9.3.7 Wind Farm Site Water Balance

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 9-5). It represents therefore, the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the site.

The surface water runoff co-efficient for the area is estimated to be approximately 95% based on the underlying bedrock geology, sloping ground and poorly draining soil coverage.

The highest long-term average monthly rainfall recorded at Ballyvourney over the period 1987 - present occurred in January, at 200.8mm. The average monthly evapotranspiration for the synoptic station at Cork Airport over the same period in January was 7 mm. The water balance indicates that an average estimate of surface water runoff for the study area (525ha) during the highest rainfall month is 968,100 m^3/month or 31,229m^3/day as outlined in Table 9-5 .

Table 9-5: Water Balance and Baseline Runoff Estimates for Wettest Month (January)

Water Balance Component	Depth (m)
Average January Rainfall (R)	0.2008
Average January Potential Evapotranspiration (PE)	0.007
Average January Actual Evapotranspiration (AE = PE x 0.95)	0.00665
Effective Rainfall January (ER = R - AE)	0.19415
Recharge co-efficient (5% of ER)	0.0097
Runoff (95% of ER)	0.1844

Table 9-6: Baseline Runoff for the Site

Study Area (ha)	Baseline Runoff per month (m^3)	Baseline Runoff per day (m^3)
525	968,100	31,229

9.3.8 Surface Water Flow Monitoring

As part of the construction compliance a surface water flow/level monitoring network was installed in the downstream Toon River. An existing network exists within the River Lee and Sullane River catchments which was used during the monitoring. A summary of local catchment characteristics upstream of the stations is provided in Table 9-7.

The locations and proposed approach were agreed with Cork County Council in advance. 3 no. suitable locations were identified along the Toon River at SW1, SW2 and SW3.

The Toon River monitoring network included the permanent installation 3 no. OTT Orpheus mini water level loggers, recording water levels at 15-minute intervals at each of the SW monitoring locations. Water level monitoring began on 20/09/2018 and is still ongoing. Hydrographs for each of the stations are shown as shown in Appendix 9-1. The locations of the sondes are shown on Figure 9-2.

Table 9-7: Summary of Catchment Characteristics Upstream of Monitoring Stations

Location	Toon River (SW1)	Toon River (SW2)	Toon River (SW3)	Sullane River (19054)	River Lee (19017)
Area (km^2)	7.562	14.06	24.653	55.82	171.544
BFISOIL	0.5484	0.975	0.5996	0.5602	0.4257
SAAR (mm)	1797.81	1761.92	1760.84	2029.1	2068.45
FARL	1	1	0.995	0.997	0.892
DRAIND (km/km^2)	1.314	1.193	1.191	1.35	1.53
S1085 (m/km)	16.6	12.3867	9.2964	13.8748	3.3105
ARTDRAIN2	0	0	0	0	0
URBEXT	0	0	0	0	0
Qmed (m^3/s)	4.7108	6.9478	10.977	34.144	80.7705

Note: All data taken from http://opw.hydronet.com/

The data from SW1 are indicative of a small upstream river, with typical flows in the region of 100-150 L/s and with flashy responses to heavy rainfall events.

SW2 is located approximately 3.3 km downstream from SW1. Flows appear to increase as the river flows downstream i.e. from 60 l/s at SW1 to 125 l/s at SW2 on 01/10/2018. This suggests that at this point in time, the additional 6.5 km^2 of catchment area upstream of SW2, compared to SW1, is contributing to a near 100% increase in flow. The trend continues at different rates throughout the range of flow rates observed during the monitoring period.

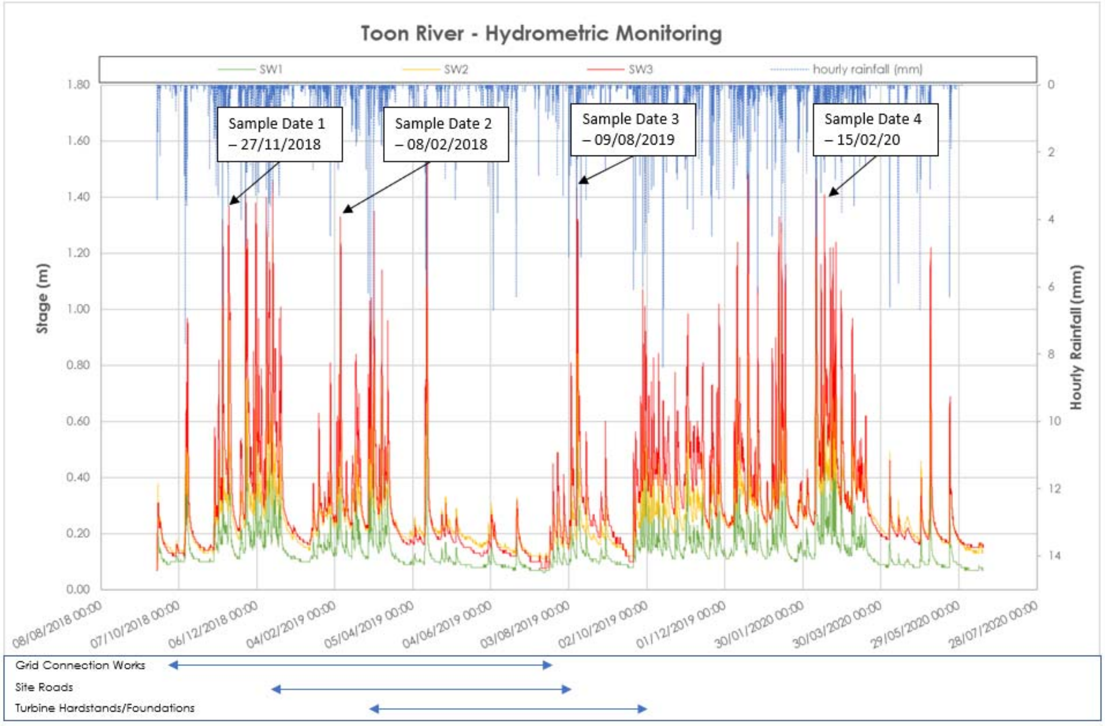
Flows of up to 3000 L/s were recorded at SW3, compared with flows of 750 L/s and 2250 L/s at SW1 and SW2 respectively on these dates.

In order to determine runoff characteristics of the Toon sub-catchment, data from each individual peak event was extracted from the larger dataset and analysed for SW1 and SW3 (no rating curve was developed for SW2, as the adequate data to develop one was not captured. The data from SW1 and SW3 are sufficient to undertake the analysis presented here).

The recession constant "*k*" (slope of the receding flood hydrograph) for each post peak fall in the hydrograph is a simple hydrological characteristic that was calculated for stations SW1 and SW3. For SW1 the recession constant was determined for various recessions (a recession is a decline/fall in the hydrograph after a peak flow event), and varied between 0.06 and 0.19, with an average of 0.14. For SW3 the recession constant varied between 0.04 and 0.07, with an average of 0.054.

Four sample dates of peak flows in the Toon River were selected (2 no. pre-wind farm site construction and 2 no. post construction) where the preceding 72-hour rainfall depth volumes are similar (or at least equal) for the pre and post construction are shown on Plate 9-1 below. The hydrographs shown that the maximum stage height of the peaks during the pre-construction flood events are similar if not less than the post construction events. The Toon River has significantly lower flows compared to the River Lee and therefore would be more sensitive with respective site runoff.

The analysis of hydrographs for the Toon River and River Lee shows that the development has no traceable/measurable impact on river flows or levels in either of the rivers. This is because the development runoff volumes are small/negligible compared to the total flows in the Toon River and River Lee. Runoff from the development site is having no measurable impact on river flows/river levels in either watercourse (i.e. the Toon River and the River Lee).



