9.0 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

This chapter describes the existing hydrological, hydrogeological and water quality characteristics at the site of the proposed project. The potential effects on the water environment arising from the development of the windfarm and associated infrastructure including the grid connection and road/junction accommodation works associated with the turbine delivery route (TDR) are assessed. The drainage of the project is considered which includes proposed mitigation measures to reduce any potential negative effects associated with the construction, operation and decommissioning of the proposed development. Any residual effects are also assessed.

The proposed development site is approximately 7.3km long in the north/south direction and is approximately 2.7km wide in an east/west direction at the widest point. The site lies between the settlements of Mullinavat, Inistioge and Ballyhale, which are located approximately 4.1km southwest, 5.7km northeast and 1.9km northwest of the site of the proposed wind farm respectively.

The main urban centre in the region is Waterford City, located approximately 15.5km to the south of the proposed wind farm site. The site of the proposed wind farm has an area of approximately 1,434 hectares and comprises a single elongated land parcel. The wind farm is located on commercial forestry and agricultural land.

Planning Permission is being sought from Coillte for the installation of 21 No. wind turbines of up to 185m tip height, and all associated infrastructure and works, which are described in detail in Chapter 2 of this EIAR (Description of the Proposed Development).

The total area of the proposed wind farm permanent footprint for Castlebanny is 36.29ha. This provides an approximate coverage of 2.5% of the wind farm site area of approximately 1,434 ha For the purposes of this assessment, the area within a 1km buffer of the proposed permanent footprint of the wind farm site forms the primary study area. The application includes for all necessary connections to the electricity grid. All elements of the proposed project, including grid connection, works associated with the turbine delivery route and replant lands have been assessed as part of this EIAR.

9.1.1 Statement of Authority

TOBIN Consulting Engineers (TOBIN) have completed this chapter. TOBIN Hydrologists and Hydrogeologists are very familiar with the site characteristics for the Castlebanny Wind Farm, having worked on wind farms at Lisheen, Bruckana and Derryadd set in various ground conditions and water environments. This chapter has been completed by Declan Morrissey and Michelle Wong, TOBIN hydrogeologists with nine- and ten-years' experience respectively, specialising in environmental site assessments and EIAs. It was reviewed by John Dillon, TOBIN hydrogeologist, with 18 years' experience. Duncan Hardwick, TOBIN water resources engineer, has been responsible for carrying out the site-specific hydraulic modelling Flood Risk Assessment.

9.1.2 Scope of Assessment

The scope of the assessment undertaken is set out as follows:

1. Characterise the hydrological and hydrogeological baseline conditions of the existing environment based on a desktop study and site investigation;
2. Identify the possible impacts of the proposed development during construction, operation and decommissioning of the project on the receiving hydrological and hydrogeological environment;
3. Develop mitigation measures to reduce or eliminate the identified potential negative impacts; and
4. Identify any residual impacts after mitigation measures are implemented.

9.1.3 Legislative / Guidance Review

This EIAR has been prepared in accordance with the requirements of the codified Directive 2011/92/EU as amended by Directive 2014/52/EU (hereafter referred to as the 'amended Directive'.

This EIAR has been prepared with reference to the requirements of the following legislation (where relevant):

- S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations;
- S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended;
- S.I. No. 9/2010 - European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended;
- S.I. No. 477/2011 - European Communities (Birds and Natural Habitats) Regulations 2011
- Consolidated EIA Directive 2011/92/EU as amended by Directive 2014/52/EU;
- European Communities (Water Policy) Regulations 2003 [S.I. No. 722/2003];
- Waste Management Act 1996 as amended;
- Water Framework Directive (2000/60/EEC); and
- Groundwater Directives (80/68/EEC) and (2006/118/EC).

The hydrology and hydrogeology section of the EIAR is carried out in accordance with guidance contained in the following:

- "Advice Notes on Current Practice in the Preparation of Environmental Impact Statements" (EPA, September 2003);
- "Guidelines on the Information to be contained in Environmental Impact Statements" (EPA, 2002);
- "Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports" (EPA, 2017);
- "Draft Advice Notes on Preparing Environmental Impact Statements" (EPA, September 2015);
- The guidelines and recommendations of the Institute of Geologists of Ireland (IGI) publication 'Geology in Environmental Impact Statements – A Guide' (2002);
- Inland Fisheries Ireland (2016) "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites"
- IGI Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (2013);

- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;
- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010);
- PPG1 – Understanding your environmental responsibilities – good environmental practices;
- PPG2 – Above ground oil storage tanks;
- PPG5 – Works or Maintenance in or near water;
- CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- CIRIA C697 SuDS Manual; and
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.

In addition to the Regulations and Guidelines above, this EIAR has been prepared in accordance with the currently adopted *"Wind Energy Development Guidelines for Planning Authorities (2006)"*, with cognisance of the Department of Housing, Planning and Local Government (DHPLG, 2019) *Draft Revised Wind Energy Development Guidelines*.

9.1.4 Study Methodology

An examination of the existing hydrological/hydrogeological regime was carried out through a combination of consultation with relevant authorities, a desktop review of the hydrological/hydrogeological resource and site-specific fieldwork. These elements are described further below.

The assessment of the water environment consisted of the following:

- A desk study of available information including a review of site investigations, relating to surface water and groundwater, undertaken within or adjacent to the site;
- A walkover of the site and surrounding area;
- Surface water quality monitoring;
- Drainage distribution and catchment mapping;
- Interpretation of all data to establish the baseline environment; and
  Assessment of flood risk.

Information retained by the Geological Survey of Ireland (GSI), the Office of Public Works (OPW) and EPA was accessed to provide the hydrological and hydrogeological setting of the site. Relevant documents and datasets used to provide the setting of the site included EPA Water Quality Data, topography maps and GSI Hydrogeological Data.

The relevant sections of the Kilkenny County Development Plan 2014 - 2020 were also consulted in the preparation of this report.

The following sources of information were utilised to establish the baseline environment:

- The Geological Survey of Ireland (GSI) groundwater records for the area were inspected, with reference to hydrology and hydrogeology;
- Office of Public Works (OPW) flood mapping;
- Catchment Flood Risk Assessment and Management (CFRAM) and Preliminary Flood Risk Assessment (PFRA) Map data;
- EPA water quality monitoring data for watercourses in the area;
- Results from the chemical analysis of water samples taken in 2003 - 2018;

- EPA Water Framework Directive Monitoring Programme;
- Information from the River Basin Management Plan for the South Eastern River Basin District (SERBD) 2009-2015;
- Information from the 2nd Cycle River Basin Management Plan, 2018-2021; and
- Site visits of the study area.

TOBIN Consulting Engineers carried out an investigation in February 2020, July 2020 and September 2020, in order to assess the water environment in the vicinity of the proposed development.

Recommendations arising from consultations with both Inland Fisheries Ireland and Kilkenny County Council (refer to Appendix 1-3 within (Chapter 1, Introduction) were incorporated into the water impact assessment and mitigation measures.

In this chapter, the potential impacts on the water environment resulting from the proposed development are evaluated and mitigation measures are proposed to reduce any significant impacts. Based on the mitigation measures proposed, the significance of the residual impact on the water environment is determined.

The significance of effects of the proposed development has been assessed in accordance with the EPA guidance document *Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (August 2017)[1]. Table 1.1 (available in Chapter 1, Section 1.6.2) is taken from the EPA document. It outlines guidance for describing the quality and significance of effects.

The magnitude of any effects considers the likely scale of the predicted change to the baseline conditions, resulting from the predicted effect and takes into account the duration of the effect i.e. temporary or permanent.

Potential impacts may have negative, neutral or positive qualities where:

- Positive impact – A change which improves the quality of the environment;
- Neutral impact – A change which does not affect the quality of the environment; and
- Negative impact – A change which reduces the quality of the environment.

The diagram below shows how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact.

[1] https://www.epa.ie/pubs/advice/ea/EPA%20EIAR%20Guidelines.pdf

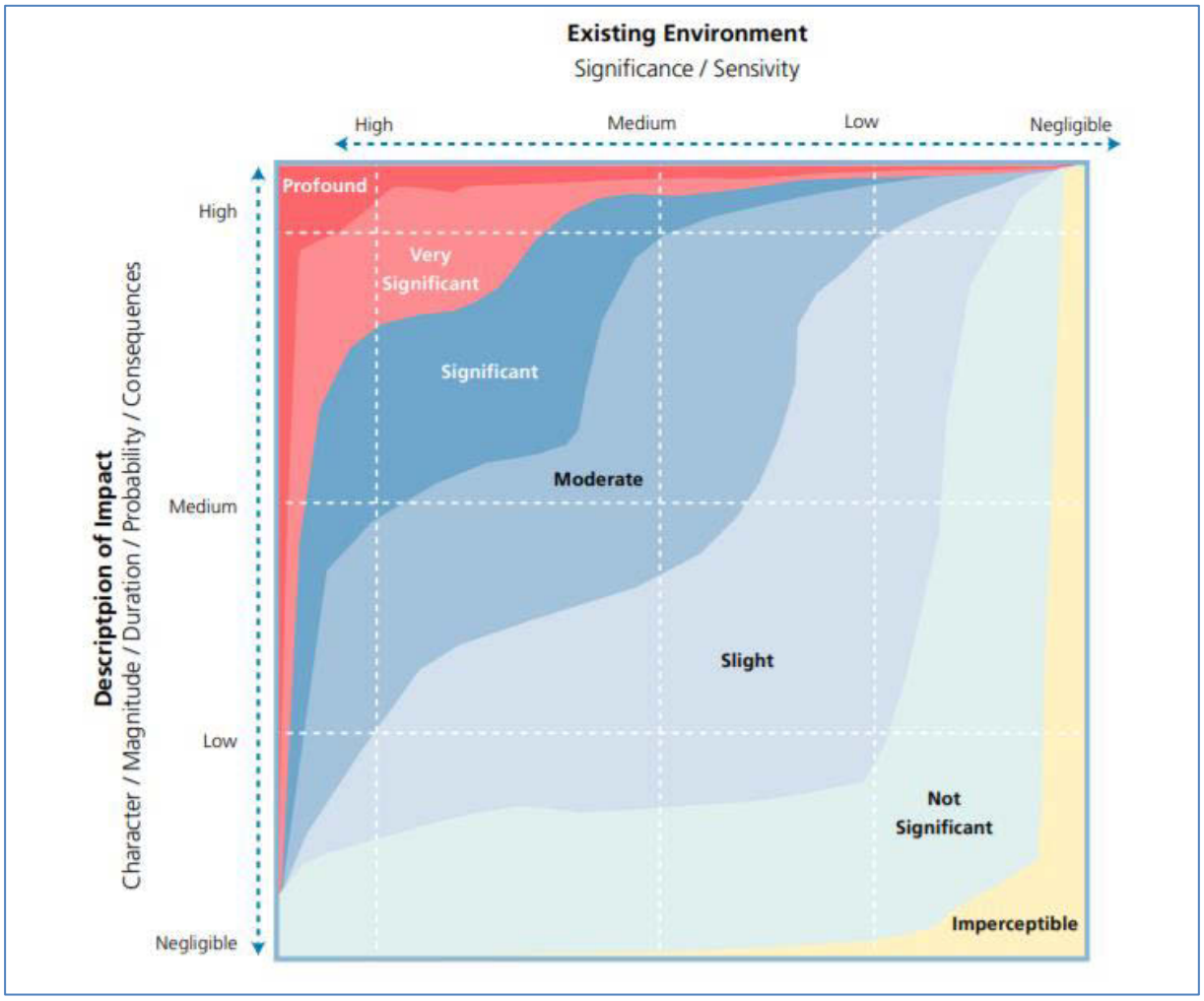


Image 9.1: EPA EIAR significance of impacts matrix

In order for a potential impact to be realised, three factors must be present. There must be a source of a potential effect, a receptor which can be adversely affected and a pathway or connection which allows the source to impact the receptor. Only when all three factors are present can an effect be realised.

9.1.4.1 Consultation

Consultation took place with a number of organisations including the following relevant bodies:

- An Bord Pleanála;
- Kilkenny County Council;
- Inland Fisheries Ireland;
- Geological Survey of Ireland;
- Department of Arts, Heritage and the Gaeltacht;
- Waterways Ireland;
- EPA;
- Irish Peatland Conservation Council;
- The Office of Public Works; and

- The Forest Service.

9.2 EXISTING ENVIRONMENT

9.2.1.1 Site Walkover and Investigations

Field work involved:

- A walkover survey of the site to identify hydrological features on site, wet ground, drainage patterns and distribution, exposures, drains etc;
- Trial Pitting in 2020;
- Borehole testing in 2020, and
- Field analysis of water samples in 2020.

Following the field surveys, the results were reviewed in ArcGIS software in conjunction with publicly available hydrological and hydrogeological data from the GSI, EPA and OPW. Various maps were produced, representing a graphical interpretation of the field results.

On a regional scale, the site at Castlebanny and its environs is located across the Suir and Nore Hydrometric Areas and Catchments. The delineation of the sub-catchments and general area of confluence is shown in Figure 9-1 'Regional Catchment Delineation Overview'.

The proposed development site is located within the National River Basin District of the 2nd cycle river basin management plan, formerly the South Eastern River Basin District (SERBD) within the 1st cycle river basin management plan. At a local scale, the proposed wind farm is located between the Arrigle River to the east and the Ballytarsna River to the west of the wind farm. The Arrigle River discharges to River Nore and eventually into the River Barrow. The Ballytarsna River discharges to River Blackwater (Kilmacow) and then into River Suir.

9.2.2 Topography

The topography of the proposed development site is a moderately sloping dome shaped hill, rising from c.130 mAOD in the east and 120 mAOD in the west to a high point of 250 mAOD and 265 mAOD in the centre of the site. Water to the east and north flows towards the River Nore and water on the west and south flows towards the River Suir.

9.2.3 Surface Water Hydrology

The purpose of this section is to describe the surface water environment including the following:

- Catchments;
- Site surface water features and drainage;
- Flood risk assessment;
- Assessment of hydrometric data;
- Surface water abstractions within the catchment of the site; and
- Surface water quality.

9.2.3.1 Catchments

A catchment, also referred to as a drainage basin and watershed, is a topographic area that collects and discharges surface streamflow through one outlet or mouth (Mays, 2012). The

catchment boundary is the line dividing land where surface drainage flows toward a given stream from land where it drains into a separate stream.

The regional natural surface water drainage pattern, in the environs of the Castlebanny Wind Farm proposed development site is shown on Figure 9-1 'Regional Catchment Delineation Overview'. The proposed development site is located within the River Nore and River Suir catchments, located within the National River Basin District. Part of the proposed development site is located within the catchment of the River Barrow and River Nore Special Area of Conservation (SAC; Site Code: 002162).

Figure 9-2 'Surface Water Features/Local Wind Farm Catchment Delineation'' and Figure 9-3 'Existing Surface Water Features & Surface Water Monitoring locations' includes a significant number of unnamed streams but EPA reference numbers have been applied for identification purposes. The proposed development lies within a number of sub-catchments and sub-basins, identified in Table 9-1. The proposed development is located in a delineated area for action as set out in the 2018-2021 River Basin Management Plan.

