STATKRAFT

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED DERNACART WIND FARM, COUNTY LAOIS

VOLUME 2 – MAIN EIAR

CHAPTER 14 - HYDROLOGY AND WATER QUALITY

DECEMBER 2019

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14 HYDROLOGY AND WATER QUALITY

14.1 INTRODUCTION

This chapter describes the existing hydrology and water quality of the local environment in the study area and examines the aspects of the hydrology and water quality of the local environment that could be affected by the activities associated with the proposed Dernacart Wind Farm.

The drainage of the proposed development is considered, taking account of mitigation measures to reduce or eliminate any residual impacts on hydrology and water quality.

14.1.1 Study Area

The proposed Dernacart Wind Farm development comprises up to 8 wind turbines with a tip height of up to 185 m, hardstanding areas, upgrade of existing tracks and construction of new access tracks, construction of an on-site substation, temporary compound and associated works. The proposed site layout is shown on Figure 4.2.

The studies have included the turbine delivery route and underground grid connection cable between the proposed wind farm turbines and the proposed on-site substation and between the on-site substation and the future proposed 110 kV Bracklone substation in Portarlington. The grid route study area includes proposed watercourses crossings, identifying locations of the grid route within flood zones and identifying historical flooding in the proximity of the grid route.

The wind farm is located in Laois County approximately 1.8 northwest of Mountmellick. The site ranges in elevation from 80 m OD to 73 m OD.

Surface water runoff from the site drains to Forrest Upper stream, White Hill (W) stream and Cottoner's Brook stream. These streams are tributaries of the River Barrow. In terms of the grid connection, drainage from the route is to the Forrest Lower Stream, White(W) Hill stream, Cottoner's Brook stream, Clonygowan stream, Rathmore stream, the River Barrow and an unnamed stream which is a tributary of the River Barrow.

14.2 METHODOLOGY

The following sources of information were considered in this assessment:

- Legislation and guidance as described in Section 14.2.1.
- A desk-based assessment of the surface water hydrology and water quality in the catchments relevant to the development, including an assessment of the watercourses which will be intercepted and those which will receive surface water runoff from the proposed development.
- A field assessment of the existing hydrological environment, to both verify desk-based assessment and record all significant hydrological features.
- Laois County Development Plan 2017-2023.
- Offaly County Development Plan 2014-2020.

14.2.1 Relevant Legislation and Guidance

14.2.1.1 Relevant EU Directives and Legislation

Water Framework Directive

The Water Framework Directive (WFD) has established a system for the protection and improvement of water quality and water dependent ecosystems. Since its enactment, it has influenced the management of water resources and has affected conservation, fisheries flood defence, planning and development. It has contributed to ensuring that all impacts on water resources – physical modification, diffuse and point source pollution, abstraction or otherwise – are controlled.

The overriding objective of the WFD is to achieve at least 'good status' in all European waters and to ensure that no further deterioration occur. European waters are classified as ground waters, rivers, lakes, transitional and coastal waters. The WFD has been implemented in Ireland by dividing the island of Ireland into eight river basin districts. These districts are natural geographical areas that occur in the landscape.

The WFD has been transposed into Irish law by means of the following main Regulations:

- European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003)
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009)
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)
- European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2010 (S.I. No. 610 of 2010)
- European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011)
- European Union (Water Policy) Regulations 2014 (S.I. No. 350 of 2014)

Water Framework Directive Waterbody Status

The European Communities Environmental Objectives (Surface Water) Regulations 2009 (S.I. No. 272 of 2009)[1] (the Surface Water Regulations), give effect to the criteria and standards used for classifying surface waters in accordance with the WFD. There are five categories of surface water status: 'High', 'Good', 'Moderate', 'Poor' and 'Bad'.

A surface waterbody must achieve both good ecological status and good chemical status before it can be considered to be of good status. The chemical status of a waterbody is assessed based on certain chemical pollutants. The ecological status is assessed based on Biotic Indices or Quality (Q) Values. The EPA Biological Quality Rating System for Rivers (Q Rating System) and its relationship with the WFD Status is shown in Table 14-1.

Table 14-1: EPA Q Rating System and WFD Status

Q-Value	Water Quality	WFD Status
Q5	Pristine	High
Q4-5	Very good	
Q4	Good	Good
Q3-4	Slightly Polluted	Moderate
Q3	Moderately Polluted	Poor
Q2-3	Moderate to Poor	
Q2	Poor	Bad
Q1-2	Poor to bad	
Q1	Bad	

In accordance with the Surface Water Regulations, water classified as 'High' or 'Good' must not be allowed to deteriorate. Water classified as less than good must be restored. The Surface Water Regulations also state that, for the purpose of classification, a status of less than good is assigned in the case of a waterbody where the environmental objectives are not met.

[1] Amended in 2012 (S.I. No. 327 of 2012) and 2015 (S.I. No. 386 of 2015)

Water Framework Directive Risk Assessments

A baseline risk assessment was completed of the water bodies within each River Basin District in 2005. This assessment involved using information on water pollution indicators, point and diffuse pollution sources, water abstraction and existing commercial activities. River Basin Management Plan and Programme of Measures have been prepared by Department of Housing, Planning and Local Government.

14.2.1.2Relevant Guidance

The following guidelines were considered in the development of this chapter to identify relevant objectives relating to hydrology and surface water quality:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports - Draft, Environmental Protection Agency (EPA), August 2017
- Advice Notes for Preparing Environmental Impact Statements, EPA, Draft September 2015
- Wind Energy Development Planning Guidelines - Department of the Environment, Heritage and Local Government, 2006
- Best Practice Guidelines for the Irish Wind Energy Industry - Irish Wind Energy Association,2012

In addition to considering the relevant documents above the methodology for the baseline assessment has been devised with due consideration of the following guidelines:

- Greater Dublin Strategic Drainage Study (GDSDS): New Development Policy, - Dublin Drainage, March 2005
- The Planning System and Flood Risk Management - Guidelines for Planning Authorities - Department of Environment, Heritage and Local Government (DoEHLG) and the Office of Public Works (OPW), November 2009
- Environmental good practice on site guide (fourth edition) (C741)- Construction Industry Research and Information Association (CIRIA), January 2015)
- Best Practice Guide BPGCS005 Oil Storage Guidelines (Enterprise Ireland)
- Control of water pollution from linear construction projects (C648) - Construction Industry Research and Information Association (CIRIA), December 2001
- Control of water pollution from construction sites. Guidance for Consultants and Contractors (C532) - Construction Industry Research and Information Association (CIRIA), December 2001
- PUB C571 Sustainable construction procurement - a guide to delivering environmentally responsible projects - Construction Industry Research and Information Association (CIRIA), January 2001
- UK Guidance for Pollution Prevention (GPP):
  - GPP2: Above ground oil storage tanks (Natural Resources Wales (NRW), Northern Ireland Environment Agency (NIEA), the Scottish Environment Protection Agency (SEPA), Energy Institute, Oil Care Campaign, January 2018)
  - GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer (NRW, NIEA, SEPA, November 2017)
  - GPP5: Works and maintenance in or near water (NRW, NIEA, SEPA, January 2017)
  - GPP8: Safe storage and disposal of used oil (NRW, NIEA, SEPA, July 2017)
  - GPP21: Pollution Incident Response Plans (NRW, NIEA, SEPA, July 2017)
  - GPP22: Dealing with Spills (NRW, NIEA, SEPA, October 2018)
  - GPP26: Safe storage of Drums and intermediate Bulk Containers (IBCs), (NRW, NIEA, SEPA, February 2019)
- Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes (National Roads Authority, 2005)
- Guidelines on Protection of Fisheries During Construction Works In and adjacent to Waters (Inland Fisheries Ireland, 2016)

- GE-INT-01003- Introduction to the NRA Design Manual for Roads and Bridges (Transport Infrastructure Ireland, December 2013)

14.2.2 Desk Study

The desk study involved an examination of the hydrological aspects and water quality aspects of the following sources of information:

- Current and historic Ordnance Survey Ireland mapping, and ortho-photography.
- OPW Indicative Flood Maps (https://www.floodinfo.ie/map/floodplans/).
- Review of the WFD online mapping and data (available at http://watermaps.wfdireland.ie.
- Review of the EPA online mapping (https://gis.epa.ie/EPAMaps/).
- History of flooding and status of drainage in the area (available at http://www.floodinfo.ie/map/floodmaps/).
- Rainfall data (available at https://www.met.ie)

14.2.3 Field Assessment

A site walkover survey was carried out on 16th May 2019 to establish the pattern of existing drainage and to record existing hydrology features of the proposed development including the cable route. During the site visit the GPS coordinates, descriptions, and photographs of the hydrological features were recorded. The site walkover involved an initial review of available information gathered in the desk study phase followed by a site visit.

No significant constraints were noted in terms of hydrology and water quality during the site visit.

14.2.4 Evaluation Criteria

The sensitivity of receptors, the magnitude of impacts and the probability of the impacts are assessed for subject development to determine significance of the impacts.

Thresholds for assessing the sensitivity of environment and magnitude of impacts are outlined in Figure 14-1.

Impacts are either 'beneficial', 'adverse' or 'negligible' and may have influence in the short, medium or long term. Impacts may also be either temporary or permanent and have local (on site or a neighbouring site), district (e.g. borough), regional (e.g. county), national or international level effects.

14.2.4.1Sensitivity of Receptors

The sensitivity of a hydrological receptor or attribute is based on its ability to absorb development without perceptible change. Surface runoff from the proposed wind farm site drains to tributaries of the River Barrow. The hydrological environment is considered to be of high sensitivity for receptors draining to the Barrow River and the associated designated conservation areas. The receptors which are part of the special areas of conservation are rated as 'high' sensitivity.[2] The River Barrow and River Nore Special Area of Conservation (SAC 002162) is part of the Natura 2000 network of sites.

Special Areas of Conservation (SAC), Special Protection Areas (SPA) and rivers supporting salmonid species are described in Chapter 12.

[2] A handbook on environmental impact assessment Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland, Scottish Natural Heritage

14.2.4.2Assessment of Significance of Hydrology Impact

The assessment of the magnitude of an impact incorporates the timing, scale, size, duration and probability of the impact in accordance with the EPA Guidelines. The significance criteria for hydrological impacts are defined as set out in Table 14-2.

Table 14-2: Impact significance criteria[3]

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

The diagram below, Figure 14-1, shows how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact. Sensitivity of the receiving environment can be 'high', 'medium', 'low', 'negligible'. Description of impact is defined by its character, magnitude, duration, probability and consequences. The magnitude of impact can be 'high', 'medium', 'low' or 'negligible'.

[3] Guidelines on the information to be contained in environmental impact assessment report Draft August 2017

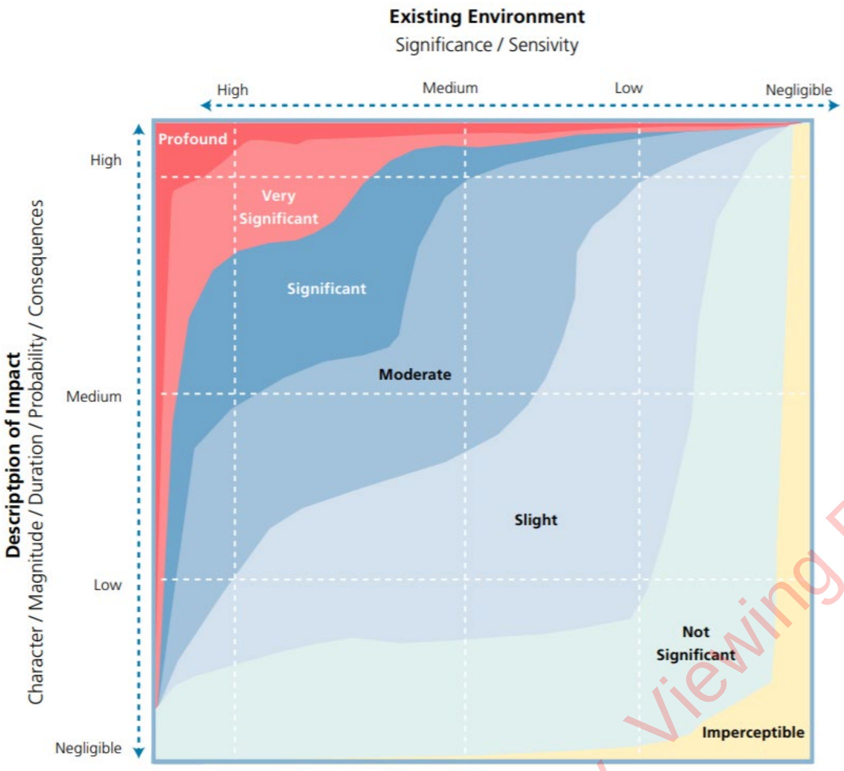

Figure 14-1: Typical Classifications of the Significance of Impacts[3]

14.2.5 Consultation

This chapter considers the consultation responses referred to in Chapter 5, with particular regard to concerns relating to hydrology and water quality. The scope of this assessment has been informed by consultation with the Inland Fisheries Ireland (IFI).

The comments expressed by the IFI in their response (dated 17th July 2019) to the scoping request for this EIAR process were considered. Concerns and recommendations related to hydrology and water quality are listed below:

- Particular attention should be paid to the hydrology of any site where excavations including excavations for road construction are being undertaken. It is important that natural flow paths are not interrupted or diverted in such a manner as to give rise to erosion or instability of soils caused by an alteration in water movement either above or below ground.
- Attention should be paid to drainage during both the construction phase and the operational phase. This includes waters being pumped from foundations or other excavations. It is particularly important during the construction phase that sufficient retention time in the settlement pond is available to ensure no deleterious matter is discharged to any waters. We strongly recommend that settlement ponds are maintained, where appropriate, during the operational phase to allow for the adequate settlement of suspended solids and sediments and prevent any deleterious matter from discharging into any natural waters. In constructing and designing silt traps, particular attention should be paid to rainfall levels and intensity. The silt traps should be designed to minimise the movement of silt especially during intense precipitation events where the trap maybe hydraulically overloaded. It is essential that they are located with good access to facilitate monitoring sampling and maintenance. A license to discharge to waters may be required from the local authority.
- IFI are also concerned about the construction of roads as these will tend to provide preferential flow paths for surface waters. Considerable detail must be provided in relation to the interception of surface water flows. Normal flows paths should be maintained both during and after construction. Situations can arise where water transportation is significantly increased in certain watercourses thereby putting additional pressures on watercourses and interfering with the sustained flow of water particularly during dry weather. This should be avoided.

