APPENDIX 9-1

FLOOD RISK ASSESSMENT

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MEENBOG WIND FARM, CO. DONEGAL

STAGE I - FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:
PLANREE LTD

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

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This report has been prepared by HES with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our terms and conditions and taking account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client, and others in respect of any matters outside the scope of the above. The flood risk assessment undertaken as part of this study is site-specific, and the report findings cannot be applied to other sites outside of the survey area which is defined by the site boundary. This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

TABLE OF CONTENTS

FIGURES IN TEXT

TABLES IN TEXT

1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO, on behalf of Planree Ltd, to undertake a Flood Risk Assessment (FRA) for the Existing Development at Meenbog Wind Farm, Co. Donegal.

The Existing Development is described in full in Chapter 4 of this remedial Environmental Impact Assessment Report (rEIAR). As described in Section 1.4.1 of this rEIAR, this FRA uses the following terminology: the 'Site', the 'Wind Farm Site', the 'Grid Connection Site', the 'Meenbog Wind Farm', the 'Existing Development', the 'Prospective Development' and the 'Subject Development'.

This FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009) (hereinafter referred to as the Guidelines (DoEHLG, 2009)). This FRA is also completed in accordance with the Flood Risk Management policies (F-P1 to F-P-4) and objectives (F-0-1), and the policies in relation to wind energy developments (WE_P-1 to WE-P-8) detailed in the Donegal County Development Plan (2024-2030).

1.2 STATEMENT OF EXPERIENCE

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

Our core area of expertise and experience is hydrology and hydrogeology, including flooding assessment and surface water modelling. We routinely work on surface water monitoring and modelling and prepare flood risk assessment reports.

This report was prepared by Michael Gill, Conor McGettigan and Nitesh Dalal.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 24 years' environmental consultancy experience in Ireland. Michael has completed numerous geological, hydrological and hydrogeological impact assessments of wind farms and renewable projects on peatlands in Ireland. He has substantial experience in surface water drainage design and SUDs design, flood modelling, and surface water/groundwater interactions. For example, Michael has worked on the EIS for Carrownagowan WF, Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 5 years' experience in environmental consultancy in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016) from University College Dublin. Conor has prepared the Land, Soils and Geology and Hydrology and Hydrogeology Chapters for numerous wind farm EIAR projects. Conor routinely completes Flood Risk Assessments for a wide variety of projects including wind farms, quarries and proposed residential developments.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management in India and over 1 year environmental consultancy experience in Ireland. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and

Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016.

1.3 REPORT LAYOUT & METHODOLOGY

This FRA report has the following format:

- Section 2 describes the site setting and details of the Existing Development;
- Section 3 outlines the hydrological and geological characteristics of the local surface water catchments in the vicinity of the Wind Farm Site and Grid Connection Site;
- Section 4 presents the current site-specific flood risk conditions at the Wind Farm Site and Grid Connection Site;
- Section 5 presents a Justification Test for the Existing Development;
- Section 6 assesses the potential change in flood risk conditions (from the baseline) at the Wind Farm Site and Grid Connection Site, as a result of the Existing Development; and,
- Section 6 presents the FRA report conclusions.

As stated above this FRA is carried out in accordance with the Guidelines (DoEHLG, 2009). The assessment methodology involves researching and collating flood related information from the following data sources and field surveys:

- Base maps – Ordnance Survey of Ireland;
- OPW Flood Hazard Maps and flooding information for Ireland, www.floodmaps.ie;
- Office of Public Works (OPW);
- Geological Survey of Ireland (GSI) online databases (www.gsi.ie);
- EPA hydrology databases (www.catchment.ie);
- Department of Agriculture, Environment and Rural Affairs (DAERA) online mapping databases);
- Northern Ireland Environment Agency (www.ni-environment.gov.uk);
- Site Walkover, drainage mapping and flow monitoring (as described in Chapter 9 of this rEIAR); and,
- The 2017 EIAR.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Wind Farm Site and Grid Connection Site along with a brief description of the Existing Development. Refer to Chapter 4 of this rEIAR for a detailed description of the Existing Development.

2.2 SITE DESCRIPTION AND TOPOGRAPHY

Wind Farm Site

The Wind Farm Site is located in Co. Donegal, ~8km to the southwest of the twin towns of Ballybofey and Stranorlar, and ~8km northeast of Donegal Town. The eastern and southern boundaries of the Wind Farm Site are defined by the border with Co. Tyrone, Northern Ireland. The closest town in Northern Ireland is Castlederg which is located ~17.1km to the southeast. The Wind Farm Site has a total area of ~892ha in area.

Current landcover/use at the Wind Farm Site is comprised of a partially constructed wind farm, areas of commercial forestry and blanket bog, and roadways. The surrounding landcover/use predominantly comprises peat bogs, commercial forestry and other seminatural areas with limited residential use along local roads.

Prior to the construction of the Existing Development, a network of existing forestry roads provided access in and around the Wind Farm Site. The Wind Farm Site was covered by blanket bog with very few natural mineral subsoil or bedrock exposures. However, a number of pre-existing borrow pits where the subsoil and bedrock profile were observed and showed that the peat directly overlies bedrock, weathered bedrock or very thin pockets of subsoils.

The elevation of the Wind Farm Site ranges between ~180 and 313mOD (metres above Ordnance Datum), with elevations generally decreasing and sloping in a north or north-westerly direction. A small section in the south of the Wind Farm Site slopes to the southeast. The Wind Farm Site is generally bordered on all sides by forestry plantations with the eastern and southern boundaries also being defined by the Northern Ireland border. The majority of the Wind Farm Site slopes in a north-westerly direction towards the Bunadowen River which flows through the Wind Farm Site. The southern section of the Wind Farm Site slopes to the southeast towards the Glendergan River.

Existing access is from the N15 National Primary Road in the northwest of the Wind Farm Site and via a local road in the north Wind Farm Site. The N15 National Primary Road runs south-west to north-east, with the Wind Farm Site lying about 2km east of the road.

Construction of the Existing Development commenced in November 2019, at which point the majority of the civil engineering works, including wind farm access roads, 110kV electrical substation, turbine hardstands, turbine foundations, and ancillary works were substantially completed over the following 12-month period up to the November 2020 Peatslide. The as-built infrastructure footprint of the Existing Development (~22.9ha including the onsite 110kV substation which is located within the Wind Farm Site) covers only a very small percentage (~2.6%) of the Wind Farm Site (892ha).

Grid Connection Site

The Grid Connection includes the on-site 110kV substation and the associated underground cabling route from the on-site 110kV substation to the Clogher 110kV substation at Cullionbouy Lower. For the purposes of this rEIAR, the Grid Connection Site refers to the underground cabling route from the Wind Farm Site entrance to the Clogher 110kV substation. The Grid Connection Site is ~9ha.

The Grid Connection underground cabling route is predominantly located along the existing public road network. The Grid Connection underground cabling route extends from the N15 National Primary Road to the L-2595 Local Road, then proceeds to the L-1985 Local Road and continues along the L-19825 Local Road to reach the Clogher substation following a private access road. The Clogher substation is situated approximately 6.5 km from the on-site substation within the Wind Farm Site. The length of the underground cabling route from the on-site 110kV substation to Clogher 110kV substation is ~9.4km.

The landcover/use in the lands surrounding the Grid Connection Site is predominantly forestry with sections of peat cutting, farming and open peatlands.