Date	SW1 Stage (m)	SW2 Stage (m)	SW3 Stage (m)	Preceeding 72hr rainfall (mm)
27/11/2019	0.88	1.14	1.4	19.5
08/02/2019	0.81	0.98	1.3	21.7
09/08/2019	0.86	0.96	1.41	49.4
15/02/2020	0.83	1.06	1.41	23.4

Plate 9-1: Hydrograph of the Toon River at SW1, SW2 and SW3

9.3.9 Flood Risk Assessment

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

No recurring flood incidents within the wind farm site boundary or immediately downstream were identified from OPW's indicative river and coastal flood map.

Where complete, the CFRAM OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the PFRA maps. There are no CFRAM maps currently available for the area of the site and therefore the PFRA maps were reviewed.

The PFRA map no. 35 (www.cfram.ie) shows the extents of the indicative 1 in 100-year flood zone which relates to fluvial (i.e. river) and pluvial (i.e. rainfall) flood events. The 1 in 100-year fluvial flood zone incorporates some land area surrounding the River Toon in the vicinity the development site and the River Lee. The 1 in 100-year fluvial flood zones mapped within the study area generally occur in close proximity to the stream channel itself. All turbine locations and the majority of access roads are located at least 50m away from streams and are outside of the fluvial indicative 1 in 100-year flood zone. There is no identifiable map text on local available historical 6" or 25" mapping for the study area that identify lands that are "prone to flooding".

There are no areas within the study area mapped as "Benefiting Lands". 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 grid connection route passes through a PFRA mapped flood zone relating to the Bunsheelin River. Due to the predominately underground nature of the works, therefore, the grid connection works had no influence on the surface water flow regime in the area.

It was a key mitigation measure of the Cleanrath wind farm development to ensure all surface water runoff was treated (water quality control) and attenuated (water quantity/flood management control), prior to diffuse discharge.

9.3.10 EPA Surface Water Quality

Within the Republic of Ireland Q-rating status data for EPA monitoring points on the River Lee and the Toon River are shown in Table 9-8 below. Most recent data available (2004 to present) show that the Q-rating for the Toon River and the River Lee is Q4 (Good Status) in the vicinity of the study area.

Table 9-8:EPA Water Quality Monitoring Q-Rating Values

Waterbody	EPA Location Description	Easting	Northing	EPA Q-Rating Status
Toon	Bridge South of Lack	119548	71027	Q4 Good
Toon	Bridge NE of Cleanrath North	122427	70383	Q4 Good
Lee	Footbridge D/S of Inchigeelagh	123850	66658	Q4 Good

9.3.11 Surface Water Quality Monitoring/Sampling

Surface water quality monitoring/sampling and field hydrochemistry monitoring (electrical conductivity and pH) at 13 no. downstream locations (SW1 – SW13) commenced monthly[1] from August 2018 and continued into the operational phase up to July 2020. The locations of the monitoring points are shown in Figure 9-2 and a summary of the field hydrochemistry results are shown in Table 9-9 below for each of the monitoring locations.

The key monitoring locations with respect the Cleanrath wind farm development are SW2, SW4, SW5 and SW7 as these are the closest monitoring points surrounding the wind turbines and are located along streams that emerge from within the site and therefore are less likely to be affected by external sources and activities. The remainder of the locations are located downstream of the grid connection.

The average pH value was between 6.9 and 7.3 and the average electrical conductivity was between 53 and 123µs/cm. There was no exceedance of the Surface Water Regulation (S.I. No. 272 of 2009) range with regard pH which is 6 to 9. There is no EQS for electrical conductivity with regard surface water.

Overall, the pH and electrical conductivity values are typical for catchments underlain with non-calcareous bedrock and peat/acidic soil coverage.

[1] Sample events were not completed in March and April 2020 due to the Covid-19 restrictions

Table 9-9: Summary of Field Hydrochemistry Monitoring

Location	pH (pH Units)			Electrical Conductivity (µS/cm)		
	Maximum	Minimum	Average	Maximum	Minimum	Average
SW1	8.1	6.2	6.9	183	64	117
SW2	7.8	6.4	7.1	123	48	93
SW3	7.9	6.6	7.1	122	61	93
SW4	7.4	6.4	7.0	101	38	77
SW5	7.7	6.3	6.9	109	30	67
SW6	7.4	6.2	6.9	166	42	74
SW7	7.6	6.4	7.0	158	43	85
SW8	7.5	6.5	7.0	159	78	122
SW9	8.1	6.5	7.2	175	87	123
SW10	7.9	6.5	7.3	109	58	87
SW11	7.7	6.7	7.0	86	51	71
SW12	7.7	6.5	7.1	121	53	79
SW13	7.8	6.1	7.1	69	39	53

Surface water quality monitoring/sampling at the 13 no. downstream locations (SW1 – SW13) was undertaken monthly between August 2018 and June 2020. Refer to Figure 9-2 for the monitoring locations.

A summary of the results for each of the parameters over the 21 no. rounds of sampling during the construction and operational phase (242 samples) are shown in Table 9-10 below.

Table 9-10: Summary of Surface Water Sampling

Parameter	Max	Min	Average	EQS	Exceedances	Exceedance Location and Number (x)
Total Phosphorus (mg/L)	0.137	0.005	0.033	-	-	-
Chloride (mg/L)	24.0	5.5	12.13	250	0	-
Nitrate (mg/L NO_3)	20.7	0.02	2.34	37.5	0	-
Nitrite (mg/L NO_2)	0.066	0.02	0.023	-	-	-
Orthophosphate P (mg/L)	0.19	0.02	0.034	0.045*	14	SW4(1), SW9(13)
Ammonia N (mg/L)	0.53	0.012	0.050	0.09*	22	SW1(5), SW2(2), SW3(1), SW5(2), SW6(2), SW7(1), SW8(1), SW9(4), SW10(1), SW12(2), SW13(1)

BOD (mg/L)	4	1	1.074	2.2*	1	SW2(1)
TSS (mg/L)	22	2	9.731	25+	0	-
pH (pH units)	8.14	6.03	7.044	6 – 9*	0	-
EC (µS/cm)	183	30	87.7	-	-	-

(+) S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations.
(*) 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).

Results for suspended solids ranged between 2 and 22mg/L with an overall average of 9.7mg/L for all the sampling locations. The actual average is likely to be significantly less than 9.5mg/L as the vast majority of the results were reported at <10mg/L which was the laboratory detection limit. There was no exceedance of S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations which is 25mg/L. The highest value of 22mg/L was reported at SW1 on 25th September 2018 which was during the construction phase. However, only the grid connections works had commenced in September 2018, and there were no active works upstream of SW1 when this highest TSS value was recorded. There were four smaller peaks (14-19mg/L) between 2018 and 2020. 3 of the 5 elevated TSS readings were following significant periods of heavy rainfall, and the other two are at locations where no wind farm related works were being undertaken upgradient of the sampling points at the time of sampling. So, the recorded exceedances are not related to wind farm or grid connections works activities.

BOD was reported between 1 and 4mg/L with an average of 1.07 mg/L. There was only 1 no. exceedance with regard the surface water regulation values where both the "Good Status" and "High Status" was exceeded on 31st August 2018 at SW2 when the highest recorded value of 4mg/L was reported. The sampling undertaken on 31st August 2018 was actually pre-construction baseline monitoring.