The use of sedimentary rocks, such as shale, in road construction should be avoided. This type of material has poor tensile strength and is liable to be crushed by heavy vehicles thereby releasing fine sediment materials into the drainage system which are difficult to precipitate and may give rise to water pollution. We recommend that specialist expertise should advise on the type of material required for road construction bearing in mind the pressures that will arise during the construction phase and the necessity to avoid pollution due to fines washing out into the roadside drainage.

- Attention should be paid to material stockpiles and their location. Drainage from disturbed and stockpiled soils will have to be considered in advance. It may be necessary to stockpile in confined areas only. Consideration must be given to runoff from any stockpiles. It should be noted that cement leachate, hydrocarbon oils and other toxic poisonous materials will require full containment and should not be permitted to discharge to any waters.
- IFI should be consulted advance in relation to crossings of watercourses or the use of any temporary diversions, with final design to be approved by IFI. When designing crossings, the length, the slope and width of any instream structure will be important. Clear span bridges are the preferred option for crossings especially in upland areas.
- Please also note that any instream works or other works which may impact directly on a watercourse should only be carried out during the open season which is from 1st July to 30th of September in each year (so as to avoid impacting on the aquatic habitat during the spawning season). It would be important that appropriate scheduling of works is allowed for.
- Following a site inspection, a number of drains were noted that while currently dry have a hydrological connection to the River Barrow. These should be included in any drainage assessment.
- The proposed methodology for and locations of the cable route watercourse crossings should also be examined in detail. This is particularly important for the proposed Barrow crossing SW of Portarlington and for the crossing of Cottoner’s Brook.

14.3 EXISTING ENVIRONMENT

This section describes the receiving environment and sets out summary of historical flooding and water quality of rivers within study area.

14.3.1 General Description of the Catchments

Dernacart Wind Farm is located within Hydrometric Area No. HA 14, Barrow, of the Irish River Network System. It is situated in the South Eastern River Basin District (SERBD). The average annual rainfall in period 1981-2010 in the area of development is 871 mm[4]. This is adopted as a reasonable estimate for average annual rainfall at the Dernacart site.

The (M5-60)[5] at development location is 14.9 mm according to the Met Éireann rainfall data.

The site is situated within two sub-catchments as defined by the WFD. These waterbodies are known as:

- Barrow_SC_0110 (14_11)
- Barrow_SC_030 (14_1)

Turbines T1, T2, T3, T4, T7, T8, the temporary compound and the on-site substation are located within Barrow_SC_010 (14_11) sub-catchment and turbines T5 and T6 within Barrow_SC_030 (14_1) sub-catchment.

The Dernacart Wind Farm site is situated within three waterbodies (sub-basins) catchments as defined by the WFD.

[4] https://www.met.ie/cms/assets/uploads/2018/07/IE_AAR_8110_V1.txt

[5] This is for a 5-year return period, with a 60-minute duration rainfall.

These waterbodies are known as:

- Barrow_030 - IE_SE_14B010300
- Barrow_040 - IE_SE_14B010500
- Cottoners Brook_010 – IE_SE_14C150500

Turbine T1 is within the Barrow_030 - IE_SE_14B010300 and Barrow_040 – IE_SE_14B010500 waterbody catchment. Turbine T5 is within the Barrow_040 – IE_SE_14B010500 and Cottoners Brook_010 – IE_SE_14C150500 waterbody catchment. Turbines T2, T3, T4, T7 and T8 are within the Barrow_040 – IE_SE_14B010500 waterbody catchment. Turbine T6 is within Cottoners Brook_010 – IE_SE_14C150500 waterbody catchment as shown on Figure 14-2.

Surface water runoff from turbines T1 and T2 drains to the east to the Forrest upper stream. From there it flows for approximately 1.3 km to the south where it turns south westly towards the River Barrow. This stream rises at an elevation of 80 m OD approximately 310 m east of the turbine T1. Surface water runoff from turbine T3 drains to an unnamed tributary of Forrest upper, approximately 55 m north of the turbine.

Surface water runoff from turbines T4, T5, T7 and T8 drains to White Hill (W) stream. From there it flows south-easterly for approximately 2.4 km before it joins the River Barrow.

Surface runoff from turbine T6 drains to Cottoner's Brook stream as shown on Figure 14-2. It rises to an elevation of c. 74 m OD at the eastern boundary of the site and flows in south-easterly direction for approximately 2.6 km where it meets the River Barrow.

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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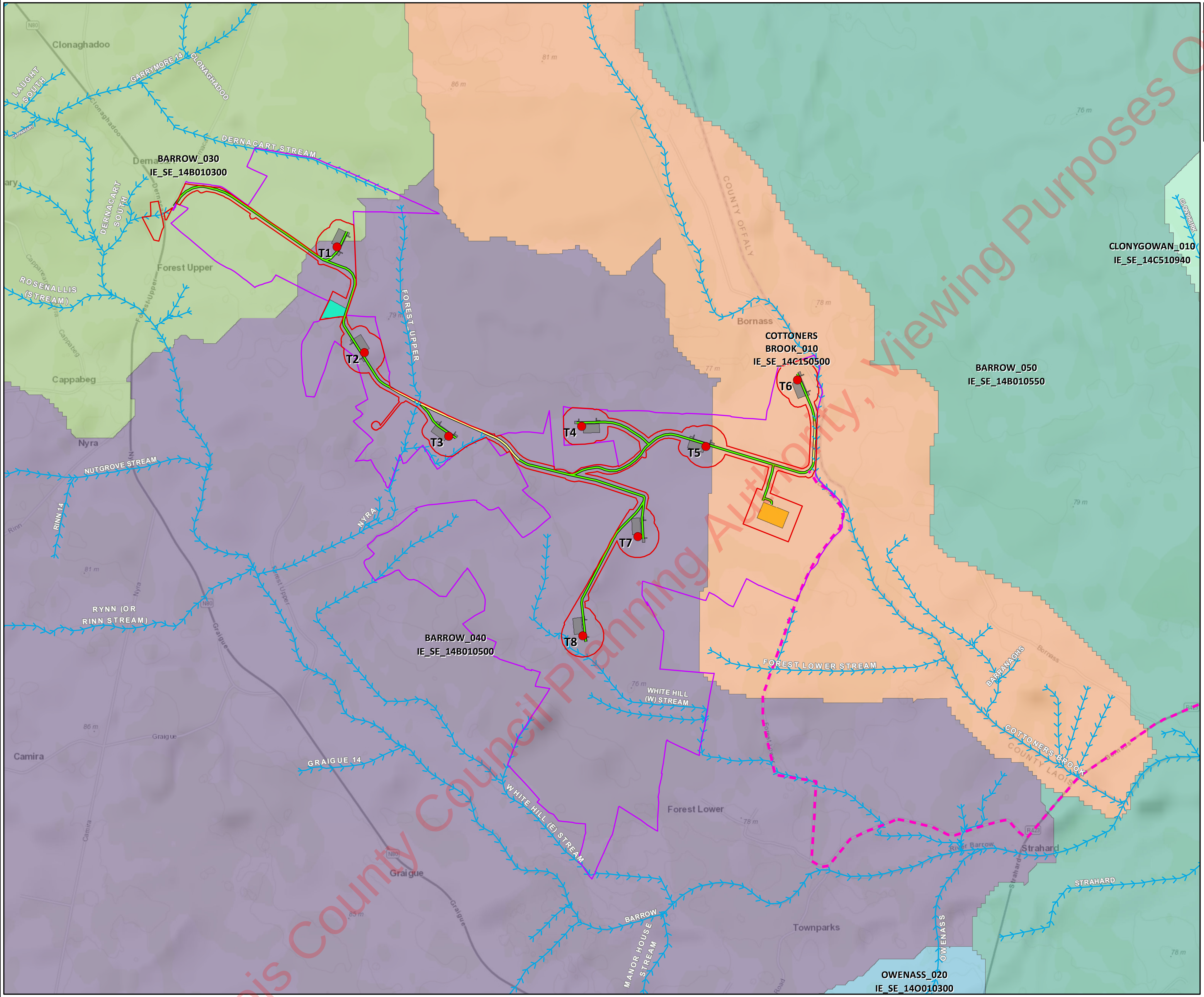

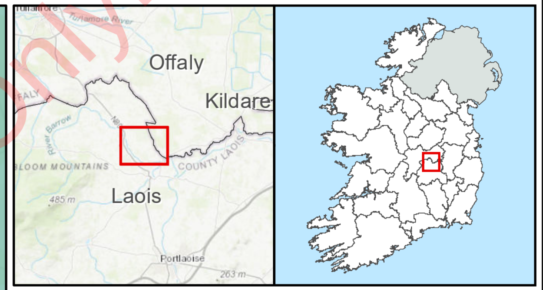

- Proposed Turbines
- Proposed Planning Boundary
- Study Area Boundary
- Proposed Cable Route
- Rivers
- Proposed Turbine Hardstanding Areas
- Proposed Substation
- Proposed Temporary Compound

Proposed Access Tracks

- Existing Track to be Upgraded
- New Track

WFD River Sub Basins

- BARROW_030, IE_SE_14B010300
- BARROW_040, IE_SE_14B010500
- BARROW_050, IE_SE_14B010550
- CLONYGOWAN_010, IE_SE_14C510940
- COTTONERS BROOK_010, IE_SE_14C150500
- OWENASS_020, IE_SE_14O010300

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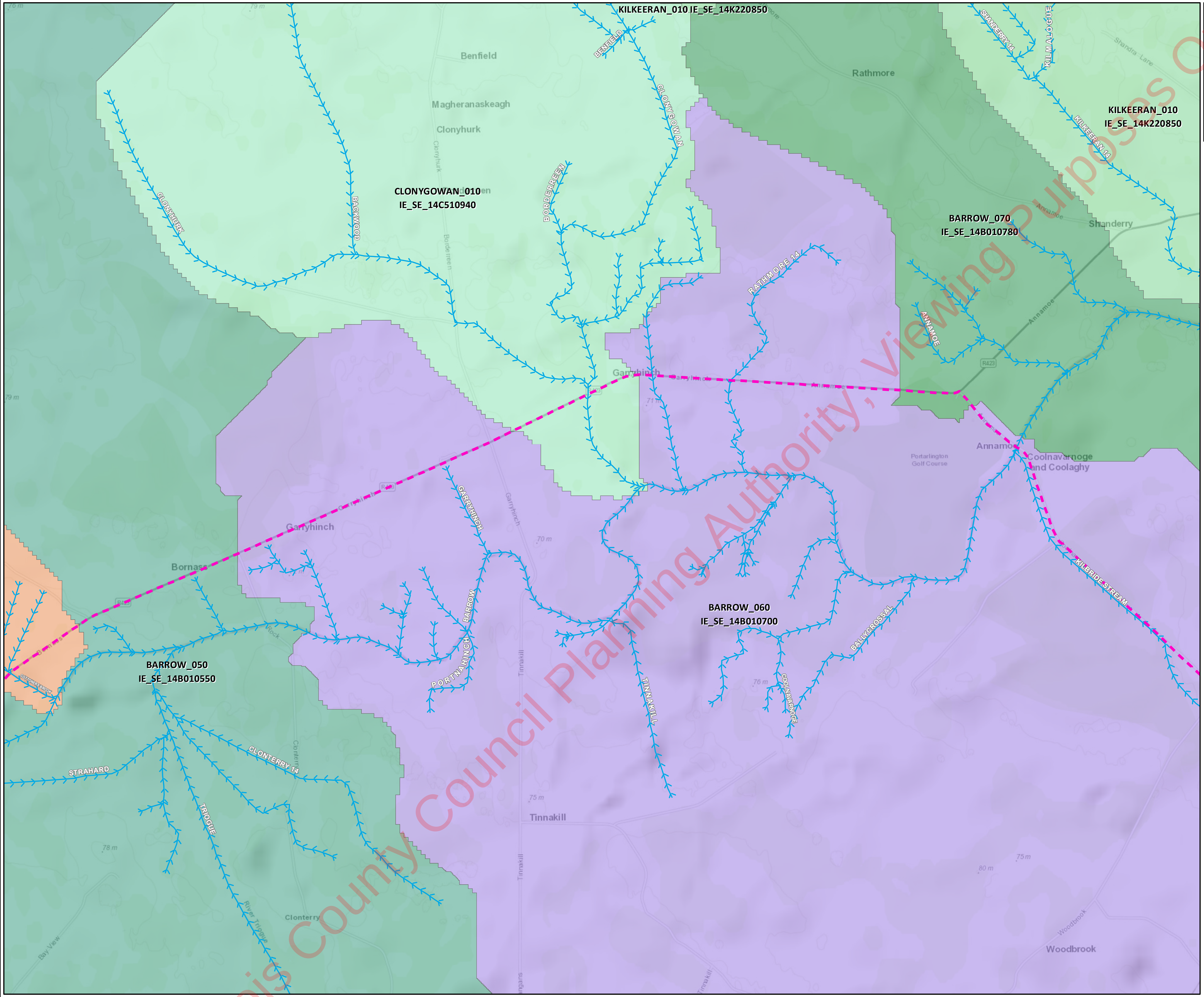

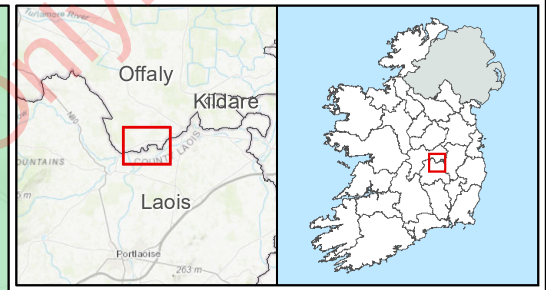

- Proposed Cable Route
- Rivers

WFD River Sub Basins

- BARROW_050, IE_SE_14B010550
- BARROW_060, IE_SE_14B010700
- BARROW_070, IE_SE_14B010780
- CLONYGOWAN_010, IE_SE_14C510940
- COTTONERS BROOK_010, IE_SE_14C150500
- KILKEERAN_010, IE_SE_14K220850