Ground elevations along the Grid Connection Site are greatest in the vicinity of the Wind Farm site entrance where ground elevations stand at ~153mOD. Elevations decrease along the N15 to the southwest, with the lowest elevations being at ~80mOD. Ground elevations along the Grid Connection rise again from the N15 towards Clogher 110kV substation which stands at ~142mOD.

A site location map is shown as **Figure A** below.

2.3 EXISTING DEVELOPMENT DETAILS SUMMARY

Construction work on the Existing Development commenced in November 2019. Although some construction activities have occurred on a sporadic basis throughout the period from November 2019 to the present, the vast majority of construction activities occurred during the 12-month period from November 2019 to November 2020. Works on the electricity substation and associated underground cabling connection to the grid continued until the second quarter of 2021. Construction temporarily resumed for a period between July and December of 2022, during which some additional works were carried out on site roads, internal site ducting, hardstanding areas, borrow pits, and peat cells.

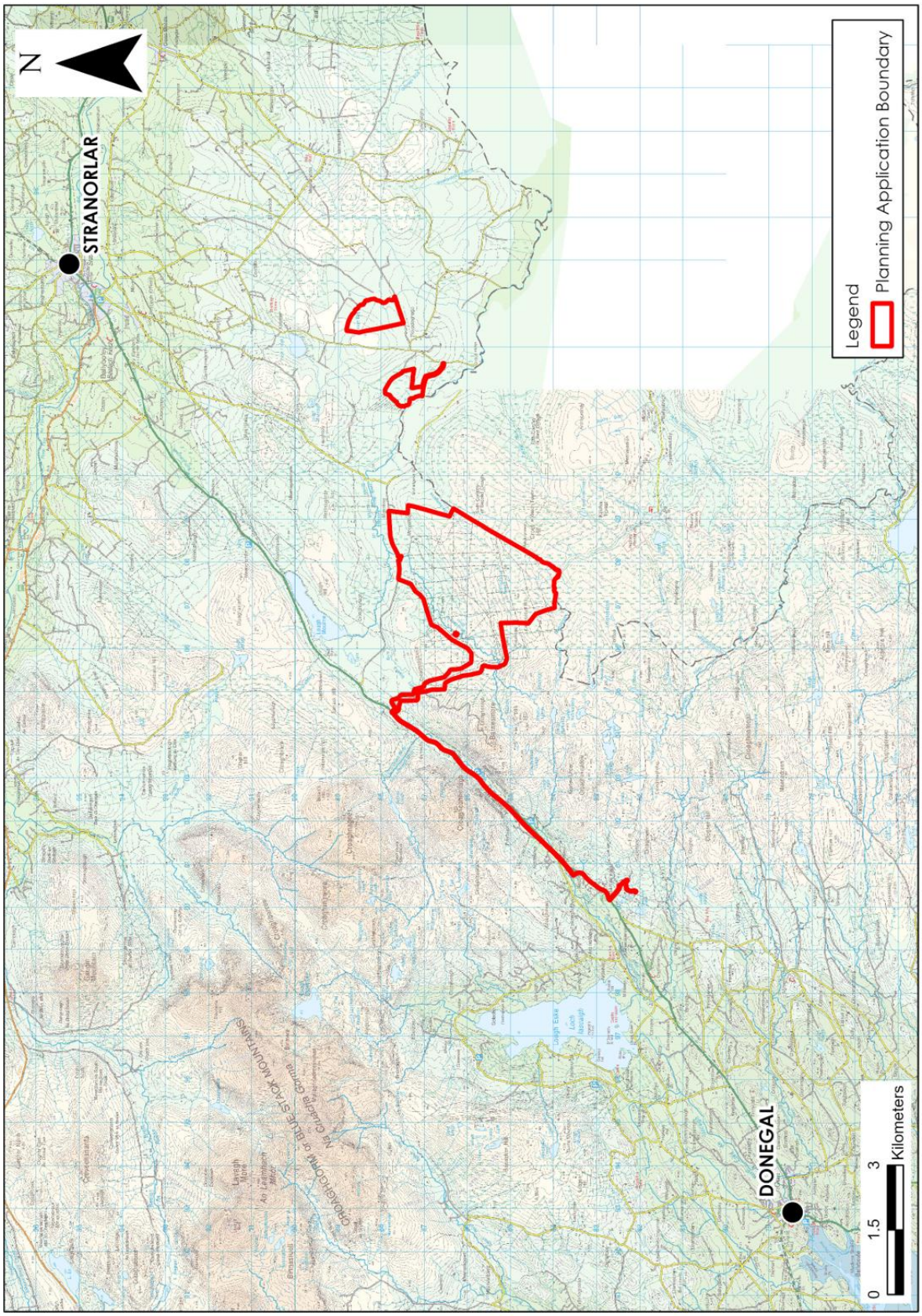

Figure A: Site Location Map

3. EXISTING ENVIRONMENT

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics in the area of the Wind Farm Site and Grid Connection Site.

3.2 BASELINE HYDROLOGY

3.2.1 Regional and Local Hydrology

Wind Farm Site

The vast majority of the Wind Farm Site is located in the Foyle River surface water catchment within Hydrometric Area No. 1. This river basin district is an international river basin district with ~3% of this district located in Northern Ireland. Meanwhile, a small area in the northwest of the Wind Farm Site is mapped in the Donegal Bay North regional surface water catchment, with Hydrometric Area No. 37 of the North Western River Basin District.

Within the Foyle River catchment, the Wind Farm Site is located in the Mourne Beg River sub-catchment (MourneBeg_SC_010). The Mourne Beg River, a tributary of the Mourne River, flows to the southeast from Lough Mourne, situated ~2km northeast of the Wind Farm Site entrance. The Mourne Beg River flows to the east, ~150m north of the Wind Farm Site before it crosses into Northern Ireland. Further downstream, this watercourse discharges into the River Derg, ~15km to the east. The River Derg continues to the east. The Mourne River is formed at the meeting of the River Derg and the River Strule, ~27km east of the Wind Farm Site. The Mourne River then flows to the north, through the town of Strabane, before it confluences with the Finn River to form the River Foyle.

In terms of WFD river sub-basins, the Wind Farm Site is located in a total of 5 no. WFD river sub-basins within the Mourne Beg River sub-catchment.

- The northwest of the Wind Farm Site is located in the Mourne Beg_010 WFD river sub-basin. This area is drained by the EPA mapped Croaghonagh Stream (EPA Code: 01C31). Note that this stream is referred to as the Mary Breen's Burn on local OSI mapping (note that the Mary Breen's Burn will be utilised for the remainder of this chapter). Mary Breen's Burn flows to the northeast and discharges into the Mourne Beg River (EPA Code: 01M01), ~1.8km northeast of the Wind Farm Site.
- A small area in the northeast of the Wind Farm Site is also mapped in the Mourne Beg_010 WFD river sub-basin. Here, the Mourne Beg River is located ~100m north of the Wind Farm Site.
- Much of the Wind Farm Site is located in the Bunadaowen_010 WFD river sub-basin (i.e. the Bunadowen River which is spelt "Bunadaowen" on EPA WFD mapping). This area is drained by the Bunadowen River (EPA Code: 01B01) and several of its smaller tributaries. There is a high density of mapped watercourses in this area of the Wind Farm Site.
- A small area in the northeast of the Wind Farm Site is mapped in the Mourne Beg River (Derrygoonan) WFD river sub-basin. This area is drained by the Shruhanagarve Stream (EPA Code: 01S26) which flows to the northeast, before it discharges into the Mourne Beg River.
- The southeast of the Wind Farm Site is located in the Glendergan River WFD river sub-basin. An unnamed tributary of the Glendergan River flows to the south from the area of the Wind Farm Site. The Glendergan River itself forms the southeastern boundary of the Wind Farm Site. This watercourse discharges into the River Derg ~3.7km to the southeast.