Orthophosphate values ranged between 0.02 and 0.19mg/L with an average of 0.034mg/L. 13 of the 14 exceedances with respect the surface water regulation values were at SW9 which is upstream of the wind farm site (but downstream of the grid connection route). One other exceedance occurred at SW4 in September 2018. No wind farm related works were being undertaken upgradient of the SW4 sampling points at the time of this sampling event. Results for all the other sampling locations were below the "High Status" threshold value (High status ≤0.025 (mean) or ≤0.045 (95%ile)). High orthophosphate concentrations can be related to agriculture or wastewater system discharges.

Results for ammonia N ranged between 0.01 and 0.43mg/L with an average of 0.039mg/L. There were 9 no. exceedances in total which occurred 6 no. sampling locations. High ammonia concentrations can be related to peatland runoff, or from agriculture or wastewater system discharges.

The sampling demonstrates that the development had no effect on downstream waters during the construction or operational phase of the development.

9.3.12 Automated Turbidity Monitoring

Continuous automated turbidity monitoring is ongoing at 4 no. locations in the area of the Cleanrath wind farm development by means of permanently in-situ turbidity sondes. Sondes DSE 1 and DSE 2 are located immediately downstream of the development on the east of the site (i.e. within the Toon River catchment). Sonde DSE 3 and DSE 4 are located downstream of the grid connection route to the west of the site. The locations of the sondes are shown on Figure 9-2.

A summary of the in-situ sondes and the upstream Cleanrath wind farm development infrastructure is shown below in Table 9-11. A summary of the turbidity data is shown in Table 9-12 below. Turbidity plots for each of the sondes versus rainfall is shown in Appendix 9-2.

In general, significant turbidity spikes at the 4 no. sonde locations are associated with heavy or prolonged rainfall events and this is due to surface water runoff from within the overall catchment area. With respect DSE 1 and DES 4, the overall surface water catchment area is significantly larger than the wind farm site area (within the catchment) and therefore the potential for activities not related to the wind farm to affect turbidity levels is high.

In terms of baseline turbidity, which will be naturally higher is flood events, a range of 10 to 20 NTU would be considered a conservative natural baseline range for river turbidity in peak flows (albeit every catchment will be slightly different depending on the landuse activities). These turbidity spikes would be short term transient events with most rivers returning to an NTU of less than 5 during non-flood periods.

Therefore, assuming a baseline of 10 to 20 NTU, the readings for DSE 1 and DSE 2 in particular are very close to natural baseline conditions. The percentage of readings above 20 NTU is higher in DSE 4, but this is likely due to the topography in the catchment which is more mountainous and steep than the DSE 1 and DSE 2 catchments which would give rise to more erosional factors. Overall, the turbidity monitoring does not show any affects/trends relating to the wind farm construction or operation. Each of the sonde locations is discussed in more detail below.

Table 9-11: Summary of Turbidity Sonde Locations

Sonde Location	Catchment	Upstream Catchment Area (km^2)	Development Infrastructure in Catchment
DSE 1	Toon River	14	Turbines T1 & T3 construction compound and the Site Entrance Road (~3.5km)
DSE 2	Toon River	2.8	Turbines T4, T5 and T8, Borrow Pit 1 and 2.5km of access road
DSE 3	Aghnakinneirth Stream	1.3	~1km of grid connection
DSE 4	Bunsheelin River	16.5	7.5km of Grid Connection

Sonde DSE 1 is located on the upper channel of the Toon River and the upstream development relating to the Cleanrath Wind is described in Table 9-11 above. The overall average turbidity recorded at DSE 1 was 8NTU, with only 4.2% of the readings exceeding 10NTU and only 2.3% exceeding 20NTU.

There were very few turbidity peaks at DSE 1 during the construction civils phase (September 2018 – August 2019) which ran through the winter of 2018/2019 which suggests that the peaks during the autumn/winter 2019 are likely to be as a result of other non-wind farm development related activities within the catchment. Also, considering the footprint of the Cleanrath wind farm development upstream of DSE 1 only accounts for <1% (~0.3%) of the total catchment area of 14km^2, it is unlikely that the turbidity peaks that occurred in the winter of 2018/2019 were as a result of the development.

Sonde DSE 2 is located on a tributary stream of the Toon River which flows through Cleanrath Lough on the southeast of the site. The catchment area upstream of DSE 2 is relatively small (2.8km^2) compared to the other sonde locations, however it is the most developed with respect Cleanrath Wind Farm infrastructure. DSE 2 has also been the most consistent with regard low levels of turbidity with 3.1% of the readings been above 10NTU and only 0.8% exceeding 20NTU. Significant turbidity spikes only occurred on a minimal number of occasions and this was during the summer of 2019. The consistently low levels of turbidity show that the development is having no effects on surface water quality.

Sonde DSE 3 is located on the Aghnakinneirth Stream where approximately 1km of the grid connection is upstream of the sonde. Sonde DSE 3 recorded the lowest number of readings above 5NTU (i.e. 2.1%). This suggest that the grid works had no influence on turbidity in the Aghnakinneirth Stream.

Sonde DSE 4 is located on the Bunsheelin River at a point where approximately 7.5km of the grid route is located upstream of its location. The overall average turbidity recorded at DSE 4 was 31NTU, with 11.2% of the readings exceeding 10NTU and 9.8% exceeding 20NTU. There were no turbidity trends evident with regard the grid connection works and therefore the elevated levels are likely to be related to local landuse practices (non-wind farm development). The catchment upstream of DSE4 is large (16.5km) and therefore there will be many off-site activities that could influence turbidity.

Table 9-12: Summary of Turbidity Data

Sonde	Average NTU	% of Readings Above 5NTU	% of Readings Above 10NTU	% of Readings Above 20NTU
DSE 1	8	8.8	4.2	2.3
DSE 2	2.2	7.1	3.1	0.8
DSE 3	3.79	2.1	1.14	0.7
DSE 4	31	13.6	11.2	9.8

9.3.13 Visual Surface Water Quality Checks

A key element of the construction phase surface water quality monitoring were the visual checks undertaken during the site inspections. As well as the on-site checks, visual checks were also undertaken at the 13 no. surface water sampling locations. Checks were also undertaken at off-site locations VC1 to VC4 (refer to Figure 9-2).

Approximately 813 no. visual checks were completed during 55 no. inspection days during the construction phase. 99% of the 813 no. visual checks show no impacts with regard surface water quality. This means that the waters inspected were visually clean with no trace of contaminants. The 1% were all minor, localised, temporary turbidity effects which were resolved by undertaking minor drainage adjustments.

9.3.14 Hydrogeology

The Devonian Old Red Sandstones are mapped to underlie the wind farm site and the grid connection route. The aquifer classification varies between Poor Aquifer (Bedrock which is Generally Unproductive except for Local Zones - Pl) and Locally Important Aquifer (Bedrock which is Moderately Productive only in Local Zones - LI). In terms of the wind farm site, the northern section of the site is underlain by a Locally Important Aquifer while the southern section is underlain by a Poor Aquifer. In terms of the grid connection the western half is underlain by a Poor Aquifer and the eastern half is underlain by a Locally Important Aquifer.

Devonian Old Red Sandstone units form sequences which can be several kilometres thick, however most groundwater flow occurs within the top 15-20 m of the aquifer, in the layer that comprises a weathered zone of a few metres and a connected fractured zone below this. Deeper flows occur along generally isolated faults or significant fractures. Diffuse recharge will occur via percolation or areas of outcropping rock. However, due to the generally low permeability of the aquifer and the high slopes, a high proportion of the recharge will discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the aquifer (GSI, 2004).

9.3.15 Groundwater Vulnerability

The vulnerability rating of the aquifer within the overall wind farm site ranges between "High to Extreme (X)" and this reflects the varying depth of local subsoils (i.e. 10m to <3m). In areas where subsoil is shallow or absent and where bedrock is outcropping, an Extreme (X) vulnerability rating is given. The majority of the wind farm site is mapped as Extreme (X) vulnerability.