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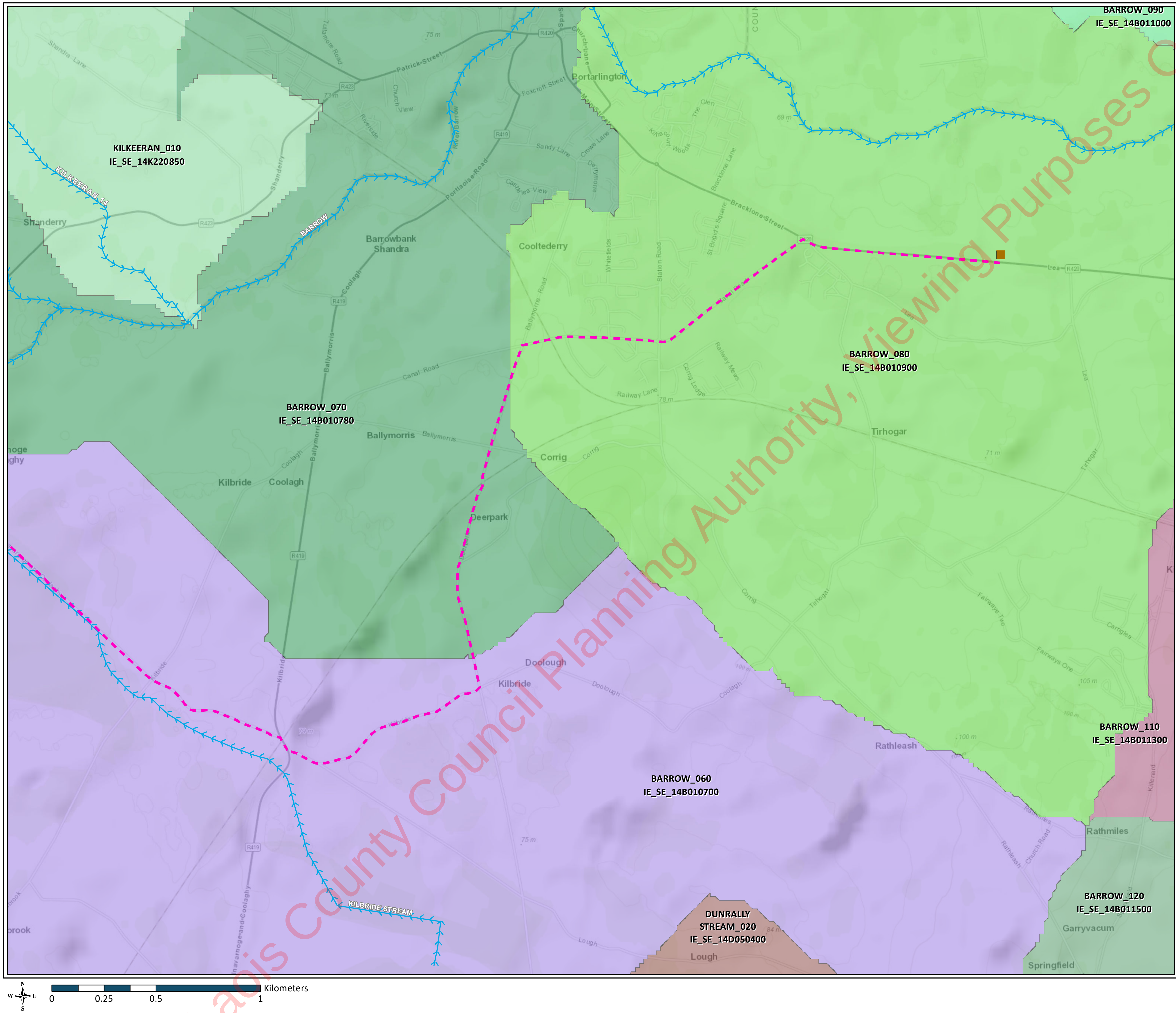

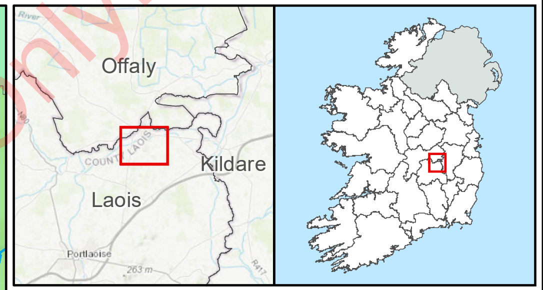

Proposed Future Bracklone Substation

Proposed Cable Route

Rivers

WFD River Sub Basins

- BARROW_060, IE_SE_14B010700
- BARROW_070, IE_SE_14B010780
- BARROW_080, IE_SE_14B010900
- BARROW_090, IE_SE_14B011000
- BARROW_110, IE_SE_14B011300
- BARROW_120, IE_SE_14B011500
- DUNRALLY STREAM_020, IE_SE_14D050400
- KILKEERAN_010, IE_SE_14K220850

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14.3.2 Historical Flooding

The OPW has produced indicative flood mapping to assist in a preliminary flood risk assessment (PFRA)[6]. The indicative flood mapping shows the southern and eastern boundary of the site is within Zone A as shown on Figure 14-3. However, there is no turbine development proposed in that area. According to flood mapping the grid route is within the flood zone.

The national flood hazard mapping (available at www.floodmaps.ie) does not indicate any record of historical flooding on the proposed wind farm site as shown in Figure 14-3. Recurring flood incidents have been recorded downstream in the main channel of the Barrow River. These recurring incidents are:

- Barrow Bay Mountmellick Recurring – approximately 2.0 km southeast of the closest turbine T8
- Barrow Cottoner's Bridge Recurring - approximately 2.6 km southeast of the closest turbine T8
- Barrow Garryhinch Recurring – approximately 4.5 km east of the closest turbine T8

A flood event occurred on 31st January 1995 and is recorded under the name Barrow Borness Bridge Jan 1995. The flooding occurred approximately 2.27 km southeast of the closest turbine T8. All recorded flood events are outside of the site boundary.

There are no areas defined as 'benefitting lands'[7] within the Dernacart Wind Fam site in the OPW flood hazard mapping.

[6] http://www.floodinfo.ie/map/floodmaps/

[7] Benefitting lands are lands benefiting from Arterial Drainage Scheme

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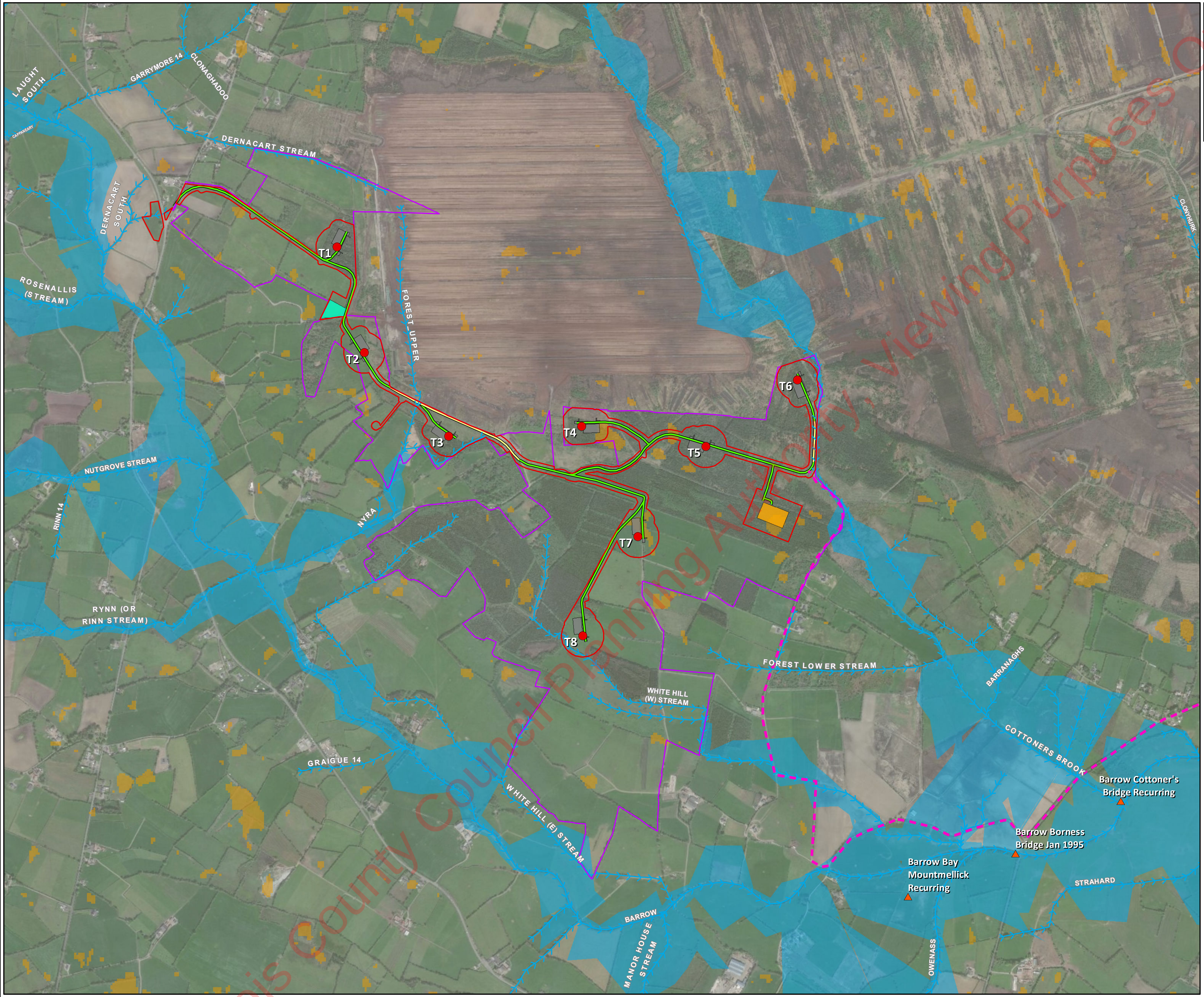

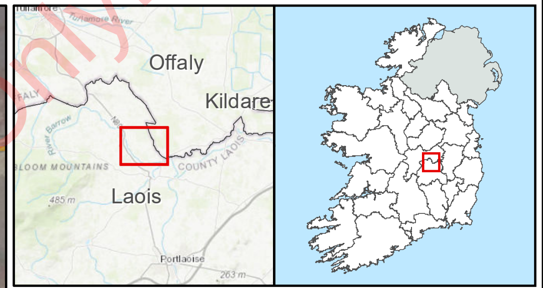

- Proposed
- OPW Historic Flood
- Proposed Planning
- Study Area
- Proposed Cable
- Rivers
- Proposed Turbine Hardstanding
- Proposed
- Proposed Temporary
- PFRA/CFRAMS 1% AEP Pluvial Flood
- PFRA/CFRAMS 1% AEP Fluvial Flood

Proposed Access

- Existing Track to be
- New Track

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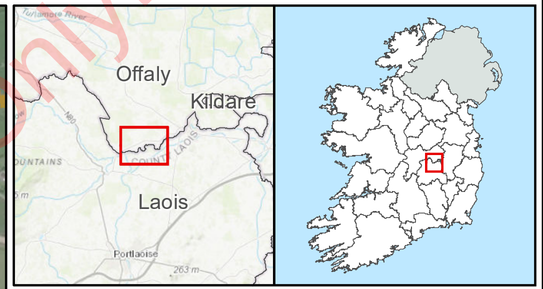

- OPW Historic Flood
- Proposed Cable
- Rivers
- PFRA/CFRAMS 1% AEP Pluvial Flood
- PFRA/CFRAMS 1% AEP Fluvial Flood

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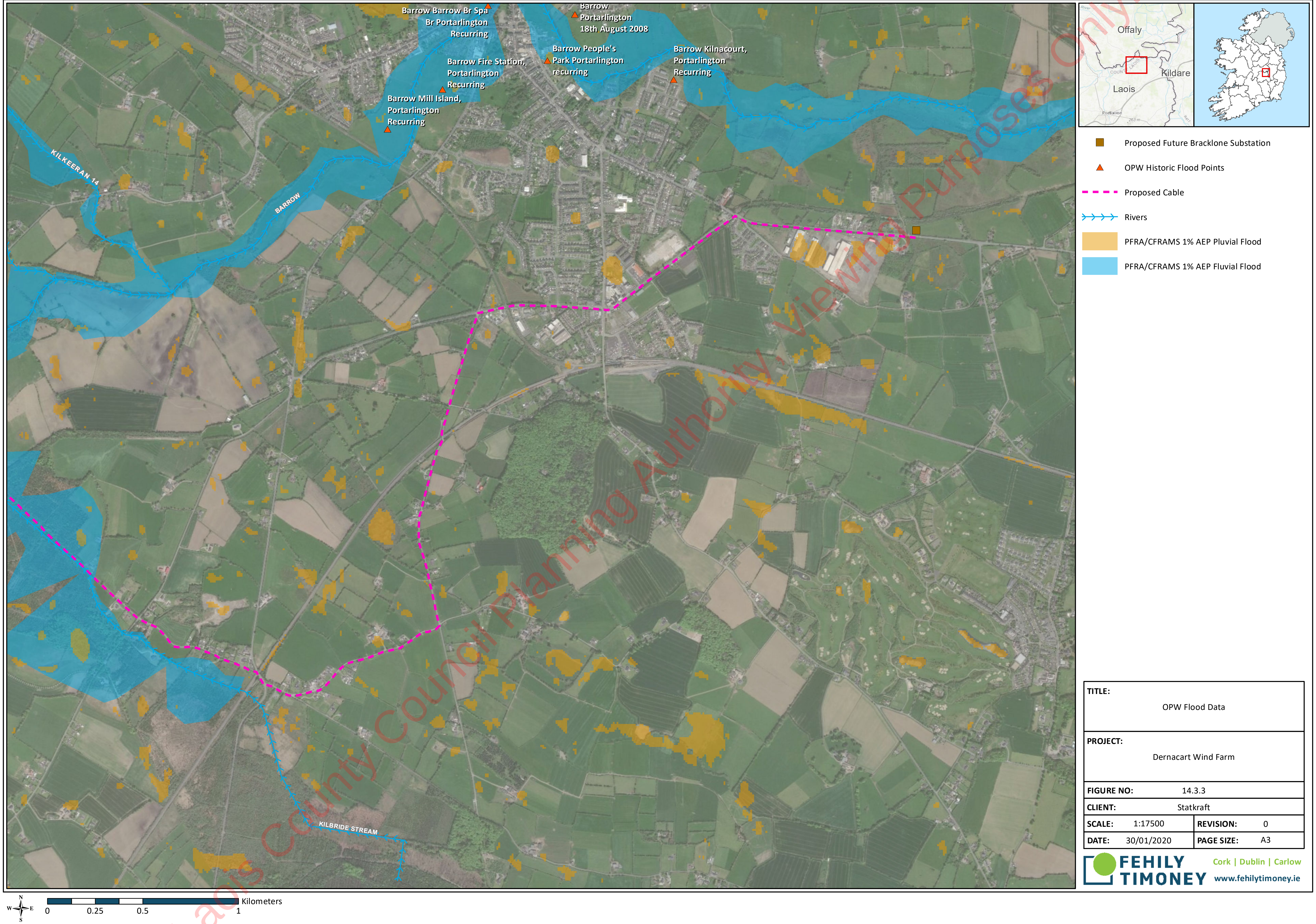