Within the Donegal Bay North surface water catchment, the Wind Farm Site is mapped in the Eske River sub-catchment (Eske_SC_010). Within this area, a tributary of the Lowerymore River,

referred to by the EPA as the Barrack Hill Stream (EPA Code: 37B16) flows to the southwest in the vicinity of the Wind Farm Site entrance. The Lowerymore River (EPA Code: 37L01) flows to the southwest, through Barnesmore Gap, before discharging into Lough Eske ~8.7km to the southwest.

Grid Connection Site

The Grid Connection Site is located in the Donegal Bay North catchment and the Eske River sub-catchment (Eske_SC_010). The Grid Connection passes through the Lowerymore_020 and Lowerymore_030 WFD river sub-basins.

Section 9.3.3.2 of this rEIAR details the locations of the existing watercourse crossings. There are a total of 14 no. crossings along the Grid Connection in the Donegal Bay North catchment.

3.2.2 Rainfall and Evaporation

Long term rainfall and evaporation data were sourced from Met Éireann (www.met.ie). The 30-year annual average rainfall (1981-2010) recorded at Ballybofey (Lough Mourne), located ~2km northwest of the Wind Farm Site. The average annual rainfall at Ballybofey (Lough Mourne) is 1,931m/year. However, the rainfall data from Lough Mourne is likely to underestimate the actual AAR at the Wind Farm Site due to elevation differences.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Wind Farm Site ranges from 2,004 to 2,185mm/year. The conservative value of 2,185mm/year is taken as the average annual rainfall for the Wind Farm Site. This is considered to be the most accurate estimate of average annual rainfall from the available desk study sources

The average potential evapotranspiration (PE) at Belmullet (36km to the west) is taken to be 527.1mm (www.met.ie). The actual evapotranspiration (AE) is calculated to be 500.7mm (95% PE). Using the above figures, the effective rainfall (ER)[1] for the area is calculated to be (ER = SAAR – AE) 1,684mm/yr.

In addition to average rainfall data, extreme value rainfall depths are available from Met Eireann. **Table A** below presents return period rainfall depths for the area of the Wind Farm Site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 5-year, 30-year, 100-year).

Meanwhile, the modelled AAR along the Grid Connection Site ranges from a minimum of 1,723mm/yr in the southwest to a maximum of 2,185mm/yr in the vicinity of the Wind Farm Site.

Table A: Site - Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	4.9	5.9	8.7	10.7
15 mins	8.1	9.7	14.3	17.6
30 mins	10.9	13.8	19.3	23.7
1 hours	14.8	18.7	26.1	32.1
6 hours	32.2	40.7	56.9	70.0
12 hours	43.6	55.1	77.0	94.7
24 hours	59.0	74.6	104.2	128.2
2 days	76.78	90.1	125.6	150.4

[1] *ER – Effective Rainfall is the excess rainfall after evaporation which produces overland flow and recharge to groundwater.*

3.3 GEOLOGY

Wind Farm Site

The published Teagasc soils map (www.gsi.ie) for the local area shows that the Wind Farm Site is predominantly overlain by blanket peat (BktPT), with some small local areas of Bedrock at surface-Non calcareous (RckNCa) and till derived from metamorphic rocks (TMp).

The published subsoils map (www.gsi.ie) shows that the Wind Farm Site is underlain almost entirely by blanket peat (BktPt), with some small local areas of Bedrock outcrop or subcrop (Rck) and till derived from metamorphic rocks (TMp).

Based on the GSI bedrock mapping (www.gsi.ie), the Wind Farm Site is underlain by a total of 3 no. bedrock geological formations. Much of the Wind Farm Site is underlain by Lough Eske Psammite Formation comprising of feldspathic psammite, quartzite and marble. The southern section and a very small area in the northern section is underlain by the Lough Mourne Formation which is noted to comprise of quartz and feldspar pebbles, green matrix Meanwhile, a small area in the west of the Wind Farm Site, at the existing entrance is underlain by the Barnesmore Granite.

The soils and subsoils present at the Wind Farm Site have been verified during site walkover surveys and intrusive site investigation completed both as part of the baseline assessment for the 2017 EIAR and during the construction phase of the Existing Development (refer to Chapter 7 of this rEIAR).

Grid Connection Site

The published Teagasc soils map (www.gsi.ie) for the local area shows that the lands in the vicinity of the Grid Connection Site are predominantly overlain by acid poorly drained mineral soils (AminPD), with blanket peat mapped in the north in the vicinity of the Wind Farm Site and in the south in the vicinity of the Clogher 110kV substation. Alluvial soils are also mapped along the Lowerymore River adjacent to the N15. Acidic poorly drained mineral soils (AminPD) are also mapped along sections of the N15.

The published subsoils map (www.gsi.ie) shows that the lands in the vicinity of the Grid Connection Site are predominantly underlain by metamorphic till, with blanket peat mapped in the vicinity of the Wind Farm Site and near Clogher 110kV substation. Alluvial subsoils are mapped along the Lowerymore River, while the GSI also map granite till along a section of the N15. The GSI also map areas of bedrock outcrop or subcrop in the lands surrounding the Grid Connection Site, particularly in Barnesmore Gap and with smaller pockets of bedrock outcrop mapped near Clogher 110kV substation.

The northern section of the Grid Connection Site is mapped by the GSI to be underlain by the Lough Eske Psammite Formation, the Barnesmore Granite and the Lough Mourne Formation.

3.4 HYDROGEOLOGY

Wind Farm Site

The Wind Farm Site is mapped to be underlain by a Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones (Pl) (www.gsi.ie). The vast majority of the Wind Farm Site is underlain by the Castlederg Groundwater Body (GWB) (IEGBNI_NW_G_005). Meanwhile, a small area in the west is underlain by the Donegal South GWB (IE_NW_G_047). Both GWBs are characterised by poorly productive bedrock.

Grid Connection Site

The Grid Connection Site is mapped to be underlain by a Poor Aquifer and the Donegal South GWB.

3.5 DESIGNATED SITES & HABITATS

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

Wind Farm Site

The Existing Development is not located within any designated conservation site, however, there are designated sites within the Wind Farm Site boundary. Small sections of Croaghonagh Bog SAC/pNHA (Site Code: 000129) and Cashelnavean Bog NHA (Site Code: 000122) are located within the Wind Farm Site. The Existing Development is also hydrologically connected to some downstream designated sites including the Lough Eske and Ardnamona Wood SAC (Site Code: 000163) along the Lowerymore River and the River Finn SAC (Site Code: 002301) along the Mourne Beg River.

The River Foyle and Tributaries SAC (Site Code: UK0030320) is located downstream of the Wind Farm Site along the Mourne Beg River and the Glendergan River. Croagh Bog ASSI (ASSI378) is located downstream of the Wind Farm Site and along the lower reaches of the Shruhanagarve Stream. This ASSI is located in close proximity to the Habitat Enhancement lands. The River Foyle and Tributaries ASSI (ASSI229) is located downstream of the Wind Farm Site along the Mourne Beg River and the Glendergan River. Killeter Forest Bogs and Lakes ASSI is located ~1km to the south of the Wind Farm Site. The Glendergan River acts as a hydraulic barrier between the Wind Farm Site and this ASSI.