9.3.16 Groundwater Hydrochemistry

There is 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 groundwater quality impacts would not be anticipated, which is the actual case for the Cleanrath wind farm.

Based on data from GSI publication Calcareous/Non calcareous classification of bedrock in the Republic of Ireland (WFD,2004), alkalinity for Devonian Old Red sandstones generally averages 100mg/L while electrical conductivity and hardness in the volcanic rocks interbedded in this type of bedrock were reported to have mean values of 554µS/cm and 301mg/L respectively.

9.3.17 Water Framework Directive Water Body Status & Objectives

The River Basin Management Plan was adopted in 2018 and has amalgamated all previous river basin districts into one national river basin management district. The River Basin Management Plan (2018 - 2021) objectives, which have been integrated into the design of the Cleanrath wind farm development, include the following:

- Ensure full compliance with relevant EU legislation;
- Prevent deterioration and maintain a 'high' status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least good status by 2021;
- Ensure waters in protected areas meet requirements; and,
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at (1) targeting water bodies close to meeting their objectives and (2) addressing more complex issues that will build knowledge for the third cycle.

Our understanding of these objectives is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all.

9.3.18 Groundwater Body Status

Local Groundwater Body (GWB) and Surface water Body (SWB) status reports are available for download from (www.catchments.ie).

The Ballinhassig GWB (IE_NW_G_005) underlies the wind farm site and is assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

9.3.19 Surface Water Body Status

The River Lee, Toon River and Sullane Beg River immediately downstream of the Cleanrath wind farm development have been given a "Good Status" but increases to "High Status" further downstream.

9.3.20 Designated Sites and Habitats

Designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). The Cleanrath wind farm development site is not located within any designated conservation site. Designated sites in proximity to the Cleanrath wind farm development study area are show in Figure 9-4.

The Gearagh cSAC covers an area of 557.95ha and comprises a 7km section of the River Lee, including the confluence with the River Toon, and is located ~7.5km east of the Cleanrath wind farm development site. It is situated in a wide flat valley and the eastern part of the site has been flooded by the Carrigadrohid dam and is subject to artificial fluctuations in water levels. The site contains the only extensive alluvial forest in Western Europe west of the Rhine, and there is also a good, though small, example of an intact oak woodland. The aquatic riverine vegetation is well-developed, areas of alluvial grassland are important for wintering waterfowl, and otters occur throughout the site.

The Gearagh SPA covers an area of 322.79ha from Annahala Bridge westwards to Toon bridge and, therefore, covers the central and western parts of the cSAC. The site supports important populations of wintering waterfowl, including swans, dabbling duck, diving duck and some waders. Six of the species have populations of national importance. The principal habitat for birds is a shallow lake which is fringed by wet woodland, scrub and grassland that is prone to flooding. Habitat quality is good and the site provides both feeding and roost sites for the birds.

Lough Allua which exists approximately 3km downstream of the wind farm site is a designated pNHA. The section of the grid connection route within the River Lee catchment drains into Lough Allua.

Approximately 2.4km of the grid connection route exists within the Roughty River catchment which is a designated pNHA.

The grid connection route runs adjacent to Sillahertane Bog NHA which is located at the western end of the grid connection route within the Roughty River catchment. The grid connection cable route follows an existing track which runs along the south-western edge of the NHA for approximately 0.77km.

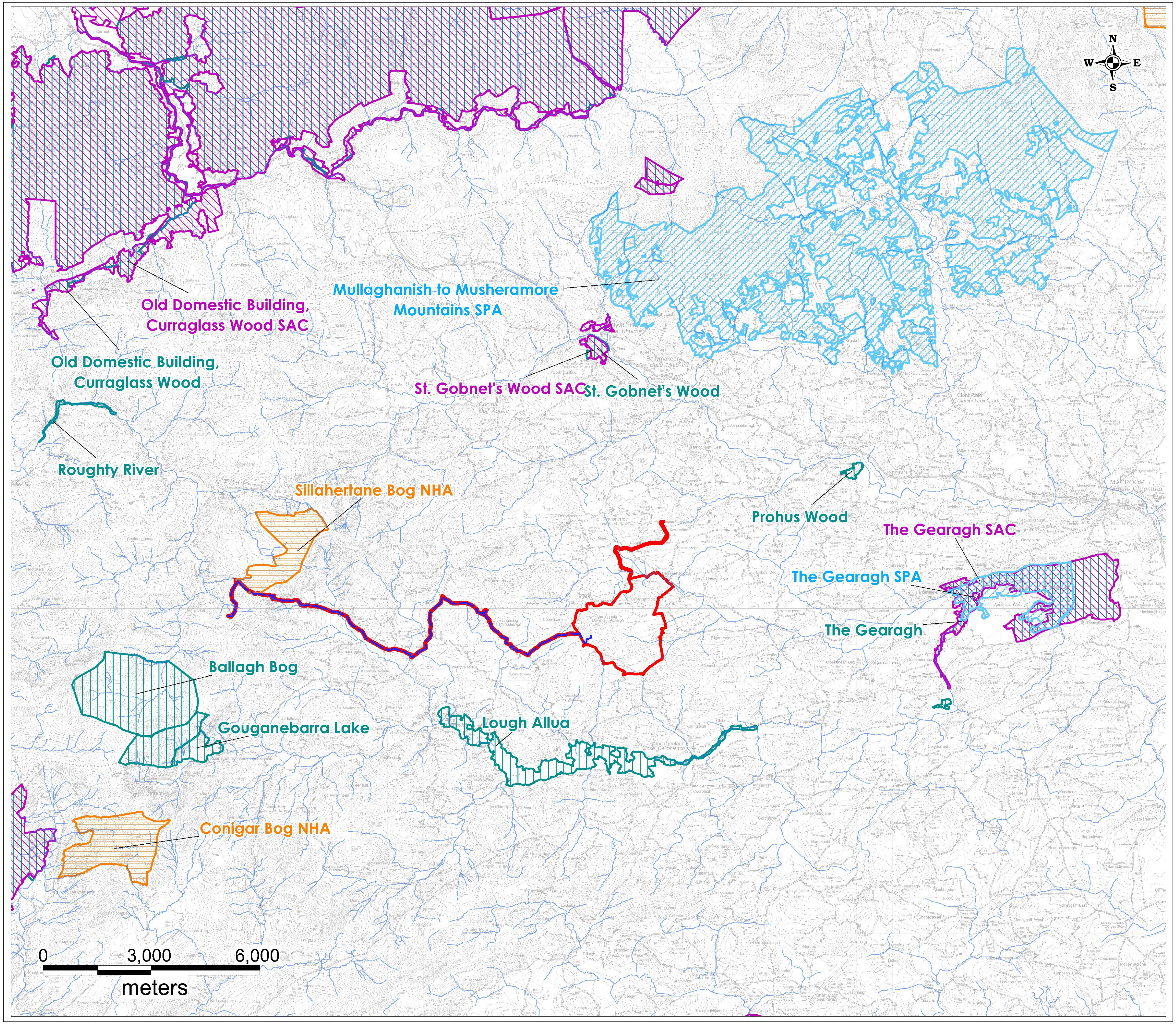
9.3.21 Water Resources

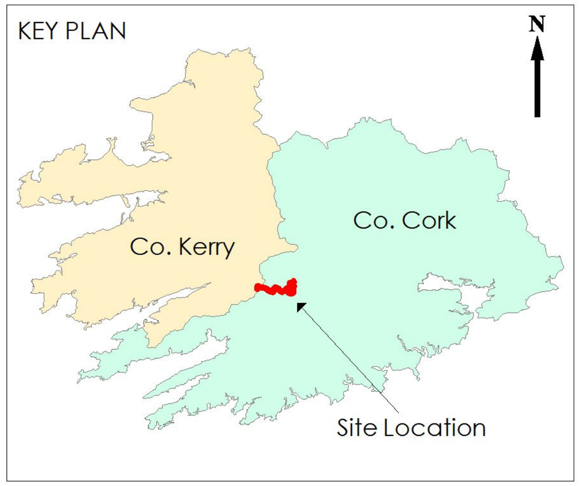
There are no groundwater protection zones mapped within the development site or study area or along the grid connection route. A search of the Geological Survey of Ireland (GSI) well database (www.gsi.ie) indicates that there are no private wells within 1km of the site.

