ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED MAIGHNE WIND FARM, COUNTY KILDARE AND COUNTY MEATH

VOLUME 2 – MAIN EIS

CHAPTER 9 – HYDROLOGY

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9.1 Introduction

The proposed development consists of the erection of up to 47 no. wind turbines with a tip height of up to 169m, access tracks, a sub-station, a permanent metrological mast, borrow pits and associated works, temporary compounds as well as temporary minor alterations to the public road for the delivery of turbines to the site (turbine delivery route). The turbines are arranged in five wind farm clusters. The clusters are Ballynakill (10 turbines), Windmill (3 turbines), Drehid-Hortland (21 turbines), Derrybrennan (2 turbines) and Cloncumber (11 turbines). All clusters are connected via associated underground medium voltage (MV) cables which run predominately along the public road network linking back to a proposed sub-station on-site at Drehid. Here the power will be converted to AC up to a maximum voltage of 220kV for export to the Irish national grid via high voltage (HV) underground cables. These elements (cable routes) also form part of the proposed development.

Whether the connection point to the national electricity transmission grid will be located at the Woodland or Maynooth substations will be determined by EirGrid plc, which is the statutory Transmission System Operator. Accordingly, the documentation submitted with this application for permission identified and evaluates 2 no. HV grid connection routes (which will operate at a voltage up to 220kV). The 2 no. HV grid connection cable routes included in this application will connect the proposed Maighne Wind Farm substation at Drehid to either one of two existing substations located at Woodland, Co. Meath or Maynooth, Co. Kildare. However, only one of these routes will be constructed following the identification of the preferred connection point by the Transmission System Operator.

This chapter has been prepared to examine the potential impacts of the proposed Maighne Wind Farm, associated cables and turbine delivery route on hydrology in the local environment. The effects of the proposed development are considered, taking account of mitigation measures to reduce or eliminate any residual impacts on hydrology.

9.1.1 Study Area

The geographical scope of the study area for hydrology comprises a study of all watercourses within the site boundary. The scope extends downstream of the site to downstream structures on these watercourses, where current pressures such as flooding have been recorded or predicted by statutory authorities. The hydrological links to environmentally designated protected areas downstream of the site, for a distance of 15km, are examined to establish the sensitivity of the receiving environment. In assessing the impacts of the TDR and MV and HV cable routes, the streams crossed by these routes are examined. Where developments exist or are proposed in upstream or downstream waterbodies with hydrological links to the site, cumulative impacts of these developments are also examined.

9.2 Methodology

The following sources of information were considered in this assessment:

- The design layout of the proposed development.
- Published literature as described in Section 9.2.2 below.
- A desk-based assessment of the surface water hydrology in the catchments relevant to the wind farm, including an assessment of the watercourses which will be intercepted by the layout of the wind farm and those which will receive surface water run-off from the proposed wind farm development.
- A field assessment of the existing hydrological environment, to both verify desk based assessment and record all significant hydrological features.

9.2.1 Relevant Guidance

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

- Guidelines on the information to be contained in Environmental Impact Statements, EPA (2002) ([1]).
- Advice Notes on Current Practice, EPA (2003) ([2])
- Wind Energy Development Planning Guidelines ([3]) .
- Best Practice Guidelines for the Irish Wind Energy Industry, Irish Wind Energy Association (2012) ([4]).
- Sustainable Development: A Strategy for Ireland, Department of the Environment, 1997 ([5])
- Kildare County Development Plan 2011-2017 ([6])
- Meath County Development Plan 2013-2019 ([7])
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a Framework for Community Action in the Field of Water Policy ([8])
- Flood Mapping Website http://www.floodmaps.ie ([9])
- OPW preliminary flood risk assessment (PFRA) indicative mapping website www.cfram.ie ([10])
- Greater Dublin Strategic Drainage Study (GDSDS): Technical Documents of Regional Drainage Policies, March 2005 ([11])
- Eastern Regional Fisheries Board - Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites ([12])
- 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) ([13])
- Environmental Good Practice on Site - Construction Industry Research and Information Association (UK) ([14])
- Best Practice Guide BPGCS005 Oil Storage Guidelines ([15])
- Control of Water Pollution from Linear Construction Sites (C648) - Construction Industry Research and Information Association (UK) (16)
- Control of Water Pollution from Construction Sites. Guidance for Consultants and Contractors (C532) - Construction Industry Research and Information Association (UK) ([17])
- Sustainable Construction Procurement. A Guide to Delivering Environmentally Responsible Projects (C571) - Construction Industry Research and Information Association (UK) ([18])
- UK Pollution Prevention Guidelines (PPG):
    - PPG1: Understanding your environmental responsibilities – good environmental practice (19)
    - PPG2: Above ground oil storage tanks ([20])
    - PPG3: Pollution Prevention Guidelines ([21])
    - PPG4: The disposal of sewage where no mains drainage is available ([22])
    - PPG5: Works in, near or liable to affect watercourses ([23])
    - PPG6: Working at construction and demolition sites ([24])
    - PPG8: Safe storage and disposal of used oil ([25])
    - PPG21: Pollution incident response planning ([26])
    - PPG26: Drums and intermediate bulk containers ([27])
- Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes - National Roads Authority, 2005 (28)
- Design Manual for Roads and Bridges (National Roads Authority (NRA) DMRB), March 2013.) (29)
- Eastern River Basin District River Basin Management Plan 2009-2015 ([30])
- South Eastern International River Basin Management Plan 2009 – 2015 ([31])
- Biological River Water Quality Data, (Environmental Protection Agency (EPA) ([32])
- Code of Best Forest Practice – Ireland, (Forest Service and Department of Marine and Natural Resources – 2000) ([33])
- Forestry and Water Quality Guidelines (Forest Service and Department of Marine and Natural Resources 2000) ([34])
  Forest Road Manual, Guidelines for the Design, Construction and Management of Forest Roads, (COFORD 2004) ([35])

Cognisance was taken of particular guidance on hydrology from the policies and objectives of the Kildare County Development Plan and the Meath County Development Plan as follows:

The Kildare County Development Plan 2011-2017 ([7]) lays down specific objectives in relation to surface water run-off as follows:

WD 4: *To improve water quality in the county in accordance with current European and National legislation.*

WD 5: *To continually monitor and review the water quality standards of Kildare County Council in light of European Communities (Drinking Water) Regulations 2007 (SI 278 of 2007), as may be amended and to ensure continuing compliance.*

SW 6: *To ensure that all developments have regard to the surface water management policies in the Greater Dublin Strategic Drainage Study (GDSDS).*

SW 12: *To seek to ensure that development will not interfere with or interrupt existing surface water drainage systems.*

SW 20: *To ensure development proposals in rural areas (excluding one-off rural housing) demonstrate compliance with the following:*

- *the ability of a site in an unserviced area to accommodate an on-site waste water disposal system in accordance with the County Kildare Groundwater Protection Scheme, and any other relevant documents / legislation as may be introduced during the Plan period.*
- *the ability of a site in an unserviced area to accommodate an appropriate on-site surface water management system in accordance with the policies of the Greater Dublin Strategic Drainage Study (2005), in particular those of Sustainable Urban Drainage Systems (SuDS).*
- *the need to comply with the requirements of The Planning System and Flood Risk Management Guidelines for Planning Authorities published by the Minister for the Environment, Heritage and Local Government in November 2009.*

The Kildare County Development Plan 2011-2017 ([7]) has set out the county's policies with regard to flooding as outlined below:

SW 3: *To ensure new development does not increase flood risk elsewhere, including that which may arise from surface water run off.*

SW 4: *To ensure effective management of residual risks for development permitted on floodplains.*

SW 5: *To have regard to the recommendations of the Liffey Catchment Flood Risk Assessment and Management Study, the Barrow Catchment Flood Risk Assessment Management Report, the Eastern River Basin District Catchment Flood Risk Assessment and Management Study and the South Eastern River Basin District Catchment Flood Risk Assessment and Management Study, and to ensure that any development adjacent to these watercourses or their tributaries take cognisance of these reports / studies.*

SW 11: *To ensure that the Justification Test for Development Management is applied to proposals for development in areas at a high or moderate risk of flooding where the development being proposed is vulnerable to flooding and would generally be inappropriate as set out in Table 3.2 of The Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009).*

SW 16: *To ensure that all new developments are designed and constructed to meet minimum flood design standards. (Refer Chapter 19, Development Management Standards).*

SW 18: *To recognise the important role of bogland and other wetland areas in flooding patterns. Development in these areas shall therefore be subject of a Flood Risk Assessment in accordance with The Planning System and Flood Risk Management Planning Guidelines (2009).*

WD 8: *To acknowledge the strategic policy recommendations in relation to flood risk identified in the Regional Planning Guidelines for the Greater Dublin Area 2010–2022.*

WD 9: *To seek to manage the risks to people and property through the implementation of flood relief schemes as per the Water Services Flood Alleviation Capital Programme 2009–2013 as may be amended during the period of this Plan.*

WD 10: *To continue to undertake works under the Arterial Drainage Programme, as prioritised and as may be amended over the period of this Plan.*

WD 11: *To liaise with adjoining Local Authorities, all relevant departments and agencies in the alleviation of flood risk in the county.*

The Meath County Development Plan 2013-2019 lays down specific objectives in relation to surface water run-off as follows:

WS SOBJ 9 *To promote compliance with environmental standards and objectives established (i) for bodies of surface water, by the European Communities (Surface Waters) Regulations 2009;*

WS OBJ 16 *To incorporate and promote the use of Sustainable Urban Drainage Systems within County Council Developments and other infrastructural projects as required in the Greater Dublin Regional Code of Practice for Drainage Works.*

WS OBJ 17 *To require the use of Sustainable Urban Drainage Systems in accordance with the Greater Dublin Regional Code of Practice for Drainage Works for new developments (including extensions).*

WS OBJ 18 *To ensure that all new developments comply with Section 3.12 of the Greater Dublin Regional Code of Practice for Drainage Works V6 which sets out the requirements for new developments to allow for Climate Change.*

The Council's policies in relation to surface water run-off include the following:

WS POL 20 *To ensure through the implementation of the River Basin Management Plans and their associated programmes of measures, and any other associated legislation, the protection and improvement of all drinking water, surface water and ground waters throughout the county.*

WS POL 21 *To work, in co-operation with relevant organisations and major stakeholders to ensure a co-ordinated approach to the protection and improvement of the county's water resources.*

WS POL 22 *To continue efforts to improve water quality under the Local Government (Water Pollution) Act 1977, as amended and by implementing the measures outlined under the Nitrates Directive (91/676/EEC) and complying with the requirements of the Surface Water Legislation Environment Objectives (Surface Waters) Regulations 2009 and other relevant regulations.*

WS POL 23 *To promote public awareness of water quality issues and the measures required to protect both surface water and ground water bodies.*

WS POL 25 *To protect, maintain and improve the natural character of the watercourses and rivers in the county Meath.*

The Meath County Development Plan 2013 - 2019 ([7]) has set out the county's policies and objectives with regard to flooding as outlined below:

WS POL 29 *To have regard to the "Planning System and Flood Risk Management – Guidelines for Planning Authorities" (DoEHLG/OPW, 2009) through the use of the sequential approach and application of the Justification Tests for Development Management and Development Plans, during the period of this Plan.*

WS POL 30 *To have regard to the findings and recommendations of the current Strategic Flood Risk Assessment prepared as part of the County Development Plan review. See Appendix 6.*

WS POL 31 *To ensure that all developments have regard to the surface water management policies in the Greater Dublin Strategic Drainage Study (GDSDS). Compliance with the recommendations contained in Technical Guidance Document, Volume 2, Chapter 4 of the Greater Dublin Strategic Drainage Study shall be required in all instances.*

WS POL 32 *To ensure that a flood risk assessment is carried out for any development proposal, where flood risk may be an issue in accordance with the "Planning System and Flood Risk Management – Guidelines for Planning Authorities" (DoECLG/OPW, 2009). This assessment shall be appropriate to the scale and nature of risk to the potential development.*

WS POL 33 *To consult with the Office of Public Works in relation to proposed developments in the vicinity of drainage channels and rivers for which the OPW are responsible, and the Council will, retain a strip of 10 metres on either side of such channel where required, to facilitate access thereto.*

WS POL 34 *To consult, where necessary, with Inland Fisheries Ireland, the National Parks and Wildlife Service and other relevant agencies in the construction of flood alleviation measures in County Meath.*

WS POL 35 *To ensure that flood risk management is incorporated into the preparation of Local Area Plans and Town Development Plans in accordance with 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities (2009)'*

WS POL 36 *To have regard to the recommendations of the Fingal East Meath Flood Risk Assessment and Management Study, the Eastern, North West and Neagh Bann Catchment Flood Risk Assessment and Management Study when finalised and approved*

WS OBJ 11 *To undertake a review of the 'Strategic Flood Risk Assessment for County Meath' following the publication of the flood mapping which is being produced as part of the Catchment Flood Risk Assessment and Management (CFRAM) Studies.*

WS OBJ 12 *To design flood relief measures to ensure appropriate protection for alluvial woodland (i.e. a qualifying interest) along the Boyne.*

WS OBJ 13 *To design flood relief measures to protect the conservation objectives of Natura 2000 sites and to avoid indirect impacts of conflict with other qualifying interests or Natura 2000 sites.*

WS OBJ 14 *To promote positive flood relief measures that can enhance habitats in the Boyne floodplain such as swales, constructed wetland basins etc.*

WS OBJ 15 *To seek to ensure that construction works are designed so as not to result in surface water runoff into cSAC or SPAs either directly or indirectly via a watercourse.*

A Strategic Flood Risk Assessment (SFRA) was prepared for County Meath for the Meath County Development Plan 2013-2019. Flood Zone mapping was prepared as part of this SFRA, indicating Flood Zones A (1% AEP) and Flood Zones B (0.1% AEP) in the vicinity of the urban settlements in County Meath. The SFRA was examined to provide guidance on flood zones in the relevant area of the site.

9.2.2 Consultation

The scope for this assessment has been informed by pre-application consultation with An Bord Pleanála, prescribed bodies and other interested parties as summarised in Chapter 4 of the EIS.

The comments expressed by KCC, NPWS, Inland Fisheries Ireland (IFI), An Taisce and Waterways Ireland in written consultations received from them and at subsequent meetings with these bodies as part of the EIA process, were considered in the preparation of this chapter.

9.2.3 Desk Study

The desk top study involved an examination of the hydrological aspects of the following sources of information:

- Current and historic Ordnance Survey Ireland mapping, and ortho-photography.
- OPW Indicative Flood Maps.
- Catchment Flood Risk Assessment and Management (CFRAM) Studies Maps.
- Study of existing surface water/drainage features in the vicinity of the proposed development.
- Study of the proposed layout of the development.
- Liaison with geotechnical specialists for details on soil conditions on the site.
- Review of designated areas within 15km of the site.
- Study of planning documents for adjacent developments.
- History of flooding and status of drainage in the neighbourhood.
- Review of consultation with statutory and interested bodies and relevant Local Authorities.
- Study of development plans.

9.2.4 Field Assessment

An initial site walkover survey took place from 31 May to the 8 July 2013 to establish the pattern of existing drainage on the site and to record any significant hydrological features. The site walkover involved a review of available information gathered in the desk study phase. During the site visit the GPS coordinates, descriptions, and photographs of the hydrological features were recorded as discussed in Section 9.3.4.

A second site walkover survey took place on 11 and 12 November 2014 to examine the final layout, which took account of changes resulting from constraints, arising from the detailed assessments by various disciplines, including hydrology. Streams crossed by the proposed layout were identified and the river crossing structures downstream of the site were recorded where relevant. Sections of the turbine delivery route and the MV and HV cable route were also examined as part of the second site walkover survey.

9.2.5 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the proposed Maighne wind farm, a number of activities will take place on site, some of which will have the potential to cause impacts on the hydrological regime at the site and the quality of waters draining the site.

9.2.5.1 Assessment of Significance of Impact on the Receiving Environment

An impact rating has been developed for each of the phases of development of the wind farm. The sensitivity of the receiving environment was first identified. Then the magnitude of the potential impact was estimated. The sensitivity rating, together with the magnitude of the potential impact, provides an overall rating of the significance of the impact prior to application of mitigation measures.

9.2.5.2 Sensitivity of Receptors

The sensitivity of an environmental receptor is based on its ability to absorb an impact without perceptible change. The hydrological environment is considered to be of high sensitivity for areas of the proposed development draining towards tributaries of the River Boyne, due to the proximity of the environmentally protected designated site: the River Boyne and River Blackwater candidate Special Area of Conservation (cSAC) (site code: 002299) and Special Protection Area (SPA) (site code: 0004232), which lies approximately 800m by hydrological links, from the proposed wind farm development at its closest point (adjacent to the Ballinakill cluster). Further, the River Glash and the Fear English River, tributaries of the River Boyne are salmonid nurseries. The Windmill cluster drains into the River Glash and the Drehid-Hortland cluster drains into the Fear English River.

The hydrological environment is also considered to be of high sensitivity for areas of the proposed development draining towards the Slate River, a tributary of the River Barrow, which is a salmonid nursery. The Slate River runs through the southern part of the site. The environmentally designated areas are discussed further in Chapter 7 Ecology.

9.2.5.3 Assessment of Magnitude and Significance of Hydrological Impact

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact in accordance with the EPA Guidelines 2002 (1). The magnitude criteria for hydrological impacts are defined as set out in Table 9.1.

Table 9.1: Assessment of Magnitude of Hydrological Impact

Magnitude	Criterion	Description and Example
Major	loss of attribute	long term changes to the hydrology and water quality e.g., loss of EU-designated salmonid fishery: • change in water quality status of river reach • loss of flood storage/increased flood risk • pollution of potable source of abstraction
Moderate	impact on integrity of attribute or loss of part of attribute	short to medium term changes to the hydrology and water quality: • loss in productivity of a fishery • contribution of significant sediment and nutrient quantities in the receiving water, but insufficient to change its water quality status
Minor	minor impact on attribute	detectable but non-material and transitory changes to the hydrology and water quality - measurable change in attribute, but of limited size and/or proportion
Negligible	impact on attribute but of insufficient magnitude to affect the use/integrity	no perceptible changes to the hydrology and water quality: • discharges to watercourse but no loss in quality, fishery productivity or biodiversity • no increase in flood risk

Potential impacts are assessed as being of major, moderate, minor or negligible significance. The shaded boxes in Table 9.2 represent impacts considered to be significant in terms of the impact assessment, taking cognisance of the sensitivity of the receiving environment.

Table 9.2: Significance of Criteria

Magnitude	Sensitivity			
	Very high	High	Medium	Low
Major	major	major	moderate	minor
Moderate	moderate	moderate	moderate	minor
Minor	minor	minor	minor	negligible
Negligible	negligible	negligible	negligible	negligible

A summary of unmitigated potential impacts and the associated significance rating due to the development of the proposed wind farm is provided in Table 9.4 in Section 9.4.7. The residual impacts following mitigation and the associated significance rating are provided in Table 9.8.

As part of the evaluation of the wind farm site, a flood risk identification and assessment was carried out as discussed in Section 9.5.

As wind farms are low intensity developments and can be deemed water compatible, as interpreted from Table 3.1 of The Planning System and Flood Risk Management Guidelines for Planning Authorities ([13]) , the flood risk 'to the development' need not be examined and a Justification Test is not deemed to be required. Any potential increase in surface water run-off due to the development, in areas deemed to be already at risk of flooding, will however be examined as part of the impact evaluation in this Chapter and mitigation measures will be proposed where required.

Where required, a cumulative flood risk assessment is undertaken. It should be noted that no essential infrastructure has been located in a 'Flood Zone A' area (a probability of flooding greater than 1 in 100) in this development.

9.3 Existing Environment

9.3.1 Site in Context

The area proposed for the Maighne Wind Farm is located across a number of river catchments, as shown in Figure 9.1.0 Waterbody Catchment Map Overview. The information in this figure is available to view in more detail in the sub maps, which are included in Volume 2a.

The northern sections of the site predominantly drain to the River Boyne and its tributaries. The main tributary of the River Boyne draining the northern sections of the site is the River Blackwater.

To the east and north east of the site, the tributaries flowing through the site, which drain to the River Blackwater are: the Kilcooney River; the Fear English River and the Mulgeeth Stream. The Kilcooney River rises near Carbury at approximately 95mOD and flows in an easterly direction along the northern site boundary. It joins the Fear English River to the south of Ballynamullagh within the site boundary.

The Fear English River rises in Parsonstown at approximately 88mOD and flows north east along the southern boundary of the site and follows along the eastern boundary of the site. After the confluence with the Kilcooney River, the Fear English River continues in a north easterly direction for 3km to Johnstown Bridge, where it meets the River Blackwater.

Mulgeeth Stream rises to the southeast of the site in bogland and flows south for approximately 3km, before turning east at Derrylea and joining the Clogheraun Stream that runs into the main channel of the River Blackwater at Newtownhortland. The River Blackwater continues for 7km in a north-westerly direction towards Johnstown Bridge. From Johnstown Bridge the River Blackwater flows in a north-westerly to northerly direction for approximately 12.5km, crossing the Royal Canal and the Blackwater Bridge at Kilmurry before joining the River Boyne at Rourkestown.

The Glash River drains the western parts of the site and flows northwards to meet the River Boyne. The Glash River rises at Mylerstown at approximately 100m OD, 0.5km upstream of the nearest point of the site boundary (Windmill cluster) and flows past this point at a distance of 0.2km to the east, before joining the main river channel of the River Boyne a further 7.5km downstream, at a location just downstream of Leinster Bridge. The Glash River passes the site boundary (Ballynakill cluster) again here at a distance of 0.5km to the west. The River Boyne runs in a north easterly direction for 3km towards Longwood, draining the northern part of the site just upstream of where it crosses under the Royal Canal at the Boyne Aqueduct. The River Boyne continues in a north easterly direction, meeting the River Deel a further 5.6km downstream at Ballymahon and meeting the River Blackwater a further 2.4km at Rourkestown. The River Boyne then flows on for 12km in a north easterly direction towards Trim in County Meath. At Trim the River Boyne turns northwards and flows for 18km to Navan Town. From Navan Town, the River Boyne veers in an easterly direction, flowing for 30km towards Drogheda. The River Boyne flows out into the Irish Sea at some 6km to the east of Drogheda.