TITLE:	OPW Flood Data
PROJECT:	Dernacart Wind Farm
FIGURE NO:	14.3.3
CLIENT:	Statkraft
SCALE: 1:17500	**REVISION:** 0
DATE: 30/01/2020	**PAGE SIZE:** A3

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14.3.3 Water Quality

The water quality status of the Barrow River and its tributaries is 'Moderate'. This is shown in Figure 14-4. River waterbody risk for Cottoner's Brook river is under Review[8]. The Barrow River and its tributaries are classified as 'At Risk' as shown on Figure 14-5.

The EPA scheme of Biotic Indices or Quality (Q) Values was developed to determine the status of organic pollution in Irish rivers by assessing the occurrence of macro-invertebrate taxa of varying sensitivity to pollution. Biological Water Quality data was examined[8].

The locations of the EPA Q-value stations for the receiving waters are shown on Figure 14-4.

Biological water quality ratings Q5, Q5-4 and Q4 relate to 'Unpolluted' status, Q3-4 relates to 'Slightly polluted', Q3 and Q2-3 relates to 'Moderately polluted' and Q2, Q1-2, Q1 relate to 'Seriously polluted' watercourse[9].

Biological Water Quality Ratings at stations downstream of the site are outlined in Table 14-3. Q-ratings range between Q3-4 to Q4 between 1994 and 2015 with lowest quality status being Q3-4 at the station Barranagh's Bridge (RS14B010500) and Barrow – Portnahinch Bridge (RS14B010600). The lower quality rating for station Twomile Bridge (RS14B010300) is Q3-4 in 1997.

There is no recorded quality status data for station Barrow – Bay Bridge (RS14B010400) and for station Bridge SE of Hammerlane (RS14B010550) since 1989.

Table 14-3: EPA Biological Water Quality Ratings

Station ID	Location	1994	1997	2000	2003	2006	2015
RS14B010300	Twomile Bridge	4	3-4	4	4	4	4
RS14B010400	Barrrow – Bay Bridge	-	-	-	-	-	-
RS14B010500	Barranagh's Bridge	3-4	3-4	3-4	3-4	3-4	-
RS14B010550	Bridge SE of Hammerlane	-	-	-	-	-	-
RS14B010600	Barrow – Portnahinch Bridge	-	-	3-4	3-4	3-4	-

[8] https://gis.epa.ie/EPAMaps/
[9] http://www.epa.ie/QValue/webusers/

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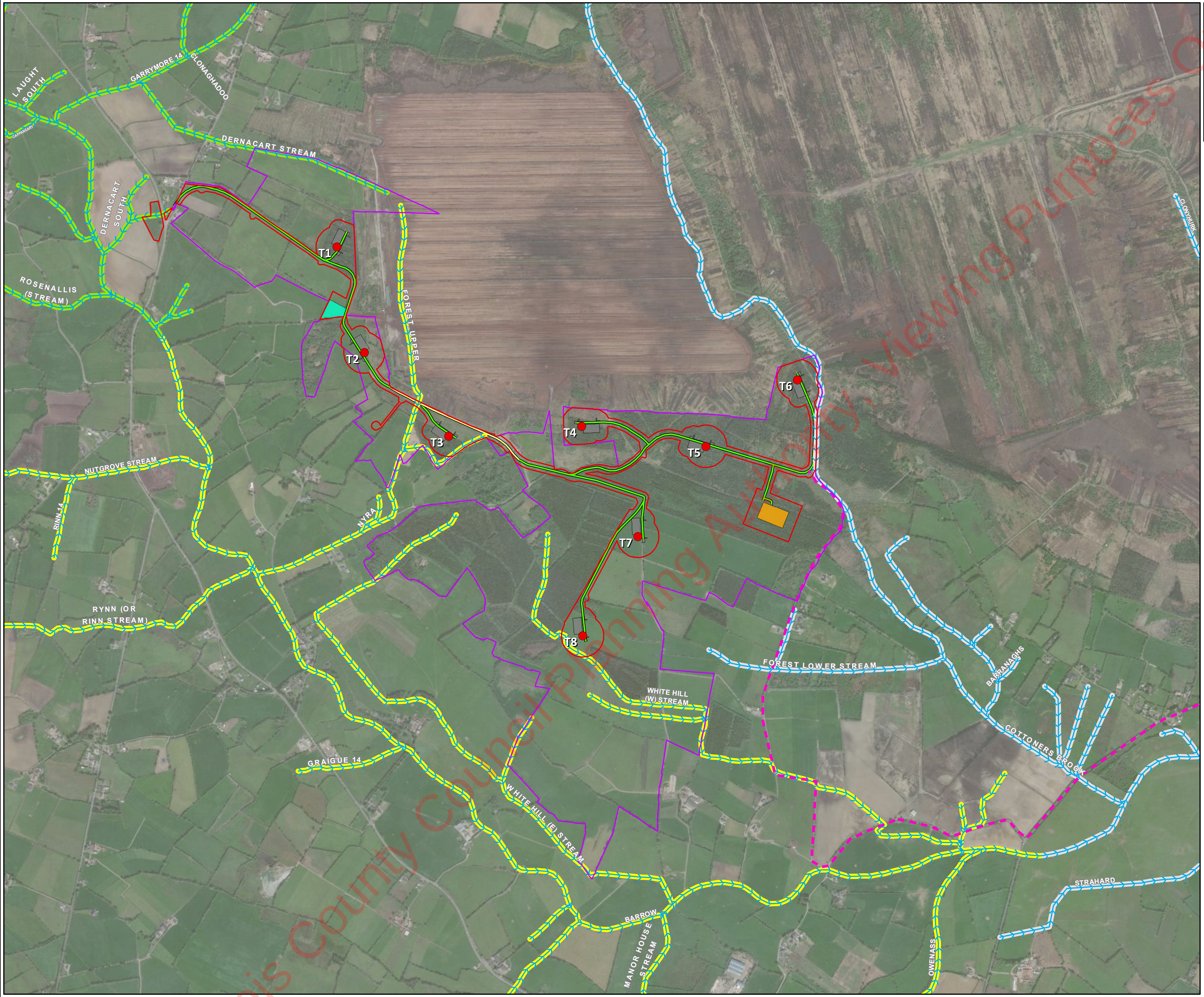

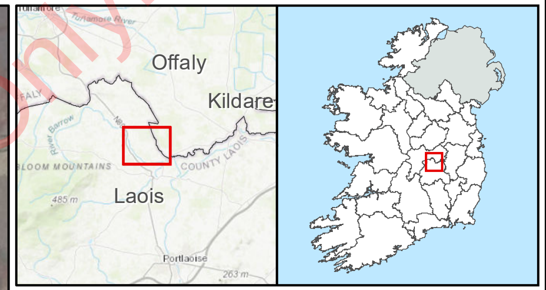

- Proposed Turbines
- Proposed Planning Boundary
- Study Area Boundary
- Proposed Cable Route
- Proposed Turbine Hardstanding Areas
- Proposed Substation
- Proposed Temporary Compound
- Rivers

Proposed Access Tracks

- Existing Track to be Upgraded
- New Track

River Waterbody WFD Status 2010-2015

- Good
- Moderate
- Unassigned

TITLE: River Waterbody WFD Status 2010-2015	
PROJECT: Dernacart Wind Farm	
FIGURE NO: 14.4.1	
CLIENT: Statkraft	
SCALE: 1:17500	**REVISION:** 0
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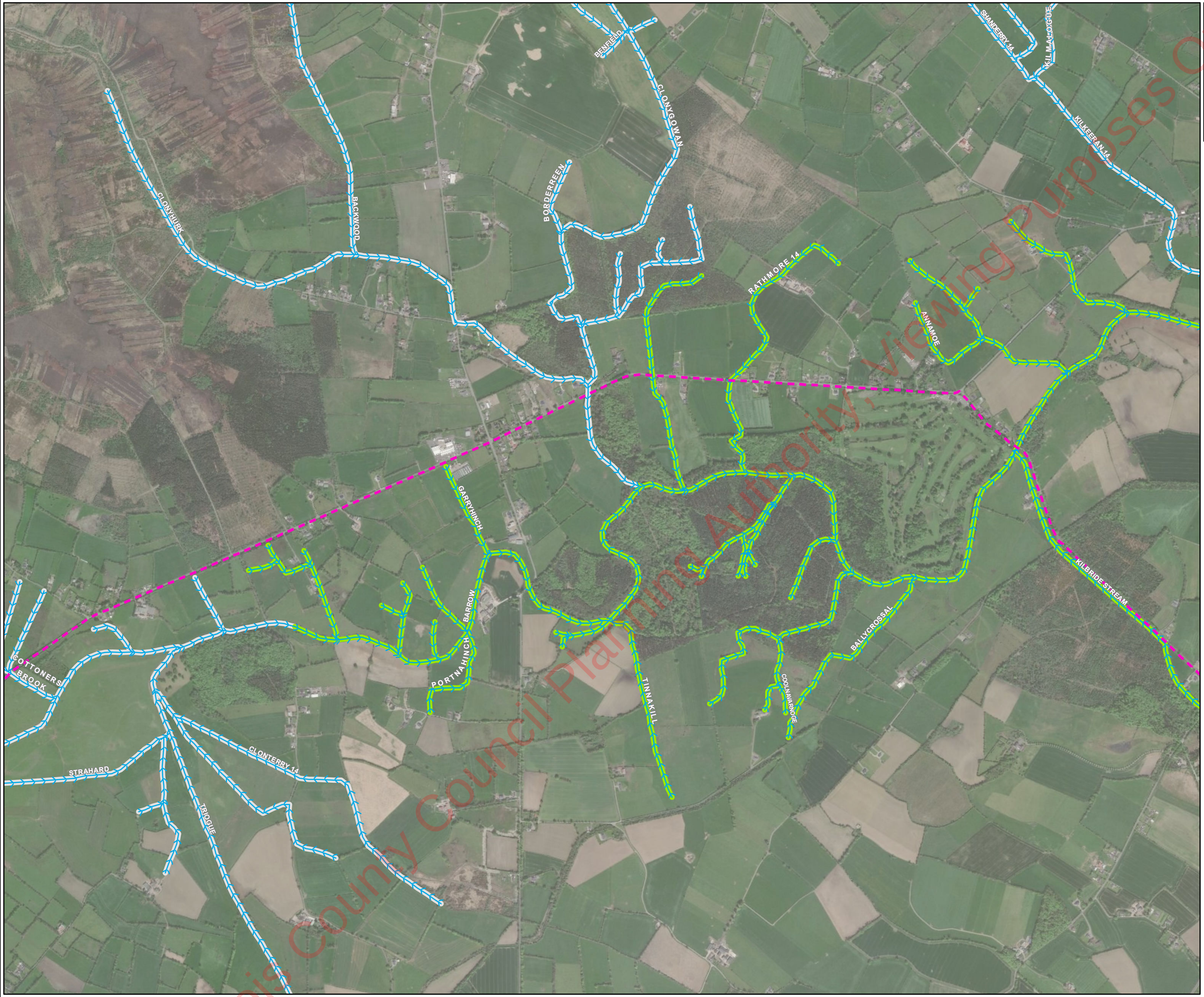

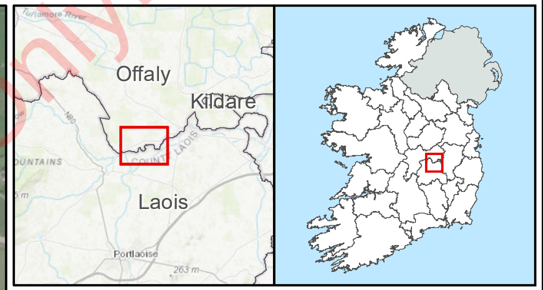

Proposed Cable Route

Rivers

River Waterbody WFD Status 2010-2015

Good

Unassigned

TITLE: River Waterbody WFD Status 2010-2015	
PROJECT: Dernacart Wind Farm	
FIGURE NO: 14.4.2	
CLIENT: Statkraft	
SCALE: 1:17500	**REVISION:** 0
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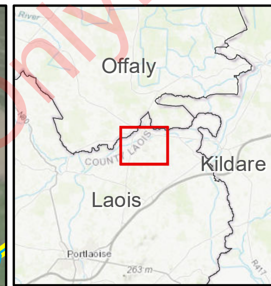

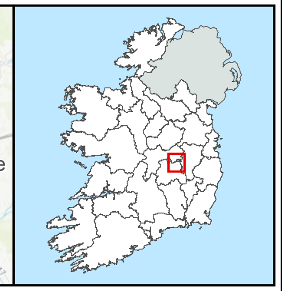

Proposed Future Bracklone Substation

Proposed Cable Route

Rivers

River Waterbody WFD Status 2010-2015

Good

Moderate

Unassigned

TITLE: River Waterbody WFD Status 2010-2015	
PROJECT: Dernacart Wind Farm	
FIGURE NO: 14.4.3	
CLIENT: Statkraft	
SCALE: 1:17500	**REVISION:** 0
DATE: 30/01/2020	**PAGE SIZE:** A3

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14.3.4 Protected Ecological Environment

The site of the proposed development is not situated within any environmentally designated areas; however, surface water runoff drains into the River Barrow and River Nore SAC (002162). The Barrow River is listed as sensitive to nutrients downstream of the location where Triogue River joins Barrow River[10].