As the GSI well database is not exhaustive in terms of the locations of all wells in the area (as the database relies on the submission of data by drillers and the public etc) it is assumed that every private dwelling in the vicinity of the Cleanrath wind farm development has a water supply well associated with it (this is a conservative assumption).

Shown on Figure 9-5 are the locations of private dwellings within 3km of the wind farm site boundary. The majority of development areas (i.e. all turbine locations and borrow pit etc) are very remote to these dwellings (Refer to Table 9-13 below) and it is not expected that there is any hydraulic connection between any potential wells and groundwater flow from the development areas. No issues were raised by local well users during the construction or operational phase.

Wells along the grid connection route and junction accommodation works were not assessed as these works were shallow with regard excavations, therefore the potential for effect was negligible.





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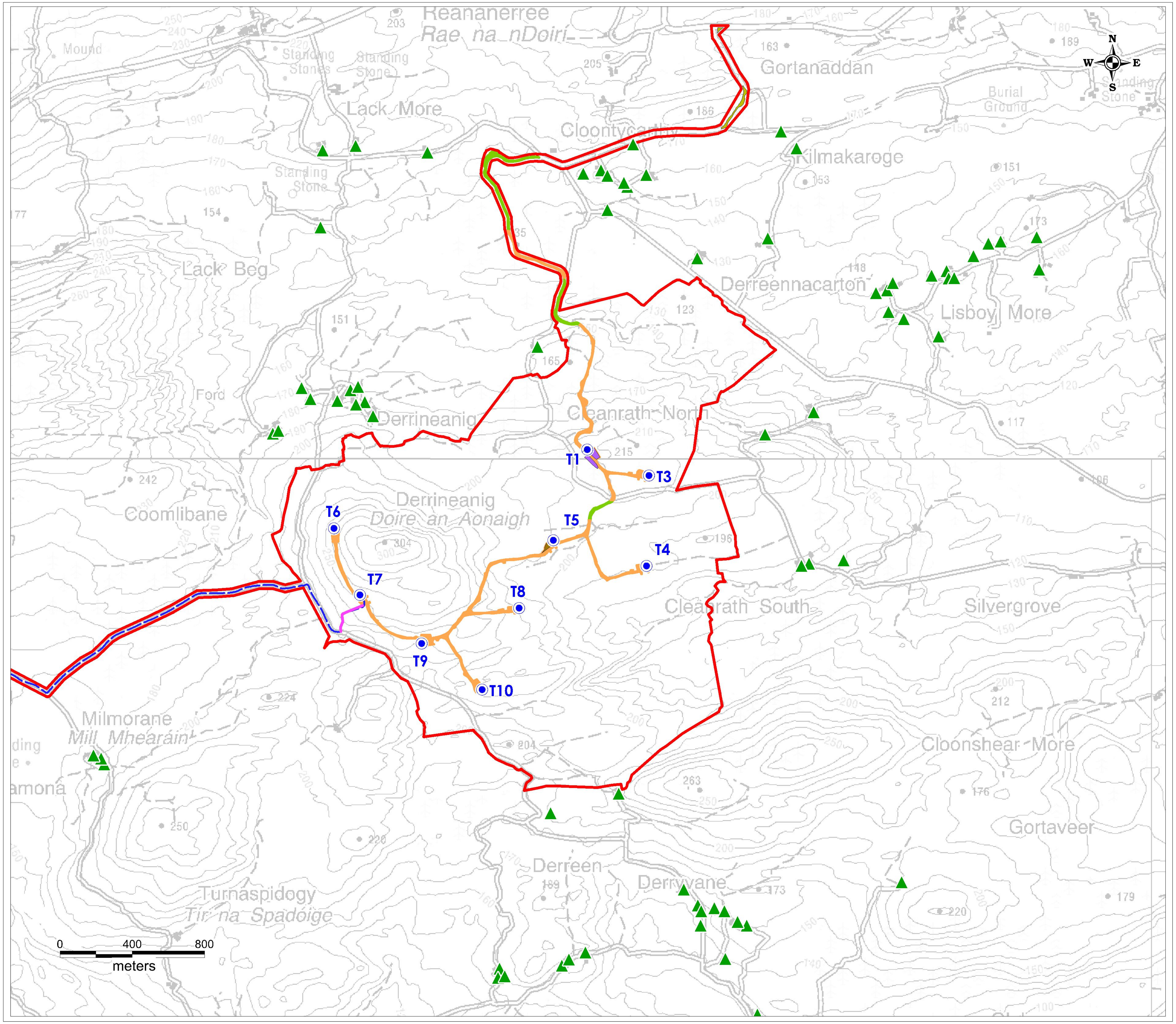
Scale: 1:100,000	Drawn By: GD
Date: 17/07/2020	Checked By: MG



Legend

- Study Area
- As Constructed Turbine Locations
- Grid Connection Cable Route
- Borrow Pit Area
- Area used as aTemporary Construction Compound
- Turbine Delivery Accomodation Areas
- Newly Constructed Roads
- Exisitng Roads Upgraded
- Operational Access/Inspection Road with underground cabling permitted under PL ref. 18/04458
- Private Dwelling Location

KEY PLAN

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Client: MKO	
Job: Cleanrath WF, Co. Cork	
Title: Nearby Groundwater Wells Map	
Figure No: 9-5	
Drawing No: P1272-5-0720-A3-9-5-00A	
Sheet Size: A3	Project No: P1272-5
Scale: 1:20,000	Drawn By: GD
Date: 17/07/2020	Checked By: MG

Table 9-13: Summary WFD Information for Surface Water Bodies

Development Footprint Location[(1)]	Distance from Closest Private Dwelling (m)[(2)]	Location of Turbine in relation to the Closest Private Dwelling[(3)]
T1	643	Remote
T3	960	Remote
T4	860	Remote
T5	1,370	Remote
T6	612	Remote
T7	1,700	Remote
T8	1,500	Remote
T9	1,115	Remote
T10	783	Remote
Borrow Pit 1	1,370	Remote
Construction Compound[2]	643	Remote

Note:
1. Distance from closest turbine, compound, borrow pit or substation (i.e. bedrock excavation). Access roads and the grid connection cable trench are not considered a potential risk due to the shallow nature of the works. The distances listed above are from the nearest wind farm infrastructure within the same surface water catchment as the dwelling.
2. Each dwelling is assumed to have an on-site private water well.
3. Hydraulically up-gradient or remote. Remote meaning there is no dwelling (assumed well) down-gradient of the Cleanrath wind farm development infrastructure.

9.4 Characteristics of the Cleanrath wind farm development

The development comprises of the following:

- 9 wind turbines, having a maximum ground to blade tip height of up to 150m metres and all associated foundations and hard-standing areas;
- New access roads (4.8km) and upgrade of internal site access roads (1.3km) and the upgrade of an existing access junctions and junction accommodation works;
- All associated site drainage;
- 1 no borrow pit (BP1);
- 1 no. construction compound
- Underground electricity connection cabling.

