APPENDIX 9-1

FLOOD RISK ASSESSMENT

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PROPOSED WINDFARM DEVELOPMENT AT GLENARD, CO. DONEGAL

SITE SPECIFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:
FuturEnergy Ireland

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

DOCUMENT TITLE:	**PROPOSED WINDFARM DEVELOPMENT AT GLENARD, CO. DONEGAL – SITE SPECIFIC FLOOD RISK ASSESSMENT**
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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO Ireland, on behalf of FuturEnergy Ireland, to undertake a site specific, Stage II Flood Risk Assessment (FRA) for a proposed windfarm development at Glenard, Co. Donegal.

This FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009).

1.2 STATEMENT OF EXPERIENCE

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

Our core 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 and David Broderck.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with 18 years environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological assessments for various developments across Ireland. Michael has significant experience in surface water drainage issues, SUDs design, and flood risk assessment.

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1.3 REPORT LAYOUT & METHODOLOGY

This Stage II FRA report has the following format:

- Section 2 describes the proposed site setting and details of the proposed development;
- Section 3 outlines the hydrological and geological characteristics of the local surface water catchments in the vicinity of the proposed development site;
- Section 4 deals with a site-specific flood risk assessment (FRA) and Justification Test for the proposed development which was carried out in accordance with the above-mentioned guidelines;
- Section 5 deals with planning policy;
- Section 6 deals with flood impact prevention; and,
- Section 7 presents the FRA report conclusions.

As stated above this FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (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) maps on superficial deposits;
- EPA hydrology maps;
- CFRAM/OPW Flood Risk Assessment Maps; and,
- Site Walkover, drainage mapping and flow monitoring.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Proposed Development site along with a description of the proposed development.

2.2 SITE LOCATION AND TOPOGRAPHY

The Proposed Development is located in an upland forestry setting on the Inishowen Peninsula, approximately 5.9km to the east of Buncrana town, Co. Donegal. Lough Swilly and Lough Foyle are located 6.1km and 5.8km to the west and east of the Proposed Development site respectively.

The Proposed Development site (delineated in green as the EIAR Site Boundary in Figure A below) is predominately a forested site with a total area of approximately 951ha. Access to the wind farm site is possible from two local roads which are located to the northeast and southwest of the wind farm site. There is a network of existing forestry roads which mainly enter from the northeast of the proposed development site.

The topography is hilly in setting with various local peaks in the EIAR area. The majority of the Proposed Development site is situated on the north-western facing slopes of Crocknacraddy Hill, where the highest point is at 360m OD which is just outside the south-eastern corner of the proposed development site.

The northern section of the site slopes in a north-westerly direction towards the Craha River which is at an elevation of approximately 120m OD at the north-western boundary of the proposed development site.

The southern half of the wind farm site is situated on the southwestern facing slopes of Crocknacraddy Hill and the southern slopes of Sorne Hill (elevation ~260m OD) which slope steadily down towards the Owenkillew River which located less then 0.5km to the south of the Proposed Development Site.

It is intended to connect the Proposed Development site to the national electricity grid via an underground cable which will connect the Proposed Development site substation to the existing Trillick 110kV substation, located 5.5km southwest of the core of the wind farm site in the townland of Ballynahone. The grid connection cabling route will measure approximately 8.4km in length and outside of the Proposed Development site (7.4km) mainly follows public roads.

The TDR accommodation works include 2 no. link roads, one between the R238 and the L1731 (0.45km) and a second along the L1731 (150m) along with road widening works to the northeast of the wind farm site close to the proposed site entrance. The TDR works areas are located adjacent to a mixture of forestry and grassland habitats.