Table 9-1: Waterbodies (within 2km radius) and the Proposed Development Site

Catchment (Catchment ID)	WFD Sub-catchment (Sub catchment ID)	River Network EPA Name (Segment Code)	River Waterbody WFD Status 2013 – 2018 (River Name & Code)	River Waterbody WFD Risk 2010-2015
Suir (16)	Blackwater [Kilmacow]_ SC_010 (16_29)	Crowbally (16_762)	Good Blackwater [Kilmacow]_010 (IE_SE_16B020080)	Not at risk
		Unnamed (16_29)		
		Ballytarsna 16 (16_30)		
		Ballytarsna 16 (16_696)		
		Ballytarsna 16 (16_1474)		
		Blackwater [Kilmacow] (16_367)		
		Castlebanny (16_368)		
		Blackwater [Kilmacow] (16_984)		
		Blackwater [Kilmacow] (16_1477)		
		Ballylusky 16 (16_3550)	Unassigned Blackwater (Kilmacow)_020(IE_SE_16B020091)	Under Review
Nore (15)	NORE_SC_220 (15_220)	Jerpoint Church Stream (15_1337)	Unassigned IE_SE_15N012310	Not at Risk
	Nore_SC_130 (15_20)	Garrandarragh (15_1532)	Unassigned Arrigle IE_SE_15A020250	Not at Risk
		Mullenhakill	High	Not at risk

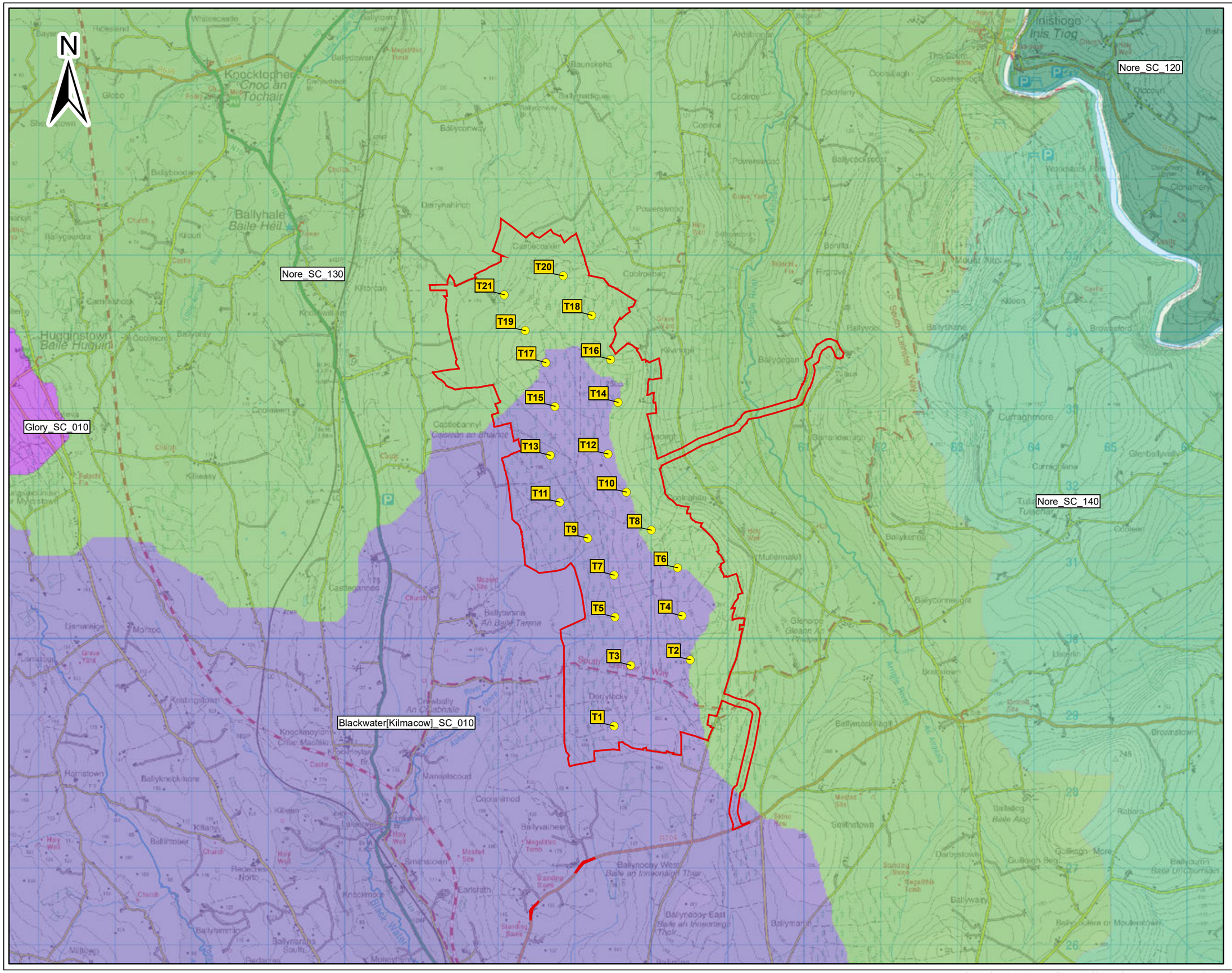
Catchment (Catchment ID)	WFD Sub-catchment (Sub catchment ID)	River Network EPA Name (Segment Code)	River Waterbody WFD Status 2013 – 2018 (River Name & Code)	River Waterbody WFD Risk 2010-2015
		(15_637)	Arrigle_020 (IE_SE_15A020250)	
		Arrigle Trib 3 (15_1475)		
		Arrigle 15_503		
		Arrigle 15_90		
		Arrigle Trib 1 (15_1253)	Good Arrigle_010 IE_SE_15A020100	Not at risk

The EIAR study area comprises of approximately 1,434 ha and has several surface water features in the region of the site. The study area includes the grid connection, replanting and turbine delivery route . The main regional surface water features include the following:

- Nore River (located approximately 4.3km north west of the development);
- Suir River (located approximately 12.5km south west of the development);
- Kilmacow - Blackwater River (Tributary of the Suir, located approximately 3.0km south west of the development);
- Arrigle River (Tributary of the Nore -located to the east of the development); and
- Jerpoint River (Tributary of the Nore located to the north of the development).

The Nore catchment includes the area drained by the River Nore and all streams entering tidal water between its confluence with the River Barrow at Ringwood, and the Barrow railway bridge at Drumdowney, Co. Kilkenny, draining a total area of 2,595km². The largest urban centre in the catchment is Kilkenny. The other main urban centres in this catchment are Abbeyleix, Callan and Thomastown. The total population of the catchment is approximately 94,700 with a population density of 37 people per km². The Nore rises on the north-eastern slopes of Borrisnoe Mountain, from where it runs northeast over an area underlain by a large gravel aquifer and past Borris-in-Ossory. The southern slopes of the Slieve Bloom Mountains are drained by the Tonet, Delour and Mountrath Rivers which join the Nore east and south of Mountrath. The Nore becomes tidal just upstream of Inistioge before continuing southeast to its confluence with the River Barrow at Ringwood. Flood relief works were completed during 2006. The River Arrigle flows north until it meets the River Nore to the north of Thomastown.

The Suir catchment includes the area drained by the River Suir and all streams entering tidal water between Drumdowney and Cheekpoint, Co. Waterford, draining a total area of 3,542km². The largest urban centre in the catchment is Waterford City. The other main urban centres in this catchment are Carrick-on-Suir, Clonmel, Caher, Thurles, Tipperary, Fethard and Templemore. The total population of the catchment is approximately 184,860 with a population density of 52 people per km². The headwaters of the Suir are located on the northern flanks of the Devil's Bit Mountain in Co. Tipperary. The river flows through a wide limestone plain, past Thurles, where the Suir is joined by the River Drish and the Tipperary Clodiagh. The Suir continues towards Cashel and onwards to Cahir and Carrick-on-Suir. The Suir becomes tidal just before reaching Carrick-on-Suir and is joined by several rivers between this point and Waterford city including the Lingaun, Portlaw Clodiagh, Pil, and Kilmacow Blackwater and then makes its way to the confluence with the Nore and Barrow Rivers east of Waterford City. The Suir estuary then turns south, flowing out to sea through Waterford Harbour between Dunmore East and Hook Head. Flood relief works were completed on the Suir at Carrick-on-Suir during 2003 and Clonmel during 2014.



Legend

- EIAR_Study_Area
- Turbine Locations

WFD_Subcatchments

- Blackwater[Kilmacow]_SC_010
- Glory_SC_010
- Nore_SC_120
- Nore_SC_130
- Nore_SC_140

Issue	Date	Description	By	Chkd.
A	15/12/2020	Final	F.H.	M.W.

0 1 2
Kilometres

Client: COILLTE

Project:

Castlebanny Wind Farm

Title:

Regional Catchment Delineation Overview with site boundary, 2km buffer and Grid Route

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
F. Healy	M.Wong	Dec 2020

Project Director: J.Staunton

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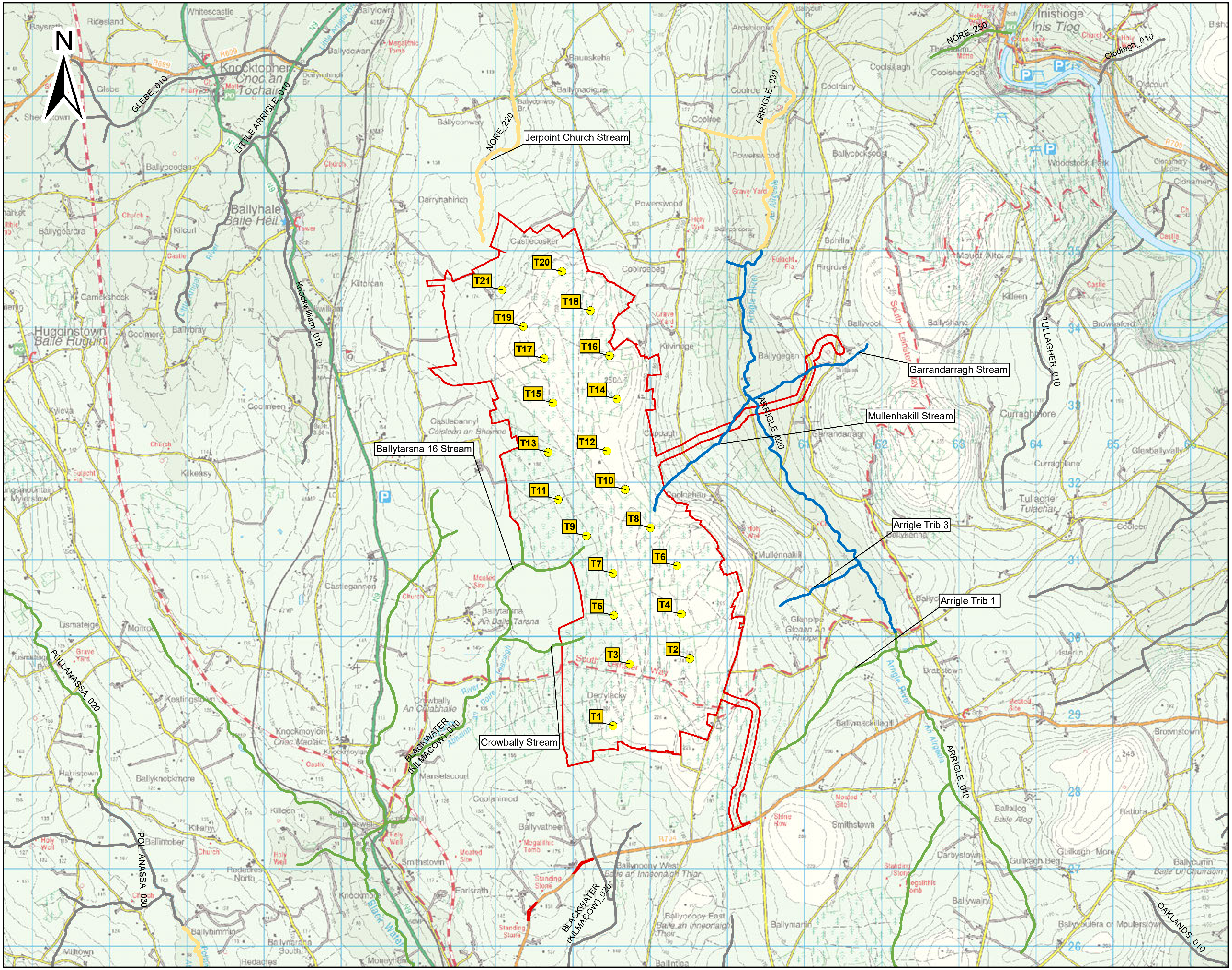
TOBIN CONSULTING ENGINEERS

Drawing No.: Figure 9.1

Draft: A



Legend

- EIAR_Study_Area
- Turbine Locations

River Status

- River Waterbody 2013–2018 Good Status River
- River Waterbody 2013–2018 High Status River
- River Waterbody 2013–2018 Mod Status River
- River Waterbody Unassigned Status River

ARRIGLE 020 - Waterbody Code

A	11/01/2021	Final	F.H.	M.W.
Issue	Date	Description	By	Chkd.

0 1 2
Kilometres

Client: COILLTE

Project: Castlebanny Wind Farm

Title: Surface Water Features/ Local Windfarm Catchment Delineation

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
F. Healy	M.Wong	Dec 2020

Project Director: J.Staunton

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Drawing No.: Figure 9.2

Draft: A

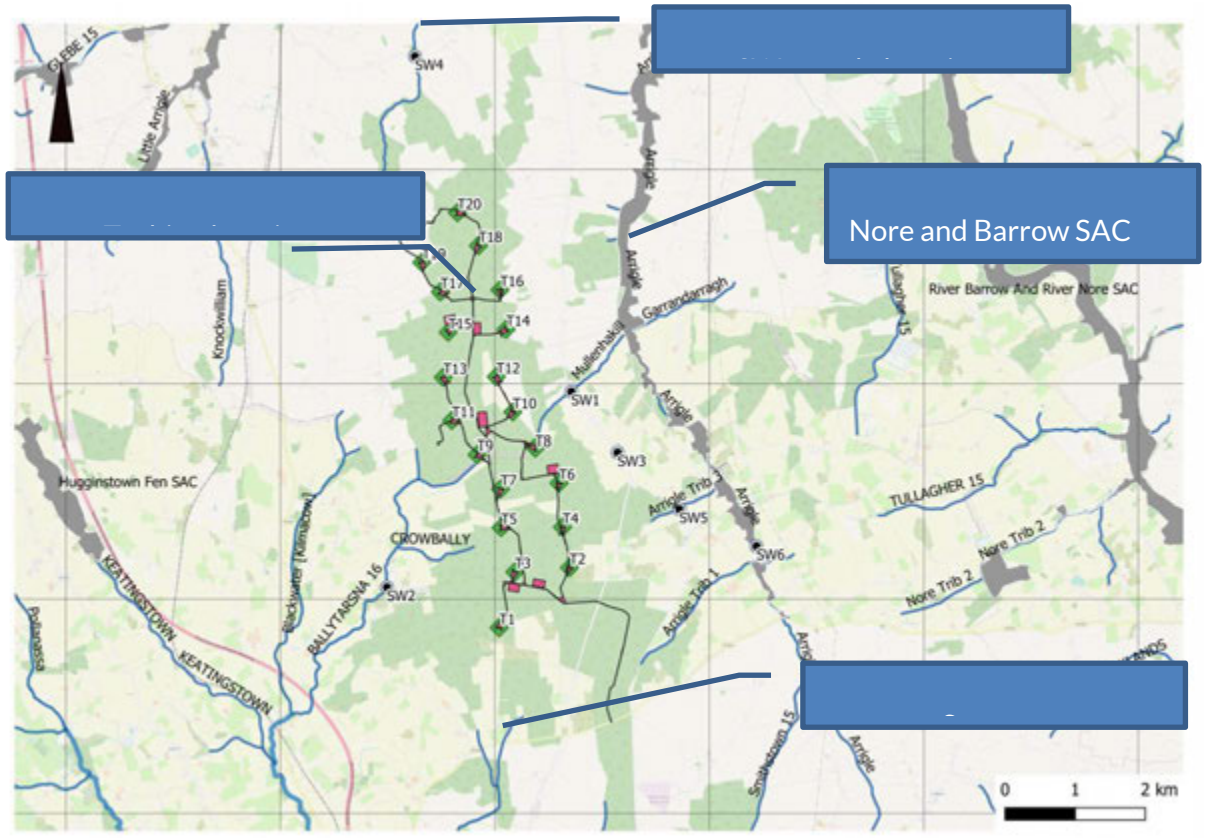

Figure 9-3: Existing Surface Water Features & Surface Water Monitoring locations

9.2.3.2 Surface Water Features & Drainage within the Site Boundary

The proposed windfarm development consists primarily of Coillte-owned commercial forestry, some privately owned forestry and agricultural grassland.