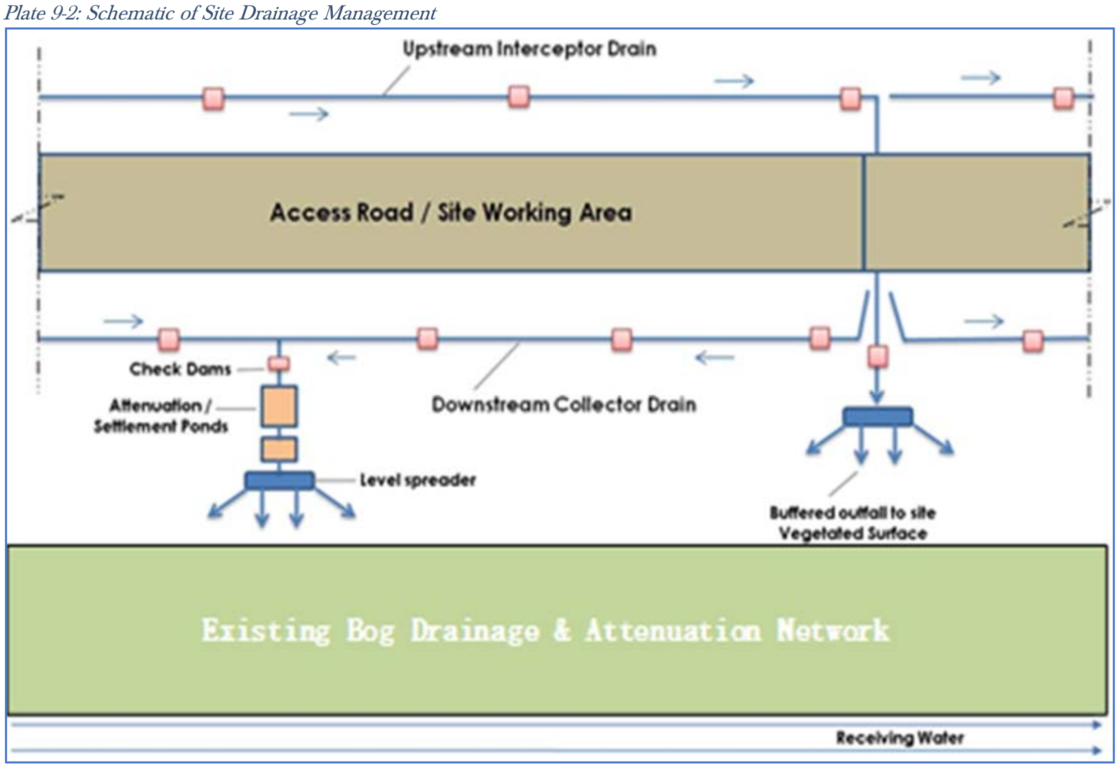
[2] *Please refer to Section 4.3.8 of Chapter 4 for details of the Construction Compound*

9.4.1 Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods are employed and continue to be employed, depending on the local conditions and topography, to manage drainage water within the Cleanrath wind farm development. 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 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 are no direct discharges to surface waters. During the construction phase all runoff from works areas (i.e. dirty water) were attenuated and treated to a high quality prior to being released. A schematic of the site drainage management is shown as **Plate 9-2** below. A detailed drainage plan showing the layout of the drainage design elements as shown in **Plate 9-2** is shown in Appendix 4-1 of this EIAR.

Various combinations/adaptations of the runoff control and drainage management measures described above were employed at the site depending on the local conditions and topography.

Plate 9-2: Schematic of Site Drainage Management



9.5 Significant Effects and Mitigation Measures

This section provides a brief overview of the potential construction phase impacts that were identified in the 2015 EIS and then the actual observed impacts. A detailed assessment of the potential impacts during the operational and decommissiong phase is then included. The outcome of the assessment of the construction phase and operational phase (to date) effects concluded that no remedial mitigation measures were required as a result of the Cleanrath wind farm development.

9.5.1 Do -Nothing Scenario

A do-nothing option to developing the Cleanrath wind farm development would have been to leave the site as it was prior to construction, with no changes made to the land-use practices of low-intensity agriculture, turf cutting and commercial forestry. This option would have no positive impact with regards to the production of renewable energy or the offsetting of greenhouse gas emissions. On the basis of the positive environmental effects arising from the Cleanrath wind farm development , the do–nothing scenario was not the chosen option. Instead, an application for planning permission was made and granted ultimately by An Bord Pleanála.

The Cleanrath wind farm development has been constructed, has been operational and is now operating in Sleep Mode with the site essentially in a shut-down mode with no export of electricity pending the outcome of the Substitute Consent process. In the event that Substitute Consent is obtained, the intention is to recommence and continue the full operation of the Cleanrath wind farm development until the end of 25 years from the formal commissioning of the turbines in July 2020 and implement the decommissioning plan for the Cleanrath wind farm development at the end of the operational period.

In the event that Substitute Consent is not granted and full operation of the development is not recommenced, it will remain in Sleep Mode which is, in effect, the "do nothing" option insofar as it represents the current situation as at the date of the application for Substitute Consent. There is the possibility that the decommissioning plan may need to be implemented early, should Substitute Consent not be granted. These scenarios are assessed in this chapter.

9.5.2 Construction Phase

The construction phase effects of the development and mitigation measures that were undertaken (where required) to reduce or eliminate those effects are summarised below. The detailed construction phase impact assessment and associated mitigation measures is included in Chapter 9 of the rEIAR which accompanies this application.

9.5.2.1 Clear Felling of Coniferous Plantation

12.32ha (hectares) in total of existing plantation forestry was felled to allow for development of the wind farm infrastructure and the grid connection route. This includes 8.14ha that was felled within and around the development footprint and 4.18ha that was temporary felled around the turbine locations. The majority of the felling areas (92.7%) were within the Toon River catchment. The total felling area accounts for only 7.1% of the existing on-site forestry coverage. The main potential effect (in the absence of mitigation) was release of sediments to local surface waters. The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Best practice tree felling measures to mitigate the risk of releases of sediment were used to break the pathway between the potential sources and the receptor. The residual effect is assessed as - Negative, imperceptible, indirect, temporary, low probability effect on downstream water quality and aquatic habitats.

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

Construction phase activities included access road construction, turbine base/hardstanding construction and grid cable trench excavation (including the loop in to Derragh substation) and this resulted in removal of vegetation cover and excavation of peat mineral subsoil and bedrock where present. In the absence of mitigation these activities had the potential to release suspended solids to surface watercourses and which could have resulted in an increase in the suspended sediment load to local surface waters. 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 were undertaken to break the pathway between the potential sources and the receptor. The residual effect is assessed to be - Negative, imperceptible, indirect, temporary, low probability effect on downstream water quality and aquatic habitats.

9.5.2.3 Impacts on Groundwater Levels During Excavation Works & from the Borrow Pit

Dewatering of borrow pits (if required) and other deep excavations (i.e. turbine bases) have the potential to impact on local groundwater levels. However, no significant dewatering was required during the construction phase and this was due the local topographical and hydrogeological regime as well as the borrow pit excavation method as outlined below. No impact on groundwater levels occurred as a result of borrow pit and turbine base excavation works as no significant groundwater inflows were encountered.

9.5.2.4 Excavation Dewatering and Potential Impacts on Surface Water Quality

Only surface water seepages/runoff occurred in turbine base excavations and borrow pit and this created a small additional volumes of water to be treated by the runoff management system. Inflows required management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore pollution issues did not occur. Proven and effective measures to mitigate the risk of releases of sediment were undertaken to break the pathway between the potential sources and the receptor. The residual effect is assessed to be - Imperceptible, indirect, temporary, low probability effects on local surface water quality and associated aquatic habitats.