Grid Connection Site

A small section of the N15, including the Grid Connection Site, overlaps with the mapped extent of the Cashelnavean Bog NHA. The Grid Connection Site runs in close proximity to the Barnesmore Bog NHA which is located topographically upgradient of the Grid Connection Site. Lough Eske and Ardnamona Wood SAC are located immediately downstream of the Grid Connection Site at Keadew Bridge.

3.6 WIND FARM SITE DRAINAGE

3.6.1 Drainage – Baseline Environment

Prior to the construction of the Existing Development, the drainage within the Wind Farm Site comprised of numerous manmade drains that were in place predominately to drain the forestry plantations. This internal forestry drainage pattern is influenced by the local topography, peat cover, layout of the forest plantation and by the pre-existing forestry road network. The forestry plantations, which still cover the majority of the Wind Farm Site are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the Wind Farm Site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation.

Mound drains and ploughed ribbon drains are generally spaced approximately every 15-20m and 2m respectively. Interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of existing forestry access roads. Culverts are located on existing access roads at stream and drain crossings and at low points under access roads which drain runoff onto down-gradient forest plantations.

The forestry drains are the primary drainage routes towards the natural streams, but the flows in the higher elevated drains are generally very low or absent most of the time.

3.6.2 Drainage – Existing Environment

Prior to the commencement of construction works for the Existing Development, drainage management systems were inserted around work areas and integrated with the pre-existing forestry drainage network described above. The Existing Development drainage system comprises of interceptor drains, culverts, settlement ponds, silt traps and silt fencing. The Wind Farm drainage system discharged into the forestry drainage network and made its way downslope into the natural streams and watercourses which drain the Wind Farm Site. There was no discharge of untreated or attenuated water from the works areas. The water quality data from the construction phase of Existing Development demonstrated that there was no significant effects.

4. FLOOD RISK DEFINITION

4.1 INTRODUCTION

The following assessment is carried out in accordance with the Guidelines (DoEHLG, 2009). The basic objectives of these guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders; and,
- Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

4.2 FLOOD ZONE PROCEDURE

This section of the report details the site-specific flood risk assessment carried out for the Wind Farm Site and Grid Connection Site. The primary aim of the assessment is to consider all types of flood risks and the potential impact on the Existing Development. As per the Guidelines (DoEHLG, 2009), the stages of a flood risk assessment are:

- Flood risk identification – identify whether there are surface water flooding issues at a site;
- Initial flood risk assessment - confirm sources of flooding that may affect a proposed development; and,
- Detailed flood risk assessment – quantitative appraisal of the potential risk to a proposed development.

As per the Guidelines (DoEHLG, 2009), there are essentially two major causes of flooding:

Coastal flooding, which is caused by higher sea levels than normal, largely as a result of storm surges, resulting in the sea overflowing onto the land. Coastal flooding is influenced by the following three factors, which often work in combination:

- High tide level;
- Storm surges caused by low barometric pressure exacerbated by high winds (the highest surges can develop from hurricanes); and,
- Wave action, which is dependent on wind speed and direction, local topography and exposure.

Coastal Flooding is not applicable to the Wind Farm Site and Grid Connection Site.

Inland flooding which is caused by prolonged and/or intense rainfall. Inland flooding can include a number of different types:

- Overland flow occurs when the amount of rainfall exceeds the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural hollows and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall and eventually enters a piped or natural drainage system;

- River flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying areas (the floodplain). This can occur rapidly in short steep rivers or after some time and some distance from where the rain fell in rivers with a gentler gradient;

- Flooding from artificial drainage systems results when flow entering a system, such as an urban stormwater drainage system, exceeds its discharge capacity and the system becomes blocked, and/or cannot discharge due to a high-water level in the receiving watercourse. This mostly occurs as a rapid response to intense rainfall. Together with overland flow, it is often known as pluvial flooding. Flooding arising from a lack of capacity in the urban drainage network has become an important source of flood risk, as evidenced during recent summers;

- Groundwater flooding occurs when the level of water stored in the ground rises as a result of prolonged rainfall to meet the ground surface and flows out over it, i.e. when the capacity of this underground reservoir is exceeded. Groundwater flooding tends to be very local and results from interactions of site-specific factors such as tidal variations. While water levels may rise slowly, they may be in place for extended periods. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life; and,

- Estuarial flooding may occur due to a combination of tidal and fluvial flows, i.e., the interaction between rivers and the sea, with tidal levels being dominant in most cases. A combination of high flow in rivers and a high tide will prevent water flowing out to sea, tending to increase water levels inland, which may flood over riverbanks.

The Guidelines (DoEHLG, 2009) provides direction on flood risk and development. It recommends a precautionary approach when considering flood risk management and the core principle is to adopt a risk-based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for inland and coastal flooding.

Flood zones are geographical areas within which the likelihood of flooding is in a particular range, and they are a key tool in flood risk management within the planning process as well as in flood warning and emergency planning.

There are three types or levels of flood zones defined within the Guidelines (DoEHLG, 2009):

- Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% (AEP) or 1 in 100 for river flooding or 0.5% (AEP) or 1 in 200 for coastal flooding);

- Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% (AEP) or 1 in 1000 and 1% (AEP) or 1 in 100 for river flooding and between 0.1% (AEP) or 1 in 1000 year and 0.5% (AEP) or 1 in 200 for coastal flooding); and,

- Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% (AEP) or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Once a flood zone has been identified for a site, the Guidelines (DoEHLG, 2009) sets out the different types of development appropriate to each identified zone (pg. 25, Table 3.1 of the Guidelines (DoEHLG, 2009)). Exceptions to the restriction of development due to potential

flood risks are provided for through the application of a Justification Test (JT), where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

The Justification Test (JT) has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that, for the reasons outlined above, are being considered in areas of moderate or high flood risk. The test is comprised of two processes.

- The first is the Plan-making Justification Test described in chapter 4 of the Guidelines (DoEHLG, 2009) and used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding. Plan making Justification Tests are made at Plan/Policy development stage such as County Development Plans, or Local Area Plans.

- The second is the Development Management Justification Test described in chapter 5 of the Guidelines (DoEHLG, 2009) and used at the planning application stage where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land. For example, application of Development Management Justification Test would be required at a site-specific level, such as for this FRA assessment, if a Justification Test is required.

4.3 FLOOD RISK IDENTIFICATION

4.3.1 Historical Mapping

To identify those areas as being at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) were consulted.

Wind Farm Site
There was no identifiable map text on local available historical 6" or 25" mapping for the local area that would identify lands that are "liable to flood" within or in the vicinity of the Wind Farm Site. Lands adjacent to the Mourne Beg River downstream of the Wind Farm Site are "liable to flood".

Grid Connection Site
Text on the 25" basemap indicates that lands adjacent to the Grid Connection Site, and the N15, in the townlands of Keadew Lower, Keadew Upper and Ardinawark are "liable to flood". These lands are adjacent to the Lowerymore River.

4.3.2 Soils Maps – Fluvial Maps

A review of the soil types in the vicinity of the Wind Farm Site and Grid Connection Site was undertaken as soils can be a good indicator of past flooding in an area. Due to past flooding of rivers deposits of transported silts/clays referred to as alluvium build up within the floodplain and hence the presence of these soils is a good indicator of potentially flood-prone areas.