A site location map is shown as

Figure A**.**

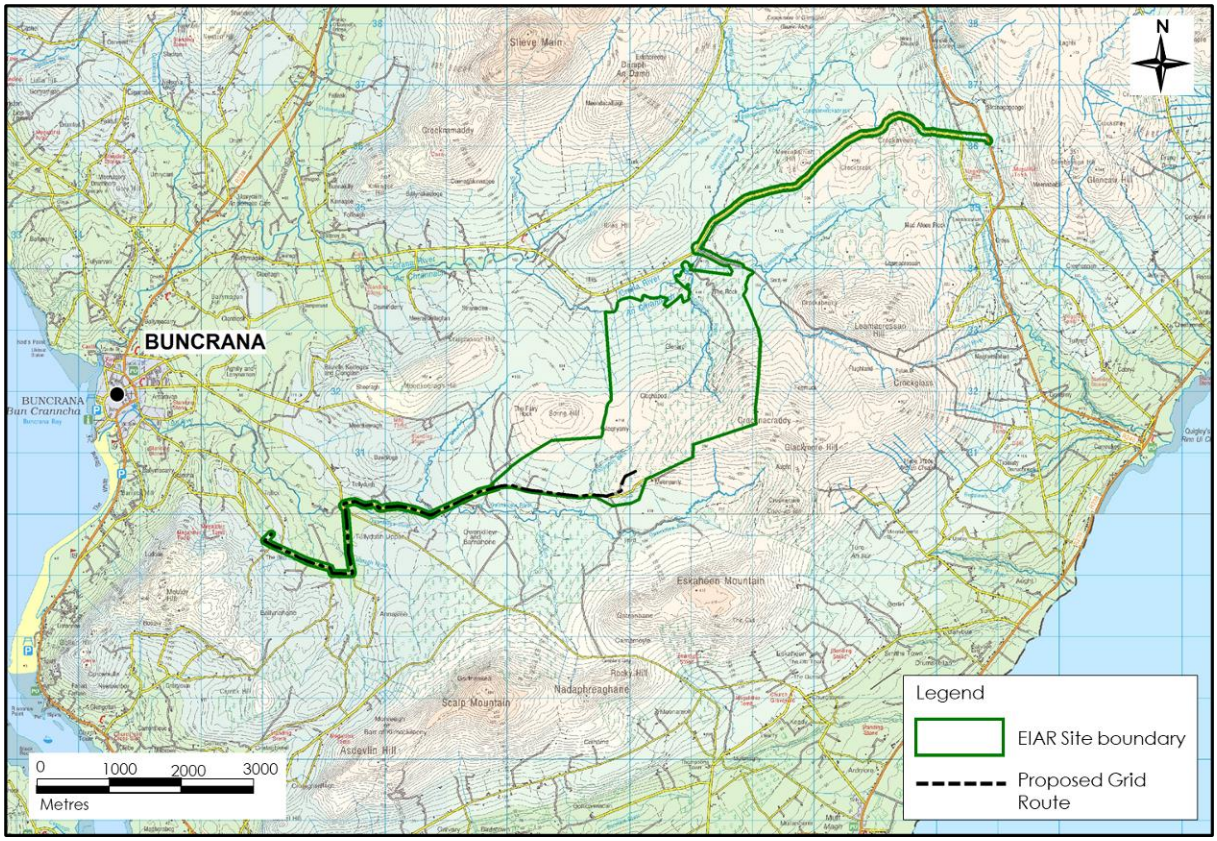

Figure A: Site Location Map

2.3 PROPOSED DEVELOPMENT DETAILS

The proposed development comprises the following:

- Construction of 15 No. wind turbines and associated hardstand areas with the following parameters:
  - a total tip height in the range of 162 metres minimum to 173 metres maximum,
  - hub height in the range of 96 metres minimum to 107 metres maximum, and
  - rotor diameter in the range of 132 metres minimum to 140 metres maximum
- 1 no. 110kV permanent electrical substation including a control building with welfare facilities, all associated electrical plant and equipment, security fencing, all associated underground cabling, wastewater holding tank and all ancillary structures and works;
- All works associated with the permanent 110kV connection from the proposed substation to the national electricity grid, via underground cabling within permanent cable ducts in the townlands of Meenyanly, Carnamoyle, Sorne, Owenkillew and Barnahone, Meenakeeragh Tullydush Upper, Annaslee and Ballynahone to the existing Trillick 110kV substation in the townland of Ballynahone;
- All associated underground electrical and communications cabling connecting the turbines to the proposed wind farm substation;
- 1 no. Meteorological Mast of 104 metres in height;
- Upgrade of existing tracks and roads, provision of new permanent site access roads including a new site entrance (in the townland of Glenard);
- 1 no. borrow pit;
- 1 permanent no. peat and spoil repository area;
- Permanent placement of peat and spoil along sections of site access roads as part of the peat and spoil management plan for the site;

- 2 no. temporary construction compounds;
- Permanent recreation and amenity works, including marked trails, seating areas, amenity car park, and associated amenity signage;
- All temporary works associated with the facilitation of turbine component and abnormal load delivery;
- Construction of a permanent link road between the R240 Regional Road and the L1731 local road; construction of a second permanent link road on the L1731; permanent road widening at three locations along the L1731 (in the townlands of Carrowmore or Glentogher and Illies) all of which will facilitate the delivery of abnormal loads to the site during the construction period and may be used during the operational period if necessary or to facilitate the decommissioning of the wind farm. Following the construction period, access to the link roads will be closed off;
- Site Drainage;
- Site Signage;
- Ancillary Forestry Felling to facilitate construction and operation of the proposed development; and
- All associated site development works.

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics in the area of the proposed wind farm.

3.2 BASELINE HYDROLOGY

3.2.1 Regional and Local Hydrology

Regionally the Proposed Development site (inclusive of the grid connection and turbine delivery route work areas) is located in the Lough Swilly surface water catchment (IE39_02) within Hydrometric Area 21 of the North Western International River Basin District (NWIRBD). Lough Swilly is located approximately between 9 and 13km downstream of the wind farm site.