9.5.2.5 Release of Hydrocarbons during Construction and Storage

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. The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all construction sites. Proven and effective measures to mitigate the risk of spills and leaks were applied during the construction phase. The residual effect is assessed as - Negative, imperceptible, direct, short-term, low probability effect on groundwater and surface water quality.

9.5.2.6 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from domestic wastewater treatment systems has the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit. During the construction phase a self-contained port-a-loo with an integrated waste holding tank was used at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works. Water supply for the site office and other sanitation was brought to site and removed after use from the site to be discharged at a suitable off-site treatment location. Therefore, there are no residual effects.

9.5.2.7 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 ± 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. Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to introduction of high pH alkaline waters into the system. Batching of wet concrete on site and washing out of transport and placement machinery are the activities most likely to generate a risk of cement based pollution. 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 were undertaken to break the pathway between the potential source and each receptor. The residual effect is assessed to be - Negative, imperceptible, indirect, short term, low probability impact.

9.5.2.8 Impacts on Hydrologically Connected Designated Sites

As outlined above the Cleanrath wind farm development is situated upstream of the Gearagh and Lough Allua which is a designated SAC and pNHA respectively. An approximate 2.4km section of the grid connection route exists within the Roughty River catchment which is a designated pNHA in places. Possible effects include water quality impacts which could be significant if mitigation was not put in place.

The grid connection route also runs adjacent to Sillahertane Bog NHA which is located at the western end of the grid route. The grid cable connection follows an existing track which runs along the south-western edge of the NHA for approximately 0.77km. The cable was installed within a trench along this track.

As stated in impact Section 9.5.2.1 and Section 9.5.2.2 above, there was only an “imperceptible and temporary impact” on local streams and rivers but this would have been very localised and over a very short time period (i.e. hours). Therefore, significant direct, or indirect impacts on the Gearagh SAC, Lough Allua pNHA or Roughty River pNHA did not occur.

The nature of the existing ground conditions, the shallow trench and hydrogeology and hydrology in the vicinity of Sillahertane Bog NHA, meant no mitigation measures were required with respect the underground grid cable works.

9.5.2.9 Impact on Freshwater Pearl Mussel Populations within the River Lee Catchment

There are small non SAC designated freshwater pearl mussel (FWPM) sites downstream of the development site in the River Lee catchment. The closest known site is 1.5km downstream of the development site in the Toon River. FWPM are also present in the River Lee both upstream and downstream of Lough Allua and in the Sullan River catchment. As stated above impacts on surface water quality locally was assessed to be imperceptible by means of the visual inspections/audits and the surface water quality monitoring and therefore there was no potential to impact on freshwater pearl mussel sites further downstream of the development. Due to the imperceptible effects on surface water quality locally to the development, there are no residual effects on freshwater pearl mussel sites.

9.5.2.10 Surface Water Impacts due to the Grid Connection and Temporary Delivery Accommodation Works

There was a requirement for 126 no. watercourse crossings along the grid connection route (which includes the loop in to Derragh substation) and this included 13 no. main existing bridge/culvert crossings and 113 no. existing smaller culvert crossings. In-stream works were required at the 113 no. existing smaller crossings where some of the culverts were replaced/upgraded as well as any watercourse crossings which required upgrade where delivery accommodation works occurred.

No in-stream works were required at any of the 13 no. main existing crossings, these crossings and the existing bridge/culverts were left in-situ, however due to the proximity of the streams to the construction work at the crossing locations, there was a potential for surface water quality impacts during trench excavation work. .

Due to the shallow nature of the grid connection and temporary junction works impacts on groundwater flows and levels did not occur.

Proven and effective measures to mitigate the risk of releases cement-based products, oils/fuels and suspended solids were undertaken to break the pathway between the potential source and each receptor. The residual effect is assessed to be - Negative, imperceptible, indirect, short term, low probability impact.

9.5.2.11 Potential Impacts on Flush Habitats

Access roads etc emplaced in peat substrates can act as drains or barriers to flow, depending on their permeability relative to peat permeability. These potential effects of road construction could potentially impact the hydrology of the peat bog and flushes at the site. Access roads which cross flush areas have the potential to impact on groundwater and surface water flows that create and maintain the flush.

Turbine T9, and the associated access roads in a radius of around 200-300 m around the turbine, are in an extensive area of acid (surface water) flush habitat. The flush extends down slope below the footprint of these works. Flushes also occur along the access road to turbine location T4.

Due to the design measures implemented during the wind farm construction within the flush areas there has been no significant alteration of the hydrology of the flush. Therefore, the residual effect is assessed to be - Negative, imperceptible, direct, long term, low probability impact.

9.5.3 Operational Phase

9.5.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. The footprint comprises turbine hardstandings, upgraded access roads and compound (~10ha footprint in total). 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.

Pathway: Site drainage network.

Receptor: Surface waters and dependent ecosystems.

Pre-Mitigation Impact
Direct, negative, moderate, permanent, moderate probability impact.

Mitigation Measures Implemented During the Operational Phase

Mitigation by Design:

Various combinations/adaptations of the runoff control and drainage management measures during the operational phase are employed at the site depending on the local conditions and topography:

- Natural vegetation filters are used regularly across the site where the local drainage and topography allowed attenuation of surface water runoff.
- Where possible, interceptor drains are installed up-gradient of infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It is now directed to areas where it can be re-distributed onto natural vegetation.
- Swales/roadside drains are used to collect runoff from access roads and turbine hardstanding areas of the site, likely to have entrained suspended sediment, and channeled it onto natural vegetation.

Impact Assessment:

Runoff Calculations

This section assesses the effect of the development site footprint on site runoff volumes compared to pre-development site runoff volumes. The water balance calculations were carried out for the month with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (refer Table 9-5).

The emplacement of the permanent development footprint (9.5ha), as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials as a worst case scenario) is estimated to result in an average total site increase in surface water runoff of 7,378 m^3/month and 238 m^3/day for the site (Table 9-16).

This represents a potential increase of 0.76% in the average daily/monthly volume of runoff from the study area in comparison to the pre-development 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 total permanent development footprint being approximately 9.5ha, representing 1.8% of the total study area of 525ha.

The additional volume in all sub-catchments is low due to the fact that the runoff potential from the site is naturally high (95%). Also, the calculation assumes that all hardstanding areas are impermeable which will not be the case as access tracks and hardstanding areas are constructed of permeable stone aggregate). The increase in runoff from the site is therefore be negligible.

Table 9-14: Water Balance and Estimated Post Development Runoff Volumes

Study Area (ha)	Site Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff (m^3)	Hardstanding Area 95% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions (m^3)
525	968,100	31,229	95,000	18,444	11,067	7,378	238	0.76

Toon River and River Lee Surface Water Level/Flow Monitoring

As described in Section 9.3.8, analysis of the hydrographs for the Toon River and River Lee shown that the development has no traceable/measurable impact on flows or levels in either of the rivers. This is because the development runoff volumes are less than negligible compared to the flows in the Toon River and River Lee. Runoff from the development site is having no measurable impact on flows/levels in either watercourse.

Residual Effects: Due to the sites natural hydrology, with its high surface water runoff rates, the overall small footprint of the development compared to the overall landholding (1.8%) and the introduced wind farm drainage measures, the increase in runoff from the site is negligible. Therefore, the residual effect is assessed to be - Negative, imperceptible, indirect, long term, low probability impact.

Significance of Effects: For the reasons outlined above, no significant effects on downstream surface water flows/levels have occurred or are likely to occur as a result of the Development.