Mullenhakill (IE_SE_15A020250) located to the east of the proposed development is a tributary feeding into Arrigle river (IE_SE_15A020250). To the west of the site, Crowbally (IE_SE_16B020080) collects with Ballytarsna 16 (IE_SE_16B020080), also known as Derrylacky River, which then feed into River Blackwater (Kilmacow) (IE_SE_16B020080).

Following site walkovers in February 2020, July 2020 and September 2020, a number of surface water features were noted on site. These are illustrated on Figure 9-3 'Existing Surface Water Features & Surface Water Monitoring locations'.

Drainage within the site is predominantly via man-made drainage channels. A number of streams/drainage channels were identified to be flowing through or adjacent to the proposed wind farm site (see Figure 9-2.).

The streams in the vicinity of Castlebanny Wind Farm are typically small, upland eroding channels (c.0.75 to 1.5m wet width). Arrigle Trib 1 Stream (EPA code: 15A30) is a small upland

eroding watercourse (FW1; Fossitt, 2000) averaging 0.75m wide and 0.05m deep, with very slight flow at the time of survey. The stream is considered to be seasonal in its upper reaches. Arrigle Trib 3 Stream (EPA code: 15A32) is a small swift flowing upland eroding stream, averaging 1.5m wide and 0.15m deep. The stream had been straightened and deepened historically and had bank heights of 1.5m in a U-shaped channel. Mullenhakill Stream (EPA code: 15M51) is a large semi-natural upland eroding stream channel, approximately 2m wide and 0.15m deep. The stream had evidence of some historical straightening and more extensive deepening (i.e. hedgerows/treelines on earthen berms deposited from historical drainage works). The Garrandarragh Stream (EPA code: 15G81) is a small upland eroding watercourse averaged 1-1.5m wide and 0.1-0.15m deep, with occasional pools. The Arrigle is a lowland depositing watercourse which had been locally straightened (old retaining walls visible), although good natural recovery was evident. The U-shaped channel is 6-7m wide with an average depth of 0.2-0.4m due the summer period.

The Crowbally Stream (EPA code: 16C76) is a small upland eroding watercourse, emanating from a coniferous woodland block located within the wind farm boundary. The stream flowed over a gentle gradient and averaged 1.5-2m wide and 0.1-0.2m deep. The channel has been straightened historically, with retaining walls visible. The Ballytarsna River (EPA code: 15B66), upgradient of the confluence with the Crowbally stream is a small, lowland depositing watercourse which averaged 1.5m wide and 0.15m deep,

The site and adjacent lands also include many man-made drains which flow to the watercourses identified in Figure 9-2 and assist in the drainage of agricultural land use and forestry. Extensive arterial drainage and field drains occur on the Coillte site. No streams are crossed by the proposed access tracks or turbine locations. However, a number of drainage ditches will be crossed and there will be some realignment of drains onsite, particularly near the proposed substation. St Molin's Well, a naturally occurring spring is located to the east of the site in the low permeability granites. The closest turbine to St. Molin's Well is Turbine 6 which is located approximately 900 m to the west of the well. It is noted that although Turbine 6 is upgradient of St Molin's Well, situated on the sandstone of the Carrigmaclea Formation, a review of contour data for the area indicates that surface water runoff from turbine no. 6 will flow to the north west suggesting no hydraulic connectivity with St Molin's Well, located to the east. Excavations are proposed within 890m of the well but topographical data indicates no hydraulic connectivity or pathway to St Molin's Well.

9.2.3.3 Flood Risk Assessment

The Planning System and Flood Risk Management Guidelines (OPW/DoEHLG, 2009) classify electricity generating stations as "essential infrastructure" considered appropriate in Flood Zone C. The proposed wind farm has therefore been assessed against a 0.1% AEP MRFS flood (i.e., a 1000-year flood in a likely climate change scenario).

The Flood Risk Assessment is provided in Appendix 9-1 and the initial flood risk assessment is summarised below:

Based on existing site topography, water arising at the site naturally flows away from the site towards lands at lower elevations.

No past flood events have been reported within 1.5 km of the proposed wind farm site. Kilkenny County Council records from 2005 or earlier indicate that the River Arrigle floods the R704, making it impassable, several times a year after sustained periods of heavy rainfall. There is also evidence of roads and rural lands at Ballyhale and Knockwilliam flooding when the local watercourse bursts its banks.

The National Preliminary Flood Risk Assessment was reviewed. Two tributaries of the River Derrylacky and one tributary of the River Arrigle rise within the site boundaries, near the proposed locations for turbines T5, T9, and T8. Based on the indicative flood map, it is estimated that the proposed wind farm site is not at risk of fluvial flooding. The natural topography of the site is such that flood waters would flow away from the site towards lands further downstream that are at lower elevations.

In 2015, the OPW produced flood maps[2] as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study. The flood extents in these maps are based on detailed modelling of Areas for Further Assessment (AFA) identified by the National PFRA.

The proposed wind farm site was not identified as an AFA. The Derrylacky and Arrigle Rivers were, therefore, not considered as part of the CFRAM Study due to their small catchment sizes. Based on the CFRAM flood map, the proposed wind farm site is far from the 0.1% AEP MRFS fluvial flood extents predicted for the River Nore and River Blackwater.

The Geological Survey Ireland (GSI) provides mapping[3] with data related to Ireland's subsurface and groundwater. There are no karst landforms in the vicinity of the site. There is, therefore, no evidence to suggest groundwater is a potential source of flood risk to the proposed wind farm site.

9.2.3.4 Assessment of Hydrometric Data

The natural surface water drainage pattern in the environs of the proposed development site is shown in Figure 9-2.

It was noted that there were no hydrometric stations located in the immediate environs of the proposed windfarm site. Although hydrometric stations do exist on watercourses downstream of the development, they include flows coming from a number of different tributaries. As such, they are not representative of the actual flows occurring at the site.

9.2.3.5 Surface Water Abstractions within the Site

There are currently no known surface water abstractions from the streams adjacent to the site. Surface water abstractions within 10 km radius of the site boundary identified three surface water abstractions, namely Thomastown Public Water Supply (PWS), Inistioge PWS and Glenmore PWS which has been noted to abstract 65 m^3/day. During community engagement discussions, the project team was informed that St Molins Well, located to the east of the

[2] floodinfo.ie

[3] https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx

development, supplies approximately two houses near the spring. Thomastown PWS is noted to be a groundwater source which is discussed in Section 9.2.4.

9.2.3.5.1 Turbine Delivery Route

The Turbine Delivery Route (TDR) (shown in Figure 2-3, Chapter 2- Description of proposed development of this EIAR) was examined along with the information contained in Chapter 16 – Traffic and Transport. The route utilises the N29, N25 and N9 National Roads, the M9 Motorway and the R704 Regional Road from Waterford Port to the site entrance.

It should be noted that there will be no works proposed along the vast majority of the TDR, with only relatively minor temporary works proposed at a number of specific locations which are shown in Figure 2-3 of this EIAR. Therefore, there will be no potential for hydrological impacts along the vast majority of this route. Works at these locations will involve some topsoil stripping and placement of hardcore to allow passage of the wind turbine components.

9.2.3.5.2 Cable Route

The proposed cable route from the wind farm to the proposed grid connection is shown on Figure 2-4, Chapter 2 of this EIAR. The grid connection is proposed to connect to the existing 110 kV overhead line via proposed cable interface towers, located in the townland of Ballyvool.

A number of drainage/stream crossings were identified from mapping along the grid connection route. The key crossings are as follows:

- Crossing of the Mullenhakill Stream, a tributary of the Arrigle River;
- Crossing of the Arrigle River. and
- Crossing of the Garrandarragh Stream – tributary of the Arrigle River.

Further details of the cable crossings, and the proposed methodologies, are provided in Chapter 2 of this EIAR (Description of the Proposed Development). No instream works are proposed for the cable works. Trenchless technology such as horizontal directional drilling (HDD) is proposed at two locations (Mullenhakill & Arrigle crossings). Crossing of the Garrandarragh River is over the culvert within the road. Minor forest and farm drains crossings will be culverted or open trenched.

The specification for cables and cable installation will be in accordance with EirGrid requirements and within the parameters assessed in this EIAR.

9.2.3.6 Surface Water Quality

Environmental Protection Agency Records:

The Environmental Protection Agency (EPA) regularly monitors water bodies in Ireland as part of their remit under the Water Framework Directive (WFD) (2000/60/EC), which requires that rivers are maintained or restored to good/ favourable status. The quality of watercourses is assessed in terms of 4 No. quality classes; 'unpolluted' (Class A), 'slightly polluted' (Class B), 'moderately polluted' (Class C) and 'seriously polluted' (Class D). These water quality classes and the water quality monitoring programme are described in the EPA publication 'Water Quality in

Ireland, 2003'. The water quality assessments are largely based on biological surveys. Biological Quality Ratings or Biotic Indices (Q values) ranging from Q1 to Q5 are defined as part of the biological river quality classification system. The relationship of these indices to the water quality classes defined above, are set out in Table 9-2 below.

Table 9-2: Relationship between Biotic Indices and Water Quality Classes

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A
Q3-4	Slightly Polluted	Class B
Q3, 2-3	Moderately Polluted	Class C
Q2, 1-2, 1	Seriously Polluted	Class D

No monitoring locations were recorded on the streams adjacent to the proposed site. However, samples were recorded downgradient of the site boundary c. 4.8 km on the Blackwater (Kilmacow) River (RS16B020060), c. 2.5 km, 4.3 km and 5.1km on the Arrigle River (RS15A020100, RS15A020250 and RS15A020200 respectively). The locations of the biological quality stations are included in Table 9-3 below and Figure 9-4 'EPA Q value stations and Surface Water Monitoring Locations.

Table 9-3: Relationship between Biotic Indices and Water Quality Classes (Sourced from EPA Maps/ Water, accessed in July 2020)

Location	Blackwater (Kilmacow) Br d/s Ballytarsna R confluence	Br W of Ballyconnaught	Arrigle - Br WSW of Bohilla	Arrigle - Br SW of Garrandarragh
Distance from site boundary	4.8 km	2.5 km	4.3 km	5.1 km
Up or down gradient	Downgradient	Upgradient	Downgradient of the majority of the site	Downgradient
River Waterbody Name	Blackwater (Kilmacow)_010	Arrigle_010	Arrigle_020	Arrigle_020
River Waterbody Code	IE_SE_16B020080	IE_SE_15A020100	IE_SE_15A020250	IE_SE_15A020250
Segment Code	16_1477	15_502	15_92	15_503
Station Code	RS16B020060	RS15A020100	RS15A020250	RS15A020200
2019	-	Q4, Good (Operational)	Q4-5, High (Operational)	-
2005	Q4, Good (PreWFD)	-	-	-
1994	-	-	-	Q4, Good (PreWFD)

The majority of EPA monitoring points indicate that the overall water quality in this area is unpolluted. The overall status of surface water/rivers in the vicinity of the proposed site is good status. This classification is based on a high macroinvertebrate value (Q-Value) according to www.wfdireland.ie.

The most recent assessment in 2019 at Blackwater (Kilmacow) River has shown satisfactory condition maintained at the uppermost site, a paucity of pollution sensitive species indicate a

decline to Moderate ecological quality and unsatisfactory conditions at the middle and lower sites.

The most recent assessment in 2019 at Arrigle River indicated is overall satisfactory. Good ecological condition maintained at Station 0100, despite apparent cattle access issues. The improvement to High ecological condition recorded at Station 0250 was also maintained and this station remained at High quality. The lower station 0300 (not listed in Table 9-3) returned to Good quality after being assessed as being Moderate since 2013.

The EPA has assigned WFD River Waterbody Approved Risks to a number of waterbodies. Blackwater (Kilmacow) River to the west of the site (Blackwater (Kilmacow)_010) downstream is 'not at risk'. South of the site (Blackwater (Kilmacow)_020) downstream of the site but not directly connected via a watercourse is 'under review'. River Arrigle (Arrigle_010 and Arrigle_020) are 'not at risk' according to 2010-2015 WFD assessment.

Site Specific Surface Water Quality:

Field monitoring results from July 2020 are included in Table 9-4 and locations shown on Figure 9-3.

Table 9-4: Surface Water Analysis Castlebanny Wind Farm 30/07/2020

Parameter	Unit	ID/Location			
		SW2 Ballytarsna Stream (west of site)	SW1 Mullenhakill - Arrigle River Trib- East of site	SW3 St. Molins Well	SW4 Jerpoint Stream, North of site
Temperature	°C	15.2	14.5	15.3	14.8
Conductivity	µS/cm	375	410	385	410
pH	pH units	5.9	6.8	8	7.5
Total Suspended Solids	mg/l	<5	12	<5	15
Ammonia as N	mg/l	<0.3	0.06	0.03	0.03
COD	mg/l O_2	-	39	37	21
Nitrate as N	mg/l	19.3	<5	<5	<5
Orthophosphate as P	mg/l	0.04	0.03	0.02	0.12

No waste facilities, IEL or IPC licensed sites are within the study area or identified within 5km of the site boundary.

Three of samples (SW1, SW2 and SW4) were taken from surface water channels where its upper reaches form from within the site boundary. One sample (SW3) was taken at a spring. The sampling took place during periods of low flow (low dilution factor), these results are as expected for the natural background environment in this area (in particular, elevated levels of ammonia and suspended solids would be expected in a glacial till soil/subsoil environment). These results provide a baseline set of results which can be used for comparative studies during the lifetime of the proposed wind farm.

All of the survey sites also had low levels of total ammonia that were equivalent to good status water quality (i.e. Total Ammonia levels ≤0.065 mg N/l) according to S.I. No. 77/2019 - European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019.