Wind Farm Site
Based on the EPA/GSI soil map for the area it appears that there are no areas of alluvium soils mapped within the Wind Farm Site. Based on the Teagasc soil map (www.gsi.ie) for the area, the Wind Farm Site is overlain by blanket peat with some pockets of bedrock at or close to the surface. These soils are not indicative of areas prone of fluvial flooding.

The closest mapped alluvium deposits are mapped along the Lowerymore River. There are no alluvium deposits mapped along the Bunadaowen River or the Mourne Beg River in the vicinity of the Wind Farm Site.

Grid Connection Site
Based on EPA/GSI soil mapping alluvial soils are also mapped along the Lowerymore River adjacent to the N15.

4.3.3 Past Flood Events Mapping

To identify those areas as being at risk of flooding, OPW's Past Flood Events Map was consulted (www.floodinfo.ie).

Wind Farm Site
No recurring or historic flood incidents were identified within the vicinity of the Wind Farm Site from OPW's Flood Hazard Mapping (refer to **Figure B** below). The closest mapped downstream recurring flood event is located ~4.2km to the southwest (Flood ID: 4194). This flood event is located along the Lowerymore River in the Barnesmore Gap.

Flood Maps (NI) were also consulted to identify downstream historic flood events in Northern Ireland. The Historical Flood Map illustrates areas that are known to have flooded in the past. The closest mapped historic flood zones downstream of the Wind Farm Site are located on the River Derg, ~8km from the Wind Farm Site.

Grid Connection Site
A recurring flood event ((Flood ID: 4194) is mapped along the Lowerymore River in the vicinity of the Grid Connection Site, and the N15.

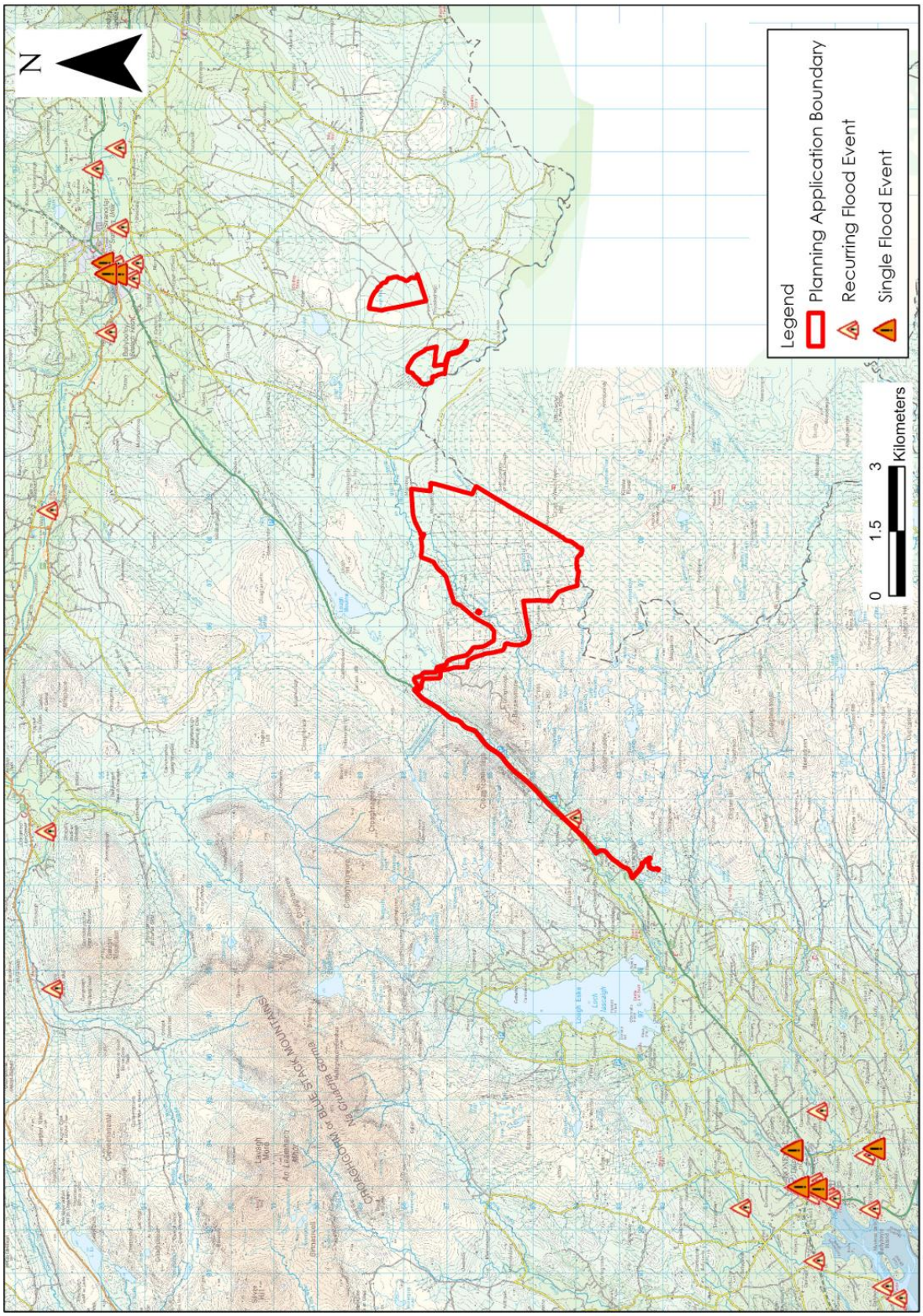

Figure B: OPW Flood Hazard Mapping (www.floods.ie)

4.3.4 GSI Historical Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding map shows areas of fluvial and pluvial flood extents during the Winter 2015/2016 flood event, which was the largest recorded flood event in many areas. This surface water flood map is available to view at www.floodinfo.ie.

Wind Farm Site

This historic flood map does not record any flood zones along the stream or rivers which drain the Wind Farm Site. 1 no. small area of surface water flooding is mapped within the Wind Farm Site. This flood zone corresponds to the location of Carrickaduff Lough and is situated ~350m from the closest element of the Existing Development (infrastructure at T6).

Grid Connection Site

There are no areas of historic surface water flooding located at the Grid Connection Site. The closest areas of flooding are associated with Cullionboy Lough and Lough Craig. The closest mapped historic flood zone is mapped ~73m to the south of the Grid Connection Site at Lough Criag.

The GSI Winter (2015/2016) Surface Water Flood Map for the local area is shown in **Figure C**.