The southern sections of the site predominantly drain to tributaries of the River Barrow. The main tributaries of the River Barrow draining the southern sections of the site are the Figile River and the Slate River.

To the south west of the site, the tributaries flowing through the site, which drain to the Figile River are: the Abbeylough River and the Cushaling River. The Abbeylough River rises at Ballynakill Lower and flows in a south westerly direction towards the Cushaling River. The Abbeylough River flows under the R403 Regional Road at Abbeylough Bridge. The river is culverted under the Grand Canal some 400m to the west of the bridge. From there, it meets the Cushaling River 3km downstream at Ticknevin, as shown in Figure 9.1.0.

The Cushaling River continues in a south-westerly direction for approximately 6km where it meets the Figile River. The Figile then flows northwest for 3.5km before turning south for 4km where it enters the village of Clonbulloge and meets the Phillipstown River.

The Figile River continues south from Clonbulloge before joining the Slate River to the south of Bracknagh. The Cushina River joins the Slate River from the west and continues as the Black River until it enters the River Barrow just to the north of Monasterevin.

To the south of the site, the tributaries flowing through the site, which drain to the Slate River are: the Killenagh Upper tributary, the Cloncumber Stream and the Ballyteige North Stream. The Killenagh Upper tributary rises to the north of Allenwood and joins the Slate River after 3.5km at Ballyteigh North, just downstream of the confluence of Ballyteige North Stream with the Slate River. Approximately 1km further downstream, the Cloncumber Stream joins the Slate River. The Cloncumber Stream rises 7km to the south of the site, at Pollardstown and flows in a north westerly direction to meet the Slate River at Drumsru.

The Slate River rises in Balynafagh at approximately 95m OD and flows in a south-westerly direction, as shown in Figure 9.1.0. After passing Agar Bridge, approximately 3.8km downstream of the confluence with the Killenagh Upper tributary, the Slate River flows southwest for approximately 4km where it enters the town of Rathangan. It continues in a south-westerly direction for a further 7km where it meets the Figile River which then enters the Black River.

The Black River flows south for 6km where, on entering Monasterevin it meets the main channel of the River Barrow. The River Barrow continues south as the main arterial river, joining the River Nore in New Ross and the River Suir in Waterford where it flows out into Waterford Harbour.

The TDR extends from Kilcock westwards towards the proposed development, to the north of Broadford and from Johnstown Bridge southwards, extending into the turbine clusters along existing roads. The TDR transgresses through the same waterbody catchments as the abovementioned rivers, however as it approaches Kilcock to the north east, it extends into the Rye Water waterbody catchment (a tributary of the River Liffey) and eastwards into the Boyne 4_Upper tributary of the River Boyne.

The preferred connection point for the HV cable to the Irish National Grid will be determined by Eirgrid in 2015, however for the purposes of this EIS, both potential routes to Woodland, Co. Meath and Maynooth, Co. Kildare are assessed. A HV substation is proposed in the Drehid cluster as shown in Figure 2.6, in order to provide a connection point between the wind farm and EirGrid's network. The HV cable route to Woodland in Co. Meath transgresses some of the same waterbody catchments as the above mentioned rivers, in addition to the Ballycorron tributary of the River Blackwater, tributaries and the main channel of the Ryewater River (a tributary of the River Liffey) as well as tributaries and the main channel of the Tolka River.

The cable route connects the turbine clusters, running southwards from Moynally extending into the turbine clusters along existing roads, as far as Cloncurry to the south west of the site (Cloncumber cluster). The MV cable route transgresses some of the same waterbody catchments as the above mentioned rivers, in addition to the Alecafin tributary of the River Blackwater and two further tributary catchments of the River Boyne.

The internal MV cable route (i.e. within the clusters) follows the existing or proposed internal access roads and as such lies in the same waterbody catchments as those already mentioned.

The TDR, cable routes (MV and HV) and grid connection will cross a number of streams along the route and the exact location of these crossings, is detailed in Sections 9.3.5 and 9.3.6.

The site contains a complex area of rolling/undulating landscape with elevations of between 70m OD and 90m OD. The site is a mix of agricultural land of either tillage or grass, with a number of forestry plots in various stages of their lifecycle and a section of cut peat contained within the site boundary.

The soil on the proposed Maighne Wind Farm development is a diverse mix of subsoil types but predominantly comprises limestone tills, cut peat, sandstone and shale till, and limestone sands and gravels. There are also significant deposits of lake sediment to the north of the site.

There is evidence of alluvium to the south of the site, with significant deposits found along the Slate River within the site boundary, as shown in Figure 8.2.0 of Chapter 8 Soils and Geology. There are also alluvium deposits downstream of the site, within 1km of the site boundary, in the River Boyne, the Fear English River and in the River Blackwater and further downstream, within 2km of the site boundary in the Cushaling River. This is discussed further in Chapter 8.

The aquifer is predominantly of low vulnerability in the turbine clusters of Windmill, Derrybrennan and Cloncumber and between moderate and high vulnerability with isolated pockets of low vulnerability in the site clusters of Ballynakill and Drehid-Hortland, as shown in Figure 10.4.0 of Chapter 10 Water Quality. The assessed vulnerability is discussed further in Chapter 10 Water Quality.

The northern part of the site drains to the environmentally protected designated sites, River Boyne and River Blackwater candidate Special Area of Conservation (cSAC) (site code: 002299) and Special Protection Area (SPA) (site code: 0004232), which lies approximately 0.8km to the north of the site by Hydrological links, at its nearest point (Ballynakill cluster). The southern part of the site drains to the River Barrow and River Nore cSAC (site code: 002162), which lies approximately 17.8km by Hydrological links from the south of the site, at its nearest point (Cloncumber cluster).

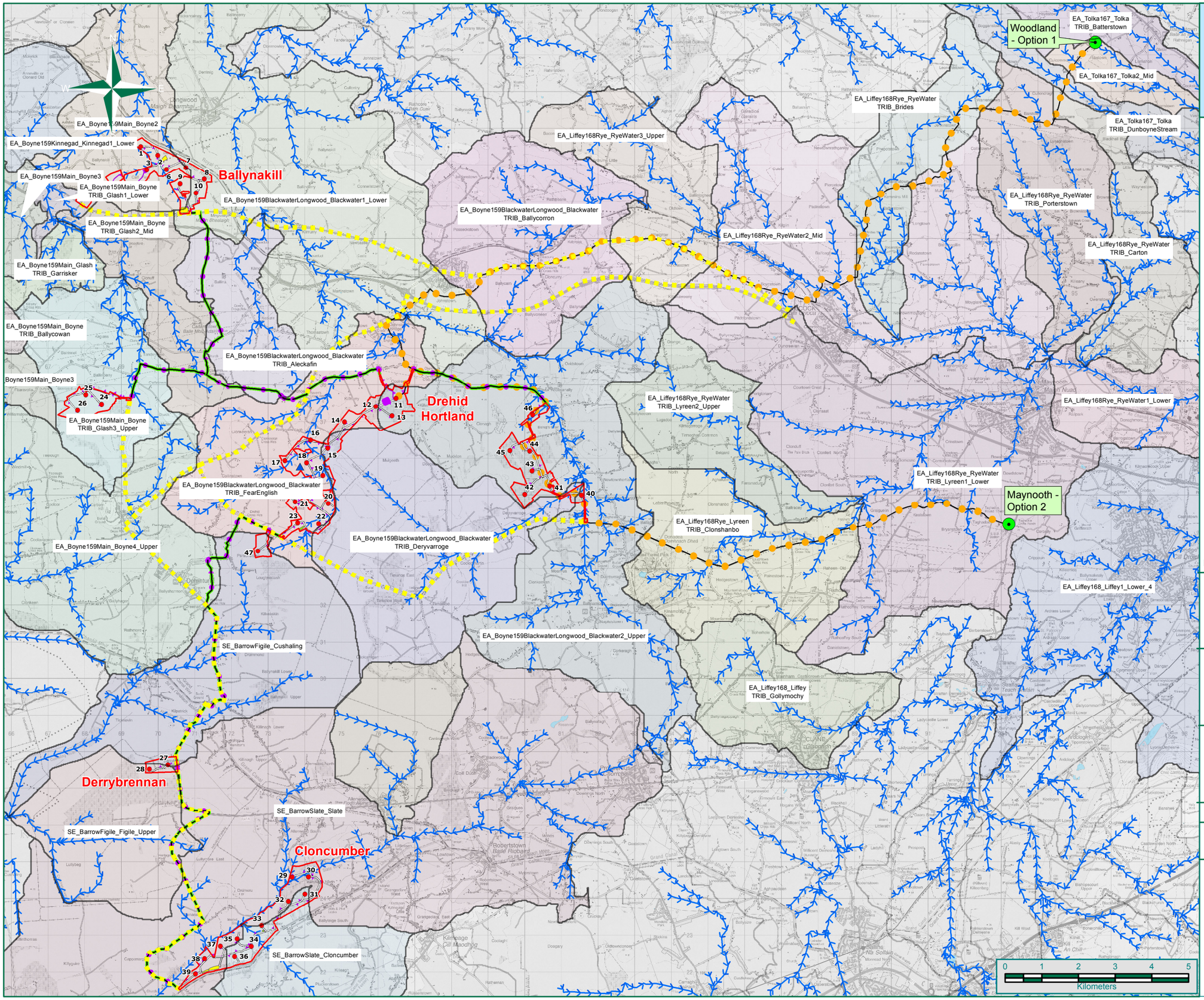
Of the other sites which are designated for environmental protection, as shown to be located within 15km of the proposed development site in Figure 7.1 of Chapter 7 Ecology, none of these are considered to be categorised as sensitive receptors with hydrological links to the site. The Ballina Bog Proposed Natural Heritage Area (pNHA) (site code: 000390) is located upstream of the Ballynakill cluster and to the west of the cable route, which will be laid in the existing road at this location. The Carbury Bog Natural Heritage Area (NHA) (site code: 001388) is located upstream of the Windmill cluster. The Donadea Wood pNHA (site code: 001391) is located upstream of the Drehid-Hortland cluster. The Long Derries, Edenderry cSAC and pNHA (site code: 000925), although appearing to be located in close proximity to the Derrybrennan Cluster, is in fact located in a different waterbody catchment and is therefore upstream of any of the proposed development for the Maighne Wind Farm. The Hodgestown Bog NHA (site code: 001393), the Ballynafagh Lake pNHA and cSAC (site code: 001387) and the Ballynafagh Bog pNHA and cSAC (site code: 000391) are all upstream of the Cloncumber cluster in the proposed Maighne Wind Farm site. There are no hydrological links from the proposed Maighne wind farm development site to the Royal Canal pNHA (site code: 002103), except where it is proposed to cross the Royal Canal with the HV cable option to Woodland substation at Kilcock. There are no hydrological links from the proposed Maighne Wind Farm site to the Grand Canal pNHA (site code: 002104), with the exception of where it is proposed to cross the Grand Canal with the TDR at Kilpatrick, to the north of the Derrybrennan turbine cluster. The environmentally designated areas are discussed further in Chapter 7 Ecology.

As part of the aquatic ecological assessment in Chapter 7, it was noted that the Boyne River is a designated salmonid river under the EU Freshwater Fish Directive (78/659/EEC). Aquatic ecological surveys found evidence of salmonid nurseries in the Figile River, 11km downstream of the site boundary; in the Abbeylough River upstream of the site; in the Slate River, where it runs through the southern part of the site and in the Fear English River, 1km downstream of the site. It was noted at a consultation meeting with the IFI for the proposed Maighne wind farm development that the River Glash is a salmonid nursery.

Both the Royal and Grand Canals cross the study area. These canals are fed by a number of feeder streams but otherwise are isolated hydrologically from the surrounding landscape. The feeder streams will not be impacted upon by the proposed development. Both of these canals are of National Importance and contain important coarse fish populations, aquatic plant communities and crayfish populations.

Given the proximity of the proposed development to environmentally protected sites and fisheries sensitive streams and rivers, there is the potential for a hydrological impact on these sites. This is discussed in more detail in Chapter 7 Ecology and in the NIS.

R:\Map Production\2014\LE14\731\04\Workspace\EIS MAPS\Chapter 9 Hydrology\LE1473104_Fig 9.1 Waterbody Catchment Map.mxd



Legend

- Turbine Location
- Wind Farm Cluster Boundary
- Proposed Substation Location
- Proposed Borrow Pit Location
- Proposed Compound Location
- Proposed Met Mast Location
- Indicative Access Track
- Cable Routes (Internal to Windfarm Cluster)
- MV Cable Route
- HV Cable Route
- Irish Grid Connection Point
- Turbine Delivery Route
- Rivers
- River Sub-basin

Date 27/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Waterbody Catchment Map Overview (Maighne)

Scale Used 1:100,000 @ A3

Figure No. 9.1.

Rev A

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9.3.2 General Description of the Catchment

The average annual rainfall (1981 – 2010) in the area of the proposed development varies from 780mm to 875mm, as determined from Met Eireann at www.met.ie.

The proposed Maighne Wind Farm development, lies within Hydrometric Area HA 14 known as Barrow of the Irish River Network, which is under the responsibility of the South Eastern River Basin District (SERBD) and HA 07 known as Boyne of the Irish River Network, which is under the responsibility of the Eastern River Basin District (ERBD). The TDR also extends into HA 09 Liffey and Dublin Bay as it approaches Kilcock. Both options for the HV cable route also extend into HA 09. All of these hydrometric areas are also under the responsibility of IFI. The site is situated within the waterbody catchments as defined by the EU Water Framework Directive (WFD - 2000/60/EC) (8), and as shown in Figure 9.1.0 Waterbody Catchment Map Overview. The information in this figure is available to view in more detail in the sub maps, which are included in Volume 2a.

The relevant waterbodies and the associated turbines, located within these waterbody catchments, for the turbine clusters within the proposed Maighne wind farm development are identified as follows:

Ballynakill

- EA_Boyne159BlackwaterLongwood_Blackwater1_Lower (T8, T10 and 1 No. Borrow Pit)
- EA_Boyne159Main_BoyneTRIB_Glash1_Lower (Access at Ballyonan only)
- EA_Boyne159Main_Boyne2 (T1, T2, T3, T4, T5, T6, T7, T9, a Temporary Compound and 1 No. Borrow Pit)

Windmill

- EA_Boyne159Main_BoyneTrib_Glash3_Upper (T24, T25 and T26)

Drehid-Hortland

- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish (T12, T14, T16, T17, T18, T19, T20, T21, T22, T23, a Met Mast and a Temporary Compound)
- EA_Boyne159BlackwaterLongwood_Blackwater2_Upper (T11, T13, T40, T41, T42, T43, T44, T45, T46, a Temporary Compound and the Substation)
- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_Deryvarroge (T15)
- SE_BarrowFigile_Cushaling (T47)

Derrybrennan

- SE_BarrowFigile_Figile_Upper (T28)
- SE_BarrowSlate_Slate
- SE_BarrowFigile_Cushaling (T27)

Cloncumber

- SE_BarrowSlate_Slate (T29, T30, T32, T35, T37, T38, T39 and 1 No. Borrow Pit)
- SE_BarrowSlate_Cloncumber (T31, T33, T34, T36 and a Temporary Compound)

The TDR will cross a number of the above waterbody catchments in addition to the following waterbodies:

- EA_Liffey168Rye_RyeWater3_Upper
- EA_Boyne159Main_Boyne4_Upper

The MV cable route will cross a number of the waterbody catchments associated with the turbine layout in addition to the following waterbodies:

- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_Aleckafin
- EA_Boyne159Main_BoyneTRIB_Glash2_Mid
- EA_Boyne159Main_Boyne4_Upper

There are two potential HV cable routes, to connect Maighne Wind Farm to one of two proposed substation locations in either Woodland, Co. Meath or Maynooth, Co. Kildare.

The two routes are included in this assessment of the impacts on hydrology but only one route will be constructed. The two proposed routes and associated waterbody catchments are shown in Figure 9.1.0.

The proposed HV cable route from the sub-station at Drehid to the substation at Woodland will cross 12 waterbody catchments as follows:

- EA_Boyne159BlackwaterLongwood_Blackwater2_Upper
- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish (IE_EA_07_317)
- EA_Boyne159BlackwaterLongwood_Blackwater1_Lower (IE_EA_07_954)
- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_Ballycorron
- EA_Liffey168Rye_RyeWater3_Upper
- EA_Liffey168Rye_RyeWater2_Mid
- EA_Liffey168Rye_RyeWateTRIB_Brides
- EA_Liffey168Rye_RyeWateTRIB_Porterstown
- EA_Liffey168Rye_RyeWateTRIB_Carton
- EA_Tolka167_TolkaTRIB_DunboyneStream
- EA_Tolka167_Tolka2_Mid
- EA_Tolka167_TolkaTRIB_Batterstown

Of these 12 waterbody catchments, the Ballynakill cluster lies at the downstream end of the EA_Boyne159BlackwaterLongwood_Blackwater1_Lower waterbody and the Drehid Hortland cluster also lies in the EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish waterbody and the EA_Boyne159BlackwaterLongwood_Blackwater2_Upper waterbody.

The proposed HV cable route from the sub-station at Drehid to the substation at Maynooth will cross five waterbody catchments as follows:

- EA_Boyne159BlackwaterLongwood_Blackwater2_Upper
- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish
- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_Deryvarroge
- EA_Liffey168Rye_LyreenTRIB_Clonshanbo
- EA_Liffey168Rye_RyewaterTRIB_Lyreen1_Lower

Of these five waterbody catchments, the Drehid Hortland cluster also lies in the:

- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish waterbody, the
- EA_Boyne159BlackwaterLongwood_Blackwater2_Upper waterbody and the
- EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_Deryvarroge.

The TDR and the MV cable route will be mostly located along the route of the existing road network within the catchments noted above. A new section of access track is required for the TDR off-road at Lullymore West, which will follow the route of an existing disused railway line for 0.99km and will include a small sweeping bend through the bog up to where it joins up with the R414. The HV cable route for the Woodland option will be located along the route of the existing road network for 32.2km within the catchments noted above. The HV cable route for the Maynooth option will be located along the route of the existing road network for 17.4km and it will be located off road for 4.9km within the catchments noted above. Where the HV route is diverted off road it will follow the route of the proposed internal roads in the Drehid-Hortland cluster. These routes will cross a number of streams and the location of these crossings, together with the proposed methods for crossing these streams are outlined in Sections 9.3.5, 9.3.6 and 9.3.7.

There will be no significant additional hard standing areas associated with either the TDR or the MV and HV cable route. Modifications to the TDR will be temporary, with the exception of the upgraded access track in Bord Na Mona lands at Lullymore, which will remain in place.

The waterbodies associated with the turbine layout are described in more detail below at each of the turbine clusters:

Ballynakill

9.3.2.1 BlackwaterLongwood_Blackwater1_Lower

An area of approximately 0.53km^2 of the cluster is within this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment is shown on the mapping to drain towards the main channel of the River Blackwater which runs in a northerly direction to the east of the Ballynakill cluster.

Surface water run-off from the cluster does not however drain into the main channel of the River Blackwater due to the Canal and artificial drainage patterns. The area instead drains overland toward the neighbouring *Boyne159Main_Boyne2* catchment. The River Blackwater has a catchment area of 53.06km^2 up to its confluence with the River Boyne at Rourkestown.

Two turbines, along with approximately 1.88km of new tracks are proposed within this catchment, of which approximately 0.18km will follow the route of an existing track, which is proposed to be upgraded. One new borrow pit is also proposed within this catchment.

The Drehid-Hortland turbine cluster, which forms part of the proposed Maighne Wind Farm development, lies within waterbody catchments which are upstream and feed into this waterbody catchment. A cumulative assessment which takes account of the hydrological link between these clusters has been undertaken in Section 9.5.3.

9.3.2.2 Main_BoyneTRIB_Glash1_Lower

An area of approximately 0.15km^2 of the cluster drains to the Glash River in this waterbody catchment as illustrated in Figure 9.1.0. The Glash River is a tributary of the River Boyne. The surface water run-off within this catchment drains towards the Glash River which runs in a northerly direction.

Surface water run-off from the cluster drains via agricultural drains to the Mulphedder Stream which is a tributary of the Glash River. The Glash River has a catchment area of 1.65km^2 up to its confluence with the main River Boyne channel.

Approximately 0.39km of new tracks are proposed within this catchment.

The Windmill turbine cluster, which forms part of the proposed Maighne Wind Farm development, lies within waterbody catchments which are upstream and feed into this waterbody catchment. A cumulative assessment which takes account of the hydrological link between these clusters has been undertaken in Section 9.5.3.

9.3.2.3 Main_Boyne2

An area of approximately 1.53km^2 of the cluster drains to the main channel of the River Boyne in this waterbody catchment, which runs in a north easterly direction, as illustrated in Figure 9.1.0.

Surface water run-off from the cluster drains via agricultural drains to the River Boyne and a number of its stream tributaries. Tributary streams flowing through this turbine cluster include Boolykeagh Stream and Ballynadrumny Stream. The Boyne2 waterbody has a catchment area of 16.89km^2 up to its confluence with the River Deel at Ballymahon.

Eight turbines are proposed within this catchment. It is proposed to construct 3.93km of new tracks within this catchment, of which approximately 0.32km will follow the route of an existing track, which is proposed to be upgraded. One new borrow pit and a temporary compound is also proposed within this catchment.

The Windmill turbine cluster, which forms part of the proposed Maighne Wind Farm development, lies within waterbody catchments which are upstream and feed into this waterbody catchment.