With regards to nutrients, ortho-phosphate levels were low across all sites and thus all met good status in this regard as required in the Surface Water Regulations. The dissolved oxygen levels were indicative of well oxygenated water with levels recorded at over 8mg/l at all sites.

In summary, the physiochemical water quality was indicative of high-status water quality across all of the survey sites with the exception of SW4 due to the elevated MRP levels at this site.

The low conductivity values indicate that the Ballytarsna 16 (SW 2- 375 µS/cm) and Arrigle Trib 1 stream (SW1 - 410 µS/cm) are predominately fed by surface water runoff and groundwater with low conductivity. The St Molins spring is located to the east of the proposed windfarm. Some nutrient enrichment (algae growth) is evident at the spring.

Field Monitoring

Field monitoring results from August 2020 are included in Table 9-5 and 9-6 below and locations shown on Figure 9-3 and Figure 9-4. Monitoring of the River Arrigle (SW6) and Trib 3 - Arrigle River (SW5) was carried out during a storm event on the 17th August 2020. Elevated turbidity was noted on the Arrigle River and Trib 3 in response to storm events.

Table 9-5: Surface Water Analysis Castlebanny Wind Farm 17/08/20 -Trib 3 Arrigle River

ID	Temp	Conductivity	pH	Turbidity
SW5 - Trib 3 Arrigle	°C	µS/cm	pH units	FNU
08:00	12.2	468	6.7	25
09:00	12.7	469.2	7	27
10:00	12.5	423	6.9	22
11:00	13.5	435	7	28
12:00	14	435	7	21
13:00	14.5	436	6.9	20
14:00	13.5	402	6.9	17
15:00	13.4	478.8	7	20
16:00	13.1	435	7	11
17:00	13	430.8	6.9	16
18:00	13.2	466.8	6.9	11
19:00	13.1	416.4	6.9	10
20:00	12.6	417.6	6.9	8

Monitoring on the Arrigle upgradient of the site (SW6 –see Figure 9-4) was also undertaken at the start and finish of the monitoring.

Table 9-6: Surface Water Analysis Castlebanny Wind Farm 17/08/20 - Arrigle River (SW6 - Upgradient)

ID	Temp	Conductivity	pH	Turbidity
Arrigle -SW6	°C	µS/cm	pH units	FNU
07:45	8.2	468	6.7	38
20:10	8.6	417.6	6.9	13

N

GLEBE_010
LITTLE ARRIGLE_010
Knockwilliam_010
NORE_220
NORE_250
Clodiagh_010
ARRIGLE_030
ARRIGLE_020
TULLAGHER_010
ARRIGLE_010
POLLANASSA_020
POLLANASSA_030
BLACKWATER (KILMACOW)_010
BLACKWATER (KILMACOW)_020
OAKLANDS_010

SW1
SW2
SW3
SW4
SW5
SW6

T1
T2
T3
T4
T5
T6
T7
T8
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
T21

Arrigle - Br WSW of Bohilla

Arrigle - Br SW of Garrandarragh

Br W of Ballyconnaught

Blackwater (Kilmacow) Br d/s Ballytarsna R confluence

Legend

- EPA Stations
- Site Sample locations
- EIAR_Study_Area
- Turbine Locations
- Rivers

Issue	Date	Description	By	Chkd.
A	07/01/2021	Final	F.H.	M.W.

0 1 2
Kilometres

Client: COILLTE

Project:
Castlebanny Wind Farm

Title:
EPA Q value stations and Surface Water Monitoring Locations

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
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Project Director: J.Staunton

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Drawing No.: Figure 9.4

Draft: A

9.2.4 Hydrogeology/Groundwater

The information provided herein relates to the hydrogeology or groundwater environment. It is provided to give context to the groundwater characteristics and flow patterns within and adjacent to the proposed project site.

9.2.4.1 Existing Groundwater Quality

The study area covers the following groundwater waterbodies (GWB), Mullinavat (IE_SE_G_155) and Inistioge (IE_SE_G_076). The Water Framework Directive (www.wfdireland.ie) for the period 2013-2018 describes the groundwater quality status as 'Good' for both GWB's. These classifications are based on an assessment of the point and diffuse sources in the area that may affect the groundwater quality. Anthropogenic pressures including agriculture are the main pressures on the Inistioge GWB.

9.2.4.2 Aquifer Potential and Characteristics

Reference to the National Aquifer Map prepared by the GSI (www.GSI.ie) indicates that there are two types of Bedrock Aquifer underlying the proposed site. The bedrock aquifers are Locally important aquifer which is moderately productive only in local zones (LI) and poor aquifer, which is generally unproductive except for local zones (PI). The various aquifer classifications are illustrated in Figure 9-5 'Aquifer Classifications'.

The subsoil deposits overlying the bedrock are not considered to be of sufficient lateral extent or depth to represent an aquifer body and are mainly comprised of low permeability sandstone till. Summarised below in Table 9-7 and in Figure 9-5, are the aquifer characteristics of the underlying aquifer and surrounding aquifers.

Table 9-7: Bedrock Aquifer Classification and Characteristics

Aquifer Classification	Permeability/Flow Mechanism	Bedrock	Karst Features
Locally Important (LI)	Productive only in Local Zones	West of the site incl sandstone and shale bedrock	No
Poor Aquifer (Pl)	Unproductive except for Local Zones	East of the site incl Granitic and Diorite bedrock	No

Groundwater flow paths within the aquifer are expected to generally follow the local surface water catchments. Adjacent to the rivers, water levels will be closer to ground level. Much of the potential recharge to these strata is rejected and throughput is low (Tedd, K. *et al.,* 2008). Groundwater flow is generally restricted to the upper weathered zone, to more permeable beds of limited extent or to fault zones. There are shallow, short, localised flow systems, often with very little continuity between them. The slope of the water table generally reflects the surface topography.

No significant dissolution features (i.e. karst) were observed from visual appraisal of the proposed site and no karst features are recorded within the GSI Karst Database of Ireland within a 2km radius of the proposed development site. These findings are discussed in greater detail in Appendix 8-2, the 'Castlebanny Wind Farm Peat Stability Risk Assessment'.

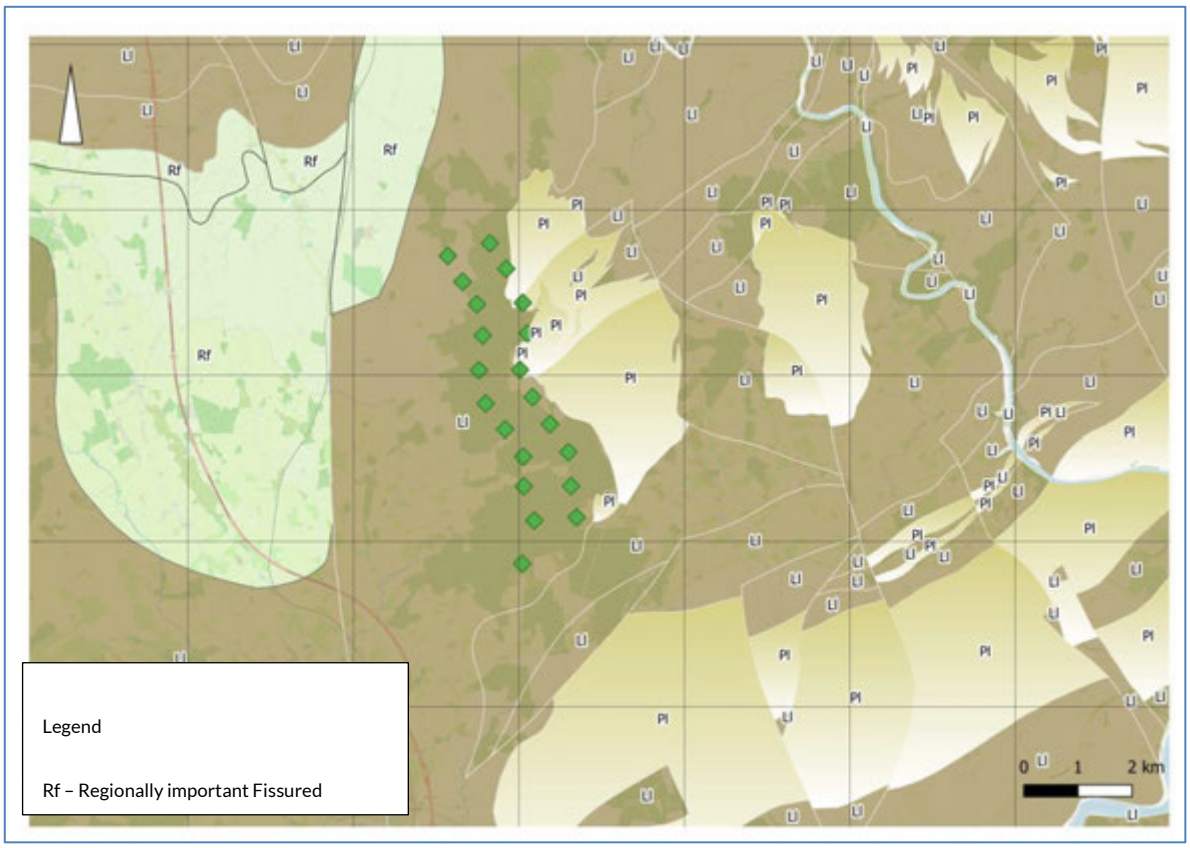


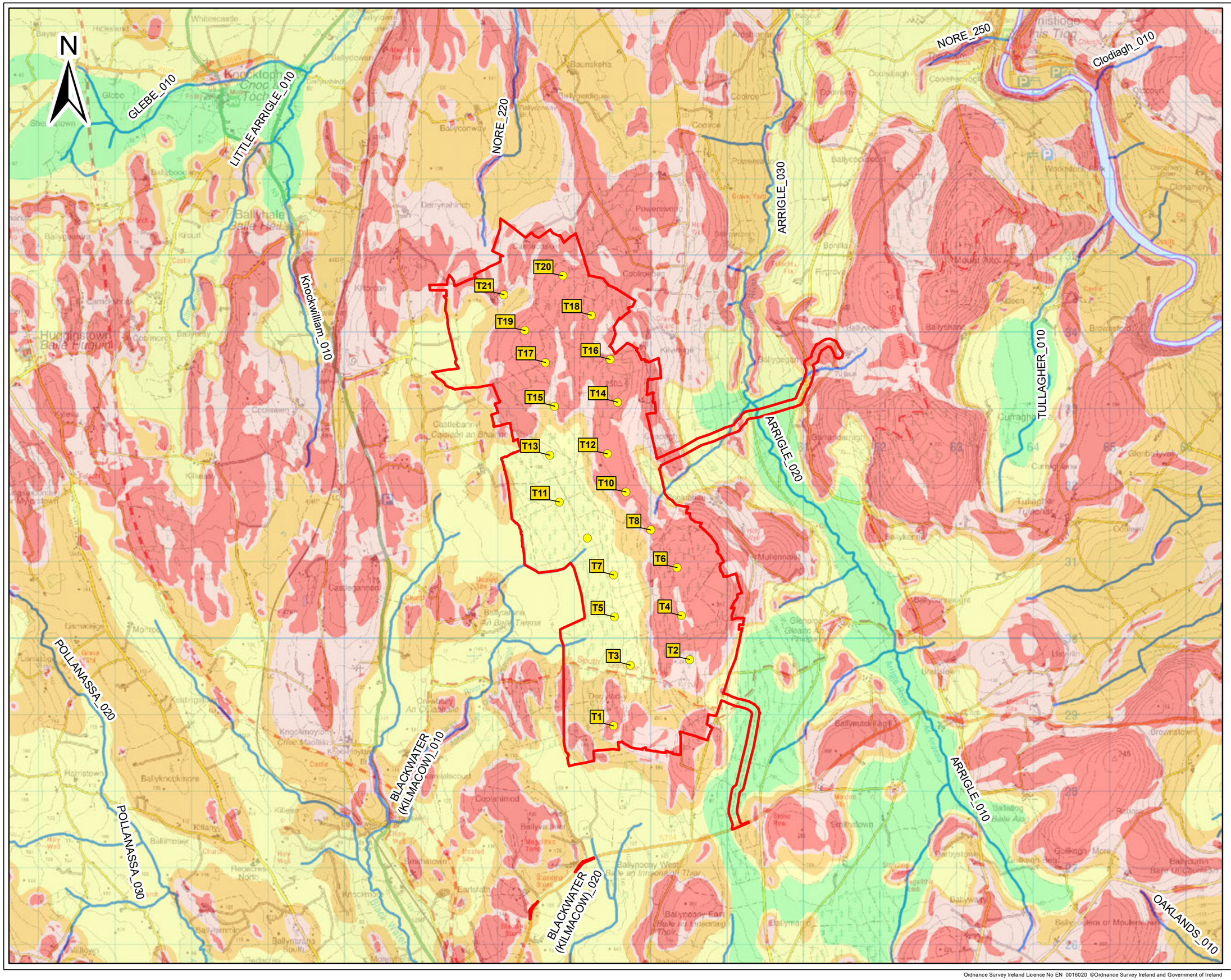
Figure 9-5: Aquifer Classifications

9.2.4.3 Groundwater Vulnerability

Groundwater vulnerability represents the intrinsic geological and hydrogeological characteristics that determine how easily groundwater may be contaminated by activities at the surface. Vulnerability depends on the quantity of contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels.

These factors are controlled by the types of subsoils that overlie the groundwater, the way in which the contaminants recharge the geological deposits (whether point or diffuse) and the unsaturated thickness of geological deposits from the point of contaminant discharge.

The groundwater vulnerability throughout the proposed site ranges from M (Medium) to X (Extreme), where bedrock is at or within 1m of surface. Figure 9-6 'Groundwater Vulnerability Map' illustrates the vulnerability classifications for this area. Site investigation and geophysical data would indicate that relatively shallow subsoil deposits occur at most turbine locations, depths of subsoils do not exceed 5.2 mBGL. Shallow soft soils were noted around the substation location.



Legend

- EIAR_Study_Area
- Turbine Locations

Vulnerability

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water
- Rivers

Issue	Date	Description	By	Chkd.
A	15/12/2020	Final	F.H.	M.W.

0 1 2
Kilometres

Client: COILLTE

Project: Castlebanny Wind Farm

Title: Groundwater Vulnerability Map

Scale @ A3: 1:45,000

Prepared by: F. Healy | Checked: M.Wong | Date: Dec 2020

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Drawing No.: Figure 9.6

Draft: A

9.2.4.4 Groundwater Usage

According to Kilkenny County Council and Irish Water, no public water scheme (PWS) is present within 2km radius of the site. Two groundwater abstractions were identified within 5km from the site (as shown in Figure 9-1 'Regional Surface Water Features/Catchment Delineation').

Listerlin Group Water Scheme (GWS) was identified 3km east of the site, drilled in 1899 for agricultural and domestic use. Thomastown PWS was identified 5km north of the site, two boreholes situated in the townland of Grennan abstract an estimated total of 3,200m^3/d to make up the public drinking water source for Thomastown.

Listerlin GWS' preliminary source protection area was delineated in 2015 and Thomastown PWS zone of contributions (ZOCs) were delineated for the EPA in 2002. No turbine is located within 2km of the GWS' source protection area and PWS' ZOCs.