Special Areas of Conservation are described in Chapter 12, Section 12.3.1 and in the accompanying NIS (Appendix 12.1 of Volume 3)

14.3.5 Internal Site Drainage

A site visit was undertaken on the 16th May 2019 to examine the existing drainage and hydrological features at the site. The visit involved a detailed walkover of the site by FT staff, recording existing drainage features and noting their locations.

Observations from the site walkover do not give rise to any significant concerns. Photographs of existing hydrological features are included in Appendix 14.1.

Drains
The proposed turbines are situated within three sub-basins. Greenfield runoff drains to tributaries of Barrow River. These tributaries are Forrest upper, White Hill (W) stream, Forrest lower stream and Cottoner's Brook. Forestry and agricultural lands are situated south and west of the Garryinch peat bog. These lands have agricultural drains and forestry drains throughout the site.

Crossings
The Forrest upper stream, tributary of the Barrow River crosses the proposed access road between turbines T2 and T3 at one location. The crossing is at an existing track southwest of the Garryinch peat bog, where it is culverted in a 1000 mm diameter concrete pipe (EXC1) as shown in Figure 14-6.

Existing Tracks
Existing tracks run through the site. Some of these tracks are access tracks for the peat bog and are approximately 4 m wide and made up of local sandstone/siltstone hardcore. It is proposed to utilise existing tracks in so far as possible to access the turbines in the proposed development. The existing tracks may will require strengthening and widening to achieve a track width of 5 m (minimum). The existing track drainage consists of 'over the edge' drainage to roadside drains.

14.3.6 Cable Route

The proposed grid route is situated within 7 sub-basins as defined by the WFD. These sub-basins are known as:

- Cottoner's Brook_010 – IE_SE_14C150500
- Barrow_040 – IE_SE_14B010500
- Barrow_050 – IE_SE_14B010550
- Barrow_060 – IE_SE_14B010700
- Clonygowan_010 – IE_SE_14C510940
- Barrow_070 – IE_SE_14B010780
- Barrow_080 - -IE_SE_14B010900

According to flood mapping the grid route is within the flood zone as shown on Figure 14-3.

[10] https://data.gov.ie/dataset/register-of-protected-areas-nutrient-sensitive-rivers

Recurring flood incidents in the proximity of the grid route are listed below:

- Barrow Bay Mountmellick Recurring
- Barrow Cottoner's Bridge Recurring
- Barrow Garryinch Recurring
- Barrow Mill Island, Portarlington Recurring
- Barrow Fire Station, Portarlington Recurring
- Barrow People's Park Portarlington Recurring
- Barrow Kilnacourt, Portarlington Recurring
- Barrow Buttle Lane, Portarlington Recurring
- Barrow Br Spa Br Portarlington Recurring
- Barrow Spa Street, Portarlington Recurring
- Barrow Droughill Portarlington Recurring
- Barrow Avondale, Portarlington Recurring

Recorded flood events in the proximity of the grid route are recorded under the name Barrow Borness Bridge Jan 1995 and Barrow Portarlington 18th August 2008.

Locations of recurring flooding and historical flood events are shown on Figure 14-3.

The proposed cable route from the proposed wind farm to the future proposed 110 kV Bracklone substation was examined. Structures will be crossed via directional drilling along the route as follows:

- Culvert over the Forrest lower stream, tributary of the Cottoner's Brook stream
- Culvert over White(W) Hill stream, tributary of the River Barrow
- Culvert/Arch Bridge over White(W) Hill stream, tributary of the River Barrow
- Bridge over Cottoner's Brook stream, tributary of the River Barrow
- Bridge over Clonygowan stream, tributary of the River Barrow
- Bridge over Unknown stream, tributary of the River Barrow
- Bridge over Rathmore stream, tributary of the River Barrow
- Bridge over River Barrow

No instream works are anticipated because the proposed method of crossing is horizontal directional drilling (HDD) with 'Clear bore' drilling fluid. Potential impacts during installation of grid route are have been assessed and presented in Section 14.4. below. The proposed mitigation measures are outlined in Section 14.7.

Crossings for the cables in the internal access roads serving the proposed wind farm, have been assessed as part of the proposed drainage for the wind farm development. These crossing locations are discussed in Section 14.6.4.

The grid connection trench will be approximately 600 mm wide and 1220 mm deep. Should any previously unidentified culvert be encountered, the grid cable will be installed above or below the culvert depending on its depth. The cable will be installed so as to not impact the culvert.

14.3.7 Turbine Delivery Route

The likely turbine delivery route was examined as described in Chapter 4 and as illustrated in Figure 4.6 in Chapter 4. A number of stream crossings were identified along the route. No modifications were identified as being required at these stream crossings.

Minor roundabouts accommodation works will be required, and a turning area is required at the junction of the N80 and the local road leading to the site. It is not anticipated that this will have any significant hydrological impact.

14.4 POTENTIAL IMPACTS

The potential impacts on the hydrological regime at the site and quality of waters draining the site are assessed in the following sections for the activities associated with each phase (construction, operation, maintenance and decommissioning) of the project. The potential impacts are assessed in accordance with the evaluation criteria outlined in Section 14.2.4.

The potential impacts in relation to an increase in flooding, cumulative flood risk with neighbouring developments, as well as specific impacts during the various phases of the project are outlined below.

14.4.1 Do Nothing Scenario

If the proposed development does not proceed, the site will remain as agricultural and forestry land for the foreseeable future including grazing, arable and forestry uses.

14.4.2 Potential Impacts during Construction

During the construction period, the development has potential to result in impacts on hydrology and water quality unless appropriate mitigation measures are implemented. As tree felling is required to facilitate construction, the potential impacts of both tree-felling and construction are examined below.

14.4.2.1Potential Direct Impacts

Activities associated with tree felling, new access tracks and upgrade of existing tracks, turbine hard-standing areas, the on-site substation and other new, hard surfaces all have the potential to contribute to an increase in runoff, as indicated in Table 14.4.

Table 14.4 shows the estimated changes in the runoff corresponding to a 1-in-100 year, 30-minute duration storm at the proposed Dernacart Wind Farm. This equates to rainfall with an intensity of 23.7 mm/h. The estimated flow was calculated using Modified Rational Method. The highest runoff will occur for extreme storm events (1 in 100 years) with high intensity rainfall.

As illustrated in Figure 14-2 the greenfield runoff from Dernacart Wind Farm drains to 3 sub-catchments. Table 14.4 indicates the estimated changes in the amount of surface water runoff to each sub-catchment.

It can be observed from Table 14.4 that surface water runoff from impermeable surfaces of the wind farm within the Barrow_030 sub-basin will increase by 0.036 m^3/s (or 0.03 %). It will increase by 0.282 m^3/s (or 0.19 %) within Barrow_040 sub-basin and by 0.068 m^3/s (or 0.13 %) within Cottoner's Brook_010 sub-basin.

The overall estimated increase in the runoff due to the development is 0.387 m^3/s (or 0.12 %). This estimated increase in runoff will reduce over time as vegetation is re-established on the site.

As discussed in Section 14.2.4.1 the hydrological environment of the Dernacart Wind Farm is considered to be of 'high' sensitivity for receptors draining to the River Barrow. The effects of the increase in runoff has negligible magnitude on receiving waters because estimated increase in runoff is low compared to the flows of receiving waters.

The runoff increase of 0.387 m^3/s (or 0.12 %) due to Dernacart Wind Farm is not significant.

Table 14.4: Increase in Surface Water Runoff

Dernacart Wind Farm			Catchment Area	Overland	Existing Tracks to be used as part of the development	New hardcore tracks, including widening of existing tracks	Turbines Base & Hard Standing and Substation	Total Run-off Imp. Area	Rainfall Intensity	Run-off	Increase in Run-off	Increase in Run-off
	Catchment	Scenario	ha	ha	ha	ha	ha	ha	mm/hr	m^3/s	m^3/s	%
	Increase in run-off to Barrow_030	Existing	2481	2481.0	0.00			**744.3**	52.1	107.9		
		Post Development		2480.4	0.00	0.41	0.15	**744.5**	52.1	107.9		
		Increase in Run-off									**0.036**	**0.03**
	Increase in run-off to Barrow_040	Existing	3485	3485.0	0.00			**1045.5**	52.1	151.5		
		Post Development		3480.7	0.00	2.31	2.02	**1047.4**	52.1	151.8		
		Increase in Run-off									**0.282**	**0.19**
	Increase in run-off to Cottoners Brook_010	Existing	1191	1191.0	0.00			**357.3**	52.1	51.8		
		Post Development		1190.0	0.00	0.47	0.57	**357.8**	52.1	51.9		
		Increase in Run-off									**0.068**	**0.13**
										TOTAL INCREASE:	**0.387**	**0.12**

Notes: *Impervious factor for overland flow is 0.3 for tracks and hardstanding areas; for the substation an impervious factor of 0.75 is applied.*
Rainfall Intensity for 1-in-100 year return period storm of 30 minutes duration supplied by Met Eireann.
10% increase is applied to rainfall intensity to allow for climate change.
Q100 flow derived using the Modified Rational method Q=2.78 x (Rainfall Intensity) x (Contributing Impervious Area.)

14.4.2.2Potential Indirect Impacts

The increase in runoff, even if relatively low, has however, the potential to cause soil erosion and consequent sediment release into the receiving watercourses. Possible potential indirect impacts on surface water quality during tree felling and construction activities include:

- Increased sediment loading of streams from personnel and traffic activities.
- Standing water in excavations could contain an increased concentration of suspended solids as a result of the disturbance of the underlying soils.
- Haul roads passing close to watercourses could allow the migration of silt laden runoff into watercourses.
- Silt carried on the wheels of vehicles leaving the site could be carried onto the public road.
- Tree felling could lead to an increase in sediment and nutrients in the surface water runoff, if the brash is left in place in the riparian buffer zones.
- Small diameter cross-drains could lead to blockages and consequent flooding and concentration of flows.
- Suspended solids could potentially lead to siltation and physical effects on flora and fauna in aquatic habitats.
- Refueling activities could result in fuel spillages.
- There is the potential for fuel spill/leaks from storage tanks which will be stored on site for plant machinery
- Sanitary waste if not contained could lead to contamination of receiving waters and groundwater.
- The removal of the vegetated material will also lead to an increase in the rate of runoff along the route of the site access roads and hardstanding areas. This increase in the rate of runoff could lead to a minor increase in flooding downstream.
- Inappropriate site management of excavations could lead to loss of suspended solids to surface waters.
- Inappropriate management of the excavated material could lead to loss of suspended solids to surface waters.
- Inappropriate management of the drainage of material storage areas could lead to loss of suspended solids to surface waters.
- Blockage of cross-drains could lead to consequent flooding and concentration of flows.
- Overland flow entering excavations could increase the quantity of surface water to be treated for sediment removal.
- Overland flows entering roadside drains could result in a concentration of flows and subsequent erosion of drains
- Grid connection and internal cable trenches could act as a conduit for surface water flows.
- The velocity of flows in roadside drainage could cause erosion in steeply sloping roadside drains.
- Flows from the new drainage system could be impeded, should blockages occur in the existing roadside drains.
- Open bodies of water and saturated ground present a risk to the safety of site personnel and the public.
- The construction of new infrastructure has the potential to obstruct existing overland flow.
- A blockage in the proposed roadside drains could allow a break out of silt laden runoff to reach adjacent watercourses or streams.
- Wet concrete could lead to contamination of receiving waters and groundwaters
- Inappropriate management of spoil heaps could result in accidental break outs of silt on site leading to the loss of suspended solids to surface waters
- Proposed roadside drains on the uphill side of new roads will have to convey all of the contributing runoff from the land above resulting in large drains being required in certain areas and mixing of overland flow with runoff from construction works. This would reduce the efficiency of any proposed stilling ponds.

14.4.2.3Grid Cable Route Installation and Horizontal Directional Drilling

The following potential impacts could result from the construction activities related to grid route installation and watercourse crossings:

- The cable trench could act as a conduit for surface runoff
- Excavated soil could be mobilised in the surface water runoff during an extreme rainfall event
- Inadequate storage of fuels and oils could lead to contamination of surface water
- The excavation of trenches for cable laying, and the launch and reception areas for directional drilling, could lead to silt laden surface water run-off
- Silt carried on the wheels of vehicles could be carried onto the public roads
- Refuelling activities could result in fuel spillage
- Suspended solids drained to watercourse could potentially lead to siltation and physical effect on flora
- Works leading to erosion of the river banks/bed could negatively impact on the fisheries habitat.

The duration and significance of the impacts on hydrology and water quality associated with grid cable route installation and HDD are provided in Table 14.5.

14.4.3 Potential Impacts during Operation and Maintenance

The main hydrological impact of the development is estimated increasing runoff of 0.387 m^3/s (or 0.12%) as discussed in Section 14.4.2. Due to the insignificance of the increase in runoff from the development, the grassing over the drainage swales, and the non-intrusive nature of site operations, there is a negligible risk of sediment release to the watercourses during the operational phase.

14.4.4 Potential Impacts during Decommissioning

The potential impacts associated with decommissioning will be similar to those associated with construction but of reduced magnitude.