Cumulative impacts with the proposed development in the upper Boyne waterbody catchments are considered as part of the flood risk assessment in Section 9.5.

Windmill

9.3.2.4 BoyneTrib_Glash3_Upper

An area of approximately 0.91km^2 within the cluster boundary drains to the Glash River and one of its unnamed tributaries in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains towards the Glash River which runs in a northerly direction.

Surface water run-off from the cluster drains via bog drains to a tributary of the Glash River. The Glash River has a catchment area of 15.2km^2 up to its road crossing at Clonuff.

Three turbines, along with approximately 2.9km of new tracks are proposed within this catchment, of which approximately 0.22km will follow the route of an existing track, which is proposed to be upgraded.

There are no other turbine clusters, which form part of the proposed Maighne Wind Farm development, within or upstream of this waterbody catchment. Cumulative impacts with the proposed development downstream are considered as part of the flood risk assessment in Section 9.5.

Drehid-Hortland

9.3.2.5 Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish

An area of approximately 2.72km^2 of the cluster drains to the Fear English River and the Kilcooney River as well as to a number of their minor stream tributaries, in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains towards the main channel of the Fear English River which runs in a north easterly direction.

Surface water run-off from the cluster drains over firm grassland and into farm drains leading to the Kilcooney River and also via forest drains to the Fear English River. The Fear English River has a catchment area of 21.7km^2 up to the Fear English Bridge.

Ten turbines, along with approximately 8.3km of new tracks are proposed within this catchment, of which approximately 1.5km will follow the route of an existing track, which is proposed to be upgraded. However, during the site walkover, one turbine (T15) located in the *Blackwater Longwood_BlackwaterTRIB_Derryvarroge* appeared to be artificially drained into this waterbody. A Met Mast and a temporary compound is also proposed within this catchment.

There are no other turbine clusters, which form part of the proposed Maighne Wind Farm development, within or upstream of this waterbody catchment. Cumulative impacts with the proposed development downstream are considered as part of the flood risk assessment in Section 9.5.

9.3.2.6 Boyne159BlackwaterLongwood_Blackwater2_Upper

An area of approximately 2.44km^2 of the cluster drains to the River Blackwater and its tributaries in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains to the River Blackwater which runs in a north westerly direction.

Surface water run-off from the cluster drains via bog drains and forest drains in a north easterly direction to meet the River Blackwater and its tributaries. The River Blackwater has a catchment area of 48.1km^2 up to its confluence with the Ballycorron River.

Nine turbines and the substation, along with approximately 6.9km of new tracks are proposed within this catchment, of which approximately 3km will follow the route of an existing track, which is proposed to be upgraded. A temporary compound is also proposed within this catchment.

There are no other turbine clusters, which form part of the proposed Maighne Wind Farm development, within or upstream of this waterbody catchment.

Cumulative impacts with the proposed development in the upper Blackwater waterbody catchments and downstream, are considered as part of the flood risk assessment in Section 9.5.

9.3.2.7 Boyne159BlackwaterLongwood_BlackwaterTRIB_Deryvarroge

An area of approximately 0.5km^2 of the cluster drains to Mulgeeth Stream in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains towards the River Blackwater which runs in a north westerly direction.

Surface water run-off from the cluster drains via forestry drains in a north easterly direction to the Mulgeeth Stream. This waterbody catchment has a catchment area of 27.1km^2 up to its confluence with the Clogheraun Stream tributary of the Blackwater River at Newtownhortland.

One turbine, along with approximately 2.3km of new tracks are proposed within this catchment. However, during a site walkover, this turbine (T15) appeared to be artificially drained to the neighbouring catchment of *Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish*.

There are no other turbine clusters, which form part of the proposed Maighne wind farm development, within or upstream of this waterbody catchment. Cumulative impacts with the proposed development downstream are considered as part of the flood risk assessment in Section 9.5.

9.3.2.8 BarrowFigile_Cushaling

An area of approximately 0.22km^2 of the cluster drains to the Parsonstown Stream in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains towards the Parsonstown Stream which runs in a south westerly direction.

Surface water run-off from the cluster drains via agricultural drainage ditches to the Parsonstown Stream. This waterbody catchment has a catchment area of 26.6km^2 up to its confluence with the Crabtree River, approximately 1km upstream of Cushaling Bridge.

One turbine, along with approximately 0.52km of new tracks are proposed within this catchment.

Part of the Derrybrennan turbine cluster, which forms part of the proposed Maighne wind farm development, lies within this same waterbody catchment. Cumulative impacts are considered as part of the flood risk assessment in Section 9.5.

Derrybrennan

9.3.2.9 BarrowFigile_Figile_Upper

An area of approximately 0.16km^2 of the cluster drains to the Crabtree River, in this waterbody catchment as illustrated in Figure 9.1.0.

The surface water run-off within this catchment drains generally in a south westerly direction through a system of man-made drainage channels towards the Crabtree River, which runs in a westerly direction.

Surface water run-off from the cluster drains via a series of well maintained, agricultural drains before joining forestry drains and bog drains to the main channel of the Figile River. This waterbody has a catchment area of 15.5km^2 up to where the Crabtree River joins the Cushaling River, approximately 1km upstream of Cushaling Bridge.

One turbine, along with approximately 0.56km of new tracks are proposed within this catchment, of which approximately 0.09km will follow the route of an existing track, which is proposed to be upgraded.

There are no other turbine clusters, which form part of the proposed Maighne Wind Farm development, within or upstream of this waterbody catchment.

9.3.2.10 BarrowSlate_Slate

An area of approximately 0.02km^2 of the cluster drains to the Killenagh Upper tributary of the Slate River, in this waterbody catchment as illustrated in Figure 9.1.0.

The surface water run-off within this catchment drains firstly in a southerly direction through a man-made bog drainage channel before turning east in line with the R414 Regional Road, into the Killinagh Upper Stream which in turn runs in a southerly direction into the main channel of the Slate River. This waterbody has a catchment area of 142.46km^2, up to its confluence with the Figile River at Bracknagh.

Surface water run-off from the cluster drains to the south towards the Killenagh Upper tributary of the Slate River.

No development as relates to the Derrybrennan cluster is proposed to be constructed within this area. As a result, no cumulative impacts apply here for this turbine cluster.

9.3.2.11 BarrowFigile_Cushaling

An area of approximately 0.14km^2 of the cluster drains to the Abbeyough River, in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment, drains through a man-made bog drainage channel in this turbine cluster, before turning north east in line with an old bog access track into the Abbeylough River. The Abbeylough River flows in a westerly direction to meet the Cushaling River 2km downstream. The Cushaling River continues in a south westerly direction. This waterbody catchment has a catchment area of 26.6km^2 up to its confluence with the Crabtree River, approximately 1km upstream of Cushaling Bridge.

One turbine, along with approximately 0.3km of new tracks are proposed within this catchment, of which approximately 0.03km will follow the route of an existing track, which is proposed to be upgraded.

Part of the Drehid-Hortland turbine cluster, which forms part of the proposed Maighne wind farm development, lies within this same waterbody catchment. Cumulative impacts are considered as part of the flood risk assessment in Section 9.5.

Cloncumber

9.3.2.12 BarrowSlate_Slate

An area of approximately 1.9km^2 of the cluster drains to the Slate River in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains towards the main channel of the Slate River which runs in a south westerly direction.

Surface water run-off from the cluster drains via forestry drains and farm drains to the main channel of the Slate River. The Slate River has a catchment area of 142.46km^2, up to its confluence with the Figile River at Bracknagh.

Seven turbines, along with approximately 5.2km of new tracks are proposed within this catchment, of which approximately 1.4km will follow the route of an existing track, which is proposed to be upgraded. Four new borrow pits are also proposed within this catchment. One new borrow pit is also proposed within this catchment.

Part of the Derrybrennan turbine cluster, which forms part of the proposed Maighne wind farm development, lies within this same waterbody catchment, however no development is proposed in this waterbody catchment within the Derrybrennan turbine cluster. As a result, no cumulative impacts apply here for this turbine cluster.

9.3.2.13 BarrowSlate_Cloncumber

An area of approximately 1.18km^2 of the cluster drains to the Cloncumber Stream in this waterbody catchment as illustrated in Figure 9.1.0. The surface water run-off within this catchment drains towards the Cloncumber Stream which runs in a north westerly direction towards the main channel of the Slate River.

Surface water run-off from the cluster drains via farm drains to the Cloncumber Stream. This tributary of the Slate River has a catchment area of 63.83km^2 up to its confluence with the main channel of the Slate River.

Four turbines, along with approximately 3.9km of new tracks are proposed within this catchment, of which approximately 1.1km will follow the route of an existing track, which is proposed to be upgraded. A temporary compound is also proposed within this catchment.

There are no other turbine clusters, which form part of the proposed Maighne Wind Farm development, within or upstream of this waterbody catchment. As a result, no cumulative impacts apply here for this turbine cluster.

9.3.3 Existing Flooding in the Area

The national flood hazard mapping website, www.floodmaps.ie (9), indicates records of historical flooding, as can be seen on Figure 9.2. The information in this figure is available to view in more detail in the sub maps, which are included in Volume 2a of this EIS.

Areas known as 'benefitting lands'[1] as defined in the OPW flood hazard mapping website have been identified for some of the clusters on this site, with the exception of the Cloncumber and Derrybrennan clusters. The turbines and the substation, located in areas identified as 'benefitting lands' are within the following clusters:

- Ballynakill – Turbines T1, T2, T3, T4 and T5
- Windmill – Turbines T24, T25 and T26
- Drehid-Hortland – Substation and turbines T11, T12, T13, T14, T15, T16 and T18

Historically these lands were bogland, subject to flooding or poor drainage. From the site walkover undertaken for the proposed development, it was observed that these lands have now been mostly artificially drained by agricultural or forestry drainage or in the case of Windmill, artificial bog drainage, therefore the mapping presented on the OPW website for these zones, while worthy of note, requires updating to reflect the current situation on these lands. The OPW has produced indicative flood mapping to assist in a preliminary flood risk assessment (PFRA) www.cfram.ie. (36). Areas that could be subject to pluvial flooding are also shown on this mapping. The PFRA mapping prepared for the CFRAMs is considered to be more relevant to reflect the zones subject to fluvial and pluvial flooding in these lands. The turbine hard standing, associated tracks and the substation identified by OPW to be within 'benefitting lands' will drain satisfactorily during normal storm events. In an extreme event drainage may be temporarily impeded, with temporary standing water occurring in the swales draining the hardstanding areas and access tracks, however the drainage system will continue to operate as the flood event recedes.

The process for developing the pluvial flood extent maps, prepared by the OPW, was based on 'dropping' various depths and intensities of rainfall over a range of durations, and modelling how that rainfall would flow over the land and, in particular, pond in low-lying areas. Those features pertinent to the proposed development have been recorded during site walkovers and can be seen in the photographs included in Appendix H1 of Volume 3 EIS Appendices.

Any recorded incidents within 2.5km downstream of each cluster and any relevant indicative fluvial or pluvial mapping from these sources is discussed below.

[1] A dataset prepared by the Office of Public Works identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage.

Ballynakill

Two records of historical flooding were recorded within 2.5km of this cluster, as follows:

- A recurring flood incident has been recorded at Ashfield Bridge, to the north west of this cluster. Photographs were taken by the OPW in November 2002 and in January 1995 after very heavy and prolonged rainfall, which show the extent of flooding upstream of the River Boyne.
- The road at Moyvally to the south of the cluster is also recorded as flooding annually. ([9]) This incident, occurred to the south east of the Ballynakill cluster and in a different tributary to any part of the proposed Maighne wind farm development. The incident is therefore not relevant to the cluster.

A historic breach occurred in the canal embankment, as mentioned at a consultation with Waterways Ireland.

The study area is included in the Eastern Catchment-based Flood Risk Assessment and Management Study (CFRAMS), however no detailed mapping is currently available in the relevant area of the Maighne Wind Farm development. The OPW have identified Areas for Further Assessment (AFAs) in their PFRA mapping, where they consider there to be a significant risk of flooding. There have been no AFAs identified by OPW for the area within or in the vicinity of this cluster and therefore it is unlikely that a detailed assessment will need be undertaken by OPW in this area.

The settlements of Ballivor and Longwood are included within the Eastern CFRAM as areas that will be subject to more detailed hydraulic modelling and flood mapping, which was expected to be published in 2014, according to the SFRA prepared for the Meath County Development Plan ([7]), however these detailed studies are not yet available. The indicative flood mapping shows the proposed access track to Turbine T1 and the track to Turbine T3 to be crossing an indicative floodplain. Turbine T1 is also shown to be located within a 'Flood Zone A' area i.e. an area with a probability of flooding in a 1 in 100 year flood, as shown in Figure 9.2.0.

An area of track between Turbine T5 and T4 and between T1 and T2 is identified as being within an indicative pluvial flooding area. Some localised depressions in the undulating landscape were recorded in these areas during the site visit, but no particular hydrological features were noted at these locations. These areas are discussed further in Section 9.4.5.

Windmill

There is no record of flooding within 2.5km downstream of the Windmill cluster. A recurring flood incident has however been recorded downstream in the River Boyne at Ashfield Bridge, 10km north of the cluster, as also noted above for the Ballynakill Turbine Cluster.

The study area is included in the Eastern CFRAMS, however no detailed mapping is currently available in the relevant area of the cluster. There have been no AFAs identified for the area within or in the vicinity of this cluster and therefore it is unlikely that a detailed assessment will need to be undertaken by OPW in this area. The indicative flood mapping shows the proposed cluster to be out with any indicative floodplain 'Flood Zone A' area, as shown in Figure 9.2.0, with the exception of a small area of an existing road which will be used as the entrance from the east to this cluster, which encroaches on a 'Flood Zone A' area.

A small area on this cluster between turbine T24 and T25 and along the track to the west of T25 is identified as being within an indicative pluvial flooding area. These areas were found to coincide with low points in bog drains during the site visit. These areas are discussed further in Section 9.4.5.

Drehid-Hortland

Two records of historical flooding, where recurring flood incidents have been recorded (9) within 2.5km downstream of this cluster, are as follows:

- At Newtown to the east of the cluster, where the River Blackwater overflows its banks after heavy rain
- Downstream at Knocknally, to the north of the cluster, in the flood plain of tributaries of the River Blackwater

The study area is upstream of the area included in the Eastern CFRAMS, however no detailed mapping is currently available in the relevant area of the cluster. There have been no AFAs identified for the area within or in the vicinity of this cluster and therefore it is unlikely that a detailed assessment will need to be undertaken by OPW in this area.

The indicative flood mapping indicates a number of the proposed access tracks to turbines as crossing an indicative floodplain 'Flood Zone A' area and two new crossings of the Fear English River are proposed here along the track to T15 and the track to T16, as shown in Figure 9.2.0. Turbine T40 is also shown to be located within a 'Flood Zone A' area, as shown in Figure 9.2.0. The area where it is proposed to locate T40 was examined in more detail and it was noted that the ground is locally higher to the west of T40 and that it is more likely that this turbine location is 'skirting' the floodplain rather than within it. The substation is not located in a 'Flood Zone A' area.

Turbines T17 and T47 are shown to be adjacent to indicative pluvial flooding areas in Figure 9.2.0. No hydrological features of note were found to coincide with the proposed development in these areas during the site visit.

Derrybrennan

The national flood hazard mapping website, www.floodmaps.ie ([9]), records a recurring flood incident at Kilinagh, to the east of the cluster, where a stream is reported to flood annually in heavy rainfall. ([9]). The stream floods due to a lack of capacity in a culvert under the Grand Canal downstream. This latter incident at Kilinagh, occurred to the east, upstream of the Derrybrennan cluster. The incident is therefore not relevant to the cluster.

Recurring flood incidents have also been recorded downstream at Clonbulloge Bridge in the village of Clonbulloge, some 13.5km downstream of this cluster. Aerial photographs were taken by Offaly County Council on 19 August 2008 after very heavy and prolonged rainfall, which show the extent of flooding upstream of the village along the Figile and Phillipstown Rivers. It was noted that the photographs were not taken at peak water levels. ([9]) The Area Engineer noted in the minutes of a meeting in 2005 with Offaly County Council and the Barrow Drainage District that the flood incident at Clonbulloge occurs in the River Figile flood plain and that it floods most winters and the road is liable to flood. ([9])

The indicative flood mapping indicates flooding approximately 2.5km downstream of the cluster at the confluence of the Lugherra River, the Cushaling River and the Crabtree River as well as indicative flooding in the Lullymore East tributary of the Figile River, 1.5km downstream of the cluster, as shown in Figure 9.2.

The indicative flood mapping indicates the proposed access track where it crosses the Abbeylough River at Iron Bridge, to be crossing an indicative floodplain, however there are no modifications proposed to the structure at this location.

There are two areas within this cluster, identified as being within an indicative pluvial flooding area. However no turbine, access track or other supporting infrastructure element is proposed to be located in any of these areas.

Cloncumber

Two records of historical flooding, where recurring flood incidents have been recorded (9) within 2.5km downstream of this cluster are available.

Recurring flood incidents have been recorded downstream at Cloncurry and Rathangan. The Area Engineer noted in the minutes of a meeting in 2005 with Kildare County Council and the ESBI that the flood plain of the Slate River floods every year. ([9])

The indicative flood mapping shows the access track between turbine T34 and T33 and between T29 and T30 to be crossing an indicative floodplain. Turbines T34, T29 and T30 are also shown to be located within a 'Flood Zone A' area i.e. an area with a probability of flooding in a 1 in 100 year flood, as shown in Figure 9.2.

An area adjacent to T32 (but outside the footprint of the turbine hardstanding) is identified as being within an indicative pluvial flooding area. This area was found to coincide with the head of a drain during the site visit. The proposed layout of the development avoids any pluvial areas identified within this turbine cluster.

R:\Map Production\2014\LE14\731\04\Workspace\EIS MAPS\Chapter 9 Hydrology\LE1473104 Fig 9.2 OPW Flood MapRevB.mxd

Roe's Bridge - FRA Boolykeagh Stream

FRA River Blackwater

Ballynakill

Windmill

Drehid Hortland

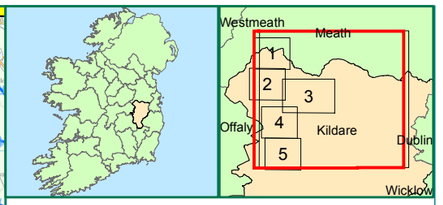
Derrybrennan

Cloncumber

Agar Bridge - FRA Slate River

Woodland - Option 1

Maynooth - Option 2



Legend

- Turbine Location
- Wind Farm Cluster Boundary
- Proposed Borrow Pit Location
- Proposed Compound Location
- Proposed Substation Location
- Proposed Met Mast Location
- Indicative Access Track
- MV Cable Route
- Cable Routes (Internal to Windfarm Cluster)
- Irish Grid Connection Point
- HV Cable Route
- Turbine Delivery Route
- River Network
- OPW Historic Flood Points
- PFRA/CFRAMS: 1% AEP Fluvial Flood Extent
- PFRA/CFRAMS: 1% AEP Pluvial Flood Extent
- Flood Risk Assessment Undertaken at Bridge Crossings

0 1 2 3 4 5 Kilometers

Date 27/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

OPW Flood Data Map
Maighne Overview

Scale Used 1:100,000 @ A3

Figure No. 9.2.

Rev A

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9.3.4 Internal Site Drainage

The internal site drainage was observed for each turbine cluster of the site, within the proposed Maighne wind farm development, during site walkover surveys. The GPS coordinates of the location of hydrological features observed during the site walkover have been noted and these features are shown in Figure 9.3.0 – Hydrological Features Overview Map. The information in this figure is available to view in more detail in the sub maps, which are included in Volume 2a. The details of the features are described in Appendix H1 of Volume 3 EIS Appendices. The proximity of these features to the proposed wind farm layout is shown on the mapping. Photographs of some of the hydrological features are also provided in Appendix H1 of Volume 3 EIS Appendices. Particular observations in each turbine cluster are described in this section as follows:

Ballynakill

A site walkover survey took place on 2 July 2013 with a subsequent visit on 11 November 2014.

The cluster is relatively flat, with elevations in the region of 70mOD. The cluster is predominantly agricultural grassland. This turbine cluster is located approximately 2.0km to the southwest of Longwood Village.

The existing farm tracks running through the cluster have an operational drainage regime. This comprises roadside swales leading to existing stream or drain crossings. There is also some 'Over the Edge' drainage along some of the existing tracks some of the proposed access routes follow existing farm tracks, which are typically 3.5m wide. The existing tracks drain 'over the edge' to roadside drains. Streams and drains are piped across the existing forestry tracks in pipes varying from 300mm diameter to 600mm diameter.

Turbine T1 is located in the indicative floodplain for a 1 in 100 year return period flood as identified in the OPW PFRA mapping. It was observed on this cluster that T1 and T5 are located in a low-lying marshy area. The proposed access track to turbine T1 and T3 will cross an area identified in the OPW PFRA mapping as an indicative floodplain. Turbine T2 also appears to be located in the indicative floodplain for a 1 in 100 year return period flood. Ponding was observed close to Turbine T6. These areas are discussed further in Section 9.4.5.

The area proposed for the Ballynakill cluster drains both directly into and also via a number of tributaries of the River Boyne and the Glash River.

Part of the cluster which is shown in the *Longwood_Blackwater1_Lower* catchment is artificially drained to the *Boyne159Main_Boyne2* catchment as a result of the waterbody being dissected by the canal and railway being located at a high point.

Windmill

A site walkover survey took place on 8 July 2013 with a subsequent visit on 11 November 2014.

The cluster is quite flat, with elevations in the region of 90mOD. The lands within this cluster are in an active worked bog with extensive bog tracks and regular drainage. This cluster is located approximately 5km to the northwest of Edenderry.