According to the GSI database, there are no recorded well within the proposed development study area. According to the GSI well data, there is 1no. groundwater well to the east of Turbine No. 8. There are no known water supply wells within 730m of the turbines or borrow pits. It has been noted that many of the dwellings in the vicinity of the proposed development are served by private wells. For the purposes of the assessment, on a worst-case basis, all dwellings have been assumed to have a groundwater well 50m from the dwelling in the direction of the proposed development.

9.2.4.5 Groundwater Flow

On a regional scale, the groundwater flow direction is generally a subdued reflection of surface water drainage. Therefore, on a regional scale, the groundwater flow is considered to be towards the surrounding tributaries located to the east (Arrigle River) and west (Ballytarsna River) of the windfarm. Limited recharge to groundwater is likely to occur due to the presence of moderate permeability subsoil overlain by poorly drained gley soil. GSI estimates groundwater recharge over the area within the site boundary in the range of 100 to 168 mm/ yr with the application of a recharge cap. To the north of the proposed development at Castlebanny, red and brown conglomerate and sandstone bedrock are noted to be at ground surface. No significant groundwater discharges or large springs exist within the site. A Holy Well, identified as St Molin's Well, is located approximately 0.89km from the nearest proposed site infrastructure. The well is a spring. It was stated by a local resident that the water from the well is collected in a tank within the well area and discharges to one or two nearby houses downgradient. The well also serves as a locally important religious site. Local groundwater flow discharges to the local streams and drainage ditches in the area.

Groundwater levels were measured on site at the 2 No. boreholes adjacent to the borrow pits. Groundwater levels at BH N and BH S measured 1.9 to 6.25mbgl respectively indicating groundwater was generally deeper in the southern portion of the site. At a local scale, groundwater is expected to follow the topographic lay of the land indicating flows to the northwest and to the east where the site itself is situated at the higher elevation. The groundwater eventually discharges into rivers, namely Arrigle River and Ballytarsna River respectively.

9.3 POTENTIAL IMPACTS

9.3.1 Introduction

This section addresses the potential impacts on the hydrological and hydrogeological environment as a result of the development of the proposed wind farm. The potential impacts may comprise direct and indirect impacts on the quality of surface waters and groundwater. Thus, the hydrological and hydrogeological assessment identified water sensitive receptors located within the proposed site area and downstream from the proposed infrastructure works.

Annex III of the amended EIA Directive uses the following criteria to consider such impacts:

- the magnitude and spatial extent of the impact (for example geographical area and size of the population likely to be affected);
- the nature of the impact;
- the transboundary nature of the impact;
- the intensity and complexity of the impact;
- the probability of the impact;
- the expected onset, duration, frequency, and reversibility of the impact;
- the cumulation of the impact with the impact of other existing and/or approved projects; and
- the possibility of effectively reducing the impact.

The current proposals for all construction activities and operational infrastructure were reviewed to identify activities likely to impact upon identified water bodies including relevant water courses within and remote from the site. Following the identification of sensitive water receptors and potential impacts to the water environment at the development stage, the extent and severity of potential construction, operational, decommissioning and cumulative impacts were evaluated, taking into account all proposed control measures included in the project design.

9.3.1.1 Sensitivity of Receptors

The sensitivity of an environmental receptor is based on its ability to absorb an impact without perceptible change. The hydrological environment is considered to be of moderate to very high sensitivity for receptors draining to Arrigle, Nore and Blackwater Rivers via hydrological links. The EPA has found the water quality in the receiving waters to be good (Q4). Further information on the sensitivity rating for aquatic macroinvertebrates species can be found in Section 6.2 of the Biodiversity Chapter.

9.3.2 Do Nothing Scenario

If the wind farm development does not proceed, the proposed development site will remain as an agriculture and forestry site. Forestry will continue to be managed in accordance with the Forestry and Water Quality Guidelines.

If the Castlebanny Wind Farm development does not proceed, the proposed development site will remain as areas of agriculture and forestry, where normal agricultural and forestry activities will continue to occur into the future. Commercial forestry operations (including the associated drainage measures) would continue at the site. Agricultural practices (including the associated

drainage measures) would continue at the site. The increasing or decreasing pressures on the local water quality will continue without separate intervention. There are no significant impacts to the hydrological and hydrogeological environment in a do-nothing scenario.

9.3.3 Worst Case Scenario

Localised and short-term contamination of surface water streams could occur during the construction and operational phases, which in turn could affect the ecology and quality of the downstream water bodies such as the Arrigle River and Ballytarsna River. Also, potentially localised groundwater contamination may occur. However, good environmental practice on site and mitigation measures outlined in Section 9.6 will be put in place to prevent this from happening.

9.3.4 Construction Phase

9.3.4.1 Construction Activities

The construction phase of the development will involve the following key activities that could have potential impacts on surface water and groundwater conditions:

- Earthworks related to:
  - Construction of temporary and permanent infrastructure on site, including turbine foundations, hardstands, site access tracks, substation, construction compounds, and all associated onsite infrastructure;
  - Laying of underground electrical cabling, both within the proposed wind farm site, and as part of the grid connection;
  - Minor works at a number of locations along the TDR;
  - Borrow Pit excavations; and
  - Stockpiling material.
- Handling and storage of hydrocarbons, concrete and other potential water pollutants.

The construction of the temporary site compounds, site access tracks, turbine foundations, turbine hardstands, borrow pits, laying of underground electrical cabling and drainage channels will involve the removal of vegetation and forestry, the excavation of mineral subsoil and rock primarily from proposed borrow pits. Exposed and disturbed ground may increase the risk of erosion and subsequent sediment laden surface water runoff. The release of suspended solids is primarily a consequence of the physical disturbance of the ground during the construction phase, if not correctly compacted.

Incorrect site management of earthworks and excavations could, therefore, lead to loss of suspended solids to surface waters as a consequence of the following activities:

- Soil stripping, if necessary, to construct the access tracks, site compounds, turbine foundations, hardstands, turbines/hardstanding/tracks and substation;
- Run-off and erosion from soil stockpiles (prior to reinstatement/profiling/side casting);
- Dewatering of excavations for turbine foundations and angle mast foundations (where necessary). The result of increased sediment loading to watercourses is to degrade water quality of the receiving waters and change the substrate character.

9.3.4.2 Hydrology and Hydrogeological Impacts

Based on the construction phase activities outlined above, the potential hydrological and hydrogeological impacts can be summarised as follows:

- Surface water quality impacts;
- Surface water flow alterations; and
- Groundwater flow and quality impacts.

The proposed development represents 2.5% of the area within the wind farm site boundary There is potential for an increase in runoff due to <35ha of permanent additional hardstanding surfaces (e.g. turbine foundations, access tracks, substation buildings).

No significant quantity of peat was identified on site from site investigations. Minor areas of humic soils/ topsoil of less than 0.5m was noted in some areas.

Hardstand areas and additional access tracks could potentially reduce the infiltration capacity of the soils in areas where earthworks are undertaken and increase the rate and volume of direct surface runoff. Surface water control measures are incorporated into the design of the proposed development. The potential for an increase in runoff to streams is limited as surface water runoff will be controlled as part of the project design. Further detail is provided under Section 9.5.4 of this chapter.

Pre-mitigation, the potential construction impact will be a slight negative short-term impact.

As noted from the Flood Risk Assessment (Appendix 9-1), it is estimated that the stormwater management system proposed as part of the development will limit runoff from the site to greenfield runoff rates, therefore mitigating against an increase in flood risk elsewhere. Pre-mitigation, the potential construction impact will be an imperceptible neutral effect.

Pluvial Flooding:

There is no record of pluvial flooding or surface water ponding at the proposed wind farm site. Surface water arising at developed areas of the site will be managed by a dedicated stormwater drainage system designed in accordance with Sustainable Drainage Systems (SuDS) principles, limiting discharge from the site to greenfield runoff rates.

It is estimated that the natural landscaping and topography of the site will provide safe exceedance flow paths and prevent surface water ponding, therefore minimising residual risks associated with an extreme flood event or a scenario where the stormwater drainage system becomes blocked.

On this basis, the proposed wind farm is not at risk of pluvial flooding and there will be no cumulative effects on flood risk elsewhere based on the Flood Risk Assessment. The proposed development will not significantly alter the drainage regime of the site. Therefore, no cumulative impacts on other projects are anticipated.

Fluvial Flooding:

Two tributaries of the River Ballytarsna and one tributary of the River Arrigle flow within the subject site. The streams are <1m wide and dry during low flow periods. Due to the size of these streams, (catchment areas <1km^2), they were not surveyed or modelled as part of the OPW's CFRAM programme.

Based on the indicative flood mapping produced as part of the National PFRA Study, it is estimated that the proposed wind farm is not at risk of fluvial flooding from watercourses in the area.

The landscaping and topography of the site also provides a natural overland flow path to convey water away from the essential infrastructure.

While the R704 at the River Arrigle and local roads at Ballyhale and Knockwilliam are known to flood after heavy rainfall, there are no OPW records of past flooding within 1.5 km of the proposed wind farm site.

It is calculated that the stormwater management system proposed as part of the development will limit runoff from the site to greenfield runoff rates, therefore mitigating against an increase in flood risk elsewhere.

Groundwater Flooding:

There is no evidence from Geological Survey Ireland mapping to suggest that groundwater is a potential source of flood risk to the proposed wind farm site.

Coastal Flooding:

Given the elevated nature of the proposed wind farm site (145 mOD to 265 mOD), it is estimated that there is no risk of coastal flooding.

Based on the results of the Flood Risk Assessment, it is estimated that the risk of flooding to the proposed wind farm development will be minimal and that the development will not increase the risk of flooding elsewhere.

There is a potential impact on water quality as a result of the construction of turbine bases and excavation of borrow pits on site. Turbine base areas for example, are typically 3.5m to bottom of foundation concrete and will be up to 6 m deep based on site investigations. The final turbine base depths are dependent on ground conditions and groundwater encountered.

Groundwater inflows may need to be pumped, resulting in short term localised drawdown of the water table and discharges to surface water channels. Further assessment on the potential impacts on groundwater levels during excavation has been included under Section 9.5.3.4. There are no known water supply wells nor any PWS ZOCs within 730m of the proposed turbine locations and borrow pits. All infrastructure within the wind farm site inclusive of turbines, borrow pits, construction compounds, the met mast and the substation are located over 50m

from streams. The grid route crosses streams and this has been further discussed under Section 9.5.3.5.

As described in Chapter 2, Description of the Proposed Development, the proposed development involves the felling of a total of 82.9ha of onsite forestry in order to facilitate the construction of the wind farm infrastructure. Offsite areas established as suitable for replanting for the proposed development have been identified in Co Mayo, Roscommon, Westmeath and Clare (See Appendix 2-5 to this EIAR).

The main potential impacts during felling operations are the mobilisation of sediment and nutrient release (See Appendix 2-4 to this EIAR).

During construction of the wind farm, there is a risk of accidental pollution incidences from the following sources:

- Spillage or leakage of oils and fuels stored on site;
- Spillage or leakage of oils and fuels from construction machinery/vehicles;
- Spillage or leakage of wastewater from temporary site facilities;
- Spillage of oil or fuel from refuelling machinery on site; and
- Spillages arising during the use of concrete and cement for turbine foundations and hardstanding areas.

There will be a risk of pollution from site traffic through the accidental release of oils, fuels and other contaminants from vehicles. 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 (pH11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ≥ 6 ≤ 9 is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to aquatic environment. The washing out of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution. The pre-mitigation impact is considered as indirect, negative, short-term and likely to impact surface water.

9.3.4.3 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling)

Construction phase activities of the proposed development will require earthworks resulting in the removal of vegetation cover and excavation of mineral subsoil and are detailed in the Description of the Proposed Development (Chapter 2). No significant peat was identified on site. Minor areas of humic soils/topsoil of less than 0.5m was noted in some areas. Potential sources of sediment laden water include:

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

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in

turn could affect the water quality and fish stocks of downstream water bodies. Potential impacts are significant if not mitigated against. The pathways identified for construction earthworks are drainage and surface water discharge routes. The main receptors are downgradient rivers (Arrigle, Jerpoint Church Stream and Ballytarsna) and associated dependent ecosystems.

The pre-mitigation impact is indirect, negative, significant, temporary and of a medium probability impact.

All proposed main forest drainage crossings will be bottomless culverts or clear span structures. Clear span structures will be used at drain crossings south of T9 and T5. For the clear span structures, the existing banks will remain undisturbed and no in-stream excavation works are proposed. Therefore there will be no direct impact on the stream at the proposed crossing location. Drainage width, side slopes and substrate will be replicated in the proposed drainage channels. Where existing drains need to be rerouted/reprofiled, the original bed material will be reused. The sizing of any new internal drainage crossings will maintain existing depth of flow and channel characteristics. Where required, culverts will be buried at an appropriate depth below the channel bed.

9.3.4.4 Potential Impacts on Groundwater Levels during Excavation Works & from Proposed Borrow Pits

Dewatering of borrow pits and other deep excavations (i.e. turbine bases) have the potential to impact on local groundwater levels. Groundwater level impacts are not anticipated to be significant due to the local hydrogeological regime, as described below.

Borrow pit areas, where the shale bedrock depth ranges from near surface to 1.8 mBGL, will be excavated up to a maximum depth of 10m and deep excavations (i.e. turbine bases) up to 6 m deep, will encounter groundwater. It is unlikely that all borrow pits will be over 6m deep on average based on material balance calculation. Groundwater inflows may need to be pumped, resulting in short term localised drawdown of the water table and discharges to the surface water channels.

The pathway identified for deep excavations is groundwater flow paths. The receptor is groundwater levels and groundwater wells. The volumes of groundwater encountered will not be significant (based on the minor inflows encountered during site investigations) and low recharge rates (described in Section 9.2.4.5). The estimation of hydraulic properties from slug tests (see below) indicate dewatering requirements to result in 0.1m drawdown at 5 to 30 m from the point of abstraction. There are no wells within 0.73 km of the borrow pits and turbine locations.

Aquifer Hydraulic Properties

Slug tests were undertaken in BH N and BH S to provide an estimate of the hydraulic conductivity of the bedrock formation. This method consists of measuring the static water level (head) in the well, then introducing a near instantaneous change in water level, and measuring the change in water level over time until the water level returns to the original static water level.

The instantaneous change in piezometric head (static water level) can be achieved by adding or removing a volume of water from a well.

A slug test provides a very local estimate of hydraulic conductivity or transmissivity in the near vicinity of a well. As for aquifer tests, several analytical methods have been developed for the analysis of slug tests. Hvorslev (1951) was used to analyse the data.

The hydraulic permeability of the unconsolidated material interpreted from the data recorded from the test and interpreted using the mathematical solution by Hvorslev by matching a straight line to water- level displacement collected during an overdamped slug test is presented in Appendix 9-2. The average permeability, based on a number of different interpretations of the data for each shallow borehole is listed below:

BH N: K(average) = 0.01 m/day

BH S: K(average) = 0.06 m/day

Based on the range of permeability recorded within the site, a notable increase in permeability occurs to the south of the site. Based on the slug test data, the Transmissivity is at the lower range at > 0.1 m^2/day. Due to the presence of fractures (some noted to be clay infilled) and quartz veins in the boreholes and due to the potential variability within the formation, a conservative figure of 1 to 10 m^2/day is used.