TDR works, which includes the 2 no. link roads at the L1731, are located in the Culdaff – Clonmany – Donagh coastal regional catchment. This regional catchment is also located within the NWIRBD.

On a more local scale, the northern half (~61% of the EIAR study area) of the wind farm site (including 9 no. of the proposed 15 no. turbines) is located in the Crana River surface water catchment (Crana_SC_10). The southern half (~36% of the EIAR study area) of the wind farm site (including 6 no. of the proposed 15 no. turbines, substation and the grid connection cable) is located in the Mill River surface water catchment (Burnfoot_SC_10). Both the Crana River and the Mill River drain to Lough Swilly.

Locally, the TDR works are located in the Donagh River sub-basin - Donagh_010 (which flows in a northerly direction into Trawbreaga Bay, which is approximately15km downstream of the TDR works area) and in the Cabry River sub-basin (Cabry_010) (~0.36% of the EIAR study area) which flows into Lough Foyle approximately 8km downstream of the TDR works area.

A summary of the local hydrology with respect the proposed windfarm infrastructure is shown in **Table A** below. A local hydrology map of the area is shown as **Figure B.**

Regional Catchment	Sub-catchment	Main Development Infrastructure	Primary On-Site Drainage Features
Lough Swilly	Crana River (Crana_SC_010)	9 no. turbines, 1 no. borrow pit, 1 no. temporary compound, amenity pathways, peat and spoil repository and TDR works (wind farm site entrance and road widening on L1731)	Glenard River and Camowen River
	Mill River (Burnfoot_SC_010)	6 no. turbines, 1 no. temporary construction compound, met mast, WF substation, grid connection route	Pollandoo Burn, Owenkillew River and Maragh River
Culdaff – Clonmany – Donagh Coastal	Glennagannon_SC_010 (Donagh River (Donagh_010)	TDR works (link road widening on L1731)	2 no. unnamed 1st order headwater streams
	BogstownRiver_SC_010 (Cabry River (Cabry_010))	TDR Works (link road between R420 and L1731)	1 no. unnamed 1st order headwater stream