There would be increased trafficking and an increased risk of disturbance to underlying soils at the Dernacart Wind Farm, during the decommissioning phase, in this instance, leading to the potential for silt laden runoff entering receiving watercourses from the wheels of vehicles.

During decommissioning, it may be possible to reverse or at least reduce some of the impacts caused during construction by rehabilitating construction areas such as turbine bases, hardstanding areas, the substation and site compound. This will be done by covering with topsoil to encourage vegetation growth and reduce runoff and sedimentation.

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude. However, as noted in the Scottish Natural Heritage guidance on restoration and decommissioning of onshore wind farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. It is therefore 'b*est practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm*'.

Grid connection cables will be left in the ground, therefore no potential impacts during decommissioning stage are likely to occur.

14.4.5 Potential Impacts during Turbine Delivery

No modifications were identified as being required at the stream crossings. Therefore, it is not anticipated that turbine delivery will have any significant hydrological impact.

Minor roundabouts accommodation works are required. However, it is not anticipated that this will have any significant hydrological impact.

14.4.6 Potential Impacts of a Risk of Flooding

There are no turbines located within the indicative floodplain as shown in Figure 14-3. The proposed substation and new access tracks are not located in the indicative floodplain. There is therefore no flood risk to any turbines, the substation and new access tracks during a flood event.

A flood risk assessment (FRA) was prepared for this site, to determine the impact of increased hard surfaces from this development on downstream flooding. The flood risk identification and assessment are included in Section 14.5.

14.4.7 Potential Cumulative Impact

The nearest wind farm development in the vicinity of the Dernacart Wind Farm include the existing Mount Lucas Wind Farm Turbines 13 km to the north-northeast and permitted Moanvane Wind Farm approximately 7 km northeast of the Dernacart Wind Farm. Dernacart and Mount Lucas wind farms are hydrologically connected. Surface water runoff from both developments drain to the River Barrow. As discussed in Section 14.4.2 the runoff from Dernacart Wind Farm is of imperceptible significance on the hydrology and water quality. Due to the imperceptible significance of runoff and hydrology distance between Dernacart and Mount Lucas wind farm no significant hydrology impact is envisaged.

Surface water runoff from both developments drain to the River Barrow. However, surface runoff from the Moanvane Wind Farm drains to Barrow_SC_040 sub-catchment unlike Dernacart Wind Farm. Due to the imperceptible significance of runoff at Dernacart wind farm and hydrology distance between Dernacart and Moanvane wind farm no significant hydrology impact is envisaged.

As discussed in Section 4 the grid connection route will connect proposed on-site Dernacart substation with the future proposed Bracklone substation. Bracklone substation is to be located approximately 1.6km east of Portarlington, Co. Laois. According to the flood mapping, the substation is not within the flood zone A and B. The closest recurring flooding is approximately 1.6km southeast and is recorded under the name Barrow Kilnacourt, Portarlington Recurring. The River Barrow is approximately 650m north of the substation. Due to the construction of the substation increase in runoff is expected. The proposed substation is expected to have a drainage system which will mitigate impact of increased runoff on hydrology and water quality. Due to the imperceptible significance of runoff at Dernacart Wind Farm and hydrology distance between Dernacart Wind Farm and the future proposed Bracklone substation, no significant hydrology impact is envisaged.

14.4.8 Summary of Unmitigated Hydrological Impacts

A summary of unmitigated potential impacts due to the development of the proposed development is provided in Table 14.5.

Table 14.5: Summary of Potential Hydrological Impact Significance on Sensitive Receptors

Activity	Potential Impact	Receptor	Sensitivity	Magnitude/ Probability	Significance
Construction Phase					
Site tracks, turbine construction, substation	Increase in rate of runoff	River Barrow	High	Negligible	Not Significant
Site tracks, crossings, cabling, HDD, turbine construction, crane pad construction, substations, tree felling and management of material storage areas	Release of suspended solids into watercourse	River Barrow	High	Medium	Significant
Site tracks, crossings, cabling, HDD, turbine construction, crane pad construction, substations, tree felling and management of material storage areas	Release of hydrocarbons or fuel spill	River Barrow	High	Negligible	Not significant
Drainage crossings, turbine construction, substations, temporary compounds	Obstruct hydrological flow	River Barrow	High	Negligible	Imperceptible
Operation & Maintenance					
Site access tracks , turbine hardstanding areas, substations	Increase in rate of runoff	River Barrow	High	Negligible	Not significant
Site access tracks , turbine hardstanding areas, substations	Erosion and sedimentation	River Barrow	High	Negligible	Not significant
Decommissioning					
Use of equipment for dismantling and removing turbine components	Erosion and sedimentation	River Barrow	High	Negligible	Not significant

It can be observed from Table 14.5 that the activities during the construction of the subject development, if unmitigated, would have a 'Not significant' impact on receiving watercourses in terms of an increase in runoff and risk of sedimentation in sensitive catchments would have 'Significant' impact.

Operation and maintenance and decommissioning activities are not expected to have a significant effect on the receiving watercourses.

14.5 FLOOD RISK IDENTIFICATION AND ASSESSMENT

14.5.1 Flood Flow Conveyance

As discussed in Section 14.3.2, the flood mapping from the OPW shows the project is within an indicative floodplain. However, no development is expected in that area.

As part of the flood risk assessment, calculations were completed for an existing culvert stream crossing (EXC1) over the Forrest Upper stream. In order that flood flows would not be obstructed, the culvert was assessed to convey a 1 in 100-year flood event with a 20 % allowance for climate change.

A hydrological assessment was conducted using two methods of flood estimation for catchments less than 25km^2, to determine the 1 in 100-year flow at the proposed new crossing:

- Institute of Hydrology (IOH) 3-variable equation method, where Q_{BAR} is multiplied by the appropriate design factor (standard error factor) which is 1.65.
- Flood Studies Supplementary Report (FSSR) 3-variable equation method, with a standard error factor of 1.5.

The greatest flow determined from the two methods was then multiplied by the regional growth factor of 1.96 to obtain the 100-year peak flow value. To accommodate the effect of future climate change in Ireland, the 100-year peak flow value was then multiplied by 1.2 to get the design 100-year flood value at the crossing. [11]

The approximate catchment area and the flood flow estimated for 1 in 100 years storm event including an allowance for climate change of 20% is included in Table 14.6.

The existing culverts are assessed to determine if they are adequate to take the design flow. It is estimated that the existing culverts are adequately sized to take the 1 in 100 year design flow, however it will be necessary to extend it to accommodate road widening at this location. Therefore, it is proposed to replace EXC1 with a bottomless culvert.

Preliminary design of the new bottomless culvert at the location of EXC1 is provided in Appendix 14.2. The proposed culvert is 1m long, 1m high and 5m wide.

Photos of EXC1 are provided in Appendix 14.1.

[11] Greater Dublin Regional Code of Practice for Drainage Works

Table 14.6: Culvert Sizing

Location	AREA	SAAR	SOIL	IH 124			FSSR 6 3-Term Equation			Max. Design 100 yr Flood	Bore capacity	Comment
				Q_{BAR}	Q_{100}	Increase by 20% for Climate Change	Q_{BAR}	Q_{100}	Increase by 20% for Climate Change			
	km^2	mm	-	m^3/s	m^3/s		m^3/s	m^3/s		m^3/s	m^3/s	mm
Existing Culvert EXC1	0.34	871	0.40	0.2	0.5	0.6	0.2	0.5	0.5	0.6	1.6	Existing 1000 mm circular concrete culvert has enough bore capacity to accommodate 1:100 year flow.

Note:

Catchment area is determined from OPW FSU web portal.

SAAR is provided from Met Eireann.

SOIL type index is determined from FSR Maps.
Climate change allowance is 20%.[12]

[12] Greater Dublin Regional Code of Practice for Drainage Works

14.5.2 Flood Zones

As discussed in Section 14.4.6, there are no turbines or substation located within the indicative floodplain as shown in Figure 14-3. Therefore, there is no flood risk to the Dernacart Wind Farm during a flood event. The grid route cable crosses through some flood zones but the installed grid cable has no impact on flood risk as this will be below existing ground.

14.5.3 Estimated Increase in Flood Risk

The estimated increase in runoff due to the construction of the wind farm is provided in Table 14.4. Although the increase in runoff is found to be of low significance (overall 0.387 m^3/s (or 0.12 %)), there is evidence of flooding in the River Barrow and in the area Cottoner's Brook stream and Forrest Upper joining the River Barrow. Therefore, a predictive assessment was carried out at the crossings of these watercourses. Location of analysed crossings are located as shown on Figure 14-6.

As part of the flood risk assessment, the greenfield design flow for a 1 in 100-year return period was estimated using two methods of flood estimation for catchments less than 25 km^2, to determine the 1 in 100-year flood at the location of the crossing structure.

The two methods to estimate greenfield runoff are:

- Institute of Hydrology (IOH) 3-variable equation method, where Q_{BAR} is multiplied by the appropriate design factor (standard error factor) which is 1.65.
- Flood Studies Supplementary Report (FSSR) 3-variable equation method, with a standard error factor of 1.5.

The greatest flow determined from the two methods was then taken and multiplied by the regional growth factor of 1.96 to obtain the 100-year peak flow value. To accommodate the effect of future climate change in Ireland, the 100-year peak flow value was then multiplied by 1.2 to get the design 100-year flood value at the crossing[13].

The increase in flow due to the proposed development was then estimated within the sub-catchments upstream of these structures. The pre and post development flows were then analysed for their impact on the capacity of the structure at the downstream crossing.

The flow calculations are set out in Table 14.7.

[13] Greater Dublin Regional Code of Practice for Drainage Works

Table 14.7: Q_{100} Flows at Downstream Structures[14], Pre and Post Construction

Location	AREA	SAAR	SOIL	IH 124			FSSR 6 3-Term Equation			Max. Design 100 yr Flood	Estimated Increase in Design 100y flow due to Development	Post Development Design 100yr Flow
				Q_{BAR}	Q_{100}	Increase by 20% for Climate Change	Q_{BAR}	Q_{100}	Increase by 20% for Climate Change			
	km^2	mm	-	m^3/s	m^3/s		m^3/s	m^3/s		m^3/s	m^3/s	m^3/s
Forrest Upper Stream, 80 m upstream of confluence	1.96	924	0.40	0.8	2.6	3.1	0.8	2.4	2.9	3.08	0.01	3.09
White Hill (W) Stream	1.01	925	0.40	0.4	1.4	1.7	0.4	1.3	1.6	1.70	0.17	1.87
White Hill (W) Stream	1.18	929	0.40	0.5	1.6	2.0	0.5	1.5	1.8	1.97	0.17	2.14
Unnamed Stream Crossing	1.48	932	0.40	0.6	2.0	2.4	0.6	1.9	2.2	2.42	0.17	2.59
Cottoner's Brook Stream	11.83	903	0.40	3.8	12.4	14.9	4.1	12.2	14.6	14.86	0.07	14.92

Note:

Catchment area is determined from OPW FSU web portal.

SAAR is provided from Met Eireann.

SOIL type index is determined from FSR Maps. Soil Type 3.

Climate change allowance is 20%.[15]

[14] Refer to Figure 14.7 for locations

[15] Greater Dublin Regional Code of Practice for Drainage Works

14.5.3.1 Forrest Upper Stream Crossing

The structure crossing over Forrest Upper stream is a 300 mm concrete pipe.

A hydraulic analysis of the crossing structure was undertaken using Pipe Flow Advisor software to determine the capacity of the crossing structure, pre and post development. It was found that in the existing scenario, the culvert does not meet required capacity to convey 1 in 100 years design flow.

The existing culvert has capacity of 0.10 m^3/s. The pre-development design flow is 3.08 m^3/s and post development design flow is 3.09 m^3/s. The increase in runoff due to the development is negligible, however flooding around culvert structure is expected to occur for both scenarios and this is consistent with the OPW flood mapping where the adjacent lands in the immediate vicinity of the structure are shown to flood in a 1 in 100-year event. According to PFRA mapping this area is within the site boundary. However, there is no proposed development in that area and the closest turbine is approximately 220 m northeast of the flood zone.

The calculations and results of the modelling are included in Appendix 14.2.

14.5.3.2 White Hill (W) Stream Crossing 1

The structure crossing over White Hill (W) stream is a box culvert 2.0 m wide and 1.6 m high.

A hydraulic analysis of the structure was undertaken using Pipe Flow Advisor software to determine the capacity of the crossing structure, pre and post development.

It was found that in the existing scenario, the culvert has enough capacity to convey 1 in 100 years flow.

The design flow for pre development scenario is 1.70 m^3/s and for post development flow is 1.87 m^3/s. Water depth at the culvert location might increase from 311 mm to 331 mm due to the change in surfaces at the wind farm. The estimated increase in water depth at the crossing structure due to the development is 20 mm.

Any potential for an increase in flooding is therefore expected to be of low significance. The surrounding area is not expected to be flooded and this is consistent with OPW flood mapping. Further, this exercise does not take into account the mitigation proposed in the drainage design to reduce flows.

The calculations and results of the modelling are included in Appendix 14.2.

14.5.3.3 White Hill (W) Stream Crossing 2

The structure crossing over White Hill (W) stream is a box culvert 2.0 m wide and 1.6 m high.

A hydraulic analysis of the crossing structure was undertaken using Pipe Flow Advisor software to determine the capacity of the crossing structure, pre and post development.

It was found that in the existing scenario, culvert has enough capacity to convey 1 in 100 years design flow.

The design flow for pre development scenario is 1.97 m^3/s and for post development scenario 2.14 m^3/s. Water depth at the culver location might increase from 343 mm to 362 mm due to the change in surfaces at the wind farm. The estimated increase in water depth at the crossing structure due to the development is 18 mm.

Any potential for an increase in flooding is therefore expected to be of low significance. Further, this exercise does not take into account the mitigation proposed in the drainage design to reduce flows.

The calculations and results of the modelling are included in Appendix 14.2.