Dewatering volume

The volume of water and the radius of influence is first estimated by empirical Sichardt Formula for radial flow:

$$R_o = C\ (H - h_w)\sqrt{K}$$

C = empirical calibration factor usually taken as 3000 when units are (m) for drawdown and (m/s) for permeability; H = initial aquifer piezometric or phreatic level; hw = piezometric or phreatic level in the equivalent well; (H – h_w) = drawdown in equivalent well (i.e. target drawdown); k = permeability.

Estimation of Discharge and Drawdown:

Radial Flow

- Unconfined conditions:

$$Q = \pi \,.\, k\ \frac{(H^2 - h^2)}{\{\ln(Ro/_{re})\}}$$

- Where r_e is the equivalent well radius. r_e can be taken as the radius of the equivalent well.

Based on the above principles and a Transmissivity value of 1 to 10 m^2/day; required groundwater discharge rates of 200 to 500 m^3/day are obtained. Assuming each borrow pit is reaching a maximum depth of 10 m BGL and dewatering from BH N and BH S, where static water levels were measured in July 2020 at 1.9 m BGL and 6.7 mBGL respectively. The empirical estimate calculates the 0.1m drawdown at >30 and >5m respectively. There are no wells within 730 m of the borrow pits.

Dewatering of borrow pits and other deep excavations (i.e. turbine bases) have the potential to impact on localised groundwater levels. However, groundwater level impacts are not anticipated to be significant, due to the low permeability bedrock aquifer and the relatively small volumes to be abstracted e.g. 200 to 500 m^3/day. Dewatering will locally depress groundwater levels by 0.1m in the immediate vicinity (5 to 30 m) of the pumping regime.

The pre-mitigation impact is considered as not significant, short term and unlikely to impact groundwater wells due to potential impacts of dewatering being very shallow and limited to 0.03 km from the point of abstraction, resulting in a temporary localised shallow depression in the aquifer.

9.3.4.5 Turbine Delivery Route and Cable Route

The excavations for cable route trenches and the temporary alterations for the TDR may have a direct permanent impact on the exposed soils and rock in the form of increased erosion and sediment release that, without mitigation, could also have additional impacts on water quality (due to sedimentation of water courses).

No in-stream, over-stream (i.e. within a bridge) or riparian works are proposed to facilitate the turbine delivery route road/junction accommodation works. Where any works are proposed within 50m of a watercourse, there is an increased potential for sediment release to the watercourse. The small scale and temporary nature of these works will result in ground conditions similar to agricultural cultivation at these locations. Overall, without mitigation, these works have the potential to have slight negative short-term effect on the surface water environment.

Modifications along the TDR involves the temporary removal of street furniture and clearing of some vegetation in addition to the temporary local widening at bends/junctions using hardcore material. Inappropriate management of the carrying out of these modifications could result in blockages of existing roadside drainage.

Any excavations for the cable route will expose bare soil for a temporary period over a short section of the trench.

The trench will be backfilled immediately following the installation of each section of cabling. While the trench is open, there will be a potential impact to the adjacent watercourse of an increase in the concentration of suspended solids.

There are 4 no. watercourse crossings on the proposed grid connection route. The locations of these crossings are shown on Figure 2-4. It was found that 2 no. of the crossings are over small

streams, while 1 no. is across the River Arrigle. One crossing is over a drainage ditch. Two of these locations have an existing culvert. A number of minor forestry and shallow artificial agricultural field drainage channels were also present, though these are thought to remain dry for the vast majority of the time.

The method for crossing two watercourses, including the Arrigle River and the Mullenhakill Stream, is a trenchless crossing. It is proposed that horizontal directional drilling (HDD) under the stream bed will be undertaken to prevent direct impacts on the watercourse. HDD involves drilling of a pilot hole from a drilling machine positioned at one side of the obstacle to be crossed. The hole is then reamed to make it larger and once the hole is of sufficient size, a pipe or conduit is pulled into the drilled hole. During the horizontal directional drilling, groundwater may be encountered.

The proposed HDD method carries a risk of indirect impacts from sediment laden runoff during the drilling launch pit excavation works. There is also the unlikely risk of frac out and contamination of the watercourse with drilling mud (clay). Receptors include the Arrigle River, River Nore and River Barrow. Mitigation measures to manage silt are included in section 9.6.The underground cable route follows an existing local road (L-3418) at its eastern end. Where this occurs, the cable will pass over two crossings, the drainage ditch and culverted stream within the road as described in Chapter 2 (Description of the Proposed Development). Guidance /mitigation measures recommended by Inland Fisheries Ireland (IFI) during the consultation process have been incorporated into the design of the proposed crossings.

The pre-mitigation impact of the TDR/Grid Route is considered as slight, short term and unlikely to impact due to the use of trenchless technology and proposed design.

9.3.5 Operational Phase

The proposed development footprint will comprise of 35 ha within the overall wind farm site area of 1,434ha (2.5%). The potential for significant changes in runoff is, therefore, low with a slight potential increase in runoff.

In addition, the greenfield runoff rate has been calculated based on the Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). The mean annual maximum flow rate(Qbar) is calculated to be 9.74 l/s/ha and 19 l/sec/ha for 1 in 100 year events. Based on climate change and an increase in hardstand surfaces, the potential increase in runoff. The potential for infiltration on the site is limited due to the existing moderate slopes and low/moderate permeability soils/bedrock. Climate change scenarios suggest fluvial floods in the 2080's increasing by up to 10% (low and medium low scenarios) or by up to 20% (medium high and high scenarios). Present recommendations are to include in the design flow a 20% increase in flood peaks as a result of climate change. The potential for increased runoff is addressed in the SuDs design measures. Mitigation measures are outlined in section 9.6 and include the use of swales, settlement ponds and other SuDs measures. Overall runoff is included below in table 9-8.

Table 9-8: Runoff calculation

Item	Values	Notes
Study Area	1,434 hectares-	
Development area	35 hectares-	Permanent Area of development –
Rainfall	1023mm/yr	Met Eireann data
Impermeable area predevelopment	80%	Low permeability soils and bedrock
Impermeable area post development	80.25% -	Based on the increase in runoff from 80 to 90% in the development footprint
Increase in runoff	100.5 m3/day	Increase in Runoff from impermeable area -
Potential Percentage runoff increase	0.25 %	Mitigation included in section 9.4

With regard to water quality impacts, while there will be no significant direct discharges to the surface water environment during the operational phase due to the nature of the development. Occasional access will be required there will be vehicles periodically on the site at any given time. This may lead to occasional accidental emissions, in the form of oil, petrol or diesel leaks, which could cause localised contamination of site drainage channels. However, due to the periodic nature of visits, the risk of surface water pollution during operation is considered to be low.

The presence of occasional maintenance workers at the proposed substation will lead to the generation of foul sewage from toilets and washing facilities. This foul sewage will be collected and tankered off-site for disposal at a licensed wastewater treatment facility such as Ballyhale-Knocktopher and Waterford.

The pre-mitigation impact is considered as slight, short term and likely to impact on surface waters.

9.3.6 Decommissioning Phase

Decommissioning of the proposed wind farm development will involve the disassembly and removal of the turbines offsite. These impacts have been assessed as similar to the Construction Phase and, therefore, the mitigation measures for the Construction Phase will also be implemented during decommissioning. Turbine hardstands will be covered over with soil and allowed to vegetate. It is not proposed to restore the hardstanding areas to commercial forestry after decommissioning.

Potential impacts will be minimised by leaving elements of the proposed development in place where appropriate including the site roads, turbine foundations, substation and the grid connection infrastructure. Internal roads and drainage will remain in place for forestry and recreational access and management.

9.3.6.1 Magnitude and Significance of Impact

The magnitude of an impact includes the timing, scale, size and duration of the potential impact. The magnitude criteria for hydrology/hydrogeology are defined as set out in Table 9-9 and 9-11 below.

Table 9-9: Magnitude and Significance of Hydrological/Hydrogeological Criteria – Construction

Criteria	Description	Duration and Frequency of Effects	Significance of Potential Effect
Runoff Regime	Potential localised increase in surface water runoff may be caused by impermeable areas on site. Impermeable areas may give rise to a slight increase in surface water flow locally but will not have a significant impact on the volumetric flow rate of downstream rivers. Potential increase in runoff is <1% from the windfarm area.	Short term and rarely	Slight negative
Surface Water Quality	Sedimentation of drainage ditches and streams. Sensitive receptors include the River Arrigle, River Nore, Suir and River Barrow.	Temporary and occasional	Slight/moderate negative
Groundwater Levels	No change in groundwater is expected. No ZOCs or wells within 50m of turbines.	Not applicable	Not significant
Groundwater Quality	Minor leaks or spills during the construction phase.	Short term and occasional	Not significant

Table 9-10: Magnitude and Significance of Hydrological/Hydrogeological Criteria – Operational

Criteria	Description	Duration and Frequency of Effects	Significance of Potential Effect
Runoff Regime	Increased surface runoff caused by impermeable areas on site may increase surface water flow locally but will not have a significant potential effect on the volumetric flow rate of downstream rivers. Site to be maintained at greenfield runoff rates.	Long term and rarely	Not significant
Surface Water Quality	No significant loss in water quality is expected.	Long term and rarely	Not significant
Groundwater Levels	No significant change in groundwater is expected.	Not applicable	Not significant
Groundwater Quality	No change in groundwater quality is expected.	Not applicable	Not significant

Table 9-11: Magnitude and Significance of Hydrological/Hydrogeological Criteria – Decommissioning

Criteria	Description	Duration and Frequency of Effects	Significance of Potential Effect
Runoff Regime	Potential localised increase in surface water runoff may be caused decommissioning activities on site. Impermeable areas may give rise to a slight increase in surface water flow locally but will not have a significant impact on the volumetric flow rate of downstream rivers. Potential increase in runoff is <1% from the development area.	Short term and rarely	Slight negative
Surface Water Quality	Sedimentation of drainage ditches and streams. Sensitive receptors include the River Arrigle, River Nore, Suir and River Barrow.	Temporary and occasional	Slight/moderate negative
Groundwater Levels	No change in groundwater is expected. No ZOCs or wells within 50m of turbines.	Not applicable	Not significant
Groundwater Quality	Minor leaks or spills during the decommissioning phase.	Short term and occasional	Not significant

9.4 MITIGATION MEASURES

As outlined in Chapter 2, Description of the Proposed Development, the design of the proposed development has considered a range of best practice construction measures which will ensure avoidance and reduction of impacts throughout the construction, operational and decommissioning phases. Additional measures have been developed to mitigate the impacts identified in the preceding section.

9.4.1 Mitigation by Avoidance

In identifying and avoiding sensitive surface waters, the proposed development has implemented 'avoidance of impact' measures. Mitigation by avoidance is viewed as part of the 'Reasonable Alternatives' outlined in Chapter 3. Examples include moving the grid connection route away from streams discharging into the River Arrigle, locating fuel storage and construction compounds >50 m from surface water streams. No marked streams are crossed by the turbine access tracks. A number of internal drains including drains near T5 and T9 are crossed by internal access tracks. These are typically dry during the summer months.

9.4.2 Mitigation by Prevention and Reduction

A number of mitigation measures are outlined below and are considered as in-built to the design of the project. These mitigation measures are a combination of measures to comply with legislation and best practice construction methods to be implemented in order to prevent water (surface water and groundwater) pollution. Examples of these measures are the storage of potentially polluting materials in fully bunded tanks and controlling / reducing runoff from hardstand areas.

9.4.3 Mitigation Measures – Construction Phase

In order to mitigate potential impacts during the construction phase, best practice construction methods will be implemented in order to prevent water (surface water and groundwater) pollution. A CEMP (Appendix 2-7 of the EIAR) was developed for the project to ensure adequate protection of the water environment. All personnel working on the project will be responsible for the environmental control of their work and will perform their duties in accordance with the requirements and procedures of the CEMP.

During the construction phase, all works associated with the construction of the wind farm will be undertaken in accordance with the guidance contained within CIRIA Document C741 'Environmental Good Practice on Site' (CIRIA, 2015). Any groundwater encountered will be managed and treated in accordance with CIRIA C750, 'Groundwater control: design and practice' (CIRIA, 2016). Groundwater from the borrow pits will be treated in the settlement lagoons. Subject to landowner permission, selected private water supply wells at representative locations closest to turbine and borrow pit locations around the site will be monitored for water level and quality pre-construction and during the construction phase.

All mitigation and management measures outlined hereunder will be incorporated into the Surface Water Management Plan, which forms part of the CEMP (Appendix 2-4 of the EIAR). Mitigation measures are incorporated into the CEMP and will be incorporated into the

specification for the Civil Engineering Works contract. The implementation of the Surface Water Management Plan will be overseen by a suitably qualified ecologist/engineer and will be regularly audited throughout the construction phase. The assigned ecologist/engineer will be required to stop works on site if he/she is of the opinion that a mitigation measure or corrective action is not being appropriately or effectively implemented.

Monitoring

It is recommended that local surface water features in the immediate vicinity of the site boundary are monitored pre-construction and during construction to take account of any variations in the quality of the local surface water and groundwater environment as a result of activities related to the proposed development. Monitoring of selected groundwater wells/spring including St Molins Well and private water supply wells (for water level and quality), subject to landowner consent, will be undertaken pre-construction and during the construction period.

Inspections of silt traps are critical after prolonged or intense rainfall while maintenance will ensure maximum effectiveness of the proposed measures. Turbidity monitors/alarms will be strategically placed upgradient on the River Arrigle and downgradient of works to assess on-going construction works. A programme of inspection and maintenance will be designed, and dedicated construction personnel assigned to manage this programme. A checklist of the inspection and maintenance control measures will be developed and records kept.

During the construction phase, field testing and laboratory analysis of a range of parameters will be undertaken at adjacent watercourses, specifically following heavy rainfall events (i.e. weekly, monthly and event based as appropriate).

9.4.3.1 Turbines, Hardstanding, Temporary Construction Compounds, Met Mast, Access tracks

As stated previously, to maximise the erosion and sediment control benefits of natural vegetation soil cover, stripping of soil is to be kept to a minimum and confined to construction areas only. Where practical, construction works will be staged to minimise the extent and duration of disturbance, e.g. plan for progressive site clearance, only disturbing areas when they are scheduled for current construction work.

To minimise any impact on the underlying subsurface strata from material spillages, all oils and solvents used during construction will be stored within specially constructed dedicated bunded areas. Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles will take place in a designated area of the site, away from surface water gullies or drains. Spill kits and hydrocarbon absorbent packs will be stored in this area and operators will be fully trained in the use of this equipment. For certain vehicles which are less mobile, refuelling may need to occur elsewhere on site. This will be carried out using a double skinned and bunded bowser, towed behind a jeep (or similar). Refuelling using this will take place only by trained personnel, and only at locations greater than 50m from any watercourse. A spill kit will be stored with the bowser and the person operating the bowser will be trained in their use. When not in use this will be stored in the designated area of the construction compounds.

All construction waste will be sorted and stored in on-site skips, prior to removal by a licensed waste management contractor.

9.4.3.2 Concrete

Concrete is required for the construction of the turbine bases and foundations. After concrete is poured at a construction site, the chutes of ready mixed concrete trucks must be washed out to remove the remaining concrete before it hardens. Wash out of the main concrete bottle will not be permitted on site; wash out is restricted only to chute wash out. Wash down and washout of the concrete transporting vehicles will take place at an appropriate facility offsite.