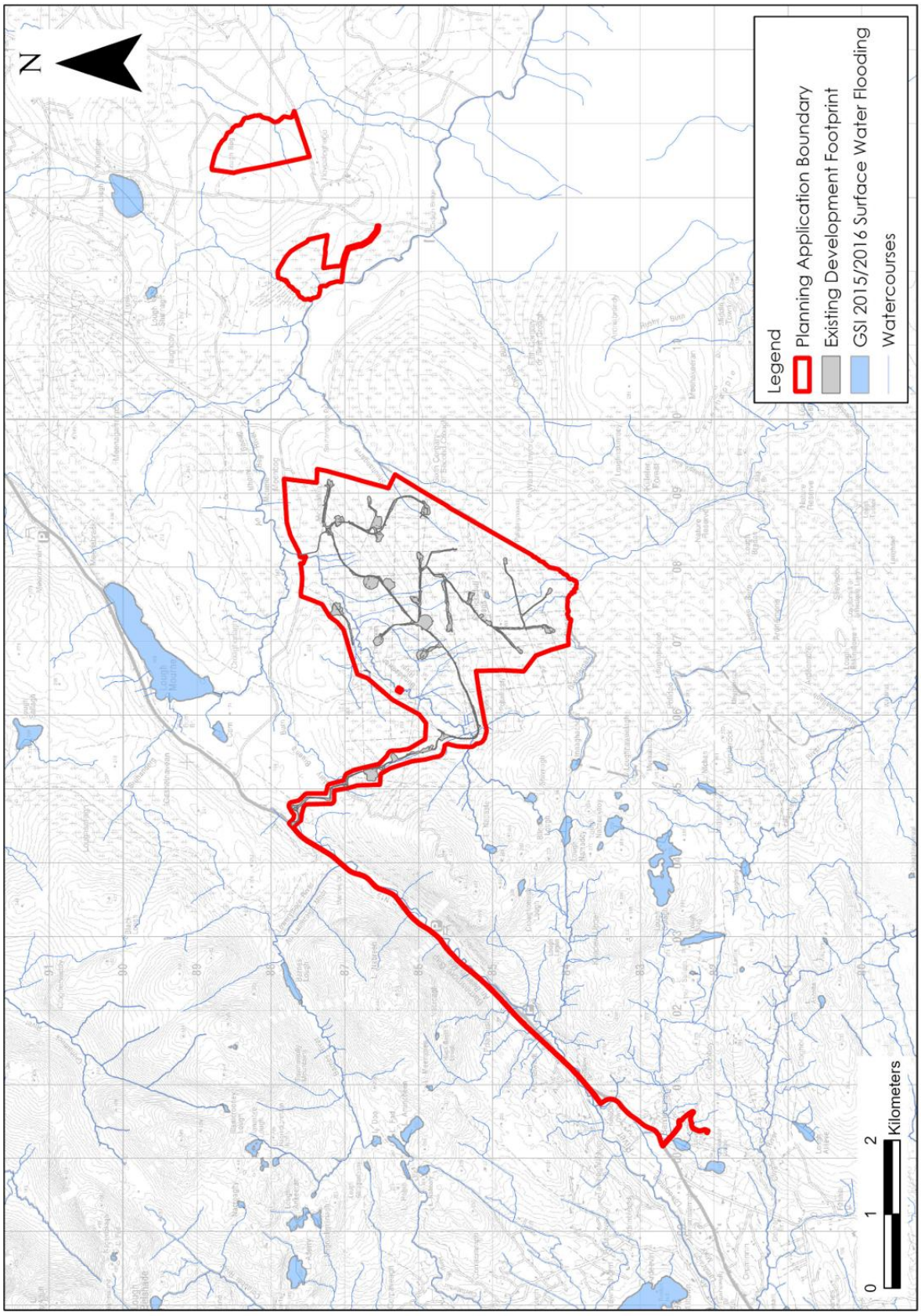

Figure C: GSI Historical Surface Water Flood Map

4.3.5 CFRAM Maps – Fluvial Flooding

Catchment Flood Risk Assessment and Management (CFRAM)[2] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA maps. CFRAM mapping of river flood extents are available at www.floodinfo.ie.

No CFRAM mapping has been completed for the area of the Wind Farm Site and Grid Connection Site. The closest downstream mapped CFRAM fluvial flood zones are located at Donegal Town.

4.3.6 National Indicative Fluvial Flood Mapping

The National Indicative Fluvial Flood Mapping (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments greater than 5km^2, in the Republic of Ireland, for which flood maps were not produced under the CFRAM Programme.

The Present Day Scenario has been generated using methodologies based on historic flood data and does not take into account the potential changes due to climate change. The potential effects of climate change on flooding have been separately modelled (see **Section 4.3.9** below.)

Wind Farm Site

The NIFM for the Present Day Scenario maps a flood zone within the north of the Wind Farm Site along the Bunadowen River. The flood zones from this river are generally constrained to be immediate vicinity of the channel. However, the flood zones are slightly more extensive along the north of the Wind Farm Site. These areas of the Wind Farm Site are located in Fluvial Flood Zones A and B while the remainder of the Wind Farm Site is located within Fluvial Flood Zone C (low risk).

The Existing Development largely avoids the mapped fluvial flood zones. The only Existing Development infrastructure within the flood zones is a road in the very north of the Wind Farm Site. The total footprint of the Existing Development within the high and medium probability flood zones is ~305m^2 and ~306m^2 respectively. The works in this area comprised an upgrade of an existing forestry track which existed prior to the construction of the Existing Development.

Grid Connection Site

Fluvial flood zones are mapped along the length of the Lowerymore River adjacent to the N15 and the Grid Connection Site. Some overlap occurs between the flood zones and the Grid Connection Site. The length of the Grid Connection within the mapped fluvial flood zones is ~500m.

The areas of the Grid Connection Site mapped in the flood zones largely corresponds with existing bridge locations. These watercourse crossings and the public road network existed prior to the construction of the Existing Development.

The National Indicative Fluvial Flood Mapping for the present day is included as **Figure D** below.

[2] *CFRAM is Catchment Flood Risk Assessment and Management. The national CFRAM programme commenced in Ireland in 2011 and is managed by the OPW. The CFRAM Programme is central to the medium to long-term strategy for the reduction and management of flood risk in Ireland.*