14.5.3.4White Hill (W) Stream Crossing 3

The structure crossing over the White Hill (W) stream is a combination of a 600 mm diameter concrete pipe and an arc bridge 2.8 m wide and 1.8 high over the stream channel. During light rains, when flows are low, water flows through the concrete pipe. Flow through the arc bridge occurs when flows in the channel exceeds the capacity of the pipe.

A hydraulic analysis of the 600 mm concrete pipe and the nearest equivalent arch bridge structure was undertaken using Pipe Flow Advisor software to determine the capacity of the structure, pre and post development.

The design flow for pre-development scenario is 2.42 m^3/s and for post development scenario 2.59 m^3/s.

According to calculations, water depth at the crossing location might increase by 15 mm due to the change in surfaces at the wind farm.

Any potential for an increase in flooding is therefore expected to be of low significance. Further, this exercise does not take into account the mitigation proposed in the drainage design to reduce flows.

The calculations and results of the modelling are included in Appendix 14.2.

14.5.3.5Cottoner's Brook Stream Crossing

The Cottoner's Brook stream crossing structure is an arc bridge 3.0 m wide and 1.3 high over the stream channel.

A hydraulic analysis of the crossing structure was undertaken using Pipe Flow Advisor software to determine the capacity of the crossing structure, pre and post development.

It was found that in the existing scenario, the culvert has enough capacity to convey 1 in 100 years design flow.

The design flow for pre development scenario is 14.86 m^3/s and for post development scenario 14.92 m^3/s.

Water depth at the crossing location might increase from 981 mm to 985 mm due to the change in surfaces at the wind farm. The estimated increase in water depth at the crossing structure due to the development is 4 mm.

Any potential for an increase in flooding is therefore expected to be of low significance. Further, this exercise does not take into account the mitigation proposed in the drainage design to reduce flows.

The calculations and results of the modelling are included in Appendix 14.2.

14.5.4 Essential Infrastructure

Essential Infrastructure is defined in Table 3.1 of *The Planning System and Flood Risk Management Guidelines for Planning Authorities, OPW, November 2009*, as 'Primary transport and utilities distribution, including electricity generating power stations and substations, water and sewage treatment, and potential significant sources of pollution (SEVESO site, IPPC sites, etc.) in the event of flooding'. The proposed substation in this development therefore comes under the category of 'Essential Infrastructure'.

The proposed substation is outside the 50 m buffer from the nearest stream. The substation is also outside the Flood Zone A and B areas shown on Figure 14-3.

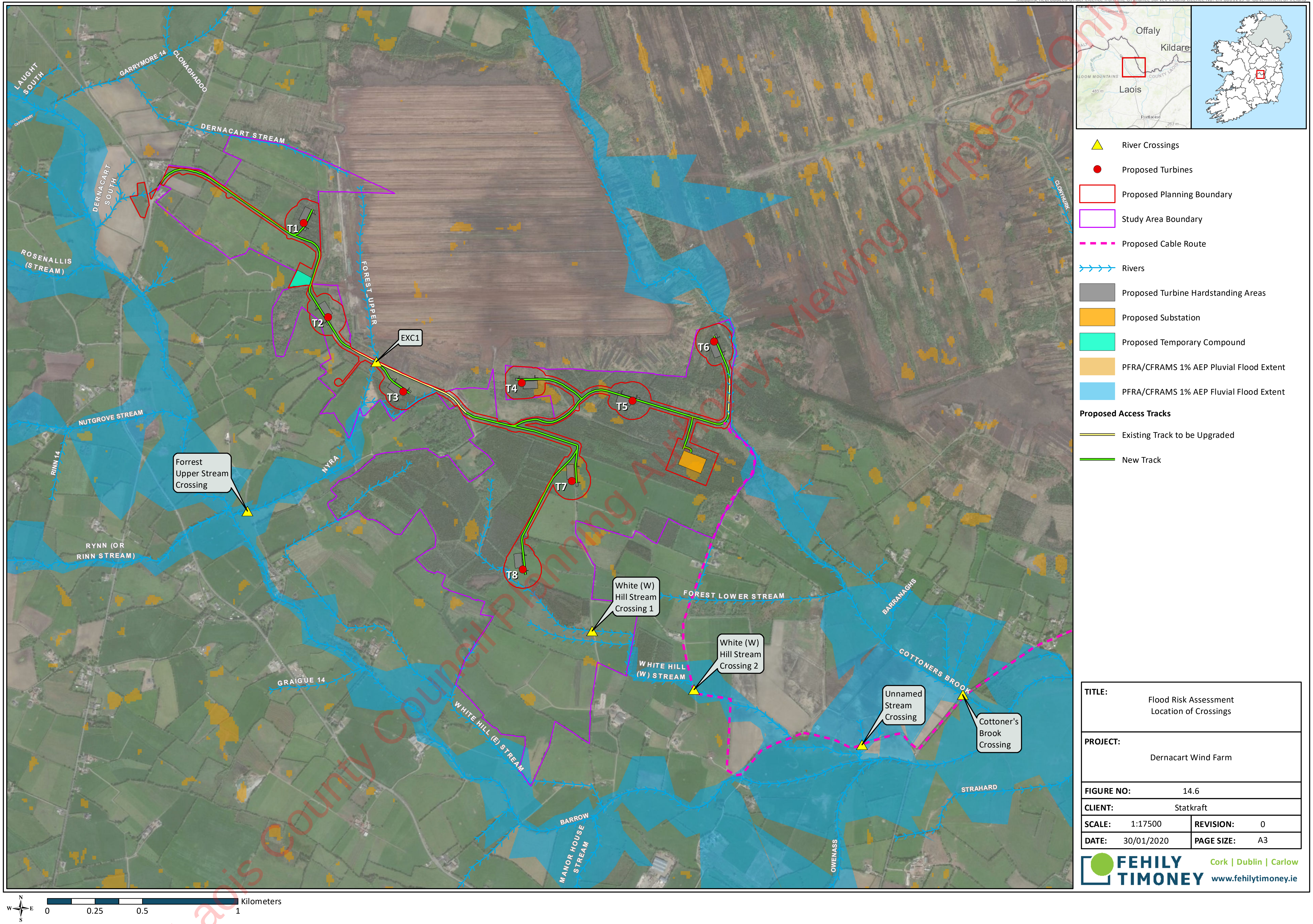
14.5.5 Summary of Flood Risk Identification and Assessment

A flood risk assessment has been undertaken for this development. As noted in Section 14.3.2 recurring flooding is expected at the confluences of the White (W) Hill stream, Cottoner's Brook stream and the River Barrow.

Flooding of the area adjacent to the confluences of the River Barrow could occur due to the high-water elevation in the River Barrow which might cause backups at Forrest Upper stream, White (W) Hill stream and the Cottoner's Brook stream.

As discussed in Section 14.4.2,1, the increased surface water runoff due to development is negligible and these flows are further reduced with the proposed drainage system. Increase in the water elevation at the locations of crossings, as discussed in Section 14.5.3, is also negligible. Therefore, the proposed development has a minimal impact on flooding risk in the surrounding area.

The route of the grid cable through flood zones is shown in Figure 14-3. The increase in runoff due to grid cable installation is not expected because the finished surfaces are not changed. Therefore, no impacts on the flood risk is expected.



TITLE:	Flood Risk Assessment Location of Crossings
PROJECT:	Dernacart Wind Farm
FIGURE NO:	14.6
CLIENT:	Statkraft
SCALE: 1:17500	REVISION: 0
DATE: 30/01/2020	PAGE SIZE: A3

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14.6 PROPOSED DRAINAGE

The proposed drainage design for the subject development has been informed by the potential impacts, discussed in Section 14.4 and the flood risk assessment undertaken in Section 14.5. In addition to providing for drainage of the development, the drainage design has the capacity to introduce hydrological links from the proposed development to the receiving environment, during the construction and operation phase.

An appropriate drainage design is the primary mitigation measure for a development, and in this case it will incorporate silt control measures and a reduction in the rate of surface water runoff from the proposed development.

The mitigation measures that follow in Section 14.7 refer to the drainage design and also include other best practice measures to mitigate any potential impacts from the development. Each county has specific concerns in relation to the control of surface water from new developments and the drainage design has taken account of these concerns.

The proposed layout of the drainage for the development is shown on the Planning drawings which accompany the planning application. Where possible existing access roads and tracks have been utilised in the layout design for the proposed wind farm to minimise the disturbance to soils.

The following types of surfaces are considered on this site in addressing the drainage for the proposed development:

- existing hardcore tracks and surfaced access roads which might be widened,
- proposed new site access tracks and hard surfaces associated with the construction of turbines,
- proposed on-site substation,
- temporary site compounds.

14.6.1 Interceptor Drains

It is not expected that overland flows will be obstructed to any great extent by the drainage layout, however, where required, interceptor drains will collect overland flows on the upslope side of the access tracks and hardstanding areas. The overland flow will then discharge diffusely on the downslope side over vegetated area within the site boundary.

14.6.2 Existing Hardcore Tracks and Surfaces Access Roads

The drainage system for the existing tracks and roads will largely be retained. During the site walkover it was observed that most of the existing tracks were approximately 4 m wide. It is proposed to widen approximately 888 m of existing tracks by around 1 m, with some additional widening at bends tracks. All track widening will be undertaken using clean uncrushable stone with a minimum of fines. This will involve slight relocation of existing roadside swales to allow widening.

Still traps will be placed in the new roadside swales. Details of a typical silt trap are included in Appendix 14.3.

14.6.3 New Site Access Tracks and Hard Surfaces

It is proposed to construct 5494 m of completely new access track. Proposed new tracks and turbine hard standing areas will be drained as per the existing drainage system via roadside swales with stilling ponds at the end of the swale. The details on stilling pond are included in Appendix 14.3.

These grassed swales will serve to detain flow and reduce the velocities of surface water flows. The swales will be typically 0.15 m in depth with a bottom width of 0.9 m and side slope of 1 in 3. The swales will be constructed in accordance with CIRIA C698 Site Handbook for the Construction of SuDS.

Where roadside drains are laid at slopes greater than 2%, check damns will be provided. This will reduce effective slope and runoff velocities and any consequent potential for erosion.

Site drainage, including silt traps and stilling ponds, will be put in place in parallel with or ahead of the construction, such that excavation for the new infrastructure will have functional drainage in place.

The stilling ponds will remain in place throughout the construction phase. The stilling ponds will be designed to drain diffusely overland, over existing vegetated area, within the site boundary.

Still fencing will be provided at strategic locations as shown on the Planning drawings which accompany the planning application, to further protect watercourses during the construction phase. Details of this fencing are included in Appendix 14.3.

14.6.4 Proposed Watercourse and Access Road Crossings

Watercourse crossing
The existing crossing EXC1 over the Forrest Upper stream will be reconstructed. It is proposed to replace the EXC1 with a bottomless culvert. Dimensions of the culvert are provided in Section 14.5.1. The collector cable is proposed to be put in the access road above the culvert.

A Section 50 application will be required to obtain the consent of the OPW for the design of the stream crossing at EXC1. The IFI will also be consulted at the detailed design stage.

Access Road Crossings
Minor drains such as manmade agricultural and forest drains will be crossed using 450 mm diameter pipes.

Recommended cross drains to convey drainage across tracks, are 225 mm diameter pipes.

Silt Protection Controls (SPCs) are proposed at the location of the drain crossings. It is recommended that the SPCs will consist as a minimum of silt traps containing filter stone and filter material staked across the width of the swales and upstream of the outfall to any receiving watercourse.

14.6.5 Drainage of On-site Substation

The proposed location of the substation is shown in Figure 4.2.1. It is proposed to drain the area of the substation using shallow swales, with a stilling pond at the end of the swale run. The stilling pond will remain in place following the construction period.

At the upslope side of the substation interceptor drains will be installed.

14.6.6 Drainage of Temporary Site Compound

The proposed location of the temporary site compound is shown in Figure 4.2.1.

Drains around the hard-standing areas of the site compound will be in the form of shallow grassed swales to minimise the disturbance to sub-soils.

Surface water runoff from the compound will be directed through a Class 1 Full Retention Oil Interceptor before discharge to the 'dirty' water drainage system for the site. This dirty water drains to a stilling pond before final discharge over land.

During the construction phase, it will be necessary to provide bottled water for potable supply for the construction personnel. A water tanker will supply water to be used for other purposes.

Portaloos and / or containerised toilets and welfare units with storage tanks will be used to provide toilet facilities for site personnel during construction.

All portaloo units located on site during the construction phase will be operated and maintained in accordance with the manufacturer's instructions and will be serviced under contract with the supplier. All such units will be removed off-site following completion of the construction phase.

14.7 MITIGATION MEASURES

14.7.1 Proposed Mitigation Measures for the Construction Stage

Proposed drainage measures to reduce and protect receiving waters from potential impacts during construction of the proposed development are outlined in Section 14.4.2. These include measures to prevent runoff erosion from vulnerable areas and consequent sediment release into the nearby watercourses to which the proposed development site drains. The mitigation measures proposed to reduce potential direct, indirect and cumulative impacts of the development as well as along the turbine delivery route and cable route are outlined below.