The soil in this cluster is mainly cut peat with a small pocket of glaciofluvial sand and gravel in the north of the cluster. The development in this cluster is to the north in the area of cut peat. It was observed on this cluster that surface water pathways from the proposed footprint of the development are not connected to the perimeter drains bounding the area of cut peat to the south of the cluster. There are existing bog drains throughout the cluster. A network of artificial drainage channels runs through the land in a south east to North West direction. Streams and drains are piped across the existing bog tracks in pipes. Some of the proposed access routes follow existing tracks, which vary between 3.0m and 4.5m wide. Some tree-felling will be required to facilitate the location of access tracks within this cluster.

The existing tracks typically drain 'over the edge' into roadside drains. Drains are piped across the existing tracks and entrances with pipes varying in size from 300mm diameter to 600mm diameter. A small number of pluvial features were recorded on this cluster, which correspond to low points in drains in the cluster which may be subject to seasonal ponding.

The proposed entrance to this cluster is located in the indicative floodplain for a 1 in 100 year return period flood of the Glash River. It is an existing entrance road. A temporary bridge will be required adjacent to the existing bridge at the entrance to this cluster to facilitate the delivery of turbines. The temporary bridge will match the dimensions of the existing bridge immediately downstream. Therefore there will be no new obstruction to flood flows in the floodplain. A Flood Risk Assessment (FRA) was prepared for the site, to determine the impact of increased hard surfaces from this development on downstream flooding. The FRA is included in Section 9.5.

Drehid-Hortland

A site walkover survey took place on 31 May 2013 and the 10 June 2013, with a subsequent visit on 12 November 2014.

This cluster is relatively flat, with elevations varying from 90mOD in the west of the cluster to 70m - 80mOD in the east of the cluster. Land use varies between farmland, bogland and mature forestry in the east with some woodland scrub and agricultural land. Details of the existing forestry at the cluster are included in Chapter 2 - The Development. This cluster is located approximately 1.3 km to the south of Johnstown Bridge village.

The cable route extends into the location of the substation at Kilmurry, with external connections coming into the cluster from either Woodland or Maynooth, when the HV cable route is selected by Eirgrid.

There are existing farm, bog, and forestry drains throughout the cluster. The proposed sub-station is located in an area of mature coniferous forest. Some tree-felling will be required to facilitate the location of turbines, the associated access tracks and the substation in this cluster. The method of tree-felling is discussed further in Chapter 2.

The existing forestry tracks running through the cluster have an operational drainage regime. This comprises roadside swales leading to existing stream or drain crossings. The bog land is characterised by artificial drains traversing the bog at regular intervals while the farmland is also drained artificially in areas along boundary ditches.

Some of the proposed access routes follow existing farm and forestry tracks, which are typically 3.0m wide. The existing tracks drain ‘over the edge’ to roadside drains.

Streams and drains are piped across the existing forestry tracks in pipes varying from 300mm diameter to 600mm diameter. There is extensive wet natural bog along the southern boundary of the western section of this cluster, including flooded bog lagoons and pools.

Turbines T17 and T47 were shown to be adjacent to indicative pluvial flooding areas in Figure 9.2.0., however no particular hydrological features of note were observed here during the site visit.

Turbine T40 is located in the indicative floodplain for a 1 in 100 year return period flood as identified in the OPW PFRA mapping. Observations on this cluster however show that the ground rises to the west of T40 and it is more likely that this turbine skirts the floodplain and does not obstruct the overland flows draining to the adjacent rivers at this location. The proposed access tracks to a number of turbines will cross an area identified in the OPW PFRA mapping as an indicative floodplain for a 1 in 100 year return period flood, in particular the entrance road to the eastern section of this cluster in the vicinity of T40. However parts of this access road are existing. There will be no appreciable obstruction to flood flows in the floodplains as a result of new access roads, which will be mostly at grade with the existing terrain. Any stream crossings will be conveyed in culverts, sized to take the 1 in 100 year flood flow with a 20% allowance for climate change (11). A new bridge will be required, crossing the River Blackwater along the access track as it enters into the eastern part of this cluster. A preliminary size has been estimated for this bridge in Section 9.5.1. A flood risk assessment was prepared for the proposed development, to determine the impact of increased hard surfaces from the development on downstream flooding and this is included in Section 9.5.

Derrybrennan

A site walkover survey took place on 18 July 2013, with a subsequent visit on 12 November 2014.

The cluster is quite flat, with elevations in the region of 80mOD. The turbine locations are for the most part located in particularly well drained, firm agricultural grassland or tillage, surrounded by either a forested site or a working bog.

There is an existing agricultural drain to the north of the forested section of the western part of this cluster. Some tree-felling will be required to facilitate access tracks on this cluster and to facilitate the location of turbine T27.

Some of the proposed access routes follow existing forestry tracks and farm lanes, which are typically 3.5m wide. The existing tracks drain 'over the edge' to roadside drains. Streams and drains are piped across the existing farm tracks in pipes of 300mm diameter.

The cluster is a mix of agricultural land with a pocket of forestry at the proposed location of T27.

Cloncumber

A site walkover survey took place on 02 July 2013, with a subsequent visit on 12 November 2014.

The cluster is quite flat, with elevations in the region of 70mOD. The cluster consists of forestry in the east and well drained farmland in the west. It is bounded by the Slate River to the north and by the Grand Canal (Barrow Line) to the south. Details of the existing forestry at the cluster are included in Chapter 2 - The Development. The cluster is located approximately 2.5km to the south west of the village of Allenwood.

There are existing farm and forestry drains throughout the cluster. A network of artificial drainage channels runs through the western portion of the cluster which contains agricultural land. Some tree-felling will be required to facilitate the location of turbines and associated access tracks within this cluster.

The existing forestry tracks running through the cluster have an operational drainage regime. This comprises roadside swales leading to existing stream or drain crossings. The farmland is characterised by artificial drains traversing the land at regular intervals and flowing north to the main channel of the Slate River. A section of existing road runs along the bank of the Barrow Line of the Grand Canal which on one side drains over the edge and on the other side to the canal. It is not proposed to use this section of existing track to access the wind farm.

Surface water run-off from the cluster drains via farm drains, typically 1.5m wide x 1m deep to the Cloncumber Stream. Some of the proposed access routes follow existing forestry tracks, which are typically 3.0m wide. The existing tracks drain 'over the edge' to roadside drains, typically 1m wide x 1m deep. Streams and drains are piped across the existing forestry tracks in pipes varying from 300mm diameter to 600mm diameter. The Slate River runs from east to west through the cluster and is crossed by a masonry arch bridge. The proposed access track to turbine T34 and the access track between T29 and T30 will cross an area identified in the OPW PFRA mapping as an indicative floodplain. The access track crosses the Slate River between T29 and T30. There is an existing bridge downstream at this location, which is 3m wide at the location of the crossing. It was observed during site walkover survey that T31, T33, T34 and T36 drain to Cloncumber Stream, a tributary of the Slate River. Turbines T32 and T31 are located in forestry while T29 is located in harvested forestry. Turbines T34, T29 and T30 are located in the indicative floodplain for a 1 in 100 year return period flood.

It was noted on this cluster that the Barrow Line of the Grand Canal runs on a high embankment, along with an existing adjacent track, along the southern boundary of the cluster.

9.3.5 Turbine Delivery Route

The TDR as shown on Figure 2.10, was examined along with the Delivery Route Selection and Assessment Report, which is included in Appendix K of Volume 3 EIS Appendices. A number of stream crossings were identified along the route, as follows:

- Moyvalley Bridge structure, which crosses over the Royal Canal on the R148
- Structure over the Moyvalley Stream on the R148
- Cosgrove's Bridge structure over the Aleckafin River on the R148
- Blackwater Bridge structure at Kilmurry on the R148
- Structure over the Royal Canal at Enfield on the R148 Dublin Road
- Harris's Bridge structure on the R148 over the Ballycorron River
- Structure over a Stream on the R148, to the east of Cloncurry Cross Roads
- Structure over the Gallow Stream on the R148 at Nicholastown
- Structure over the River Blackwater at Johnstown Bridge on the R402
- Structure over the Togher River at Thomastown on the R402
- Structure over the Sweep River at Kilshanshoe on the R402
- Structure over the Kilcooney River at Collinstown
- Structure over the Fear English River at Drehid
- Structure over a Stream at Timahoe Cross Roads
- Blackwater Bridge structure over the Clogheraun Stream at Derrycrib
- Structure over a Stream at Coologmartin
- Structure over a Stream at Derrylea
- Structure over the River Boyne at Carbury on the R402
- Structure over the River Boyne at Carbury on a Local Road
- Structure over the River Boyne to the south of Carbury on the R403
- Grace's Bridge structure on the R403 over the Ballyshaneen River
- Dillon's Bridge structure over the Cushaling River at Drummond on a Local Road
- Structure over the Kileaskin Stream at Drummond on a Local Road
- Kilpatrick Bridge structure over the Grand Canal on a Local Road to the north east of the turbine cluster at Derrybrennan.
- Iron Bridge structure over the Abbeylough River at Kilpatrick on a Local Road
- Structure over the Figile River at Lullymore East on the R414
- Two structures over the Drumsru tributary of the Slate River at Barnaran
- Agar Bridge Structure over the Slate River at Cloncurry

Modifications were identified to be required, at two of these canal/river crossings: Kilpatrick Bridge over the Grand Canal on a Local Road to the north east of the turbine cluster at Derrybrennan. Modifications are required due to the narrow width of the bridge, which is currently only 3.7m wide at this location, to facilitate access to the turbine cluster at Derrybrennan. The deck will be replaced and widened here over the Canal. The canal bridge is under the responsibility of Waterways Ireland and the canal is within the environmentally designated protected area of the Grand Canal pNHA, site code 002104.

Approved methods for widening and strengthening of these bridges have been discussed with Waterways Ireland in consultations with them on 20 November 2014 and on 8 December 2014.

A modification is required at the exit from the Bord na Mona site to R414, east of Rathangan. The hedge is to be removed and hardcore to be placed over verge and drained. Modifications are required along a section of the disused railway in Bord Na Mona lands, where the TDR goes off-road from the R414 for 0.99km and winds back to tie-in with the existing road at Lullymore. The existing railway route will be upgraded to the required standard for the turbine delivery route.

A temporary bridge structure is required to be constructed adjacent to the existing bridge at the entrance to the Windmill cluster, to facilitate the turbine delivery route.

The temporary bridge will be constructed to Eastern Regional Fisheries Board Guidelines and it will be designed to provide at least the same capacity as that provided by the existing culvert immediately downstream.

To facilitate the turbine delivery route to the Drehid-Hortland cluster, some modifications are required at the 'S' bend on L5025 to make a strip of land adjacent to the road loadbearing for 140m into the hedge line.

This area is identified by the OPW in their PFRA mapping as an area prone to pluvial flooding, as shown on Figure 9.2.0 OPW Flood Data Map Overview. The upgrade of the road here could introduce further flood flow channels in this area, if not designed appropriately.

Modifications are required at the entrance to the Cloncumber cluster. The modifications proposed are to a bridge over a drain, which is a disused Mill Race that leads to the Slate River, some 0.6km downstream. The land drain bridge will have to be extended and hardcore placed on the left hand side. The parapet wall of the bridge is also to be lowered to allow vehicles to pass. The bridge will be extended to match the existing bridge dimensions and it will be constructed in accordance with Eastern Regional Fisheries Board Guidelines. The design and any demolition works for the lowering of the parapet wall, will ensure that no deleterious matter can enter the drain.

The location and photographs of some of the hydrological features which relate to the TDR can also be seen in Figure 9.3., with details provided in Appendix H1 of Volume 3 EIS Appendices.

9.3.6 Cable Route

The proposed MV cable route from the wind farm clusters to the proposed grid connection, is shown on Figure 2.1.0 Site Layout Overview Map. A number of structures will be crossed along this route. The proposed methods of crossing structures include:

i. Horizontal Directional Drilling (HDD)

This is a widely-used method of installing underground pipes and cables whereby a surface-launched drilling rig would be used to drill in an underground arc beneath the watercourse, with minimal impact on the surrounding area.

ii. Alternative Trenchless Option

This would involve digging two pits, an entrance pit and a receiving pit, on either side of the watercourse. The two pits would then be connected by ducts underground, installed either by a drilling or pipe-ramming method, without disturbing the watercourse above.

In-stream works will be avoided where possible, however where this is not possible open-cut methods will be used as follows:

- Open-cut methods: Installation of the cable over the structure where sufficient depth is available, or where a pipe crossing exists, a section of the pipe will be temporarily removed, the new cable(s) will then be laid and the pipe re-instated.

Crossing locations noted are as follows:

- Structure over the Clonuff tributary of the Glash River at Cadamstown Cross Roads
- Structure over the Glash River at Calfstown
- Structure crossing Fear English River at Kilwarden
- Structure over tributary of Fear English River at Coolree
- 2 No. structures over streams, tributary of River Blackwater at Dysart
- 2 No. structures over streams, tributary of River Blackwater at Knockanally
- Dillon's Bridge structure over the Cushaling River at Drummond on a Local Road
- Structure over the Kileaskin Stream at Drummond on a Local Road
- Bridge over the Grand Canal at Kilpatrick on a Local Road
- Iron Bridge structure over the Abbeylough River at Kilpatrick on a Local Road
- Structure over the Figile River at Lullymore East on the R414
- Two structures over the Drumsru tributary of the Slate River at Barnaran
- Agar Bridge Structure over the Slate River at Cloncurry

Some of the above crossing locations are within or close to environmentally designated protected areas and fisheries sensitive streams. The sensitivity of the watercourses to be crossed by the MV cable routes, is discussed further in Chapter 7 Ecology and Chapter 10 Water Quality.

IFI approval will be sought for the crossing of important fisheries waters. Waterways Ireland approval will also be sought, for the proposed crossing of the Grand Canal.

Crossing locations for the MV cables within each wind farm cluster, have been assessed as part of the proposed drainage for the proposed development and are discussed further in Section 9.6.4. The location and photographs of some of the hydrological features which relate to the cable route can also be seen in Figure 9.3., with details provided in Appendix H1 of Volume 3 EIS Appendices.

9.3.7 Grid Connection

The 2 no. HV grid connection cable routes included in this application propose to connect the proposed Maighne Wind Farm substation at Drehid to either one of two existing substations located at Woodland, Co. Meath or Maynooth, Co. Kildare, as shown on Figure 2.1.0 Site Layout Overview Map. However, only one of these routes will be constructed following the identification of the preferred connection point by the Transmission System Operator. A number of structures will be crossed along these routes. The proposed methods of crossing structures will be as outlined for the cable route above.

Crossing locations noted for the Maighne - Woodland Route are as follows:

- Structure over tributary of Fear English River at Coolree
- Structure over tributary of Fear English River at Gorteen
- Fear English Bridge over Fear English River at Johnstown Bridge
- Structure over River Blackwater on the R402, at Johnstown Bridge
- Structure over tributary of the River Blackwater on Johnstown Road
- Harris's Bridge over Ballycorron River on R148 at Cloncurry
- Structure over tributary of the Ballycorron River on R148 east of Cloncurry
- Structure over tributary of the River Ryewater on R148 at Nicholastown
- Structure over tributary of the River Ryewater on R148 at Boycetown
- Allen Bridge over Royal Canal on R148 at Kilcock
- Balfeaghan Bridge over the River Ryewater on R158 north of Kilcock
- Structure over tributary of the River Ryewater on R125
- Brides Well Bridge over Brides Stream, tributary of River Ryewater at Calgath on R125, at the Junction with Watery Lane
- 2 No. structures over tributaries of the River Ryewater at Kemmins Mill on
- Structure over Bryanstown tributary of the River Ryewater at Mulhussey
- Jenkinstown Bridge over tributary of the River Ryewater at Jenkinstown
- Structure over tributary of the River Ryewater at Barstown
- Structure over the Dunboyne Stream, tributary of the River Tolka at Cullendragh
- Structure over the Lustown Stream, tributary of the River Tolka at Culcommon

Crossing locations noted for the Maighne - Maynooth Route are as follows:

- Structure over tributary of Fear English River at Coolree
- 2 No. structures over streams, tributaries of River Blackwater at Dysart
- Structure over stream, tributary of River Blackwater at Knockanally
- New structure over unnamed Stream, tributary of River Blackwater at Knockanally as part of the internal development at the Drehid-Hortland cluster
- New structure over Mulgeeth Stream as part of the internal development at the Drehid-Hortland cluster
- New structure over Clogheraun Streams part of the internal development at the Drehid-Hortland cluster
- Clogheraun Bridge over tributary of the River Blackwater
- Structure over tributary of River Blackwater at Ballagh Cross-roads
- Telfer's Bridge over a Baltracey River at Kilnamoragh North
- 2 No. structures over the Baltracey River tributary of the Lyreen River on L1010
- Lyreen Bridge over tributary of Lyreen River on L1010 at Graiguelin
- Structure over Treadstown tributary of the Lyreen River on L5037 at Donaghstown
- Structure over the Tagdahdoe Stream tributary of the Lyreen River on L5037 at Taghadoe.

Some of the above crossing locations are within or close to environmentally designated protected areas and fisheries sensitive streams. The sensitivity of the watercourses to be crossed by the HV cable routes, is discussed further in Chapter 7 Ecology and Chapter 10 Water Quality.

Where connection from the proposed wind farm is to be made to the national grid, IFI approval will be sought for the crossing of important fisheries waters. Waterways Ireland approval will also be sought, should the Maighne – Woodland route be chosen, where a crossing of the Royal Canal will be required.

R:\Map Production\2014\LE14\731\04\Workspace\EIS MAPS\Chapter 9 Hydrology\LE1473104 Fig 9.3 Hydrological Features Map.mxd

Ballynakill

Windmill

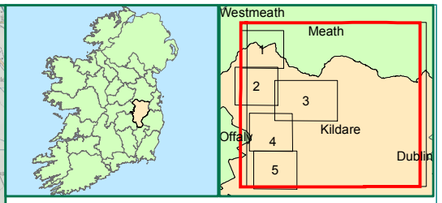
Drehid
Hortland

Derrybrennan

Cloncumber

Woodland -
Option 1

Maynooth -
Option 2



Legend

- Turbine Location
- Wind Farm Cluster Boundary
- Proposed Borrow Pit Location
- Proposed Compound Location
- Proposed Substation Location
- Proposed Met Mast Location
- Indicative Access Track
- MV Cable Route
- Cable Route (Internal to Windfarm Cluster)
- Irish Grid Connection Points
- HV Cable Route

Hydrological Features Overview

- Agri/Road/Track/Pipe Crossing, Bridge, Culvert
- Bog Drain, Drainage Ditch, Forest Drain, Road Drain
- Over the Edge Drain/Stream
- Floodplain, Flooding, Marsh, Pluvial Path
- Stream, River
- Other

0 1 2 3 4 5
Kilometers

Date 25/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Hydrological Features Map
Maighne Overview

Scale Used 1:100,000 @ A3

Figure No. 9.3.

Rev A

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9.4 Potential Impacts

The potential impacts on the hydrological regime are assessed in the following sections for the activities associated with each phase (construction, operation, maintenance and decommissioning) of the proposed Maighne Wind Farm development. The potential impacts (including cumulative) are assessed in accordance with the evaluation criteria outlined in Section 9.2.6, with a summary provided in Table 9.4 in Section 9.4.7. The drainage of the proposed development is then considered, taking account of mitigation measures to reduce or eliminate any residual impacts.

9.4.1 Do Nothing Impact

If the proposed wind farm development does not proceed, the site will remain in parts as poor draining agricultural and bog land for the foreseeable future including grazing, arable, peat milling and forestry uses. In areas where conifer forestry plantations are present, deforestation and reforestation will continue to occur into the future.

9.4.2 Potential Impacts during Construction

During the construction period, the development has the potential to lead to impacts on hydrology unless appropriate mitigation is applied.

9.4.2.1 Potential Direct Impacts

Tree felling, new site access roads, turbine hard-standing areas, the on-site sub-station and other new, hard surfaces have the potential to contribute to a low level increase in run-off, as indicated in Table 9.3 overleaf.

Table 9.3 shows the estimated changes in the volume of runoff corresponding to a 1-in-100 year, 30-minute duration storm at the proposed Maighne Wind Farm. The calculations include the increases in run-off due to the increase in hardstanding as a result of road widening and due to an upgrade of an old railway line in Bord Na Mona lands along the turbine delivery route to the north and south of the Derrybrennan cluster. The estimated percentage increase in run-off from each of the clusters is as follows:

Ballynakill

EA_Boyne159BlackwaterLongwood_Blackwater1_Lower	0.03%
EA_Boyne159Main_BoyneTRIB_Glash1_Lower	0.15%
EA_Boyne159Main_Boyne2	0.30%

Windmill

EA_Boyne159Main_BoyneTrib_Glash3_Upper	0.19%

Drehid-Hortland

EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_FearEnglish	0.38%
EA_Boyne159BlackwaterLongwood_Blackwater2_Upper	0.16%
EA_Boyne159BlackwaterLongwood_BlackwaterTRIB_Deryvarroge	0.07%
SE_BarrowFigile_Cushaling	0.02%

Derrybrennan

SE_BarrowFigile_Figile_Upper	0.04%
SE_BarrowSlate_Slate	0.00%
SE_BarrowFigile_Cushaling	0.05%

Cloncumber

SE_BarrowSlate_Slate	0.04%
SE_BarrowSlate_Cloncumber	0.05%

An overall increase in run-off of 0.15% could be expected from the parts of the proposed development draining to the River Boyne catchment and an overall increase in run-off of 0.03% could be expected from the parts of the proposed development draining to the Barrow River catchment. These estimated increases in run-off will reduce over time as vegetation is re-established on the site. It is not expected therefore that the estimated increases will give rise to any significant impacts.

Further, the magnitude of the impact does not take into account the proposed mitigation measures. The impact significance will be assessed in Section 9.4.7.