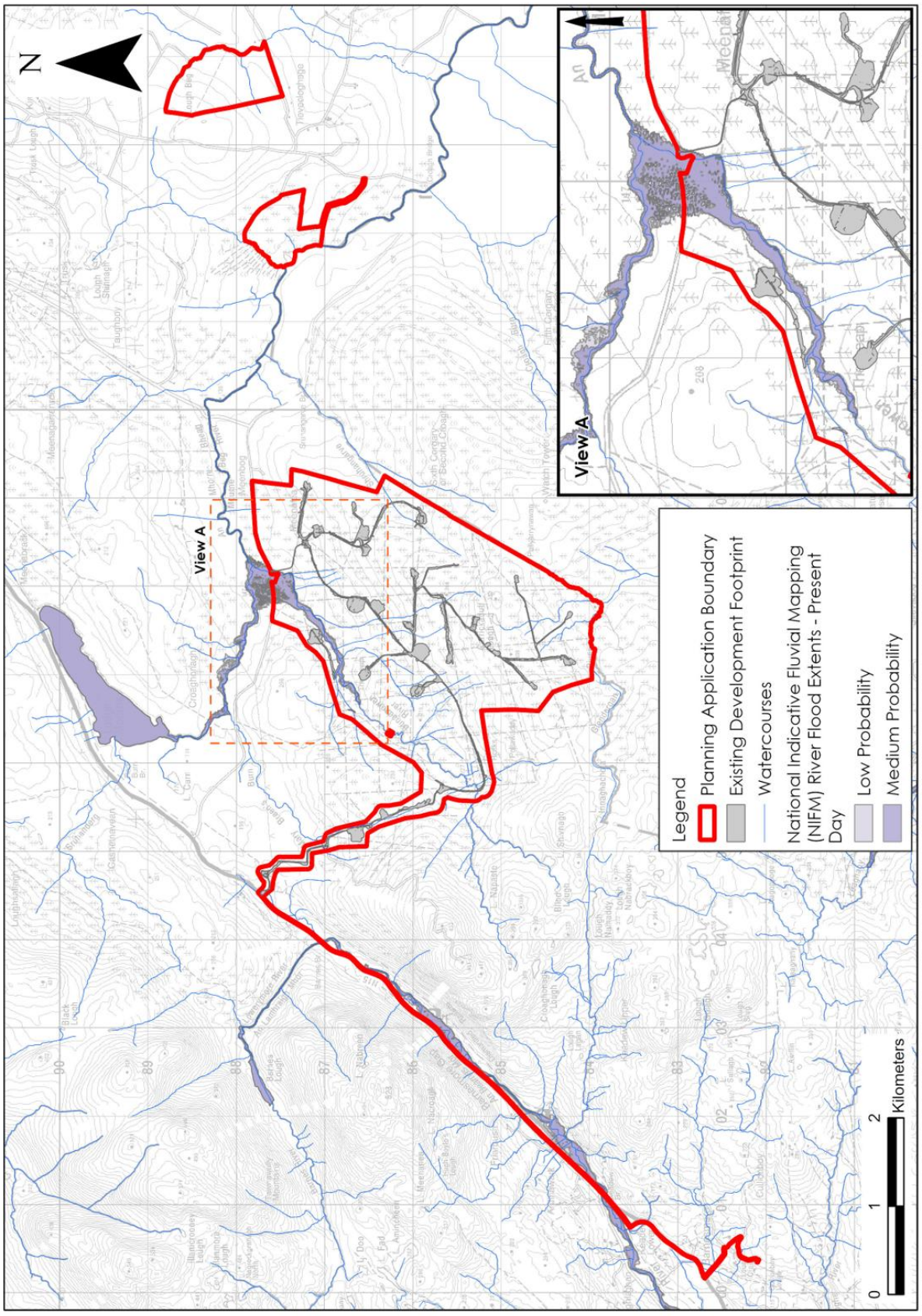

Figure D: OPW National Indicative Flood Mapping

4.3.7 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the Wind Farm Site and Grid Connection Site or in the surrounding area.

4.3.8 Coastal Flooding

The Wind Farm Site is located ~14.5km from Donegal Bay and stands at a significant elevation above sea level (~145 to 312mOD). The closest mapped CFRAM coastal flood zones are mapped at Donegal Town. Therefore, the Wind Farm Site is not at risk of coastal (tidal) flooding.

The Grid Connection Site is also located inland and at significant elevations above sea level. There is no risk of coastal flooding.

4.3.9 Climate Change

Fluvial flood modelling has also been completed to consider future climate scenarios where the potential effects of climate change can increase rainfall.

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood etens based on a 30% increase in rainfall. Both of these modelled flood extents show similar flood zones to the Present Day Scenario discussed above in **Section 4.3.6**. Therefore, flood zones at the Wind Farm Site and Grid Connection Site are unlikely to impacted by future climate change.

4.3.8 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, there are small sections of the Wind Farm Site and Grid Connection Site that are located within the mapped fluvial flood zones. These occur within the Wind Farm Site along the Bunadaowen River and at the Grid Connection Site along the Lowerymore River.

The sections of the Existing Development mapped within the flood zones at the Grid Connection Site were located at pre-existing watercourse crossings or along the local road network. Note that Horizontal Direction Drilling (HDD) was completed at these locations.

The only element of the Existing Development which are located within the mapped fluvial flood zones within the Wind Farm Site is a small section of access roads. A road also existed at this location prior to the construction of the Existing Development.

All other components of the Existing Development including the proposed turbines locations and the onsite substation, are located in Flood Zone C and are considered to be at low risk of flooding.

4.3.9 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Wind Farm Site and Grid Connection Site can be described using the Source – Pathway – Receptor Model ("S-P-R"). Given the typical sloping topography and ground elevations, the potential for pluvial flooding is generally low. The primary potential source of flooding in this area, and the one with most consequence for the Existing Development, is fluvial flooding of the local streams which drain the Wind Farm Site and Grid Connection Site during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.3.10 Summary – Initial Flood Risk Assessment

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it has been determined that flooding is unlikely to be problematic in the areas of the Existing Development. The potential sources of flood risk for the Wind Farm Site and Grid Connection Site are outlined and assessed in **Table B.**

Table B: S-P-R Assessment of Flood Sources for the Wind Farm Site and Grid Connection Site

Source	Pathway	Receptor	Comment
Tidal	Not applicable	People, property, land and infrastructure.	The Wind Farm Site and Grid Connection Site are located a significant distance from any estuary or tidal waterbody and at a significant elevation above sea level.
Fluvial	Overbank flooding of the Bunadaowen River and other smaller rivers and streams that drain the Wind Farm Site and Grid Connection Site.	People, property, land and infrastructure.	NIFM fluvial flood zones are mapped along the Bunadaowen River within the Wind Farm Site. A small section of road (306m^2) associated with the Existing Development is within the Flood Zone. The Existing Development involved the upgrade of a pre-existing track at this location. All other components of the Existing Development within the Wind Farm Site are located in Flood Zone C and are considered to be at low risk of fluvial flooding (Flood Zone C). Fluvial flood zones are mapped along the Lowerymore River in the area of the Grid Connection. However, the works were completed by HDD at these locations.
Pluvial	Ponding of rainwater on Site	People, property, land and infrastructure.	There is very little risk of pluvial flooding within the Wind Farm Site and Grid Connection Site due to the sloping nature of the land. Drainage moves relatively freely downslope due to the sloping topography; the existing forestry drains and the high density of natural watercourses and streams. Therefore, there is little risk of pluvial flooding at the Wind Farm Site and Grid Connection Site.
Surface water	Surface ponding/ Overflow	People, property, land and infrastructure.	Same as above (pluvial).
Groundwater	Rising groundwater levels	People, property, land and infrastructure.	Based on local hydrogeological regime and GSI mapping, there is no apparent risk from groundwater flooding.

5. JUSTIFICATION TEST

5.1 REQUIREMENT FOR A JUSTIFICATION TEST

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test[3] is shown in **Table C** below.

All vulnerable and/or sensitive elements of the Existing Development (i.e. proposed turbines locations and substation) are located in Flood Zone C and are therefore appropriate from a flood risk perspective and would not require a justification test.

The only elements of the Existing Development mapped within the flood zones include a small section of access road within the Wind Farm Site and sections of the Grid Connection Site at existing watercourse crossing locations along the N15 National Primary Road.

A justification test is presented below for the areas within the flood zone.

Table C: Matrix of Vulnerability versus Flood Zone

	Flood Zone A	**Flood Zone B**	**Flood Zone C**
Highly vulnerable development (including essential infrastructure)	Justification test	Justification test	**Appropriate** (onsite substation and proposed turbines locations)
Less vulnerable development	**Justification test** (~305m^2 of access road within the Wind farm Site and ~500m of Grid Connection)	**Appropriate** (~306m^2 of access road within the Wind farm Site and ~500m of Grid Connection)	**Appropriate** (site access roads, temporary compounds, etc)
Water Compatible development	Appropriate	Appropriate	**Appropriate**

Note: Taken from Table 3.2 (DoEHLG, 2009)
Bold: *Applies to this project*

5.2 JUSTIFICATION TEST

A small portion (306m^2) of the Existing Development within the Wind Farm Site and a further section of the Grid Connection (~500m) are located within Fluvial Flood Zone A/Flood Zone B. A Justification Test needs to be undertaken to review issues of proper planning and sustainable development.