- The increase in the rate of surface water runoff along the route of the site access roads and hard-standings areas will be mitigated by the proposed drainage system design which includes provision of stilling ponds to reduce concentration of suspended solids in the runoff from these areas. This has been further mitigated by avoidance through design, in the utilisation of existing tracks and existing drainage systems where possible.
- Stilling ponds with a diffuse outflow detail will be put in place in advance as construction progresses across the site. Erosion control and retention facilities, including the stilling ponds will be regularly maintained during the construction phase. The three-stage treatment train (swale – stilling pond – diffuse outflow) proposed to retain and treat the discharges from hard surface areas as a result of the development will minimise the risk of flooding downstream.
- Where haul roads pass close to watercourses, silt fencing will be used to protect the streams. Silt traps will also be provided at outfalls from roadside swales to existing drains. Silt traps will be kept upstream of outfalls to allow a buffer zone to the outfall.
- A suitably qualified person will be appointed by the developer to ensure the effective operation and maintenance of drainage and other mitigation measures during the construction process. The operations management of the proposed development will include regular monitoring of the drainage system and maintenance as required.
- Standing water, which could arise in excavations, has the potential to contain an increased concentration of suspended solids as a result of the disturbance to soils. Water will be pumped into the site drainage system (including stilling ponds), which will be constructed at site clearance stage, in advance of excavations for the turbine foundations.
- Drains around hard-standing area will be shallow to minimise the disturbance of sub soil.
- The developer will ensure that erosion and sediment controls, namely silt-traps, silt fencing and swales are regularly maintained during the construction phase.
- Interceptor cut-off drains will be provided on the upslope site of the access roads to prevent the mixing of overland flows with the drainage for the proposed development. These interceptor drains will discharge diffusely over land to avoid concentration of runoff. The roadside drains will therefore only carry the site access road runoff and so avoid carrying large volumes of water and concentrating flows.
- Cross drains of 450 mm will be provided to prevent a risk of clogging for drainage crossings and conveying flow from agricultural drains and forestry drains over access track roads.
- Roadside swales will serve to attenuate any increase in surface water runoff.
- Where new cross-drains are proposed on this site to convey surface water from roadside swales to outfalls, these will be sized at a minimum of 225 mm diameter to avoid blockages.
- Silt fencing will be erected at the locations of the drain crossings for the duration of the construction period.
- Site access tracks have been laid out to reduce longitudinal slope of roadside drains where possible. Where roadside drains are laid at slopes greater than 2%, check damns will be provided. This will reduce effective slope and runoff velocities and any consequent potential for erosion.
- Where agricultural tracks and forestry roads will be used to access the development, the roadside drains alongside these roads will be cleared of obstructions, should it be found that debris and vegetation are impeding flows.
- Any diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of the materials stored.

- Refuelling of plant during construction will only be carried out at designated refuelling station locations on site.
- Prior to leaving the site, every truck delivering concrete to the site must wash the chute only to a lined pit provided at each turbine location.
- Silt fencing will be erected at the location of stream crossings along the cable route.
- Cables will be installed in trenches adjacent to the site access roads, or laid within the access road line, where required. Trenches will be excavated during dry periods where possible in short sections and left open for minimal periods, to avoid acting as a conduit for surface water flows.
- The temporary storage of excavated material on site will be put at least 50 m from watercourses.
- Wet concrete operations are not required for this site within or adjacent to watercourses. However, if wet concrete operations are required, an appropriate risk assessment will be completed prior to works being carried out and strategically located concrete washout areas will be provided.
- Portaloos and / or containerised toilets and welfare units will be used to provide toilet facilities for site personnel. Sanitary waste will be removed from site via a licenced waste disposal contractor.
- Instream works or other works which may impact directly on a watercourse should only be carried out during the open season which is from 1st July to 30th of September in each year (so as to avoid impacting on the aquatic habitat during the spawning season).
- Planned inspections or verifications of equipment will be undertaken to ensure there are no leaks or spillages during the works.

All of the mitigation measures detailed above will ensure that the water quality status of the receiving waterbodies is not affected by the proposed development.

For replacement of the culvert the following measures will be implemented:

- A suitably qualified person will be appointed by the developer to ensure the effective operation and maintenance of drainage and other mitigation measures during the construction process. The operations management of the subject development will include regular monitoring of the drainage system and maintenance as required.
- All open water bodies adjacent to proposed construction areas will be protected by fencing.
- Weather warnings will be monitored, and no construction will take place during extreme events to mitigate against potential flooding.
- Excavated subsoil material not required for in-site reinstatement will be removed to the designated material storage areas at the borrow pit locations.
- Any diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of such materials stored.
- Refueling of plant during construction will only be carried out at designated refueling station locations on site.
- Additional protection will be provided in the form of silt fencing downslope where required during construction, to further ensure that there is no impact from the development to streams and rivers downslope of the site.
- Daily visual inspections of drains and streams will be performed during the construction period to ensure suspended solids are not entering the streams and rivers alongside the work area, to identify any obstructions to channels, and to allow for appropriate maintenance of the existing roadside drainage regime. If excessive suspended solids are noted, construction work will be stopped, and remediation measures will be put in place immediately.

14.7.1.1Grid Cable Installation

The following mitigation measures are proposed during construction stage:

- Weather forecasts will be monitored, and no construction will take place during extreme rainfall events to mitigate against potential flooding.
- Mitigation measures will be provided where surface water flows may be temporarily prevented from reaching gullies during trench excavation. Typical mitigation measures will include the provision of temporary overground surface water channels using sand bagging for example to divert flows to downstream gullies.

- Trenches will be excavated during dry periods where possible in short sections and left open for minimal periods, to avoid acting as a conduit for surface water flows.
- Any excavated material will be used in the reinstatement of the cable trenches subject to approval. Surplus material will be removed from the site to an appropriate facility. There will be no stockpiling of excavated material.
- All excavated soil material will be managed on site in accordance with the Outline CEMP.
- Silt fencing will be provided around any exposed areas to prevent the ingress of suspended solids into adjacent watercourses. These mitigation measures will prevent surface water contamination and will prevent subsequent flows of contaminated water into watercourses.
- Additional protection will be provided in the form of silt fencing downslope where required during construction, to further ensure that there is no impact from the development to streams and rivers downslope of the site.
- Daily visual inspections of drains and streams will be performed during the construction period to ensure suspended solids are not entering the streams and rivers alongside the work area, to identify any obstructions to channels, and to allow for appropriate maintenance of the existing roadside drainage regime. If excessive suspended solids are noted, construction work will be stopped, and remediation measures will be put in place immediately.

14.7.1.2Horizontal Directional Drilling

As discussed in Section 14.3.6 the grid cable route crosses 7 watercourses. The proposed crossing method is horizontal directional drilling (HDD), this will avoid the requirement for any instream works. Proposed mitigation measures are listed below:

- An Environmental Engineer with a "stop work" authority will be engaged to monitor the construction phase of the development when the water crossing is being undertaken.
- The working area around the bridge/culvert crossings will be fenced off prior to the commencement of works to avoid damage to bankside habitat
- Siltation of watercourses will be mitigated using silt traps and by avoiding operating within watercourses where feasible
- Watercourses will be visually inspected
- Should increased levels of siltation be recorded within the watercourses during the course of the construction phase, the Environmental Engineer will halt construction works until the source of the pressure can be found and remediated
- Surplus material will be removed from the site to an appropriate facility. There will be no stockpiling of excavated material. A setback distance of at least 20 m from watercourses will be adhered to when storing temporary spoil
- There are no instream works likely due to the use of HDD, however, prior to any works taking place near water courses the Inland Fisheries Ireland will be consulted
- Construction works onsite will be timed to occur outside periods where heavy rainfall would be expected
- Silt traps will be regularly maintained during the construction phase. All personnel working onsite will be trained in pollution incident control response.
- Appropriate signage will be place along the proposed route outlining the spillage response procedure and a contingency plan to contain silt. A regular review of weather forecasts of heavy rainfall is required, and the contractor is required to prepare a contingency plan for before and after such events
- HDD operations to be limited when low levels of rainfall are forecast.
- Visual inspection to take place at all times along the bore path of the alignment.
- Silt fences will be constructed around proposed work areas prior to commencement of works.
- No refuelling will take place within 50m of the stream zone or any sensitive habitats.
- During the drilling process, a mixture of a natural, inert and fully biodegradable drilling fluid will be used.

14.7.2 Proposed Mitigation Measures for Tree Felling

Tree felling will be undertaken prior to the construction of site access tracks and hard-standing areas. The area of proposed felling is ca. 18ha. A vegetation ground cover is expected to be established relatively quickly once trees have been felled. Thus, no significant increase in the rate of runoff is anticipated as a result of felling nor is the risk of downstream flooding or sedimentation due to increased erosion.

Tree felling will be the subject of a felling licence from the Forest Service and must be carried out in accordance with the conditions of such a licence. A Limited Felling License will be in place prior to works commencing on site. To ensure a tree clearance method that minimises the potential for sediment and nutrient runoff, the construction methodology will follow the specifications set out in the Forest Service Forestry and Water Quality Guidelines (2000) and Forest Harvesting and Environmental Guidelines (2000).

Trees will be felled away from aquatic zones where possible. Brash mats will be used as necessary on any off-road harvesting routes, removed and replenished if they become worn. Branches, logs or debris will not be allowed to accumulate in aquatic zones and will be removed as soon as possible.

14.7.3 Proposed Mitigation Measures for Operation and Maintenance Stage

The main potential hydrological impact of the development is an increase in runoff from a storm event to the existing land drainage, due to the change in land use resulting in an increase in impermeable ground conditions. Due to the limited increase in potential runoff from the site, there should be negligible release of sediment to the watercourses post-construction. The increase in runoff is considered insignificant and mitigated by means of the drainage system. The drainage system will be left in situ during operational phase.

When operational, the development will have a negligible effect on surface water quality as there will be no further disturbance of soils.

During the operation phase, small quantities of oil will be used in cooling the transformers associated with the facility. There is therefore a potential for small oil spills. Risks of potential oil leakage and potential pollutants draining to the watercourse from the installed transformer is mitigated by means of transformer interceptor bund wall.

It is not envisaged that maintenance will give rise to any significant impacts on the hydrological regime of the area. The maintenance schedule for the development will include timely and effective maintenance of the onsite drainage system.

The maintenance regime will include inspecting the following:

- Drains, cross-drains and culverts for any blockages
- Outfalls to existing field drains and watercourses
- Existing roadside swales for any obstructions
- Swales and stilling ponds
- Progress of the re-establishment of vegetation.

The maintenance regime will also include implementing appropriate remedial measures as required after the above inspections and testing the water quality at the outfalls at appropriate intervals. Visual inspections will be undertaken during maintenance in accordance with maintenance schedules as set out in CIRIA C753 or equivalent.

14.7.4 Proposed Mitigation Measures for Decommissioning Stage

In the event of decommissioning of the Dernacart Wind Farm facilities , the access tracks may be used in the decommissioning process. Mitigation measures applied during decommissioning activities will be similar to those applied during construction stage.

It is proposed that turbine foundations and hardstanding area should be left in place and covered with local soil/topsoil at decommissioning stage.

Removal of this infrastructure could result in considerable disruption to the local environment in terms of an increased possibility of sedimentation, erosion and of contamination of the local water table. It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing them.

Grid connection cables will be left in the ground, therefore no potential impacts during decommissioning stage are likely to occur. Hence no mitigation measures are required.

14.8 RESIDUAL IMPACTS

The residual impacts of the proposed development are summarised in Table 14.8 below, using the evaluation criteria outlined in Section 14.2.4.

Table 14.8 indicates that, following the implementation of mitigation measures, the residual risk to the receiving watercourses would be imperceptible and not significant during the construction, operation and decommissioning stage of the wind farm development.

14.8.1 Construction Stage

Increased surface water runoff due to construction activities is likely to occur. Sediment release is likely to occur due to disturbance of soils. However, the measures to be implemented to mitigate against the effects of increased runoff and potential for sedimentation of watercourses, will ensure that the residual impacts of the construction stage are imperceptible.

14.8.2 Operational Stage

Increased surface water runoff due to the presence of the wind farm development is likely to occur. However, there are no significant residual impacts relating to hydrology and water quality as the increased associated mitigation measures will be implemented and sediment release to watercourses is unlikely to occur as there is no further planned soil disturbance.

14.8.3 Decommissioning Stage

The decommissioning plan will include a surface water management plan. This will ensure that the residual impacts of the decommissioning stage of the wind farm will not be significant.

Table 14.8: Residual Hydrological Impact Significance for Sensitive Receptors

Activity	Potential Impact	Receptor	Sensitivity	Before Mitigation		After Mitigation	
				Magnitude/ Probability	Significance	Magnitude/ Probability	Residual Significance
Construction Phase							
Site tracks, turbine construction, substations	Increase in rate of runoff	River Barrow	High	Negligible	Not Significant	Negligible	Imperceptible
Site tracks, crossings, cabling, turbine construction, HDD, crane pad construction, substations, tree felling and management of material storage areas	Release of suspended solids into watercourse	River Barrow	High	Medium	Significant	Negligible	Not significant
Site tracks, crossings, cabling, turbine construction, HDD, crane pad construction, sub-stations, tree felling and management of material storage areas	Release of hydrocarbons or fuel spill	River Barrow	High	Negligible	Not significant	Negligible	Not significant
Drainage crossings, turbine construction, substations, temporary compounds	Obstruct hydrological flow	River Barrow	High	Negligible	Imperceptible	Negligible	Imperceptible
Operation & Maintenance							
Site access tracks, turbine hardstanding areas, substations	Increase in rate of runoff	River Barrow	High	Negligible	Not significant	Negligible	Imperceptible
Site access tracks, turbine hardstanding areas, substations	Erosion and sedimentation	River Barrow	High	Negligible	Not significant	Negligible	Not significant
Decommissioning							
Use of equipment for dismantling and removing turbine components	Erosion and sedimentation	River Barrow	High	Negligible	Not significant	Negligible	Not significant

14.9 CONCLUSION

Construction and operation of the proposed Dernacart Wind Farm is likely to give rise to increases in surface runoff of 0.387 m^3/s (or 0.12 %) above current levels due to changes to the site surface. Increases in runoff due to construction of the wind farm are imperceptible.

Release of sediment is likely to occur due to disturbance of soil. Sediment release to watercourses is related to the type of works being undertaken on the site. The potential for sediment release is likely to be higher during the earthworks phase of construction, i.e. during periods of soil disturbance, than when turbines are being installed. Due to the sensitivity of the receptors, sediment control measures will be implemented throughout the site to minimise the risk of sediment entering downstream watercourses.

Surface runoff drains to tributaries of the River Barrow. The River Barrow is part of a Special Area of Conservation, therefore effective mitigation measures will be implemented to ensure that any impacts would be of imperceptible significance. The proposed mitigation measures are outlined in Section 14.7.

The proposed Dernacart Wind Farm development is not expected to contribute to any significant, negative cumulative effects with other existing or proposed developments in the vicinity.

With mitigation measures, outlined in Section 14.7, put in place during construction, operational and decommissioning stage the proposed development will have imperceptible significance on the hydrology and water quality of the area.