Table 9.3: Increase in Surface Water Run-off

Turbine Cluster	Catchment	Scenario	Catchment Area	Overland flow area x 0.3 Imp. Factor	Existing Tracks to be used as part of the development	x 0.75 Imp. Factor	New hardcore tracks, including widening of existing tracks	x 0.75 Imp. Factor	Turbines Base & Hard Standing and Substation	x 0.75 Imp. Factor	Total Run-off Imp. Area	Q flow coefficient Mod. Rational Method	Rainfall Intensity for 1 in 100 yr storm of 30 mins. X 1.1 for Climate Change, Met Eireann*	Run-off	Increase in Run-off	% Increase in Run-off	% Increase in Run-off in Main River Catchments
			ha	ha	ha		ha		ha		ha		mm/hr	m3/s	m3/s		
Ballynakill	Increase in run-off to Blackwater1_Lower Waterbody	Existing	5306	1591.79	0.05	0.04					1591.82	2.78	57.39	253.966			0.15
		Post Development		1591.42	0.05	0.04	0.79	0.59	0.43	0.32	1592.37	2.78	57.39	254.053			
		Increase in Run-off													0.087		
		% Increase in Run-off														**0.03**	
	Increase in run-off to Glash1_Lower Waterbody	Existing	165	49.50	0.00	0.00					49.50	2.78	57.39	7.897			
		Post Development		49.45	0.00	0.00	0.17	0.13	0.00	0.00	49.58	2.78	57.39	7.910			
		Increase in Run-off													0.012		
		% Increase in Run-off														**0.15**	
	Increase in run-off to Boyne2 Waterbody	Existing	1689	506.67	0.10	0.08					506.75	2.78	57.39	80.848			
		Post Development		505.66	0.10	0.08	1.67	1.25	1.70	1.28	508.26	2.78	57.39	81.090			
		Increase in Run-off													0.242		
		% Increase in Run-off														**0.30**	
Windmill	Increase in run-off to Glash3_Upper Waterbody	Existing	1521	456.28	0.07	0.05					456.33	2.78	57.39	72.805			
		Post Development		455.71	0.07	0.05	1.25	0.94	0.64	0.48	457.18	2.78	57.39	72.941			
		Increase in Run-off													0.136		
		% Increase in Run-off														**0.19**	
Drehid Hortland	Increase in run-off to BlackwaterTRIB_FearEnglish Waterbody	Existing	2173	651.77	0.44	0.33					652.10	2.78	57.39	104.038			
		Post Development		650.13	0.44	0.33	3.32	2.49	2.13	1.59	654.55	2.78	57.39	104.429			
		Increase in Run-off													0.391		
		% Increase in Run-off														**0.38**	
	Increase in run-off to Blackwater2_Upper Waterbody	Existing	4808	1442.12	0.92	0.69					1442.81	2.78	57.39	230.193			
		Post Development		1440.61	0.92	0.69	2.18	1.64	2.87	2.15	1445.09	2.78	57.39	230.555			
		Increase in Run-off													0.362		
		% Increase in Run-off														**0.16**	
	Increase in run-off to BlackwaterTRIB_Deryvarroge Waterbody	Existing	2710	813.00	0.00	0.00					813.00	2.78	57.39	129.709			
		Post Development		812.62	0.00	0.00	1.05	0.79	0.21	0.16	813.57	2.78	57.39	129.800			
		Increase in Run-off													0.091		
		% Increase in Run-off														**0.07**	
	Increase in run-off to Cushaling Waterbody	Existing	2659	797.70	0.00	0.00					797.70	2.78	57.39	127.268			
		Post Development		797.57	0.00	0.00	0.23	0.17	0.21	0.16	797.90	2.78	57.39	127.300			
		Increase in Run-off													0.032		
		% Increase in Run-off														**0.02**	
Derrybrennan	Increase in run-off to Figile_Upper Waterbody	Existing	1552	465.59	0.03	0.02					465.61	2.78	57.39	74.286			
		Post Development		465.46	0.03	0.02	0.22	0.17	0.21	0.16	465.81	2.78	57.39	74.317			
		Increase in Run-off													0.031		
		% Increase in Run-off														**0.04**	
	Increase in run-off to Slate Waterbody	Existing	14246	4273.80	0.00	0.00					4273.80	2.78	57.39	681.860			
		Post Development		4273.67	0.00	0.00	0.45	0.34	0.00	0.00	4274.00	2.78	57.39	681.892			
		Increase in Run-off													0.032		
		% Increase in Run-off														**0.00**	
	Increase in run-off to Cushaling Waterbody	Existing	2659	797.51	0.62	0.47					797.98	2.78	57.39	127.313			**0.03**
		Post Development		797.25	0.62	0.47	0.68	0.51	0.21	0.16	798.38	2.78	57.39	127.377			
		Increase in Run-off													0.064		
		% Increase in Run-off														**0.05**	
Cloncumber	Increase in run-off to Slate Waterbody	Existing	14246	4273.67	0.42	0.32					4273.99	2.78	57.39	681.890			
		Post Development		4272.65	0.42	0.32	1.92	1.44	1.49	1.12	4275.52	2.78	57.39	682.135			
		Increase in Run-off													0.245		
		% Increase in Run-off														**0.04**	
	Increase in run-off to Cloncumber Waterbody	Existing	6383	1914.80	0.32	0.24					1915.04	2.78	57.39	305.534			
		Post Development		1914.12	0.32	0.24	1.44	1.08	0.85	0.64	1916.07	2.78	57.39	305.699			
		Increase in Run-off													0.164		
		% Increase in Run-off														**0.05**	

Notes:
Factor of 1.1 is applied to rainfall intensity to allow for climate change in accordance with GDSDS
Rainfall intensity for 1 in 100 year return period storm of 30 min. duration supplied by Met Eireann
Q100 flow derived using the Modified Rational method Q = 2.78 x (Rainfall Intensity) x (Contributing Impervious Area)
Main River Catchments highlighted as follows: Boyne Barrow

*Q determined from Modified Rational Method using Intensity in 1 in 100 yr, 30 minute duration storm including 10 % increase in rainfall for climate change allowance giving an intensity of 57.39 mm/hr

9.4.2.2 Potential Indirect Impacts

The relatively low increase in run-off has however, the potential to cause localised soil erosion and consequent sediment release into the receiving watercourses via the drainage system for the proposed development, if unmitigated.

Possible potential indirect impacts on drainage and surface water quality during the construction phase of the project prior to mitigation include:

- Increased sediment loading of streams from personnel and traffic activities; exposed borrow pit areas and inappropriate management of excavations, excavated material and drainage of material storage areas could lead to siltation and physical effects on flora and fauna in aquatic habitats.
- Haul roads passing close to watercourses could allow the migration of silt laden run-off 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 run-off, 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.
- Refuelling activities adjacent to water bodies could result in fuel spillages, polluting receiving waters.
- Excavation of peat could lead to an increase in suspended solids in the surface water run-off and from minor quantities of exposed mineral soils. The removal of the vegetated material will also lead to an increase in the rate of run-off along the route of the site access roads and hard-standing areas. This increase in the rate of run-off could lead to a minor increase in flooding downstream.
- Blockage of cross-drains could lead to consequent flooding and concentration of flows.
- Flows from the new drainage system could be impeded, should blockages occur in the existing roadside drains which may lead to localised flooding.
- Overland flow entering borrow pits could increase the quantity of surface water to be treated for sediment removal.
- Cable trenches could act as a conduit for surface water flows and subsequent flooding elsewhere on the site.
- The velocity of flows in roadside drainage could cause erosion in steeply sloping roadside drains.
- Stream flows could be impeded due to inappropriate design of stream crossings.
- Open bodies of water and saturated ground present a risk to the safety of site personnel and the public. Hazards of this type include the streams and rivers throughout the site and other wet areas observed during the site walkover (as identified in the Hydrological Features in Appendix H1 of Volume 3 EIS Appendices).
- 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 run-off to reach adjacent watercourses or streams.
- Overland flows entering roadside drains could result in a concentration of flows and subsequent erosion of drains and a reduction in the efficiency of any proposed stilling ponds.

9.4.2.3 Potential Impacts from the Turbine Delivery Route, Cable Route and Grid Connection

The proposed modifications were examined in the Delivery Route Selection and Assessment report, which is included in Appendix K of Volume 3 EIS Appendices. Some of the proposed modifications have the potential to impact on hydrology as follows.

There is the potential risk of the ingress of silt, concrete or other deleterious matter into the canal/stream during the construction of modifications to bridges to facilitate the delivery of turbines at the following location:

- at the bridge over the Grand Canal at Kilpatrick on a Local Road to the north east of the turbine cluster at Derrybrennan. This bridge is currently only 3.7m wide to facilitate access to Derrybrennan. This canal bridge will be replaced as it does not have sufficient capacity or width for turbine deliveries. The options here have been discussed with Waterways Ireland.

- Modifications are required at the entrance to the Cloncumber cluster. The modifications proposed are a temporary extension to a bridge over a drain, which is a disused Mill Race that leads to the Slate River, some 0.6km downstream.
- A temporary bridge structure is required to be constructed adjacent to the existing bridge at the entrance to the Windmill cluster, to facilitate the turbine delivery route.

To facilitate the turbine delivery route to Drehid-Hortland, some modifications are required at the 'S' bend on L5025 to make a strip of land adjacent to the road loadbearing for 140m into the hedge line. This area is identified by the OPW in their PFRA mapping as an area prone to pluvial flooding, as shown on Figure 9.2.0 OPW Flood Data Map Overview. The upgrade of the road here could introduce further flood flow channels in this area, if not designed appropriately.

Where an existing drain is to be modified for the TDR, at the exit from the Bord na Mona site to R414, to the east of Rathangan, surface water from the road could flow elsewhere. Modifications are required along a section of the disused railway in Bord Na Mona lands, where the TDR goes off-road from the R414 for 0.99km at Lullymore West. The existing railway route will be upgraded to the required standard for the turbine delivery route. The construction of this road could lead to sediment release in the adjacent bog drainage if the drainage of the road is not designed appropriately.

There is the potential risk of the ingress of silt, into the stream during the laying of cabling at stream crossings where trenchless techniques are not deemed to be possible.

Trenchless techniques will be used where possible for the laying of cables at stream crossings. There are two options available:

iii. Horizontal Directional Drilling (HDD)

This is a widely-used method of installing underground pipes and cables whereby a surface-launched drilling rig would be used to drill in an underground arc beneath the watercourse, with minimal impact on the surrounding area.

iv. Alternative Trenchless Option

This would involve digging two pits, an entrance pit and a receiving pit, on either side of the watercourse. The two pits would then be connected by ducts underground, installed either by a drilling or pipe-ramming method, without disturbing the watercourse above.

Trenchless crossing techniques were selected as they minimise the environmental impacts associated with the crossing of river/streams and it is anticipated that these techniques will be used at all of the EPA identified 'blue line river' crossings. Small excavations will be required at the launch and reception areas for the cable installation, however these will be set back from the watercourse. In all cases, the relevant bodies, including IFI, Waterways Ireland and Bord Na Mona will be consulted in the detailed design of the crossings.

Where these techniques are not possible open-cut methods will be used. Open-cut methods associated with the cable routes will be subject to the time of year and a pre-construction survey. Any excavations, will expose bare soil for a temporary period over a short section of trench, which could convey small quantities of silt into the receiving waters, if left unmitigated.

In some instances, the cable-ducts will be laid in the bridge or culvert structure, which carries the road across the watercourse, where there is sufficient depth within the structure.

There are also situations where the water course passes through a culvert when it will be feasible to excavate for the cables to cross underneath the culvert. An alternative crossing methodology, which may be employed, will be to lay the cables by excavating a trench in the bed of the water-course. This method will be particularly applicable for crossings of streams which intersect the internal access roads in the wind farms. The trench will be backfilled immediately following the installation of each section of cabling. While the trench is open, there will be a potential impact to the adjacent watercourse of an increase in the concentration of suspended solids.

9.4.2.4 Potential Cumulative Impacts

The increase in the rate of surface water run-off due to the increase in hard surface areas as a result of the development within the waterbody catchments, in addition to development in other waterbody catchments upstream in this site, together with any additional adjacent developments, could lead to a minor cumulative risk of flooding downstream.

The potential cumulative hydrological impact was examined in relation to current proposed NRA road schemes. There are no such schemes planned or currently under construction in the vicinity of the site for the proposed Maighne wind farm development.

The following neighbouring wind farms, as shown on Figure 2.11 to be within a 20km buffer of the site for the proposed Maighne wind farm development, were examined for potential cumulative hydrological impacts during construction with the proposed development:

- Crowinstown Wind Farm Permitted
- Dryderstown Wind Farm, Permitted
- Yellowriver Wind Farm, Permitted
- Mountlucas Wind Farm, Permitted

The above neighbouring permitted wind farms are not located within any of the same waterbody catchments as the proposed development for Maighne Wind Farm. They are also not located within any of the same waterbody catchments within which the TDR and the cable route are located. The potential cumulative hydrological impact is therefore considered to be negligible.

There are a number of industries in the vicinity of the proposed Maighne Wind Farm development, namely Carbury Compost Ltd, Bord na Móna Drehid Waste Management Facility, Allenwood Business Park, Monaghan Mushrooms, Clairstone Ltd, Moyvalley Meats, Brady's Family Ham, Doran Nurseries and Irish Industrial Explosives Ltd. Some of these industries are licenced by the EPA and they are required to monitor groundwater and surface water up and down stream of their facilities and in addition, they have strict controls on the surface water discharges from these sites. These controls coupled with the proposed mitigation measures for the operation of the wind farm mean that the cumulative impacts on hydrology are considered to be negligible. The cumulative impact of these industries on water quality has been addressed in Chapter 10 Water Quality.

The cumulative impact of the turbine clusters draining to the same waterbody catchments is assessed in the flood risk assessment in Section 9.5.3.

9.4.3 Potential Impacts during Operation and Maintenance

9.4.3.1 Potential Direct Impacts

The main potential hydrological impact of the development is a 0.15% increase in the run-off to the River Boyne catchment and a 0.03% increase in run-off from a storm event to the River Barrow catchment, due to the change in land use resulting in an increase in impermeable ground conditions. The time of concentration of surface water flows will decrease as a result of the additional hard-surfaced areas resulting in additional flows being discharged to the roadside drains during rainfall events. Some infiltration will occur through the road construction material to be used in the site access roads.

Due to the insignificant increase in potential run-off from the site and the non-intrusive nature of site operations, there should be negligible release of sediment to the watercourses post-construction.

9.4.3.2 Potential Indirect Impacts

During the operation phase, small quantities of oil will be used in cooling the transformers. There is potential for contamination via the drainage system, in the event of an uncontrolled release of any oil to the drainage network and in the absence of oil and petrol interceptors.

It is not envisaged that the maintenance activities taking place on the wind farm, involving general maintenance for the operation of the wind farm and including maintenance of the drainage system and reinstated areas, will give rise to any significant, impacts on the hydrological regime of the area.

9.4.3.3 Potential Cumulative Impacts

The increase in the rate of surface water run-off due to the increase in hard surface areas as a result of the proposed development within the waterbody catchments, in addition to existing large scale development in these waterbody catchments, could lead to a minor cumulative risk of flooding downstream.

The following turbine clusters in the proposed Maighne wind farm development are either partially or wholly located within the same main river catchments as each other and are therefore to be considered cumulatively:

- River Boyne – Ballynakill, Windmill and Drehid-Hortland
- River Barrow - Drehid-Hortland, Derrybrennan and Cloncumber

The overall potential impact of the whole of the proposed Maighne wind farm development on the River Boyne and the River Barrow was estimated and the overall cumulative increase in surface water run-off into the waterbody catchments of these two rivers, was found to be of low significance, as shown in Table 9.3. Potential cumulative impacts are also assessed in Section 9.5 Flood Risk Identification and Assessment.

The following neighbouring wind farms, as shown on Figure 2.11 to be within a 20km buffer of the site for the proposed Maighne wind farm development, were examined for potential cumulative hydrological impacts during the operation of the proposed development, assuming that any of the listed permitted wind farms could be in operation before or concurrently with the Maighne wind farm development:

- Crowinstown Wind Farm Permitted
- Dryderstown Wind Farm, Permitted
- Mountlucas Wind Farm, Existing
- Yellowriver Wind Farm, Permitted
- Mountlucas Wind Farm, Permitted

The above neighbouring wind farms are not located within any of the same waterbody catchments as the proposed development for Maighne Wind Farm. They are also not located within any of the same waterbody catchments within which the TDR and the cable route are located. The potential cumulative hydrological impact is therefore considered to be negligible.

They are also not located within any of the same waterbody catchments within which the TDR and the cable route are located. It should be noted that the TDR and the cable route will not contribute to any significant increase in surface water run-off. The potential cumulative hydrological impact is therefore considered to be negligible.

The location of existing business developments in the vicinity of the proposed development was examined for potential cumulative hydrological impacts. Most of these developments are not located within any of the same waterbody catchments as the proposed development for Maighne Wind Farm. Due to the insignificant increase in potential run-off from the site, it is not expected that the cumulative impact with existing business developments will give rise to any significant impacts.

Other developments are located at significant distances from the proposed development and/or drain into different tributaries of the main rivers running through the site and it is therefore not expected that they will have any significant potential cumulative hydrological impact with the proposed development, in particular given the small increase in surface water run-off expected in these catchments from the proposed development, as shown in Table 9.3.

The potential cumulative hydrological impact was examined with the M4/M6 Kilcock - Kinnegad PPP Motorway Scheme which passes through the site for the proposed Maighne wind farm development. The cumulative hydrological impact with the M4/M6 Kilcock - Kinnegad PPP Motorway Scheme was found to be negligible for the operation phase, as this road scheme incorporates attenuation of the surface water drainage on this scheme.

9.4.4 Potential Impacts during Decommissioning

It is proposed that the turbine foundations, site tracks and hard standings will be left in place during decommissioning. These areas will be left to revegetate naturally. In the event of decommissioning of the Maighne Wind Farm, the proposed access tracks may be used in the decommissioning process.

There would be increased trafficking and an increased risk of disturbance to underlying soils at the wind farm, during the decommissioning phase, in this instance, leading to the potential for silt laden run-off entering receiving watercourses from the wheels of vehicles.

9.4.5 Potential Impacts of a Risk of Flooding

There are four turbines located within the indicative floodplain i.e. 'Flood Zone A', as shown in Figure 9.2.0., namely T1 in the Ballynakill turbine cluster and T34, T29 and T30 in the Cloncumber cluster. Turbine T40 in the Drehid-Hortland cluster is shown to be within an indicative floodplain, however when examined further, it is more likely to be skirting the floodplain, due to the higher ground immediately to the west of the turbine location. The proposed substation is not located in the indicative floodplain.

There is no flood risk to any turbines located in or near an indicative 1% AEP (Annual Exceedance Probability) flood zone i.e. 'Flood Zone A' area during a flood event. This is a result of avoidance by design which includes the following; all seals on turbine towers within the potential flood plain will be designed and built to ensure no water ingress to the tower. In addition the ducts in the foundation will be sealed to ensure no ingress of water and the foundation will be designed and built to take account that the foundations could be exposed to water. There is no flood risk therefore to the turbines during a flood event.

There will be no appreciable obstruction to flood flows in the floodplain as a result of new access roads and turbine hardstanding areas, which will be mostly at grade with the existing terrain.

In addition, the proposed access tracks to a number of turbines will cross an area identified in the OPW PFRA mapping as an indicative floodplain and therefore have the potential to obstruct flood flows. This impact will be avoided by design as follows; any stream crossings will be conveyed in culverts, sized to take the 1 in 100 year flood flow with a 20% allowance for climate change.

Some small areas of the site were identified in OPW PFRA mapping as being within an indicative pluvial flooding area. However, no particular hydrological features of note were observed during the site visits, in the areas of the site where development is proposed.

No construction personnel, operation or maintenance personnel will be permitted on site during extreme flood events.

Landowners, including commercial operators such as at the peat milling operations in the Windmill cluster, will however carry on their normal activities in the vicinity of the wind farm and will take the usual precautionary measures as far as practicable during flood events. Emergency operations during a flood event are not envisaged on the wind farm.

A 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 is included in Section 9.5.

Information was received from Irish Water on foul and storm sewerage infrastructure in the vicinity of the proposed Maighne Wind Farm. There is no sewerage infrastructure in the vicinity of the turbine clusters. There is sewerage infrastructure however running along the HV route to Woodland, at Johnstown Bridge and at Kilcock. There is also some sewerage infrastructure running along the MV route at the outskirts of Derrinturn. Irish Water will provide detailed maps of the infrastructure in these areas. Any risk of flooding due to impact on 3rd party services will be avoided by close liaison with Irish Water and by proofing the location of services using slit trenches. Modifications to the TDR include small increases in hardcore areas to facilitate vehicle manoeuvres'. For the most part there is no sewerage infrastructure in these areas, however, where gullies exist, these will remain operational and the new hardcore areas will be laid to falls, ensuring that surface water runoff does not either pond in these areas or result in ponding on the existing road.

9.4.6 Particular Impacts in Specific Turbine Clusters

9.4.6.1 Windmill

There is the potential risk of a loss of bog habitat due to excavations for the turbine cluster at Windmill. However, the development in this turbine cluster is in the northern section of the area of cut peat. It was observed in this cluster that surface water pathways from the proposed footprint of the development are not connected to the perimeter drains bounding the area of cut peat to the south of the cluster. The potential impacts of the development at this cluster in relation to the proposed bog management in the adjacent site are discussed further in Chapter 7 Ecology. This cluster is currently under active commercial extraction and is a highly modified habitat.

The proposed development at this turbine cluster will have no further adverse impact on the proposed bog management in the adjacent site. The existing bog drains drain in a south-east to north-west direction i.e. away from the area of proposed bog management in the adjacent site. The proposed drainage of the cluster will avoid excavations in the bog as far as possible, with the exception of some interception of existing drains. The location of the proposed development to the north of the area of cut peat will ensure that no direct impacts (such as habitat loss or surface damage) will occur in the adjacent site. This is discussed further in Chapter 7 Ecology and the proposed drainage of the development is discussed further in Section 9.6.