The Existing Development has been the subject of a site-specific flood risk assessment (this report), and the following has been determined:

i. A small area of access track (305m^2) is mapped within the NIFM Flood Zone A mapping (306m^2 in Flood Zone B). Prior to the construction of the Existing Development a forestry access track existed at this location. The works associated with the Existing Development within this flood zone included the upgrade of the pre-existing track. Given the small footprint and nature of the works within the flood zone the Existing Development had an imperceptible impact on flood water levels / flood risk.

[3] *A 'Justification Test' is an assessment process designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk, (DoEHLG, 2009).*

The works along the Grid Connection had no potential to increase the flood risk. The Grid Connection overlaps with the flood zones at pre-existing watercourse crossings or along pre-existing roads (totalling ~500m in length). The works completed in these areas included the excavation of a shallow trench and the backfilling of the trench. The crossings were completed by HDD.

ii. The design of the Existing Development underwent an iterative design process which sited all other site infrastructure outside of the NIFM fluvial flood zones within the Wind Farm Site.

iii. No specific flood related mitigation was required as the Existing Development had no potential to increase the flood risk; and,

iv. The Existing Development is compatible with the wider planning and flood related objectives of the area, including the provision of wind energy developments at appropriate locations.

6. FLOOD IMPACT ASSESSMENT

This section presents an assessment of the flood risk caused by the Existing Development.

There was no change flood risk as a result of the Existing Development for the following reasons:

- The vast majority of the Existing Development at the Wind Farm Site, including all proposed turbines locations, the onsite substation are located outside of all mapped flood zones.

- The only element of the Existing Development, at the Wind Farm Site, mapped within the flood zones at the Wind Farm Site comprised a very small section of access road. The total footprint of the road within the medium probability flood zone is ~306m^2 (305m^2 in the high probability flood zone). This area is infinitely small in comparison to the total area of the NIFM fluvial flood zones. The proposed footprint within the flood zone represents 0.003% of the flood zone within the Wind Farm Site The emplacement of this infrastructure had no potential to result in any significant displacement of floodwaters. A preexisting access track existing at this location prior to the Existing Development and the upgrade of the track has not resulted in any increase in the flood risk. The Existing Development has not increased the flood risk upstream or downstream of the Wind Farm Site and Grid Connection Site.

- Sections of the Grid Connection were also mapped within fluvial flood zones. However, existing watercourse crossings and the public road network existing at these locations prior to the construction of the Existing Development. The Existing Development did not result in any in stream works at the crossing location and the cable trench was backfilled once the ducting had been laid. The works were transient in nature and were completed over a short time period. No flood events were recorded during the construction phase. The construction of the Grid Connection had no potential to increase the flood risk elsewhere.

- The Existing Development has been constructed in accordance with the drainage design principles detailed in the 2017 EIAR and the 2019 CEMP. We note that the Permitted Development was deemed to be appropriate from a flood risk perspective;

- The on-site wind farm drainage system was designed to ensure that all surface water run-off was treated (water quality control) and attenuated (water quantity/flood management control);

- All runoff was routed through settlement ponds and/or silt fences and outflow from the settlement ponds was released in a controlled and diffuse manner and pre-existing greenfield runoff rates;

- There was no release of untreated or unattenuated waters from the Existing Development areas;

- Therefore, with the implantation of the drainage system, the Existing Development has no potential to increase the magnitude of downstream hydrograph peaks; and,

- The change in runoff volumes associated with the Existing Development is considered to be equivalent to that which was assessed in the 2017 EIAR.

For these reasons, the Existing Development has not and will not result in any increase in downstream flood risk.

6.1 IN CUMULATION EFFECTS WITH THE PROSPECTIVE DEVELOPMENT

This section addresses the potential cumulative effects on flood risk of the Existing Development combined with the Prospective Development.

This rEIAR for the Existing Development concluded that the emplacement of the Existing Development infrastructure could have resulted in an increase in surface water runoff of 96.6m^3/day. This would have represented an increase of 0.13% from the baseline runoff rates in the absence of any drainage system. However, the drainage system was installed in conjunction with the Existing Development. This drainage system ensures that all water was treated and attenuated prior to discharge from the Existing Development areas. The assessment concludes that there was a neutral effect on surface water flows.

Similarly, Section 9.5.3.1 of the EIAR for the Prospective Development concluded that the Prospective Development footprint would result in an increase in runoff of 90.5m^3/day. This represents an increase of 0.12% from the baseline runoff rates. Note that this assessment was a conservative assessment, as it considered to entire footprint of the Prospective Development. This footprint also includes large areas of the Existing Development such as the existing on-site roads and hardstands which will be subject to minor upgrades as part of the Prospective Development. Even with this conservative assessment the Prospective Development will not result in any significant increase in the downstream flood risk. This is a consequence of the high greenfield surface water runoff rates due to the presence of peat soils and a Poor Bedrock Aquifer. Furthermore, the Prospective Development drainage system will ensure that runoff is restricted to greenfield rates and that the Prospective Development will not result in any increase in flood risk elsewhere. The assessment concluded that the impact was a neutral effect on surface water flows in downstream watercourses.

Therefore, the Subject Development will not have any significant effect on flood risk.

7. REPORT CONCLUSIONS

- A flood risk identification study was undertaken to identify existing flood risks associated with the Existing Development:
    - No instances of historical flooding were identified in historic OS maps within the Wind Farm Site;
    - No instances of recurring flooding were identified on OPW maps within the Wind Farm Site;
    - The GSI Historical 2015/2016 Surface Water Flood Map records 1 no. area of surface water flooding within the Wind Farm Site. This relates to Carrickaduff Lough and is located a significant distance from the Existing Development;
    - The GSI Groundwater Flood Mapping does not record any historic or predictive groundwater flood zones within the Wind Farm Site;
    - No areas of the Wind Farm Site were identified within the OPW/CFRAM Flood Zones; and,
    - NIFM fluvial flood zones are mapped along the Bunadaowen River within the northern area of the Wind Farm Site.
- Some areas of the Grid Connection Site are mapped in fluvial flood zones associated with flooding of the Lowerymore River. However, the watercourse crossings and the public road network existed at these locations prior to the construction of the Existing Development. The works at the Grid Connection Site had no potential to displace floodwaters or alter the flood risk elsewhere in the vicinity of the Wind Farm Site and Grid Connection Site;
- The OPW National Indicative Flood mapping indicates that fluvial flooding does occur along the Bunadaowen River within the northern area of the Wind Farm Site. However, the modelled fluvial flood extents do not extent any significant distance from the river channel. The only elements of the Existing Development mapped within the flood zones was 306m^2 of site road. Due to the small footprint and nature of the infrastructure within the flood zone (upgrade of a preexisting track) the Existing Development has not increased the flood risk elsewhere. The flood risk has remained the same as a result of the Existing Development;
- All highly vulnerable components of the Existing Development are located in Flood Zone C and is considered to be at low risk of flooding; and
- In addition, the risk of the Existing Development contributing to downstream flooding is very low. The inserted drainage systems retain and slow down drainage water prior to release. Robust drainage measures have been implemented as part of the Existing Development including swales, silt traps, check dams, settlement ponds and buffered outfalls. These are the same measures which were detailed in the 2017 EIAR and the 2019 CEMP for the Permitted Development.

* *

8. REFERENCES

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