The best management practice objectives for concrete chute washout are to collect and retain all the concrete washout water and solids in leak proof containers or impermeable lined wash out pits, so that the wash material does not reach the soil surface and then migrate to surface waters or into the ground water. The collected concrete washout water and solids will be emptied on a regular basis. Washout will be undertaken at the construction compounds.

Plate 9.1: Example of Concrete Washout on Site

9.4.3.3 Fuels and Chemicals

With regards to on-site storage and handling of potentially pollutant materials:

- Fuels and chemicals will be stored within bunded areas as appropriate to guard against potential accidental spills or leakages. The bund area will have a volume of at least 110 % of the volume of such materials stored;
- All on-site refuelling will be carried out by a trained competent operative.
- Mobile measures such as drip trays and fuel absorbent mats kept with all plant and bowsers and will be used as required during all refuelling operations;
- A spill kit will be stored with the bowser and the person operating the bowser will be trained in their use;
- No refuelling will take place within 50 m of any watercourse;
- All equipment and machinery will have regular checking for leakages and quality of performance and will carry spill kits;
- Any servicing of vehicles will be confined to designated and suitably protected areas such as construction compounds; and

- Additional drip trays and spill kits will be kept available on site, to ensure that any spills from vehicles are contained and removed off site.

9.4.3.4 Erosion and Sediment Control

As outlined above, if not correctly managed, earthworks can lead to loss of suspended solids to surface waters. The main factors influencing the rate of soil loss and subsequent sediment release include:

- Climate;
- Length and steepness of slopes;
- Soil erosion potential;
- Soil Vegetation/cover;
- Duration and extent of works; and
- Erosion and sediment control measures.

9.4.3.4.1 Pre-emptive Site Drainage Management

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

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

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

Works will be suspended if forecasting suggests any of the following is likely to occur:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded; and
- Provide cover to material storage areas i.e. adequate tarpaulin over stockpile areas if material cannot be reinstated prior to suspension.

As a further precaution, near-stream construction work will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document *"Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites"*, that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall and, therefore, minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses.

Runoff will be maintained at Greenfield (pre-development) runoff rates. The layout of the development has been designed to collect surface water runoff from hardstanding areas within the development and discharge to associated surface water attenuation lagoons adjacent to the proposed infrastructure. It will then be managed by gravity flow at Greenfield runoff rates.

It is proposed, that during the ground clearance of the proposed development, the contractor will implement water control measures to limit the impact on water quality using standards measures as set out in Forestry Report – Appendix 2-4. Brash will be used along harvesting and extraction routes for soil protection. The forwarder will be loaded to the manufacturer's maximum specification and no more to avoid overloading and unnecessary soil compaction.

Suspended solid (silt) removal features will be implemented in accordance with CIRIA C697 SuDS Manual, and CIRIA C648 Control of water pollution from linear construction projects.

All temporary and permanent drainage from the site shall be designed to have as a minimum three stages of treatment, as defined in the SuDS Manual. Management of runoff will include the following:

- Filtration of water through filter media (sand / stone check dam, silt fence);
- Detention / settlement in settlement ponds or behind check dam in swales; and
- Conveyance of shallow depths of water in vegetated swale.

9.4.3.4.2 Interceptor Drains

Interceptor drains/diversion ditches will be installed ahead of the main earthworks activities to minimise the effects of collected water on the stripped/exposed soils once earthworks commence. This drainage will integrate into the existing forestry drainage. These drainage ditches will be installed on the upgradient boundary of the areas affected by the access track earthworks operations and installed ahead of the main track construction operations commencing. They will generally follow the natural flow of the ground. The interceptor drains will intercept any storm water surface run-off and collect it to the existing low points in the

ground, allowing the clean water flows to be transferred independently through the works without mixing with the construction drainage. It will then be directed to areas where it can be redistributed over the ground by means of a level spreader.

9.4.3.4.3 Swales

Track edge drainage/swales are required to control run-off from the running surface to lower water levels in the subgrade, to control surface water and to carry this flow to outlet points. Swales along access tracks are to be installed in advance of the main construction phase. On sections of track where there is significant longitudinal gradient, regular surface water interception channels will be employed – these will typically be at 10-20m intervals to collect any surface water that is discharging as sheet flow along the track and discharge the flow into the trackside swale. Swales will provide additional storage of storm water where located along gradient. Given the steep longitudinal gradients on some sections of access track, regular check dams will be employed within the trackside swale on these sections to reduce the flow velocity and provide settlement opportunity. Check dams will be constructed from course gravel/ crushed rock. Check dams will have a minimum 0.2m freeboard (from top of check dam) to top of swale level, to prevent overtopping of flows onto the access track. All check dams, etc to be checked at least once weekly via a walkover survey during the full period of construction. All excess silts to be removed and disposed of appropriately. Where check dams have become fully blocked with silt, they will be replaced.

Swales will be re-vegetated by hydro-seeding with indigenous seed mix as soon as is practicable following excavation. This will reduce the flow velocity, treat potential pollutants, increase filtration and silt retention.

9.4.3.4.4 Settlement Ponds

Settlement ponds will be located downstream of road swale sections and at turbine/hardstand locations, to manage/buffer volumes of runoff discharging from the drainage system during periods of high rainfall, thereby reducing the hydraulic loading to watercourses. Settlement ponds are designed in consideration of the greenfield runoff rates.

The following shall apply to construction of settlement ponds at the site:

- Pond depths generally to be excavated to less than 2m;
- Side slopes to be shallow, nominally at a 1 in 3 side slope (maximum); and
- Material excavated from the settlement pond should be compacted around the edge of the pond.

Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained.

The settlement pond design is based on primary settling out of suspended solids from aqueous suspension. The theory behind the design of the settlement lagoons is the application of Stoke's Law. The settlement lagoons will be designed to provide sufficient retention time and a low velocity environment to allow suspended solids of a very small particle size to fall out of suspension prior to allowing the water to outfall to the receiving environment. Flow rates for storm events will be maintained at or below greenfield runoff rates as detailed above in Section 9.5.4.

Settlement lagoons will be installed concurrently with the formation of the road and will be fenced off for safety. They will be located as close to the source of sediment as possible and as far as possible from the buffer zones of existing watercourses. The minimum buffer zone width will be 50m as outlined above.

Settlement lagoons will be regularly cleaned/maintained to provide effective and successful operation throughout the works. Outfalls and drainage ditches will be cleaned, when required, starting up stream with the outfalls blocked temporarily prior to cleaning.

The sediments/silt in the settlement lagoons will be cleaned regularly and removed via the contractor and deposited at suitable locations on site, away from watercourses. Machine access is required to excavate the accumulated sediment. Control measures include:

- Regular inspection and maintenance of settlement lagoons and drains;
- Settlement lagoon maintenance and/or cleaning will not take place during periods of extended heavy rain;
- Settlement lagoons will be fenced off for safety;
- Settlement lagoons will where practicable be constructed on even ground and not on sloping ground and where possible will discharge into vegetation areas to aid dispersion; and
- The settlement lagoons will be monitored closely over the construction timeframe to ensure that they are operating effectively.

All stockpiled material will be side cast, battered back and profiled to reduce rainfall erosion potential. The stockpiling of materials will be carefully supervised as per the mitigation measures listed in Section 8.5.1 within Chapter 8, Soils and Geology.

Traffic on site will be kept to a minimum. Only the proposed onsite access track will be used for project-related traffic.

Correct buffer zone management will help reduce the risk of sedimentation from felling operations (See Appendix 2-4). Buffer zone guidelines for planting and felling activities are provided by the Forestry Service in the *'Forestry and Water Quality Guidelines'*; it is proposed to apply these buffer zone guidelines to construction activities also. Construction activities will be curtailed within buffer zones in order to reduce erosion and sedimentation and, therefore, to protect water quality. Buffer zone widths vary from 10m to 25m, depending on slope and soil erosion classification. Details of buffer zones are included in Table 9-12.

Table 9-12: Recommended Buffer Zone Widths

Average slope leading to aquatic zone	Buffer zone width on each side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate (even to 1:7 / 0 -15%)	**10 m**	15 m
Steep (1: 7 to 1: 3 / 15 - 30%)	**15 m**	20 m
Very steep (1: 3 / > 30%)	**20 m**	25 m

The slopes across the proposed Wind Farm site are predominantly moderate with some steep slopes. As the soil type varies across the site, this suggests that a 10 to 20m buffer zone is appropriate. As an additional measure, all infrastructure on the proposed wind farm site including for turbines, borrow pits, site compounds, substation and access tracks (excluding grid connection) will maintain a 50m set back from streams.

All associated tree felling will be undertaken using good working practices as outlined in the Forestry Report and CEMP (Appendices 2-4 and 2-7 of this EIAR), the Forest Service in their 'Forestry Harvesting and Environment Guidelines' (2000) and the 'Forestry and Water Quality Guidelines '(2000). The latter guidelines deal with sensitive areas, erosion, buffer zone guidelines for aquatic zones, ground preparation and drainage, chemicals, fuel and machine oils. Brash mats will also be used to support harvesting and forwarding machinery. The brash mats reduce erosion of the surface and will be renewed as they become used and worn over time.

Temporary Site Compounds Construction

During the construction phase, two temporary site compounds will be required. Temporary on-site toilet facilities (chemical toilets) will be used. These will be sealed with no discharge to the surface water or groundwater environment adjacent to the site.

Surface Water Flow and Watercourse Crossings

Potential impacts on surface water flow during the construction phase of the wind farm are mitigated by the proposed drainage design which has been designed to minimise disturbance to the current hydrological regime by maintaining diffuse flows.

Where main drain crossings occur (i.e. access tracks), it is proposed to use a clear-span design bridge or bottomless culverts. Installation of such features will take place during dry periods to reduce the risk of sediment entering the watercourse. Smaller forestry drains with be crossed using normal culverts.

A number of ephemeral drainage features (drains) are also present on site. These appear stagnant or dry except during wet weather. Culverting of these will only take place during dry weather periods. Culverts will be designed to be of a size adequate to carry expected peak flows. Culverts will be installed to conform, wherever possible, to the natural slope and alignment of

the drainage line. Where required, culverts will be buried at an appropriate depth below the channel bed and the original bed material placed at the bottom of the culvert. The sizing of any new internal drainage crossings will maintain existing depth of flow and channel characteristics.

The CEMP and method statement for watercourse crossings follows the guidelines set out in the following documents:

- CIRIA (2001). Control of water pollution from construction sites - Guidance for consultants and contractors (C532). Construction Industry Research and Information Association, London.
- CIRIA (2006). Control of Pollution from Linear Construction Project; Technical Guidance (C648). Construction Industry Research and Information Association, London.
- CIRIA (2015a). Manual on scour at bridges and other hydraulic structures, second edition (C742). Construction Industry Research and Information Association, London.
- CIRIA (2015b). Environmental Good Practice on Site (4th edition) (C741). Construction Industry Research and Information Association, London.
- CIRIA (2019). Culvert, screen and outfall manual (C786). Construction Industry Research and Information Association, London.
- DHPLG (2019). Draft Revised Wind Energy Development Guidelines. Department of Housing, Planning and Local Government. December 2019
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- Murphy, D.F. (2004). Requirements for the Protection of Fisheries Habitat During Construction and Development Works at River Sites. Eastern Regional Fisheries Board, Dublin.
- NRA (2008). Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes. National Roads Authority.
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note);
- SNH (2012). Assessing the cumulative impact of onshore wind energy developments. Scottish Natural Heritage, March 2012.
- SNH (2019). Good Practice during Wind Farm Construction (4th edition). Scottish Natural Heritage.

Embedded culverts will be buried to a depth of 0.3m or 20% of their height (whichever is greatest) below the bed. Crossing construction will be carried out, in so far as is practical, with minimal disturbance to the drain bed and banks. If they have to be disturbed, all practicable measures including location of stockpiles away from drainage ditches will be taken to prevent soils from entering any water. Any culverting works at drains will take place only during dry periods when the drains are dry/stagnant. Silt traps will be placed on the downgradient side of the crossing.

Cement and raw concrete will not be spilled into watercourses. No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and emplacement of

pre-cast elements will take place. Pre-cast elements for bridge, culverts and concrete works will be used where possible. During the delivery of concrete on site, only the chute will be cleaned on-site, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout lagoons. These lagoons will be cleaned out by a licensed waste contractor. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Weather forecasting will be used to plan dry days for pouring concrete. The pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

A setback distance of 10 to 20 m from any watercourse will be kept clear of brash as far as practicable, to avoid felling of trees into watercourses and removal of them or any other accidental blockages that may occur. Where practicable, crossings should be adequately elevated with low approaches such that water drains away from the crossing point. Earth embankments constructed for bridge approaches will be protected against erosion e.g. by re-vegetation or rock surfacing etc.

9.4.3.5 Substation

The mitigation strategies for the substation foundations follow similar procedures to the excavations for turbine and hardstanding foundations, see Section 8.6.3.1. All works will be monitored by a suitably qualified and experienced engineer.

Where existing drainage ditches need to be realigned (e.g. around substation), the new ditch will match the profile of the existing ditch in relation to side-slope profile and the material at the base of the channel.

9.4.3.6 Turbine Delivery Route and Grid Connection Route

Silt fencing will be erected at the location of stream crossings along the grid connection route. Silt curtains and floating booms will also be used where deemed to be appropriate and this will be assessed separately at each individual location.

No refuelling of machinery will take place within 50m of a watercourse. Excavated material will not be stockpiled or side-cast within 50m of a watercourse. Appropriate steps will be taken to prevent soil/dirt generated during the temporary upgrade works to the TDR from being transported on the public road. Road sweeping vehicles will be used to ensure that the public road network remains free of soil/dirt from the location of the TDR works and grid connection when required. This will reduce the potential for sedimentation of surface watercourses locally.

Further mitigation measures in relation to the grid connection cable route and road/junction accommodation works on the TDR are outlined in the CEMP in Appendix 2-4 of the EIAR.

There will be 3 no. natural watercourse crossings along the grid connection route, and one significant drainage ditch crossing. Directional drilling is the proposed construction method for 2 no. of identified crossings, at the River Arrigle and one of its tributaries. Shallow trefoil formation will be used for the other two crossings in order to cross over existing drains/ culverts. Where existing drainage ditches need to be realigned (e.g. around substation), new ditches will match profile of existing ditch in relation to width, existing side slope profile (or lower) and material at base of channel will reused. The sizing any new culverts will be designed to maintain existing flow characteristics and depth of flow. Within the site development area, culverts will

be assessed to ensure no barriers to fish migration occur. Where barriers occur, such culverts will be improved to increase fisheries potential.

Directional Drilling Mitigation Measures:

In order to prevent significant water quality impacts and morphological impacts, trenchless technology will be carried out to install the cable below the River Arrigle and Mullenakill Stream.