The entrance to the Windmill cluster will be via an existing entrance to the site for the peat milling operations. This entrance road will cross an area identified in the OPW PFRA mapping as an indicative floodplain.

It was noted at a consultation meeting with the IFI that the River Glash is a salmonid nursery and it is under pressure, due to elevated ammonia levels due to peat soils. There will be no direct discharges to this river, from disturbed areas of peat soils. The only area draining to the Glash River will be an existing entrance road. There are no permanent modifcations proposed to the entrance road at this location.

9.4.6.2 Drehid-Hortland

The proposed substation is located close to a Source Protection Zone. There is the potential risk of pollution of the aquifer that feeds this SPZ through the infiltration of potentially contaminated surface water during the construction and operation of the substation.

Turbine T45 (Hortland) is in an SPZ. There is the potential risk of pollution of the aquifer that feeds this SPZ through the infiltration of potentially contaminated surface water during works for the excavation and construction of turbine T45.

Any impact on the SPZ will be avoided by design. Specialized construction techniques will be used for development in the SPZ. These techniques are discussed in detail in Chapter 10 Water Quality.

The entrance access road into the location of turbine T40 to the east of the cluster runs within 50m of the Clogheraun Stream, tributary of the River Blackwater. The track here is partially an existing track. There is the potential risk of the ingress of silt, into the stream during the construction of the turbine cluster which will be accessed from this entrance. The entrance access road into the location of turbine T40 to the east of the cluster runs within 50m of the Clogheraun Stream, tributary of the River Blackwater.
The track here is partially an existing track. There is the potential risk of the ingress of silt, into the stream during the construction of the turbine cluster which will be accessed from this entrance.

9.4.6.3 Cloncumber

A new bridge is required adjacent to the existing structure which crosses the Slate River at Ballyteige North, to facilitate the delivery of turbines. This is due to the narrow width of the existing bridge here, which is currently only 3.0m wide at this location and to improve the integrity of the bridge. There is the potential risk of the ingress of silt, concrete or other deleterious matter into the canal during the construction of the new bridge at this location.

9.4.7 Summary of Unmitigated Hydrological Impacts of the Wind Farm on Sensitive Receptors

A summary of unmitigated potential impact due to the development of the proposed wind farm is provided in Table 9.4.

Table 9.4: Summary of Potential Hydrological Impact Significance on Sensitive Receptors

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
site tracks, cabling, turbine construction, crane pad construction, sub-station	increase in rate of run-off	River Boyne, River Blackwater, Figile River & Slate River	High	minor	minor
site tracks, crossings, cabling, turbine construction, crane pad construction, sub-station, tree felling and management of material storage areas	erosion and sedimentation	River Boyne, River Blackwater, Figile River & Slate River	High	minor	minor
drainage crossings, turbine construction, sub-station, temporary compounds	chemical pollution	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible
Operation & Maintenance					
site access tracks	increase in rate of run-off	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible
reinstated material storage areas in the borrow pits	erosion and sedimentation	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible
Decommissioning					
Increased trafficking to remove turbines	erosion and sedimentation	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible

It can be observed from Table 9.4 that some activities during the construction of the wind farm, if unmitigated, could have a minor impact on receiving watercourses, with a risk of sedimentation of sensitive catchments. Operation and maintenance activities are not expected to have a significant effect on the receiving watercourses.

As discussed, the risk of an increase in flooding is of minor significance due to the small percentage increase in run-off contributing to the catchments as a result of the wind farm development. This is discussed further in Section 9.5.

9.5 Flood Risk Identification and Assessment

9.5.1 Flood Flow Conveyance

As discussed in Section 9.3.3, the indicative flood mapping from the OPW shows a number of the proposed access tracks crossing an indicative floodplain in the vicinity of the proposed stream crossings. The proposed stream crossings will be a minimum of 900mm diameter. The stream crossings have been identified in Figure 9.8. The information in this figure is available to view in more detail in the sub maps, which are included in the Figures and Drawings Volume 2a. In order that flood flows would not be obstructed, the culverts will be sized to convey a 1 in 100 year flood with a 20 % allowance for climate change.

Additional flow connectivity culverts were not deemed to be required as the track layout allows for the crossing of streams and rivers at the narrowest part of the floodplain and they do not obstruct the flood flows. This is discussed further in Section 9.6.4.

As part of the flood risk assessment, preliminary calculations were undertaken to size the 8 No. culverts at the proposed principal stream crossings in the turbine clusters in the Maighne Wind Farm development, as shown on Figure 9.8. In addition to these stream crossings, the proposed development will cross over 4 No. existing stream crossings. The new and existing stream crossings are distributed across the following turbine clusters within the proposed Maighne Wind Farm development as follows:

- Ballynakill - 1 No. existing stream crossing
- Windmill – 1 No. existing stream crossing
- Drehid-Hortland – 2 No. existing stream crossings and 6 No. new stream crossings
- Derrybrennan - None
- Cloncumber – 2 No. new stream crossings

The calculations are included in Appendix H2 of Volume 3 EIS Appendices.

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

- The 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.
- The 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 1.96derived from Figure I.2.14 of the Flood Studies Report ([37]) 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.

For catchments greater than 25km^2, the Flood Studies Update (FSU) web portal www.opw.hydronet.com was used to determine the 1 in 100 year design flow at the proposed new crossings.

The FSU approach to estimating the peak flow for a given return period (T) involves three steps: first, estimation of the index flood, which is the median annual maximum flood (QMED); second, estimation of an appropriate flood growth curve; and third, derivation of the flood frequency curve which relates the index flood to the growth curve to provide an initial estimate of the peak flow for the required return period (T)/annual exceedance probability (AEP). Ungauged catchment analysis involves a pooled analysis with similar gauged catchments.

The approximate catchment areas and the flood flows estimated for Q_{100} including an allowance for climate change are included in Table 9.5 and Table 9.6 overleaf for each crossing. A preliminary culvert size was estimated for each stream crossing based on the calculated design flow. The design sizes take account of embedment and freeboard requirements, which were provided by IFI during the consultation process.

An allowance of 500mm is provided for embedment for closed culverts as recommended by IFI for fisheries sensitive streams. A freeboard of 300mm was also recommended by IFI. At detailed design stage each bridge location will allow for a setback of foundations of at least 2.5m from the river bank so as not to impact on the riparian habitat.

Where new structures are provided immediately upstream or downstream of existing structures, the new structure will not be smaller than the existing structure and will maintain the existing stream channel width. The culverts will be constructed in accordance with the document *Eastern Regional Fisheries Board - Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites* and in accordance with the particular guidance provided by IFI during the consultation process. The culverts will be designed to accommodate any mammal requirements. Clear bottomless culverts are preferred by IFI in fisheries sensitive streams. A typical design for a bottomless culvert (Matiere type arch structure) is included in Appendix H3 of Volume 3 EIS Appendices.

Table 9.5: Preliminary Culvert Sizing for Stream Catchments less than 25km²

					Design Flow 3 term EQN IOH Method			Design Flow 3 term EQN FSSR Method				Design Culvert Size				Adjusted Design Culvert Size		
Turbine Cluster	Culvert	AREA	SAAR	SOIL	QBAR	Q100(x 1.96SOIL Type >2, x 2.61SOIL Type 1) x 1.65	Increase by 20% for Climate Change	QBAR	Q100(x 1.96) x 1.5	Increase by 20% for Climate Change	Max. Design 100 yr Flood	Width	Height/Diameter	Freeboard 300mm (Fl)	Embedment 500mm (Fl)	Width	Height/Diameter	Culvert Type
		km2	mm		m3/s	m3/s		m3/s	m3/s		m3/s	mm	mm	mm	mm	mm	mm	
Drehid Hortland	SC1	10.9220	812	0.45	4.066	13.149	15.779	4.274	12.566	15.080	15.779	4500	1800	300		4500	2100	Clear Span Structure
Drehid Hortland	SC2	2.9760	801	0.45	1.258	4.068	4.882	1.271	3.737	4.484	4.882	2700	1200	300		2700	1500	Clear Span Structure
Drehid Hortland	SC3	0.4340	801	0.45	0.227	0.733	0.880	0.216	0.636	0.763	0.880		1050	300	500		1850	Circular Pipe
Drehid Hortland	SC4	3.2940	793	0.45	1.361	4.401	5.281	1.378	4.053	4.863	5.281	3000	1200	300		3000	1500	Clear Span Structure
Drehid Hortland	SC6	19.3360	779	0.3	2.671	8.639	10.367	3.054	8.980	10.776	10.776	3300	1800	300		3300	2100	Clear Span Structure

Notes:
1) 3-Term EQN is QBAR = 0.00066 (Area^0.92)(SAAR^1.22)(Soil^2.0) Ref.: Flood Studies Report No. 6 and QBAR = 0.00108 (Area^0.89)(SAAR^1.17)(Soil^2.17) for catchments less than 25km² (Inst. Hyd. Report No. 124)
2) SAAR (Average Annual Rainfall) from at site FSU Web Portal, www.opw.hydronet.com
3) SOIL from FSR Maps.
4) Q100 from Region curves ordinates from Flood Studies Report, Table 2.39
5) Factors of Safety multiples of 1.5 and 1.65 included for the relevant formulae.
6) Culvert catchment area determined from FSU Web Portal
7) Climate change - increase of 20% in flows - ref. OPW - Appendix C Standard Specifications for Feasibility and Pre-feasibility Studies for flood relief works - March 2004 (the note is based on the Desk Study carried out by Dr. Michael Bruen

Table 9.6: Preliminary Culvert Sizing for Stream Catchments greater than 25km²

	FSU Web Portal			Pooled Group	Pooled Group Analysis	Adjustment for Climate Change	Design Culvert Size				Adjusted Design Culvert Size		
Location	AREA	SAAR	QMED	Growth Factor	Design 100 yr Flow	x1.2	Width	Height/Diameter	Freeboard 300mm (IFI)	Embedment 500mm	Width	Height/Diameter	Culvert Type
	km2	mm	m3/s		m3/s	m3/s	mm	mm	mm	mm	mm	mm	
Drehid Hortland SC5_Mulgeeth Tributary of the River Blackwater_Ungauged site code 07_1720_6	26.7470	796	2.80	2.38	6.67	8.01	3300	1500	300		3300	1800	Clear Span Structure, to span a minimum of 2.5 m beyond the existing bank of the stream and to incorporate any mammal requirements.
Cloncumber SC7_Cloncumber Stream, tributary of the Slate River_Ungauged site code 14_1870_17	63.6760	810	2.46	2.10	5.18	6.21	2700	1500	300		2700	1800	Clear Span Structure, to span a minimum of 2.5 m beyond the existing bank of the stream and to incorporate any mammal requirements.
Cloncumber SC8_Slate River_Ungauged site code 14_235_4	53.5450	791	4.63	2.39	11.07	13.28	3300	2100	300		5000	4000	Clear Span Structure. The structure will not be smaller than the adjacent existing structure at this location, as required by OPW. The existing structure is a 5000mm wide x 4000mm high stone arch bridge. The structure will be designed to incorporate any mammal requirements.

9.5.2 Flood Zones

As discussed in Section 9.4.5., there are four turbines located within the indicative floodplain as shown in Figure 9.2.0., namely T1 in the Ballynakill turbine cluster and T34, T29 and T30 in the Cloncumber turbine cluster. Turbine T40 in the Drehid-Hortland turbine cluster is shown to be within an indicative floodplain, however when examined further, it is more likely to be skirting the floodplain, due to the higher ground immediately to the west of the turbine location. The proposed substation is not located in the indicative floodplain and no other turbines are located in an indicative floodplain. There is no flood risk to any turbines located in or near an indicative 1% AEP (Annual Exceedance Probability) flood zone during a flood event, as outlined in Section 9.4.5.

Some of the proposed new access tracks will cross an area identified in the OPW PFRA mapping as an indicative floodplain. Any stream crossings will be conveyed in culverts, sized to take the 1 in 100 year flood flow with a 20% allowance for climate change. There will be no appreciable obstruction to flood flows in the floodplains as a result of new access roads, turbine hardstanding areas and the on-site sub-station which will be mostly at grade with the existing terrain. No construction personnel, operator or maintenance personnel will be permitted on site during extreme flood events. Landowners will however carry on their normal activities in the vicinity of the wind farm and will take the usual precautionary measures as far as practicable during flood events. Emergency operations during a flood event are not envisaged on the wind farm.

Bogland and other wetland areas have an important role in flooding patterns. As discussed in Section 9.2.5.3, wind farms are low intensity developments and can be deemed water compatible, as interpreted from Table 3.1 of The Planning System and Flood Risk Management Guidelines for Planning Authorities. Wind farms are linear developments and development is not concentrated in one particular area. So long as the development does not obstruct flow paths, flooding patterns in boglands and other wetland areas will not be affected.

9.5.3 Estimated Increase in Flood Risk

The estimated percentage increase in run-off from the turbine clusters in the Maighne Wind Farm development was calculated in Table 9.3.

A predictive assessment was carried out on three structures downstream of the site as follows, at the locations shown on Figure 9.2.:

- Roe's Bridge, which conveys the Boolykeagh tributary of the River Boyne under the R160 Regional Road, just upstream of the main channel of the River Boyne
- River Blackwater crossing of a local road at Clonguiffin to the south east of Longwood
- Agar Bridge, which conveys the Slate River, a tributary of the River Barrow, under a local road.

The increase in run-off into the other waterbody catchments was considered to be minimal and therefore the same predictive assessment was not carried out for these waterbody catchments. It can be observed from Table 9.3 that the percentage increase in flows due to the proposed development, to the River Boyne catchment and to the River Barrow catchment would be distributed across a number of tributary streams within these catchments. This would increase the lag time of flows to these rivers, in particular to the downstream structure at Clonguiffin. By the time the flows from the surface water draining the proposed development reach this bridge, any potential for an increase in flooding is of low significance.

The OPW has recorded the repeated occurrence of flooding after heavy rain, at Ashfield Bridge, in the main channel of the River Boyne, immediately upstream of the confluence of the Boolykeagh tributary with the River Boyne and approximately 1km downstream of Agar Bridge in the Slate River at Rathangan as described in Section 9.3.3.

As part of the flood risk assessment, the greenfield design flow for a 1 in 100 return period was estimated using two methods of flood estimation for catchments less than 25km^2, to determine the 1 in 100 year flood in the Boolykeagh tributary of the River Boyne at the downstream structure crossing the R160 Regional Road at Roe's Bridge to the north of the site:

- the 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.
- the 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.

For catchments greater than 25km^2, the FSU web portal www.opw.hydronet.com was used to determine the 1 in 100 year design flow at the proposed new crossings. The FSU approach to estimating the peak flow for a given return period (T) involves three steps: first, estimation of the index flood, which is the median annual maximum flood (QMED); second, estimation of an appropriate flood growth curve and third, derivation of the flood frequency curve which relates the index flood to the growth curve to provide an initial estimate of the peak flow for the required return period (T)/annual exceedance probability (AEP). Ungauged catchment analysis involves a pooled analysis with similar gauged catchments.

The catchment areas and the flood flows estimated for Q_{100} including an allowance for climate change at the downstream structures are included in Table 9.7 and Table 9.8.

The increase in flow due to the proposed development was then estimated within the catchment upstream of this bridge, taking the time of concentration of flows to that point into account. The pre and post development flows were then analysed using Culvert Master software, to determine the impact on the capacity of the structure at the downstream crossing. The flow calculations for the different scenarios are set out in Table 9.7 and Table 9.8. The calculations are provided in Appendix H4 of Volume 3 EIS Appendices.

Table 9.7: Q100 flows at Roes's Bridge, Pre and Post Construction

				Design Flow 3 term EQN IOH Method			Design Flow 3 term EQN FSSR Method							
Location	AREA	SAAR	SOIL	QBAR	Q100(x 1.96SOIL Type >2, x 2.61SOIL Type 1) x 1.65	Increase by 20%	QBAR	Q100(x 1.96) x 1.5	Increase by 20%	Max. Design 100 yr Flood	Increase in design 100 yr flow due to development	Post Development Design 100 yr Flow	Existing Surcharge at Structure in Q100 Flow	Additional Surcharge at Structure in Q100 Flow due to Development
	km2	mm		m3/s	m3/s	for Climate Change	m3/s	m3/s	for Climate Change	m3/s	m3/s	m3/s	m	m
Boolykeagh Tributary of the River Boyne crossing at Roe's Bridge	4.6270	843	0.3	0.821	2.654	3.184	0.902	2.653	3.183	3.184	0.084	3.268	0.110	0.030

Notes:
1) 3-Term EQN is QBAR = 0.00066 (Area^0.92)(SAAR^1.22)(Soil^2.0) Ref.: Flood Studies Report No. 6 and QBAR = 0.00108 (Area^0.89)(SAAR^1.17)(Soil^2.17) for catchments less thatn 25km^2 (Inst. Hyd. Report No. 124)
2) SAAR (Average Annual Rainfall) from Met Eireann.
3) SOIL from FSR Maps.
4) Q100 from Region curves ordinates from Flood Studies Report, Table 2.39
5) Factors of Safety multiples of 1.5 and 1.65 included for the relevant formulae.
6) Culvert catchment area determined from FSU Web Portal
7) Climate change - increase of 20% in flows - ref: OPW - Appendix C Standard Specifications for Feasibility and Pre-feasibility Studies for flood relief works - March 2004 (the note is based on the Desk Study carried out by Dr. Michael Bruen

Table 9.8: Q100 flows at Downstream Structures, Pre and Post Construction

	FSU Web Portal			Pooled Group	Pooled Group Analysis	Adjustment for Climate Change				
Location	AREA	SAAR	QMED	Growth Factor	Design 100 yr Flow	x1.2	Increase in design 100 yr flow due to development	Post Development Design 100 yr Flow	Existing Surcharge at Structure in Q100 Flow	Additional Surcharge at Structure in Q100 Flow due to Development
	km2	mm	m3/s		m3/s	m3/s	m3/s	m3/s	m	m
River Blackwater crossing at Clonguiffin_Ungauged site code 07_231_6	161.29	806	17.16	1.92	32.94	39.53	0.152	39.68	None	None
Slate River at Agar Bridge_Ungauged site code 14_1803_4	142.79	804	6.71	2.19	14.70	17.64	0.073	17.72	None	None

The structure which conveys the Boolykeagh Stream across the R160 Regional Road, is a box culvert, 1.0m wide and 1.5m high. The stream channel has a top width of 3m, as shown in Figure 9.4.0. Details of this structure can be seen in Appendix H1 of Volume 3 EIS Appendices. A hydraulic analysis of this structure was undertaken using Culvert Master. It was found that in the existing scenario, the 1 in 100 year design flow would surcharge above the box culvert by up to 0.11m. This is consistent with the OPW Flood Data Overview mapping in Figure 9.2.0, where the road and land in the immediate surrounds of the structure are shown to flood in a 1 in 100 year flood event.

The OPW have recorded recurring flood incidents upstream of this location at Ashford Bridge, but there is no record of flooding at Roe's Bridge. Taking the time of concentration of flows into account and increasing the design flow in the post development scenario, the increase in flood levels at the structure which conveys the Boolkeagh Stream is 0.03m, which is considered to be of low significance, as this exercise does not take into account any floodplain storage in this catchment which is evident from the indicative floodplain shown in Figure 9.4, along the Boolykeagh Stream, upstream of the bridge. Further, there will be no direct discharges of surface water run-off from the development to any watercourses and SUDS drainage systems will be applied on this site, as outlined in Section 9.6. Any potential for an increase in flooding is therefore expected to be of low significance. The calculations and results of the modelling are included in Appendix H4 of Volume 3 EIS Appendices.

Figure 9.4: Boolykeagh Stream looking downstream towards Roe's Bridge

The structure at the crossing of the River Blackwater at Clonguiffin is a stone arch bridge. The vertical section is 3m high, with a 3m high arch above this, giving a total height of 6m. The width of the bridge is 8m over the river channel. The channel height to top of bank is 3m. A photograph and details of this structure can be seen in Figure 9.5.0 and in Appendix H1 of Volume 3 EIS Appendices. A hydraulic analysis of the nearest equivalent sized arch structure was undertaken using Culvert Master. It was found that in the existing scenario, the 1 in 100 year design flow would rise to a depth of almost 3m, but the stone arch bridge would not be surcharged. This is consistent with the OPW Flood Data Overview mapping in Figure 9.2.0, where the road is not shown to flood but the adjacent land is shown to flood downstream of the structure, in a 1 in 100 year flood event. The OPW have not recorded any flood incidents in the vicinity of this bridge.

Taking the time of concentration of flows into account and increasing the design flow in the post development scenario, it was found that there would be no perceptible increase in flood levels at the structure. The calculations and results of the modelling are included in Appendix H4 of Volume 3 EIS Appendices.

Figure 9.5: River Blackwater crossing of local road at Clonguiffin

The structure at the crossing of the Slate River at Agar Bridge is a stone arch bridge. The bridge is 7m wide and 3m high. The channel width is 9m, with a depth of 3m. A photograph and details of this structure can be seen in Figure 9.6.0 and in Appendix H1 of Volume 3 EIS Appendices. A hydraulic analysis of the nearest equivalent sized arch structure was undertaken using Culvert Master. It was found that in the existing scenario, the 1 in 100 year design flow would rise to a depth of up to 1.8m, but the stone arch bridge would not be surcharged.

This is consistent with the OPW Flood Data Overview mapping in Figure 9.2.0, where there is a pinch point here in the floodplain and the road is not shown to flood, but the adjacent land is shown to flood in a 1 in 100 year flood event at this location. The OPW have recorded flood incidents approximately 1km downstream of this structure. Taking the time of concentration of flows into account and increasing the design flow in the post development scenario, it was found that there would be no perceptible increase in flood levels at the structure. The calculations and results of the modelling are included in Appendix H4 of Volume 3 EIS Appendices.