9.5.3.2 Operational Phase Works

In conjunction with the above operational phase activities, and subject to substitute consent being granted, a peatland habitat restoration will be undertaken within a 4.3Ha area of the wind farm site during the operational phase of the Cleanrath wind farm development. The works will involve felling, chipping and removal of brash and restoring the peatland habitat to its original condition prior to planting which will include the blocking of drains with no further drainage to be installed around the area. During the initial restoration process, erosion of peat and subsoil and potential surface water quality effects is considered to be a potential negative, short term effect, however, over the long term the restored peatland will provide a positive impact on the wind farm site in terms of the water quality.

Ongoing maintenance with regard the turbines and the wind farm drainage will also form part of the operational phase works, but these activities will have no effect on the local hydrological or hydrogeological regime.

Pathway: Vehicle movement, surface water and wind action.

Receptor: Down-gradient surface water quality (Toon River, River Lee, Aghnakinneirth Stream, Bunsheelin River and Sullane Beg River)

Pre-Mitigation Potential Impact: Negative, slight, direct, short-term, medium probability effect on surface water quality.

Positive, significant, direct, long-term, likely effect on surface water quality (following stabilisation and growth of acrotelm).

Proposed Mitigation Measures for Habitat Restoration:

- Brash removed during the restoration process will be stored up slope of the cleared area, to provide a buffer to surface water flows which may have the potential to erode;
- During tree felling brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas; and,
- Drain blocking and use of silt fencing and check dams until stabilisation has taken place.

Residual Effect Assessment: 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 were undertaken to break the pathway between the potential sources and the receptor. The residual effect is assessed to be - Positive, indirect, long term, high probability effect on downstream water quality and aquatic habitats.

Significance of Effects: Overall Significant positive effect.

9.5.4 Decommissioning Phase

The potential impacts associated with decommissioning of the Development will be similar to those during the construction phase, but of reduced magnitude.

Turbine foundations would remain in place underground. 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 environment emissions such as dust and sediment.

The electrical cabling connecting the Cleanrath wind farm development to the substation in the townland of Rathgaskig will be removed from the underground cable ducting at the end of the useful life of the Cleanrath wind farm development or should early decommissioning be required. The cable ducting will be left in-situ as it is considered the most environmentally prudent option, avoiding unnecessary excavation, soil disturbance and potential surface water quality effects.

During decommissioning, it may be possible to reverse or at least reduce some of the impacts during construction phase by rehabilitating construction areas such as turbine bases after the dismantling of turbines. This will be completed using material imported to site as the required quantity of material does not currently exist at the site. This will require 1,547m^3 of inert soil to be imported to the site which will be sourced locally. Temporary drainage measures such as silt fencing, check dams and settlement ponds may be installed if required until the imported material has being stabilised by natural vegetation growth. However it is anticipated that the revegetation of the site during operation will have resulted in a return to the natural drainage management that will have existed prior to any construction. It is not anticipated that the restoration of turbine bases will impact this natural drainage system during decommissioning and turbine foundation reinstatement.

The decommissioning phase will also include the removal of underground cabling from the ducting on the grid connection route as described in Section 4.8 of this EIAR. Other works during decommissioning will include the temporary removal of soil berms to facilitate transport of abnormal loads and re-instatement following decommissioning. These works will be short-term, temporary with no potential for impact on the local hydrology.

A Decommissioning Plan has been prepared (Appendix 4-9) for an early decommission of the Cleanrath wind farm development the detail of which will be agreed with the local authority prior to any decommissioning. Should the Cleanrath wind farm development continue operation for the intended lifespan of approximately 25 years, 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.

Mitigation measures applied during decommissioning phase activities will be similar to those applied successfully during construction phase where relevant. Some of the impacts will be avoided by leaving elements of the Development in place where appropriate (i.e. turbine bases). The turbine bases will be rehabilitated by covering with local soil in order to regenerate vegetation which will reduce runoff and sedimentation effects. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures.

No significant impacts on the water environment are expected during the decommissioning phase of the Development.

9.5.5 Cumulative Effects

In terms of hydrological cumulative impacts arising from the wind farm infrastructure, grid connection and turbine delivery accommodation works, no significant impacts have occurred, and this has been demonstrated by the surface water quality monitoring data and flow/level monitoring data as described above.

A hydrological cumulative impact assessment with regard to other wind farm developments within a 20km radius of the development site within the River Lee catchment was also undertaken. The wind farm developments assessed are listed in Table 9-17 below.

Table 9-15: Other Wind Farm Developments in the River Lee catchment within a 20km radius of the site

Catchment Area	Wind Farm Name	Status	Potential No. of Turbines in Catchment
River Lee	Knocknamork WF	7no. permitted	7
	Bawnmore 2 WF	6 no. existing	6
	Bawnmore 1 WF	5 no. existing	5
	Garranereagh WF	4 no. existing	4
	Shehy More WF	11 no. under construction	8
	Derragh WF	6 no. existing	6
Potential Total			36

The total number of turbines that will be operating inside a 20km radius within the River Lee catchment, including the existing Cleanrath 9 no. turbines is 45.

The catchment area of the River Lee within a 20km radius of the site is ~662km^2 and therefore this equates to one turbine for approximately every ~15km^2 which is considered imperceptible in terms of potential operational cumulative hydrological impacts.

As demonstrated by the surface water monitoring data, the drainage mitigation as implemented will ensure there will be no cumulative significant adverse impacts on the water environment from the Cleanrath wind farm development, and other wind farm developments and non-wind farm developments within the River Lee catchment.

In terms of the overall Cleanrath wind farm development, approximately 2.4km of the total 15km grid route extends into the Roughty River catchment. Derragh wind Farm and Grousemount wind Farm, which are both located in the Roughty River catchment, were constructed over the same period as Cleanrath Wind Farm. Due to the fact that works within the Roughty River catchment relating to the Cleanrath wind farm development were limited to only 2.4km of grid connection, no hydrological cumulative impacts on watercourses within the Roughty River catchment occurred.

9.5.6 Assessment of Health Effects

Potential health effects arise mainly through the potential for groundwater and surface water contamination.

A wind farm is not a recognized source of pollution and so the potential for effects during the operational phase are negligible. Hydrocarbons were used onsite during the construction phase, however the volumes used were small in the context of the scale of the Development. In addition, they were handled and stored in accordance with best practice mitigation measures. There were no records/reports of groundwater or surface water contamination incidences during the construction phase or operational phase of the development.

Private wells are present along the grid connection route but due to the shallow nature of the works within the corridor of the public roads, there was no effect on these wells with respect water quality or quantity.

There were no soil contamination issues during any of the site inspections/audits completed by HES. As such, there are no impacts associated with water contamination and subsequent/associated health effects.

9.5.7 Conclusion

Extensive hydrological monitoring carried out during the construction and operational phase show that there were no significant effects on the downstream receiving waters. This is backed up by numerous site inspections/visual checks which showed that 99% of the time the waters inspected on-site were visually clean with no trace of contaminants. The 1% were all minor, localised, temporary turbidity effects which were resolved by undertaking minor drainage adjustments. There is no requirement to carry out any remedial mitigation measures as a result of the Cleanrath wind farm development.

During the decommissioning phase of the Cleanrath wind farm development, the majority of the site infrastructure will be removed from the wind farm site. The decommissioning phase will essentially involve the reverse procedures implemented during construction. No significant effects on the water environment will occur. No cumulative impacts on the water environmental occurred or will occur, nor were there any health effects reported.

In summary, no significant effects on the water environmental occurred during the construction or operational phase or will occur during the continued operational phase and the decommissioning phase of the Cleanrath wind farm development.