A number of measures to mitigate potential impacts associated with the directional drilling are listed below:

- A minimum 50 metre vegetative buffer zone will be maintained between the works area and the watercourse.
- There will be no storage of material / equipment or overnight parking of machinery inside the 50m buffer zone;
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channel along the 50m buffer zone boundary;
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse;
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages;
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area;
- Spills of drilling fluid will be cleaned up immediately and stored in an adequately sized skip before being taken off-site;
- If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works);
- This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed distribution area at least 50m from the watercourse;
- The discharge of water onto vegetated ground at the percolation area will be via a silt bag which will filter any remaining sediment from the pumped water.;
- Any sediment laden water from the works area will not be discharged directly to a watercourse or drain;
- Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse;
- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied;
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the earliest opportunity to prevent soil erosion;
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated;
- There will be no refuelling allowed within 50m of the watercourse crossing; and,
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e. Clear Bore Drilling Fluid or similar will be used);
- The area around the drilling fluid batching, pumping and recycling plants will be bunded using terram and/or sandbags to contain any potential spillage;
- One or more lines of silt fencing will be placed between the works area and the adjacent river;
- Spills of drilling fluid will be cleaned up immediately and transported off-site for disposal at a licensed facility;
- Adequately sized skips will be used where temporary storage of arisings are required;
- The drilling process / pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology or local watercourse;
- This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur then drilling will be immediately stopped;
- Any frac-out material will be contained and removed off-site; and
- The drilling location will be reviewed, before re-commencing with a higher viscosity drilling fluid mix.

9.4.3.7 Major Accidents/Disasters

As part of the requirements of the new EIA Directive, the applicant is requested to consider the "Expected Significant Adverse Effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned."

This section describes the expected significant effects on the environment arising from the vulnerability of the proposed development to risks of major accidents and/or natural disasters which are relevant the project. The EIA Directive which states the need to assess: "the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or natural disasters which are relevant to the project concerned."

In this regard, the most likely major accidents that could occur as a result of the proposed development (and its associated works) include:

- Significant hydrocarbon spillage;
- Turbine collapse; and
- Turbine or substation fire.

The most likely natural disasters that might occur and potentially impact the proposed development (and its associated works) include:

- Fire; and
- Landslide.

Due to the limited quantities of fuel on site and disperse storage, the potential for a significant spillage of hydrocarbons is negligible and does not give risk to a major accident or disaster. Notwithstanding the negligible risk of serious spillage, additional spillage protection measures are included in the mitigation measures for the Proposed Development. In the unlikely event of a minor spill, the spill will be collected by the dedicated refuelling hardstand area, only completed by trained operatives and spill kits to be made readily available. Additional measures in relation to hydrocarbon or oil spills are further discussed in Section 9.6.4.1. Section 8.5 outlines mitigation measures in relation to potential contaminants.

There are no streams in close proximity to turbine or substation locations. Due to the felling of trees around the substation and turbine locations, in the unlikely event of a fire there is no significant additional fire risk due to separation distances. In the event of substation or turbine fire there is minimal potential for fire spread due to the proposed design (i.e. hardstand areas combined with tree felling buffers) and limited volumes of hydrocarbons or flammable material. There is no significant impact on the surface water from turbine collapse, turbine or substation fire.

It can be concluded that the risk of major accidents associated with this development and hydrological/hydrogeological factors is very low and would not cause unusual, significant or adverse effects on the hydrological or hydrogeological environment during the construction, operational and decommissioning phases.

9.4.4 Mitigation Measures – Operational Phase

The following mitigation measures will be implemented during the operational stage.

9.4.4.1 Turbines, Hardstanding, Temporary Construction Compounds, Met Mast, Access tracks

The operational team will carry out maintenance works such as servicing of wind turbine and transmission infrastructure, upkeep of access tracks and any hardstand areas, ensuring drainage system remains functional throughout the operation of the windfarm.

Mitigation for the operational maintenance works include regular scheduled maintenance works, regular inspections of all project elements with any unscheduled repairs or maintenance arising to be undertaken.

The potential impact of hydrocarbon or oil spills during the operational phase of the windfarm are limited by the size of the fuel tank of vehicles used on the site. Mitigation measures for the potential release of hydrocarbons or oil spills include:

- The plant and vehicles to attend site should be regularly inspected or at least prior to the scheduled site visit to be free from leaks and is fit for purpose;
- Fuels stored on site will be minimised, any storage areas will be bunded appropriately for the fuel storage volume for the time period of the operation;
- Operational team to be competent and trained in an emergency plan for the operation phase to deal with accidental spillages; and
- Spill kits will be available to deal with accidental spillages.

9.4.4.2 Substation

All fuel will be stored in bunded areas. The bund capacity will be sufficient to accommodate 110% of the largest tank's maximum capacity or 25% of the total maximum capacities of all tanks, whichever is the greater. The exception to this being double walled tanks equipped with leak detection, which do not require additional retention.

A hydrocarbon interceptor will be installed at the proposed substation site with regular inspection and maintenance, to ensure optimal performance.

Given the requirement for sanitary facilities during occasional operation and maintenance works, wastewater effluent will be directed to an onsite holding tank, from where it will be tankered off site to a suitably licensed wastewater treatment plant. An automatic alert system

will be used to monitor the holding tank to alert the operator if the tank is nearing full capacity. A water supply will be collected using a rainwater harvesting facility on the control building. Potable water will be brought onsite in bottles.

9.4.5 Decommissioning Phase

Decommissioning of the proposed development would result in the cessation of renewable energy generation, the removal of all above ground turbine components whilst other infrastructural elements such as turbine foundations. The site access tracks, parking area, cabling and substation will remain in place.

The risks associated with leaving tracks and infrastructural components in situ are relatively low. The decommissioning phase will not require any significant works that will impact the drainage network. A fuel management plan to avoid contamination by fuel leakage during decommissioning works will be implemented as per the construction phase mitigation measures.

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the impacts will be avoided by leaving elements of the Proposed Development in place. The turbine bases and hardstanding areas will be rehabilitated by covering with locally sourced topsoil 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 in Section 9.6.3.

These impacts have therefore been assessed as similar to the construction phase. Mitigation measures for the construction phase will therefore also be implemented during decommissioning.

9.5 RESIDUAL EFFECTS

The potential residual impacts on the surrounding water quality, hydrology and existing drainage regime at the site are considered to be slight and temporary/short term in nature. The existing on-site drainage system will remain active during construction and operation of the proposed development.

The construction timescale of activities within the site will be phased and short-term in duration and, thereafter, the only activities occurring within the site will be associated with maintenance, such as maintaining the wind turbines and existing drains, ongoing maintenance, replacement of turbines and onsite infrastructure and monitoring during the operational phase. There are no significant long-term impacts.

The design of the proposed wind farm has taken account of the potential impacts of the development and the risks to the surface water and groundwater environment. Measures have been developed to mitigate the potential effects on the water environment. These measures seek to avoid or minimise potential effects in the main through the implementation of best practice construction methods and adherence to all relevant legislation. Residual impacts are outlined in Table 9-13 to Table 9-15.

Table 9-13: Magnitude and Significance of Hydrological Criteria – construction (residual impacts)

Criteria	Duration and Frequency of Effects	Significance of Potential Effect
Runoff Regime	Short term and rarely	Not significant
Surface Water Quality	Temporary and occasional	Not significant
Groundwater Levels	Short term and rarely	Not significant
Groundwater Quality	Short term and occasional	Not significant

Potential residual impacts from the construction phase of the proposed development on the hydrological and hydrogeological environment are considered to be negative, short term and not significant.

Table 9-14: Magnitude and Significance of Hydrological Criteria – operational (residual impacts)

Criteria	Duration and Frequency of Effects	Significance of Potential Effect
Runoff Regime	Long term and rarely	Not Significant
Surface Water Quality	Long term and rarely	Not Significant
Groundwater Levels	Long term and rarely	Imperceptible
Groundwater Quality	Long term and rarely	Imperceptible

Potential residual impacts from the operational phase of the proposed development on the hydrological and hydrogeological environment are considered to be negative, of an unlikely probability, long term and not significant.

Table 9-15: Magnitude and Significance of Hydrological Criteria – Decommissioning (residual impacts)

Criteria	Duration and Frequency of Effects	Significance of Potential Effect
Runoff Regime	Short term and rarely	Not Significant
Surface Water Quality	Temporary and occasional	Not Significant
Groundwater Levels	Short term and rarely	Imperceptible
Groundwater Quality	Short term and occasional	Imperceptible

Concerning the hydrological impacts, there is no potential for impact on a number of the sensitive receptors as a result of keeping most of the below ground infrastructure. No changes to the internal drainage which could lead to localised erosion are anticipated. The

decommissioning phase would have an unlikely and imperceptible impact for the high sensitivity watercourses.

9.6 CUMULATIVE IMPACTS

Cumulative effects of this project with other developments in the region, as discussed in Chapter 4 - Policy, Planning and Development Context, relate to the indirect effects that may arise due to the use of public roads as haul roads to bring materials to site. Chapter 16 - Traffic and Transport details the scenarios whereby the materials will be imported onto site and assess the cumulative effects on road networks.

In terms of the potential impacts of wind farm developments on downstream surface water bodies, the biggest risk is during the construction phase of the development as this is the phase when earthworks and excavations will be undertaken at the sites.

Potential hydrological cumulative impacts arising from the proposed Windfarm and proposed grid connection are also not expected to be significant because the cables will be placed within the one trench along existing roads thereby reducing overall excavation requirements. Also, no in-stream works are required along the grid connection route.

The proposed forestry replanting sites area remote from the site of the Proposed Development (in County Roscommon, Mayo, Clare and Westmeath) in different groundwater and surface water catchments. There is no hydrological or hydrogeological connectivity between the replanting sites and the site of the Proposed Development, and therefore there can be no cumulative effects or interactions at any phase of the development. There will be no significant impact of the replanting with the implementation of the Forestry and Water Quality Guidelines (Forest Service, 2000).

A review of Section 4.6 of this EIAR and the Kilkenny County Council Planning Register shows that the following 'other developments' as described above are relevant planning applications in terms of the 10km zone of influence radius surrounding the proposed development site.

Pl. Ref. 103 – Planning application in 2010 by ESB for the development at this site at Kilkenny 110kV electrical transformer station. The development will consist of Amendment to previously approved application Reg. Ref: 08/404. Permission was granted 22/02/2010.

Pl. Ref. 16/14 - Planning permission for the permission of a period of 15 years and the retention of existing quarry with an extraction area of approximately 1.20 ha. At Castlegannon, Ballyhale. Planning permission was granted 24/10/2016.

Pl. Ref. 16/445 – Highfield Solar Limited application for a 10 year permission for the construction of a Solar PV Energy development at Derrynahinch, Knocktopher, within a total site area of up to 10.6ha, to include one, single-storey electrical substation building, electrical transformer/inverter station modules, solar PV panels ground mounted on steel support structures. Granted by Council 17/01/2017.

Pl Ref: 16/778 - ART Generation Ltd application for a solar farm at Tullaroan, Callan, consisting of PV arrays for the generation of electricity of up to 5MW for export to the national grid on land covering an area of approximately 10.6 hectares (approximately 9.8 hectares for the solar arrays and 0.8 for the existing site entrance and access road) with associated infrastructure. Granted by Council 25/04/2017.

Pl Ref: 16/592- Solar Sense SPV3 Limited applied for permission for a solar photovoltaic installation comprising up to 26,100m2 of solar panels on ground mounted frames, 4 no. inverters housed in 2 units, 1 no.20kV substation, security fencing, new entrance onto public road, access tracks, CCTV; underground cable and ducts including underground cable and ducts along the public road to the entrance of the existing Ballyhale substation within the townland of Kiltorcan, Co. Kilkenny. Kilkenny County Council refused permission but the decision was over turned by ABP and they granted permission 13/02/2018.

Pl Ref: 18/573 – EirGrid plc application for proposed uprate works on the existing 110kV line between Great Island substation, Co. Wexford and Kilkenny substation, Co. Kilkenny, Permission was granted 08/03/2019.

Pl Ref: 19/538 – Solar Sense SPV 3 Ltd applied for permission for the provision of 4 no battery storage container required by the previously granted solar farm in Ballyhale and Kiltorcan, (Reg Ref: 16/592). Permission was granted 25/10/2019.

Implementation of the proposed drainage mitigation will ensure there will be no cumulative significant adverse impacts on the water environment from the Proposed Development in combination with other wind farm developments and non-wind farm developments within a 10km radius in the Suir and Nore River catchments.

9.7 CONCLUSIONS

The following conclusions can be drawn in relation to surface water and groundwater:

- The site drains to a number of tributaries surrounding the site boundary. Primarily to tributaries of the River Barrow and Nore SAC (River Arrigle)and River Suir;
- The site is underlain predominantly by low permeability shallow tills overlying conglomerate and sandstone where the bedrock is commonly found near the surface;
- Man-made drains are located within the site and will continue to operate as part of the water management system on site;
- The site is generally moderately sloping and has two topographically higher areas in the north and south of the site boundary, the moderate slope gradients consequently has a moderate risk due to changes caused by the development on the hydrological regime;
- Water quality in the immediate area of the site is unpolluted and is consistent with the expected natural water quality for a similar environment. The water quality reported by the EPA downstream of the site is of good/ high status; and
- The site overlies two locally important aquifers of Medium to Extreme Vulnerability.

The residual impacts on the surrounding water quality, hydrology, hydrogeology and existing drainage regime at the site are considered to be not significant and mainly short term in nature. The existing on-site drainage system will remain active during the construction and operation of the proposed wind farm and the 110kV cable and will be complemented by the drainage plan that has been designed for this development. Apart from the upgrade of existing roads and stream crossings along the grid connection, most of the Proposed Development areas are generally away from areas on the site that have been determined to be hydrologically sensitive. The large setback distance from sensitive hydrological features means they will not be impacted on by excavations/ drains or any general construction works. There are no significant long-term impacts.

Detailed mitigation measures have been provided with regard to the design, construction, maintenance and decommissioning of the proposed development. The surface water drainage plan will be the principal means of significantly reducing sediment runoff arising from

construction activities and to control runoff rates. The key surface water control measure is that there will be no direct discharge of wind farm runoff into local watercourses. This will be achieved by avoidance methods (i.e. stream buffers) and design methods (i.e. surface water drainage plan).. Water monitoring will be carried out to alert the applicant to any issues.

In summary, the available information indicates that the proposed Castlebanny Wind Farm development presents no significant long-term impact on water quality, hydrology and hydrogeology, provided that the works are designed, constructed, maintained and decommissioned in accordance with the mitigation measures outlined in this Chapter.

No significant cumulative impacts on any of the regional surface water catchment or groundwater bodies are anticipated from the Proposed Development and associated grid connection.

9.8 REFERENCES

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9.9 GLOSSARY

Aquifer A subsurface layer of layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater [Water Framework Directive (2000/60/EC)].

Hydraulic conductivity [m/d] is an expression of the rate of flow of a given fluid through unit area and thickness of the medium, under unit differential pressure at a given temperature. In subsoils, intergranular permeability dominates, whilst in rock, fissure permeability (via fractures and bedding discontinuities) dominates in limestone bedrock in Ireland.

Specific Capacity Q/s [m^3/d/m]

The rate of discharge of water from the well divided by the resulting drawdown on the water level within the well

Specific yield (%) indicates the amount of water released from an aquifer due to drainage. By definition, it is always less than porosity due to retention of some groundwater by the subsoil/rock.

Transmissivity T [m^2/d]

Transmissivity relates to the ability of an aquifer to transmit water through its entire thickness.