Figure 9.6: Slate River crossing at Agar Bridge

9.5.4 Essential Infrastructure

Essential Infrastructure is defined in Table 3.1 of The Planning System and Flood Risk Management Guidelines for Planning Authorities as "*Primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO site, IPPC sites, etc.) in the event of flooding"*. The proposed sub-station in this development therefore comes under the category of 'Essential Infrastructure'. The proposed substation is outside the 50m buffer from the nearest stream and is not within a 'Flood Zone A' area as indicated in OPW CFRAM PFRA mapping. Although the ground is quite flat at the location of the substation, it drains via forestry drains in a north easterly direction towards the River Blackwater.

9.5.5 Summary of Flood Risk Identification and Assessment

A flood risk assessment has been undertaken for this development and it concludes that the proposed development has a minimal impact on flooding risk in the surrounding area. As part of the FRA, the increase in surface water run-off due to the proposed development was estimated within the catchments upstream of three bridge structures. The predicted increase in flood level at the structure at Roe's Bridge, which conveys the Boolykeagh tributary of the River Boyne was 30mm. There was no perceptible increase found at the structure at the River Blackwater crossing of a local road at Clonguiffin nor at Agar Bridge, which conveys the Slate River, a tributary of the River Barrow. The predicted increase at Roe's Bridge was considered to be of low significance, as the exercise undertaken did not take into account for any floodplain storage in the catchments which is evident from the indicative floodplain shown in Figure 9.2.

9.6 Proposed Drainage of Maighne Wind Farm

The proposed drainage for the wind farm has been informed by the potential impacts, discussed in Section 9.4 and it has also been informed by the flood risk assessment undertaken in Section 9.5. In addition to draining 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 of the wind farm. An appropriate drainage design will be the primary mitigation measure for the wind farm which will incorporate silt protection control measures and a reduction in the rate of surface water run-off from the proposed development. The proposed drainage for the Maighne Wind Farm is set out below. The mitigation measures that follow in Section 9.7 refer to the drainage design and also include other best practice measures to mitigate any potential impacts from the wind farm. 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.In preparing the preliminary design for the proposed drainage for the Maighne wind farm development, the policies and objectives of both the Kildare County Development Plan and the Meath County Development Plan were considered as outlined in Section 9.2.1.

The proposed layout of the drainage for the development is shown in Figure 9.7.0. 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.

There are three types of surfaces to be considered on this site in addressing the drainage for the proposed development:

1) existing hardcore tracks and surfaced access roads which will be widened
2) proposed new site access tracks and hard surfaces associated with the construction of turbines
3) proposed new floating access tracks

9.6.1 Existing Hardcore Tracks and Surfaced Access Roads

The drainage system for the existing tracks and roads will largely be retained. During the site walkover it was observed that the existing tracks were approximately 3m wide. It will be required to widen these tracks by up to 1.5m, with some additional local widening at bends in the tracks. This will involve the slight re-location of existing roadside swales to allow for widening. Silt traps will be placed in the new roadside swales, upstream of the outfalls, leaving an allowance for a buffer. Details of a typical silt trap are included in Appendix H5 of Volume 3 EIS Appendices.

Some of the existing piped stream crossings will need to be extended due to the widening of the tracks to 4.5m. However the existing track is locally wider at most of the stream crossings, which will limit the number of modifications required. Where modifications are required, in consultation with IFI, the existing pipe size will be matched for these extensions.

Existing bog, agricultural and forestry drains will be retained along their existing routes and only slight diversions are anticipated to be required to provide for track widening.

9.6.2 Proposed New Site Access Tracks and Hard Surfaces

Proposed new access 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 run. The stilling ponds will remain in place following construction. The stilling ponds will drain diffusely overland, over existing vegetated areas, within the site boundary. Stilling ponds will be typically sized with a surface area of 47 m^2 and a depth of 1m, see sizing criteria and details included in Appendix H6 of Volume 3 EIS Appendices.

The swales will be typically 0.15m in depth with a bottom width of 0.9m and side slopes of 1 in 3. The swales will be constructed in accordance with CIRIA C698 Site Handbook for the Construction of SUDS.

In all it is proposed to construct approximately 31km of completely new track and to utilise approximately 10km of existing track for the proposed Maighne Wind Farm. This length will be spread out across the different sub-catchments listed in Section 9.3.2 and will include minor spurs for access to the turbines and the substation.

A minimum buffer of 50m from watercourses has for the most part been adopted for all new site tracks that run parallel to a watercourse, with the existing tracks being widened in their existing locations. Only local widening (approximately 1.5 - 2m width) is required to existing site tracks. In the case of a section of new track along the eastern access to the Drehid-Hortland cluster, the proposed new track is at a distance of 5m from the stream at its closest point. Silt fencing will be provided along the full length of the edge of the earthworks of the track at this location, where the buffer is reduced.

It is proposed that the widening will take place on the opposite side of the track from the river, where existing tracks follow the course of a river, at the locations where this occurs as follows:

- Ballynakill – Track in the vicinity of T3
- Drehid-Hortland – Track to T40 from the Local Roads (partially existing) and part of the track to T48 from the Local Road

The flood risk identification and assessment prepared for this development, and included in Section 9.5, informed the preferred site drainage design for this site. Although it was determined that any increase in run-off would be of very low significance, it was recommended that any potential for an increase in the velocity of the surface water run-off should be reduced. Site tracks will drain to grassed swales (some of which are existing). These grassed swales will serve to detain flows and reduce the velocities of surface water flows. As a result, it is expected that the risk of an increase in flooding due to the development, in the catchments of the River Boyne or the River Barrow will be of low significance. All track widening will be undertaken using clean uncrushable stone with a minimum of fines. Silt fencing will be provided at strategic locations as shown in Figure 9.7.0 to further protect the watercourses during the construction stage. The detail of the silt fencing is included in Appendix H7 of Volume 3 EIS Appendices.

To avoid any flood risk, all vulnerable infrastructure such as seals on turbine towers and ducts in the turbine foundations, will be designed and built to take into account that the foundations could be exposed to water, where the turbines are located within the indicative 1 in 100 year flood risk zone. The substation completely avoids the indicative 1 in 100 year flood risk zone and no additional drainage mitigation measures are required to protect it against flooding.

Overland flows will not be obstructed to any great extent as a result of the layout of the wind farm, however where required, interceptor channels will collect overland flows on the upslope side of the access tracks and hard standing areas. The interceptor channels will cross the access tracks in cross-drains which will be provided at regular intervals, as shown in Figure 9.4.0. The overland flow will then discharge diffusely on the downslope side over vegetated areas within the site boundary.

Where cross-drains are to be provided to convey the drainage across the track, the recommended sizes for these cross-drains are 225mm diameter pipes.

The site drains to tributaries of the River Boyne and the Slate River via artificial drains, streams and larger tributaries. It will be necessary to mitigate any increase in sediment in the surface water running off the site. There is the potential for increased sediment to enter the drains on site due to the disturbance to underlying soils during the construction stage. Silt Protection Controls (SPCs) are proposed at the location of the drain crossings. It is recommended that the SPCs will consist of 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 watercourse. This would be in addition to the measures required in the IFI guidance document, *Eastern Regional Fisheries Board - Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites* and specific requirements provided by IFI during the consultation process, which is included in Appendix B of Volume 3 EIS Appendices.

A buffer zone will remain between silt traps and watercourses with natural vegetation left intact so as to assist silt interception.

A comprehensive plan of the proposed location of silt fences was drawn up, with specific measures to address the high potential for silt pollution of nearby watercourses during works on site, as shown on Figure 9.7.0.

Additional silt fencing will be kept on site and erected as required during construction to prevent the ingress of silt into the watercourses. The silt fencing will be kept in place until the natural vegetation has been re-established.

Site drainage, including silt traps and stilling ponds, will be put in place in parallel with or ahead of construction, such that excavation for new infrastructure will have a functioning drainage system in place. There is no additional drainage required for the cable route, with the exception of measures to be undertaken at the location of the proposed watercourse crossings, as discussed in Section 9.6.4.

The existing drainage will be maintained along the sections of the TDR where modifications will be required. Where a new section of access track is required off-road at Lullymore to facilitate the delivery of turbines, this will drain to a new ditch. The ditch will connect into the existing drainage system in the Bord Na Mona lands. Silt traps will be provided in the ditch and upstream of the outfalls. These modifications are temporary in nature and slight diversions of existing roadside drains will be required to allow for short sections of widening along the TDR. It is not envisaged that any relocation of gullies etc. will be required, as the areas of oversail required for the TDR will be reinstated when the delivery period is completed. Further details on the proposed modifications are included in the Delivery Route Selection and Assessment report, included in Appendix K of Volume 3 EIS Appendices.

9.6.3 Proposed New Floating Access Tracks

In a number of locations on the proposed Maighne wind farm development, it has been deemed necessary to use floating access tracks, following the geotechnical assessment of the particular area of the site. These areas, where floating access tracks are proposed are shown in Figure 8.4, in Chapter 8 Soils and Geology. The floating access tracks are at the turbine cluster at Windmill and in sections of forestry at the Drehid-Hortland and Cloncumber turbine clusters, where the peat depths result in a preference for floating access tracks at these locations. It is also not recommended to excavate any further drainage channels or stilling ponds in such areas. The proposed drainage for floating roads will therefore drain 'Over the Edge' and the surface water will be captured in the adjacent existing drains. SPCs will be provided within these existing drains during the construction period. Interceptor drains will be provided to pick up the existing bog and forestry drains where required, to allow continuity of the flows in the drains running off the bog and through the forested areas. Stilling ponds draining the hard standing for turbines in these areas will be in the form of widened existing drains.

The proposed layout of the drainage system for the Maighne Wind Farm can be seen in Figure 9.7. All tracks will be surfaced with clean well graded stone with the minimum of fines which will be imported.

The stone used in the floating tracks will be good quality stone which is not soluble and will not break down under heavy trafficking. The track itself will provide filtration for any suspended solids being carried on the wheels of vehicles leaving the areas where the excavation for turbines is taking place during construction. It is proposed that 300 mm diameter cross-drains will be provided under the floating tracks at 12 m intervals to provide continuity of overland flows. The overland flows in this way will discharge diffusely over the natural vegetation on the downslope side, or into the existing bog and forestry drains where available. The frequency of cross-drains will avoid any concentrated saturation of ground on the downslope side.

9.6.4 Proposed Watercourse Crossings

There will be approximately eight new stream crossings required as a result of the development. The route of the access tracks will also cross four existing stream crossings. The locations of the stream crossings are shown on Figure 9.8. The information in this figure is available to view in more detail in the sub maps, which are included in the Figures and Drawings Volume 2a of this EIS.

The preliminary sizes of the principal stream crossings required throughout the site to cross tributaries of the River Boyne and the Slate River were estimated as part of the flood risk assessment. A summary of the preliminary culvert sizing is provided in Table 9.5 and Table 9.6 in Section 9.5.1. The culverts were sized to convey a 1 in 100 year flood with a 20% allowance for climate change, while maintaining a minimum freeboard of 300 mm. The calculations are included in Appendix H2 of Volume 3 EIS Appendices.

Embedded culverts must maintain the natural channel gradient, width and substrate configuration. They will be buried to a minimum of 500 mm below the stream bed at the natural gradient. Box and pipe culverts will be sized to maintain the natural stream channel width. The gradient will not exceed 3%.

In the case of box culverts on angling waters, the box will be 3 meters in height. The culverts will be designed to accommodate any mammal requirements.

To minimise adverse impacts on the fisheries resource, works in rivers, streams and watercourses are generally only permitted to be carried out during the period July-September. However the specific period for the works at each of the river crossing locations will be reviewed on a site specific basis with the IFI at detailed design stage.

The IFI has provided detailed specifications on the design of temporary and permanent stream crossings in fisheries sensitive streams. These specifications, which are included in Appendix B of Volume 3 EIS Appendices will be followed in the detailed design of the stream crossings.

As discussed in Section 9.5, additional flow connectivity culverts were not deemed to be required, as the track layout mostly allows for the crossing of streams and rivers at the narrowest part of the floodplain or does not obstruct flows.

Clear span structures will be required for the crossing of fisheries sensitive streams, at the locations as shown on Figure 9.8.0. Bridge foundations will be designed and positioned at least 2.5 metres from the river bank so as not to impact on the riparian habitat.

Existing structures will be considered to remain in place, subject to further examination of the structural capacity of these structures.

A Section 50 application will be required to obtain the consent of the OPW for the design of the seven new stream crossings as listed in Table 9.5 and Table 9.6. The IFI will also be consulted at the detailed design stage.

Minor drains such as manmade agricultural, forestry and bog drains will be crossed using 450mm diameter pipes.

All other existing stream and drain crossings will be left in place and extended where required to match the existing structure where it is proposed to widen the road. Existing stream crossings will be protected using silt fencing.

Some drain clearing will be required at existing crossings, where they have become blocked, to maintain the continuity of flows. These existing pipes may need replacing if they are found to be in a collapsed state.

Silt fencing will be erected at the location of stream crossings along the MV and HV cable routes and the TDR. For off-line cabling methods, a temporary diversion of the watercourse may be required. Silt curtains and floating booms will also be used where deemed to be appropriate and this will be confirmed in consultation with IFI at each individual location.

9.6.5 Drainage of Sub-Station

The proposed new sub-station is located in the Drehid-Hortland turbine cluster, in an area of mature forest, at the location shown in Figure 9.7.0. During the EIS preparation, a Source Protection Zone (SPZ) (Johnstown well field) was identified adjacent to the substation location. The SPZ is shown in Figure 10.3.3 and it is discussed further in Chapter 10 Water Quality. It was considered appropriate to provide impermeable hardstanding for the substation, to prevent any risks associated with infiltration to groundwater. A sealed drainage system will also be provided, extending past the area of significance i.e. concrete dished channels with a kerbed perimeter at the substation hardstanding. The concrete dished channels will drain to a stilling pond, located 200m from the Inner SPZ, which will in turn drain via forestry drains to the receiving watercourse, which is at a distance of 1km from the location of the substation. The peat is at a depth of approximately 3m in this area, therefore a piped drainage system was not considered appropriate at this location. A full retention petrol interceptor and spillage tank will be provided at the areas where fuels and oils will be stored. Any diesel or fuel oils stored at the substation will be bunded. The bund capacity will be sufficient to contain 110% of the tank's maximum capacity. Where there is more than one tank within the bund, the capacity will be sufficient to accommodate 110% of the largest tank's maximum capacity or 25% of the total maximum capacities of all tanks, whichever is the greater. Design and installation of fuel tanks will be in accordance with best practice guidelines BPGCS005 (Oil Storage Guidelines). A suitable permanent petrol and oil interceptor will be installed to deal with all substation surface water drainage.

Emergency Silt Control and Spillage Response Procedures are contained within the Site Drainage Management Plan of the CEMP (included in Appendix D of Volume 3 EIS Appendices)

To increase the time of concentration of the surface water run-off contribution from the substation, tanked permeable paving is a viable alternative to the sealed drainage system and this may be considered at detailed design stage. The proposed drainage layout is shown on Figure 9.7.0. At the upslope side of the sub-station overland flows will be intercepted in channels and discharged diffusely over vegetated areas. This will maintain recharge to the aquifer in this area.

Permanent sanitary facilities will be provided at the substation. It is acknowledged that Kildare County Council requested that wastewater treatment be used in place of a holding tank at the location of the substation, in comments provided by them, in their scoping response. However, given its proximity to a SPZ, a holding tank was deemed to be the most appropriate system to use. A holding tank will be provided at this location and this will be serviced under contract by a licensed contractor.

9.6.6 Drainage of Temporary Site Compound

The proposed locations of temporary site compounds within the turbine clusters of Ballynakill, Drehid-Hortland and Cloncumber, are as shown in Figure 9.7.0. The compounds will be set back a minimum of 50m from streams.

The temporary site compounds will drain to shallow grassed swales at the perimeter of the hard standing areas, to minimize the disturbance to sub-soils. Filter drains may be used where trafficking by site staff is required to access the temporary site compounds. The filter drains/swales will drain to a stilling pond. The proposed drainage layout is shown on Figure 9.7. The stilling pond will be backfilled following the construction period and the vacation of the temporary site compound.

Refuelling of plant during construction will be carried out at a number of dedicated refuelling station locations on site, typically at each compound or at least 100m from a watercourse using mobile bowsers. Each station will be fully equipped with a spill kit to activate a spill response and a specially trained and dedicated environmental and emergency spill response team will be appointed before commencement on site. Drip trays and spill kits will be kept available on site, to ensure that any spills from the vehicle are contained and removed off site. Only emergency breakdown maintenance will be carried out on site and appropriate containment facilities will be provided to ensure that any spills from breakdown maintenance vehicles are contained and removed off site. Emergency Silt Control and Spillage Response Procedures are contained within the Site Drainage Management Plan of the Construction Environmental Management Plan (CEMP) (included in Appendix D of Volume 3 EIS Appendices).

A designated concrete wash-down area will be - located close to every turbine cluster. Every concrete truck delivering concrete to the site must use this facility prior to leaving the site. A settlement lagoon will be provided to receive all run-off from the concrete wash down area.

Any diesel or fuel oils stored at the temporary site compound will be bunded. The bund capacity will be sufficient to contain 110% of the tank's maximum capacity. Where there is more than one tank within the bund, the capacity will be sufficient to accommodate 110% of the largest tank's maximum capacity or 25% of the total maximum capacities of all tanks, whichever is the greater. Design and installation of fuel tanks will be in accordance with best practice guidelines BPGCS005 (Oil Storage Guidelines).

It is proposed to use portaloos and/or containerised toilets and welfare units with storage tanks to provide toilet facilities for site personnel during construction.

The sanitary waste will be removed from site by a licensed waste disposal contractor. 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.

Temporary petrol and oil interceptors will be installed at the site compound and at all locations dedicated for plant repairs/storage of fuel/temporary generator installation. Surface water run-off 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 drain flows to a stilling pond before final discharge over land.

A trained and dedicated environmental and fuel spill emergency response team will be set up on site before commencement of construction on-site.

9.6.7 Drainage of Borrow Pits and Excavated Material

The proposed borrow pits are located in the Ballynakill and Cloncumber areas, as shown in Figure 9.7.0. The borrow pits will be set back a minimum of 50m from watercourses. It is proposed to drain the borrow pits to stilling ponds.

At the upslope side of the borrow pits overland flows will be intercepted in channels which will discharge diffusely over vegetated areas. The opening of borrow pits at Cloncumber will be from the east and from the west where the borrow pits are located to the north of the Barrow Line of the Grand Canal. There will be no opening of, or access to, these borrow pits from the south (canal side).

During the construction period, the excavated material will be used to reinstate the turbine bases. It is proposed to reinstate the borrow pits with surplus subsoil material from the excavations. This will be carefully managed, with sections of the borrow pits being reinstated in stages. Swales will be used to drain the reinstated sections to the stilling ponds at the borrow pit locations. Silt fencing will be erected to further protect streams, where required. The stilling ponds will remain in place until the reinstated areas have attained satisfactory re-vegetation.

All excavations shall be constructed and backfilled as quickly as possible. Excavation will not be undertaken during heavy rainfall.

Excavation will precede the turbine base construction, cable trench and access track construction. Soil will be excavated and replaced with granular fill where required. Excavation will be carried out from access roads where possible in order to reduce the compaction of topsoil.

During the construction period, spoil heaps from the excavations for the turbine bases will be stored temporarily. All stockpile material will be bunded adequately and protected from heavy rainfall to reduce silt run-off, where necessary.

Surplus soil or rock excavated during the course of the works will be used on site in the form of landscaping including low berms, where appropriate.

Material will only be stockpiled on the site where there will be immediate backfilling of the excavation with the excavated material e.g. cable laying etc. or material will be stockpiled temporarily at the excavation point and adjacent to the borrow pits, ready for collection off site. These spoil heaps will be covered and surrounded by silt fences to filter sediment from the surface water run-off from excavated material. Typical details of silt fencing are shown in Appendix H7 of Volume 3 EIS Appendices. It should be noted that any stockpiling will be short-term and temporary and will occur only within the site boundary as the construction proceeds. The site drainage system will be put in place prior to excavation, therefore the discharge routes from any temporary stockpiling will be via the site drainage system as detailed in the planning drawings. A minimum buffer of 50m will be provided between temporary stockpiles and the nearest watercourse. There will be no permanent or long-term stockpiling of material on the site.

Reinstated areas and berms will by preference re-vegetate naturally, and further measures will be undertaken, in the form of erosion control matting for example if deemed to be required.

Document Path: R:\Map Production\2014\LE14\731\04\Workspace\EIS MAPS\Chapter 9 Hydrology\LE1473104 Figure 9.7 Drainage.mxd

Ballynakill

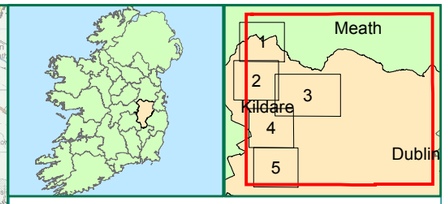
Windmill

Drehid
Hortland

Derrybrennan

Cloncumber

Existing drains within Windmill cluster run from Southeast to Northwest.



Legend

- Turbine Location
- Wind Farm Cluster Boundary

River/Stream Crossings

- Existing Crossing
- Proposed Crossing
- Proposed Borrow Pit Location
- Proposed Substation Location
- Proposed Compound Location
- Proposed Met Mast Location

Indicative Access Track

- Existing
- Proposed

Proposed Drainage

- Stilling Pond
- Stilling Pond with Diffuse Outflow
- Diffuse Outflow
- Cross Drain
- Concrete Dished Channel
- Drainage a Existing
- Interceptor Drain
- Floating Road "Over the Edge" Drainage
- Silt Fencing
- Swale
- Turbine Delivery Route

NOTE: MV Cables are not displayed on this map for reasons of clarity.

0 2,000 4,000 8,000

Meters

Date 27/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Proposed Drainage
Maighne Overview

Scale Used 1:100,000 @ A3

Figure No. 9.7.

Rev A

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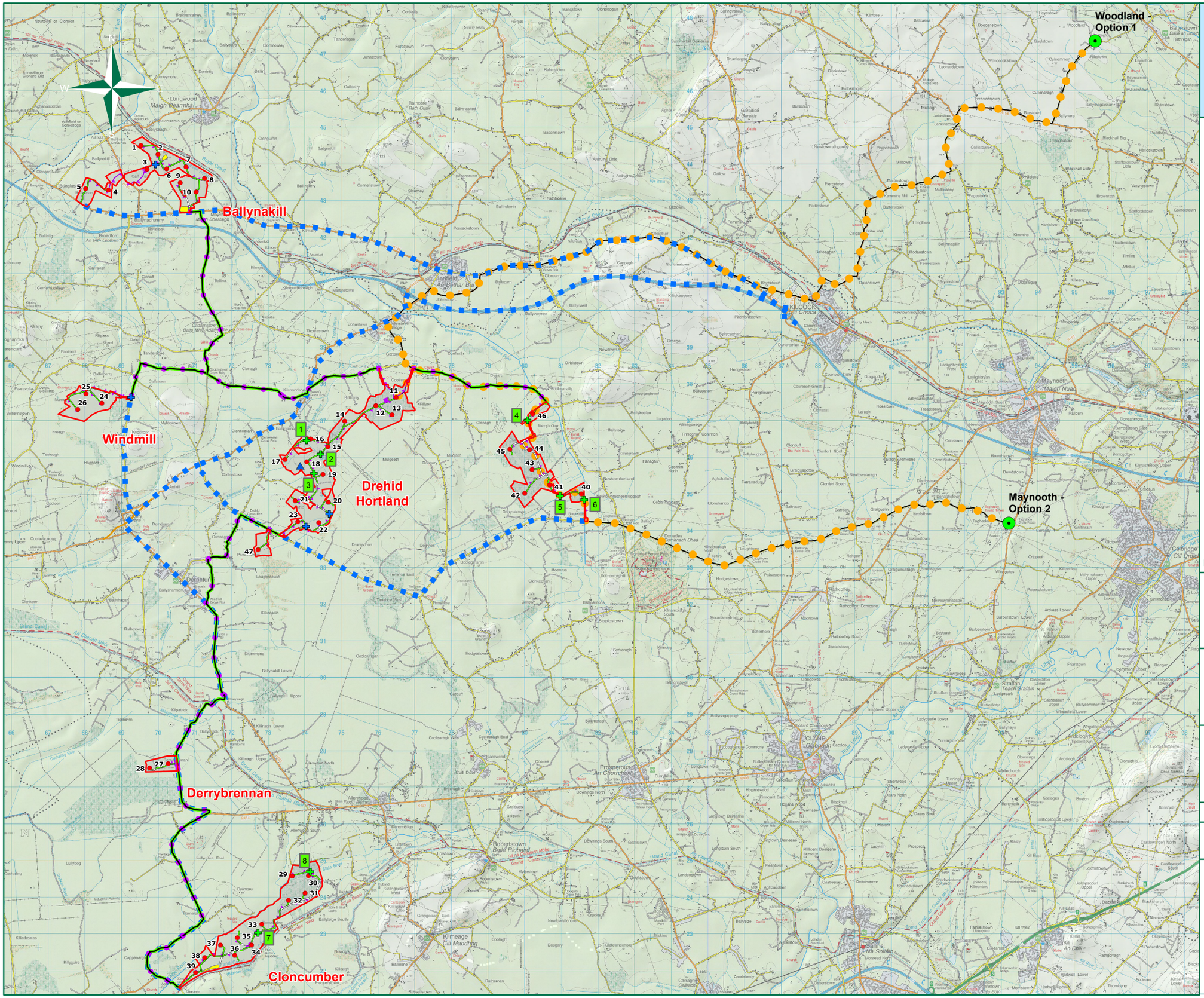

Legend

- Turbine Location
- Wind Farm Cluster Boundary

Indicative Access Track

- Existing
- Proposed
- Proposed Borrow Pit Location
- Proposed Compound Location
- Proposed Substation Location
- Proposed Met Mast Location
- Cable Routes (Internal to Cluster)
- MV Cable Route (External to Cluster)
- Irish Grid Connection Point
- HV Cable Route
- Turbine Delivery Route

River/Stream Crossings

- Existing Crossing
- Existing Crossing to be Modified
- Proposed Crossing with ID Number

Date 27/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Stream Crossings
Maighne Overview

Scale Used 1:100,000 @ A3

Figure No. 9.8.

Rev A

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9.7 Mitigation Measures

9.7.1 Proposed Mitigation Measures for the Construction Stage of the Wind Farm

Proposed drainage measures to reduce and protect the receiving waters from the potential impacts during the construction of the proposed development are as outlined above in Section 9.6. These include measures to prevent runoff erosion from vulnerable areas and consequent sediment release into the nearby watercourses to which the proposed development site discharges. The mitigation measures proposed to reduce potential direct, indirect and turbine delivery route and cable route impacts are outlined below.

- 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 wind farm will include regular monitoring of the drainage system and maintenance as required. The increase in the rate of run-off along the route of the site access roads and hard-standing areas will be mitigated by the proposed drainage system which includes the provision of stilling ponds to reduce the concentration of suspended solids in the run-off from these areas, and the addition of silt fencing where deemed necessary, as outlined in Section 9.6.2 above.
- As discussed, stilling ponds will be put in place in advance as construction progresses across the site. The stilling ponds with a diffuse outflow detail will mitigate any increase in run-off. Erosion control and retention facilities, including 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 reduce any risk of flooding downstream.
- 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. The excavations for turbines 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 bases. As the majority of turbine excavations will be within low permeability peat or glacial till, groundwater inflow is expected to be small. In areas of higher permeability soils (expected at Cloncumber), flows may be higher and exclusion techniques such as sheet piles may be required to control groundwater flow and stabilize excavations, particularly close to the river where a higher water table is expected.
- The excavated subsoil material will be removed, either to the designated material storage areas at the borrow pit locations or stockpiled close to the excavation and used as backfill material if suitable. Temporary material storage areas will be covered with impermeable sheeting and surrounded with silt fencing, which will be monitored to manage any potential loss of suspended solids to surface waters. Temporary material storage areas will be a minimum of 50 m from the true bank edge of any watercourse.
- Interceptor cut-off drains around the borrow pits will be provided to divert overland flow to the nearest watercourse, and prevent it from entering the borrow pit, to mitigate the volume of flows to be treated.
- Individual stilling ponds will be provided at borrow pit locations.
- Drains around hard-standing areas will be shallow to minimise the disturbance to sub-soils.
- Cross-drains of 450mm diameter will be provided to prevent a risk of clogging for crossings conveying flows from bog drains, agricultural drains and forestry drains across the access roads.
- All tracks will be surfaced with clean well graded stone with the minimum of fines which will be imported, to mitigate the conveyance of silt-laden run-off in the track drainage.
- Silt fencing will be used as an additional protection to watercourses where deemed necessary, where floating roads are to be constructed
- Interceptor cut-off drains will be provided on the upslope side of the site access roads to prevent the mixing of overland flows with the drainage for the proposed development. These interceptor drains will discharge diffusely over land.
- 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. Clay bunds will be constructed within the cable trench at regular intervals.
- The routes for the proposed access tracks are laid out to follow the existing tracks where practicable. Site access roads have been laid out to reduce the longitudinal slope of roadside drains and to follow natural flow paths where possible. Where roadside drains are laid at slopes greater than 2%, check dams will be provided.
  This is unlikely to occur as the slopes on the site are so flat, however the check dams, if required, will reduce the effective slope and run-off velocities and any consequent potential for erosion.
- Cognisance has been taken of the findings in Chapter 7 Ecology and Chapter 8 Soils and Geology in the location of stilling ponds to ensure that these facilities are located in suitable areas.

- Culverts will be sized in accordance with CIRIA C689 Culvert Design and Operation Guide, the Office of Public Works (OPW) guidance and the guidance provided by IFI in the design of the proposed stream crossings. A Section 50 Application will be prepared for all new stream crossings to obtain the consent of the OPW at detailed design stage.
- Where agricultural tracks, bog tracks and forestry tracks 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. Silt traps will be provided at regular intervals to reduce the concentration of suspended solids in the surface water run-off being conveyed in the existing drains, which may result from vehicles trafficking these roads from the construction areas.
- All open water bodies adjacent to proposed construction areas will be protected by fencing, including the proposed stilling ponds.
- The conceptual site drainage has been designed to complement existing overland flow and existing bog, agricultural and forestry drainage. The drainage design will be developed in full at the detailed design stage.
- Additional protection will be provided in the form of silt fencing downslope where required and at existing stream crossings during construction, to further ensure that there is no impact from the development to streams and rivers crossing the site.
- All personnel working on site will be trained in pollution incident control response. Emergency Silt Control and Spillage Response Procedures contained within the Site Drainage Management Plan of the Construction Environmental Management Plan (CEMP) (included in Appendix D of Volume 3 EIS Appendices) will ensure that appropriate information will be available on site outlining the spillage response procedure and a contingency plan to contain silt. Adequate security will be provided to prevent spillage as a result of vandalism. A regular review of weather forecasts of heavy rainfall is required and a contingency plan will be prepared for before and after such events. A record will be kept of daily visual examinations of watercourses which receive flows from the proposed development, during and for an agreed period after the construction phase. Water samples will be taken and water quality will be monitored in accordance with a water monitoring programme which will be agreed with Kildare County Council, Meath County Council and IFI, as outlined in Chapter 10.
- The developer will ensure that erosion control, namely silt-traps, silt fencing and swales are regularly maintained during the construction phase.
- Existing overland flow channels will be maintained and cross-drains provided in the access roads to allow continuity of flow. Interceptor drains where required, will be constructed upslope where there are no existing channels, with cross-drains provided at regular intervals. The roadside drains will therefore only carry the site access road run-off and so avoid carrying large volumes of water and concentrating flows.
- During the construction period an emergency facility will be provided to control the discharge from the stilling ponds. This will mitigate the risk of any accidental spillage on site affecting watercourses.
- Roads will be capped as soon as practicably possible to cover exposed subsoils and as such reduce the concentration of suspended solids being conveyed in the run-off into the drainage system.
- Where access tracks pass close to watercourses, silt fencing will be used to protect the streams by reducing the concentration of suspended solids being conveyed in the surface water run-off into watercourses. 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.
- Wheel wash facilities will be located at each site entrance to reduce construction traffic fouling public roads. Each wheel wash will come with an additional water tank which will be filled regularly. These units will be self-contained and will filter the waste for ease of disposal. Waste will be removed from each unit and from site by a permitted contractor. Additional silt fencing will be kept on site in case of an emergency break out of silt laden run-off.
- Silt traps and silt fencing for the proposed wind farm development are proposed as described above in Section 9.5 and will be put in place in advance as construction progresses across the site.
- Tree felling will be undertaken in accordance with the specifications set out in the Forest Service Forestry and Water Quality Guidelines (2000) (34) and Forest Harvesting and Environmental Guidelines (2000) (38), to ensure a tree clearance method that reduces the potential for sediment and nutrient runoff.

  Trees will be felled away from aquatic zones where possible. Branches, logs or debris will not be allowed to accumulate in aquatic zones and will be removed as soon as possible. Additional silt fencing will be erected along the banks of any streams at the location of the proposed tree felling to provide additional protection to the watercourses in this area. Felling around the required infrastructure, made up of a corridor of approximately 33m along all tracks, an area of approximately 1.3ha at each of the turbine locations located in forestry, plus an area around the substation (approximately 1.9ha) is proposed for the site.

The rate of absorption of a felled site, and therefore rate of run-off, is expected to be slightly higher than that of a forested site. However the area of proposed felling is small relative to the overall planted area and is expected to develop a vegetation ground cover relatively quickly. Thus, no significant increase in the rate of run-off is anticipated as a result of felling or risk of downstream flooding.

- 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 225mm diameter to avoid blockages.
- Roadside swales will serve to attenuate any increase in surface water run-off due to new hardcore tracks or existing track widening.
- Refuelling of plant during construction will only be carried out at dedicated refuelling station locations on site, typically at each compound or at least 100m from a watercourse using mobile bowsers. This will reduce any risk of pollutants being conveyed in the surface water run-off, into the drainage system and subsequently into watercourses. Each station will be fully equipped for a spill response and a specially trained and dedicated environmental and emergency spill response team will be appointed before commencement on site. Only emergency breakdown maintenance will be carried out on site. Drip trays and spill kits will be kept available on site, to ensure that any spills from the vehicle are contained and removed off site.
- To avoid any risk of groundwater contamination resulting from the foul drainage for the site, 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.
- Where works will be required to modify existing bridges to facilitate the delivery of turbines, pre-cast concrete will be used whenever possible, to eliminate the risk to all forms of aquatic life. Should cast-in-place concrete be required, all work will be done in the dry and effectively isolated from any water that may enter the drainage network for a period sufficient to cure the concrete. Debris containment netting will be used to arrest and contain falling objects. Silt curtains will be used where there is a risk of fine sediment getting into the stream or canal. Partial isolation may be undertaken using caissons or cofferdams. No instream works shall be carried out without the written approval of Waterways Ireland and IFI.
- Turbine delivery is not expected to take place during extreme weather conditions. The road widening at the 'S' bend on L5025, is a temporary measure to facilitate turbine delivery and this bend will be reinstated to its original layout, including the re-establishment of vegetation, following the delivery of turbines to the site. Therefore there should be no long term risk of an increase in the risk of pluvial flooding at this location.
- Where existing drains will be covered with hardcore as part of modifications for road widening to facilitate the TDR, the surface water will be diverted into new drains which will connect to the existing drainage system.
- Modifications are required to upgrade a section of the disused railway in Bord Na Mona lands. The TDR will go off-road for 0.99km and will wind back to tie-in with the existing R414 Regional Road at Lullymore. The new road will be drained to a toe drain which will in turn drain to the existing drainage system in Bord Na Mona lands. Silt traps will be provided along the toe drain at regular intervals, to avoid any increase in suspended solids from the disturbed soils entering the existing drainage system.
- Modifications are required at the entrance to the Cloncumber cluster. The modifications proposed are to a bridge over a drain, which is a disused Mill Race that leads to the Slate River, some 0.6km downstream. A temporary extension is required to the bridge. Debris containment netting will be used to arrest and contain falling objects during demolition. Silt curtains will be used where there is a risk of fine sediment getting into the stream or canal. Partial isolation may be undertaken using caissons or cofferdams. No instream works shall be carried out without the written approval of IFI.
- Silt fencing will be erected at the location of stream crossings along the cable route, to avoid any risk of an increase in the concentration of suspended solids being conveyed in the surface water run-off into watercourses. Silt curtains and floating booms will also be used where deemed to be appropriate, in consultation with IFI and Waterways Ireland and this will be assessed separately at each individual location.

An outline Construction Environmental Management Plan (CEMP) is included in Appendix D of Volume 3 EIS Appendices. This contains an Outline Site Drainage Management Plan. The Site Drainage Management Plan shall be finalised in accordance with this outline plan following the appointment of the contractor for the main construction works.

9.7.2 Proposed Mitigation Measures for the Operation Stage of the Wind Farm

It is not envisaged that the operation of the wind farm will result in significant impacts on the hydrological regime or water quality of the area, as there will be no further disturbance of soils post-construction, and only a minimum of traffic movement.

The conceptual drainage has been designed to operate effectively during the operation period. The stilling ponds will be a permanent feature, and will continue to be effective in filtering the run-off from the site should any accidental release of silt combine with the surface water run-off during operational activities.

During the operation period the swales will have vegetated and will serve to attenuate flows and remove suspended solids from the run-off.

9.7.3 Proposed Mitigation Measures for Maintenance of the Wind Farm

It is not envisaged that the maintenance period will involve any significant impacts on the hydrological regime of the area. Further, the maintenance of the wind farm will incorporate effective maintenance of the 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
- Material storage areas in the reinstated borrow pits
- 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.

Maintenance will be in accordance with CIRIA C697 (SuDS and Maintenance Manual). Daily visual inspections will be undertaken during the construction period, followed by fortnightly visual inspections until the vegetation has been re-established satisfactorily. Monthly monitoring will continue following the completion of construction until full re-vegetation has occurred, as outlined in Chapter 10 of this EIS.

9.7.4 Proposed Mitigation Measures for Decommissioning of the Wind Farm

As in the construction phase silt protection controls would again be put in place. The drainage system will remain operational during the decommissioning phase and will serve to treat any sediment laden surface water run-off due to a renewed disturbance of soils. Re-vegetation will be monitored. If it is deemed necessary, erosion control matting will be used to assist in the re-establishment of vegetation.

9.7.5 Proposed Mitigation Measures for Flooding

The FRA for Maighne Wind Farm concludes that the proposed development has a minimal impact on flooding risk in the surrounding area and therefore the increased risk of flooding as a result of the proposed development is negligible.

9.7.6 Proposed Particular Mitigation Measures for Specific Clusters

9.7.6.1 Windmill

The proposed drainage of the cluster will avoid excavations in the bog as far as possible, with the exception of some interception of existing drains. The avoidance of high bog will ensure that no direct impacts (such as habitat loss or surface damage) will occur. This is discussed further in Chapter 7 Ecology and the proposed drainage of the development is discussed further in Section 9.6.

The entrance road is an existing entrance which crosses an area identified in the OPW PFRA mapping as an indicative floodplain. However, no construction personnel, operation or maintenance personnel will be permitted in this cluster during extreme flood events. Commercial operators will take the usual precautionary measures as far as practicable during flood events. Emergency operations during a flood event are not envisaged on the wind farm.

It was noted at a consultation meeting with the IFI that the River Glash is a salmonid nursery and it is under pressure, due to elevated ammonia levels due to peat soils. There will be no direct discharges to this river, from disturbed areas of peat soils. The only area draining to the Glash River will be the existing entrance road. There are no modifcations proposed to the entrance road at this location.

9.7.6.2 Drehid-Hortland

The proposed substation is located close to a Source Protection Zone (SPZ). A sealed drainage system will be provided, extending past the area of significance i.e. concrete dished channels with a kerbed perimeter at the substation hardstanding. The concrete dished channels will drain to a stilling pond, located 200m from the Inner SPZ, which will in turn drain via forestry drains to the receiving watercourse, which is at a distance of 1km from the location of the substation.

The entrance access road into the location of turbine T40 to the east of the cluster runs within 50m of a tributary and the main channel of the Clogheraun Stream (tributary of the River Blackwater). The track here is partially an existing track. There is the potential risk of the ingress of silt, into the stream, as a result of overland silt laden surface water flows, during the construction of the turbine cluster which will be accessed from this entrance. Silt fencing will be provided along the full length of the access track where it coincides with the bank of the tributary and the main channel of the Clogheraun Stream

9.7.6.3 Cloncumber

Where a new bridge will be required next to the existing bridge over the Slate River to facilitate the delivery of turbines, pre-cast concrete will be used whenever possible, to eliminate the risk to all forms of aquatic life. Should cast-in-place concrete be required, all work will be done in the dry and effectively isolated from any water that may enter the drainage network for a period sufficient to cure the concrete. No instream works shall be carried out without the written approval of IFI.

9.8 Residual Impacts

The residual significance of the effects of the development of the wind farm site on sensitive downstream receptors is expected to be low taking account of mitigation measures as outlined in Section 9.6 and 9.7.

The residual impact is summarised in Table 9.7 below, using the impact assessment outlined above in Section 9.2.5.3 and taking account of mitigation measures in Section 9.6 and 9.7 of this document.

Table 9.7 indicates that, following the implementation of mitigation measures, the residual risk to the receiving watercourses from hydrological impacts would be negligible during the construction period and negligible during the operation of the wind farm. The implementation and efficacy of the mitigation measures will be monitored throughout the construction and operation phases.

In the unlikely event of failure of the stilling ponds as a result of a blockage for instance, it can be seen from Table 9.4 in Section 9.4.7 that this would only have a minor effect on the sedimentation in the receiving watercourses.

Mitigation systems will, where required, be in place before development works commence.

The proposed development, if undertaken as proposed, will not have an adverse effect in terms of hydrology on the integrity of the following environmentally protected designated site:

- River Boyne and River Blackwater cSAC and SPA, located at 0.66km to the north of the site by hydrological links, from the nearest point of the site boundary.

As a result, the Maighne Wind Farm is not expected to contribute to any significant, negative cumulative effects with other existing or proposed developments in the vicinity. In circumstances where the proposed mitigation measures are implemented in full, a high degree of confidence can be assured that any effects on the receiving environment will be of low significance.

Table 9.9: Residual Hydrological Impact Significance for Sensitive Receptors

Activity	Potential Impact	Receptor	Sensitivity	Before Mitigation		After Mitigation	
				Magnitude	Significance	Magnitude	Residual Significance
Construction Phase							
site tracks, cabling, turbine construction, crane pad construction, sub-station	increase in rate of run-off	River Boyne, River Blackwater, Figile River & Slate River	High	minor	minor	negligible	negligible
site tracks, crossings, cabling, turbine construction, crane pad construction, sub-station, tree felling and management of temporary material storage areas	erosion and sedimentation	River Boyne, River Blackwater, Figile River & Slate River	High	minor	minor	negligible	negligible
drainage crossings, turbine construction, sub-station, temporary compounds	chemical pollution	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible	negligible	negligible

Activity	Potential Impact	Receptor	Sensitivity	Before Mitigation		After Mitigation	
				Magnitude	Significance	Magnitude	Residual Significance
Operation & Maintenance							
site access tracks	increase in rate of run-off	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible	negligible	negligible
reinstated temporary material storage areas in the borrow pits	erosion and sedimentation	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible	negligible	negligible
Decommissioning							
Increased trafficking to remove turbines	erosion and sedimentation	River Boyne, River Blackwater, Figile River & Slate River	High	negligible	negligible	negligible	negligible

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