Table A: Summary of Local Hydrology and Proposed Infrastructure

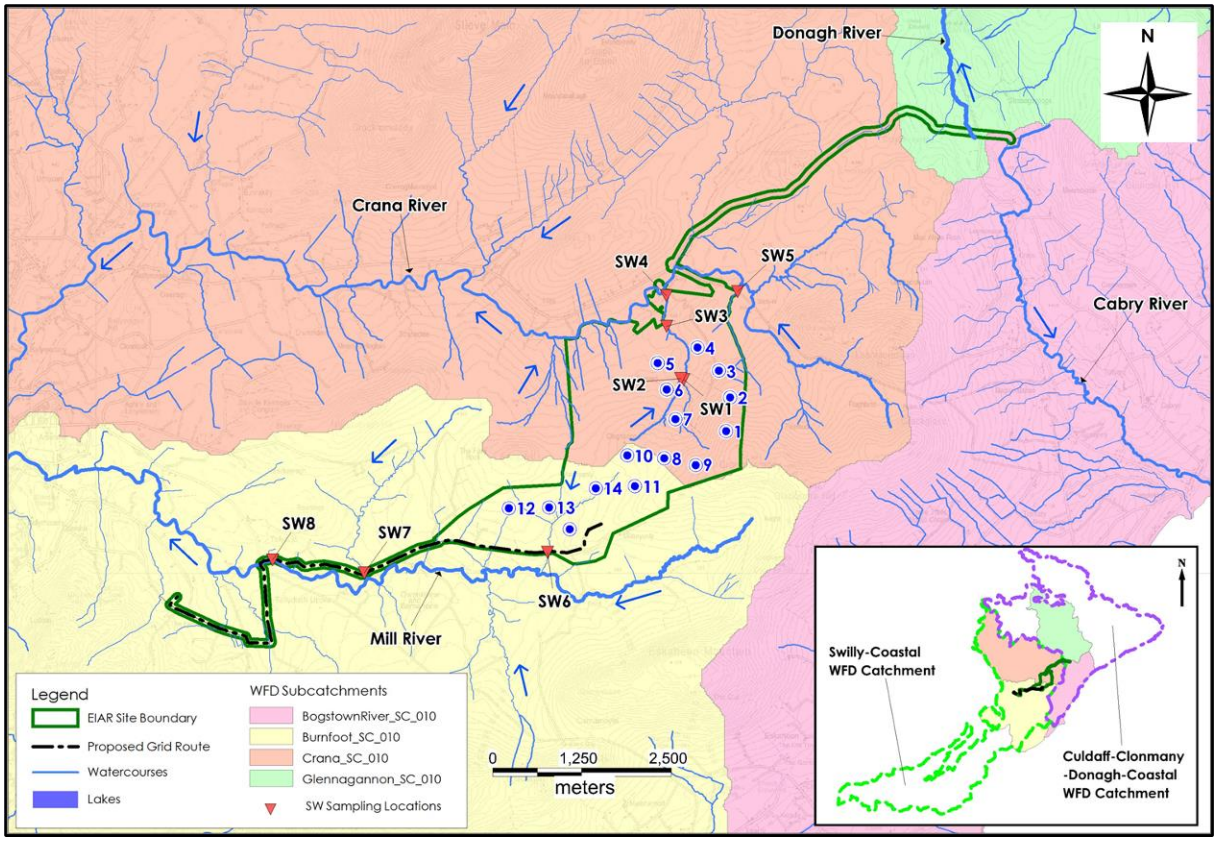

Figure B: Local Hydrology Map

3.2.2 Proposed Development Site Drainage

The majority of the northern half of the wind farm site is drained by the Glenard River (Crana_020) which emerges from within the wind farm site itself. The north-eastern corner of the wind farm site drains to the Camowen River (sub-basin of the Crana River) via a number of headwater streams. The Camowen River then flows under the TDR route and merges with the Crana River at the most northern point of the wind farm site.

The Glenard River comprises two main headwater streams that converge before flowing into the Crana River at the northern boundary of the wind farm site. The existing forestry access roads within the proposed wind farm site cross the Glenard River or its two main tributaries at 5 no. locations within the wind farm site.

The southern half of the wind farm site is drained mainly by the Pollandoo Burn (Mill (Donegal)_010) which is formed by three headwater streams that emerge within the site. The Pollandoo Burn then discharges into the Owenkillew River approximately 500m to the south of the Proposed Development site.

An existing drainage map for the Proposed Development site is attached below as **Figure 1**. The drainage map was created using OSI mapped watercourses, aerial photography, field mapping and Lidar data. Lidar data allows detailed mapping on the topographic contours of the site, thereby identifying all the linear drainage features at the site that are greater than 150m in length. Based on this assessment the main drainage pathways at the site are shown and the connectivity (i.e., pathways and outlet points) of these drains with the downstream EPA mapped streams/rivers can be clearly illustrated.

Surface water flow monitoring (8 no. locations) of the main streams emerging from the wind farm site and along the grid connection and TDR works areas was carried out on 4 no.

occasions and this data is presented in **Table B** below. The locations of the monitoring points are shown on **Figure B**. The flows are typical for watercourses ranging from headwater streams (i.e. SW1 & SW2) to large rivers (i.e. SW8 - Owenkillew River) in predominately peatland setting.

Within the Proposed Development site there are also numerous manmade drains that are in place predominately to drain the forestry plantations. The current internal forestry drainage pattern is influenced by the topography, peat subsoils, layout of the forest plantation and by the existing road network. The forest plantations, which cover ~60% of the Proposed Development site (where deforestation has occurred forests drains still exist as before) are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation.

Location	23/10/2019	13/02/2020	03/06/2020	26/05/2021
	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)
SW1	5	8	3	4
SW2	10	15	5	7
SW3	30	35	20	25
SW4	40	52	30	38
SW5	10	15	8	10
SW6	20	35	12	15
SW7	200	310	120	130
SW8	350	430	230	240

Table B: Surface Water Flow Measurements

3.2.3 Rainfall and Evaporation

Long term Annual Average Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall recorded at the Carrowkeel rainfall station, located approximately 6km east of the wind farm site is 1,630mm/year.

However, the AAR at Carrowkeel rainfall station is likely to underestimate the actual AAR at the Proposed Development site due to the elevation difference (the highest elevation at the Proposed Development site is 360m OD which is higher than Carrowkeel, 37m OD). Met Eireann modelled AAR values for the wind farm site range between 1,496 and 1,630mm year. The highest modelled value (1,630mm/year) is used for the Proposed Development site baseline assessment.

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Malin Head, approximately 25km north of the wind farm site. The long-term average PE

[1] Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.

for this station is 555mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 527mm/year (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,630 mm/year – 527mm/year

ER = 1,103mm/year

Table C below presents return period rainfall depths for the area of the proposed Glenard 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).

Table C: Summary of Rainfall return periods for proposed Glenard WF site.

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	3.8	6.6	13.9	17.1
15 mins	6.2	10.9	19.5	28.0
30 mins	7.8	12.3	22.9	32.0
1 hour	10	16.2	26.8	36.5
6 hours	18.6	27.2	40.4	51.5
12 hours	23.6	33.3	47.3	58.9
24 hours	30	40.6	55.5	67.3
2 days	37.1	48.6	63.9	75.8

3.3 GEOLOGY

The published soils map (**www.epa.ie**) for the area show that the majority of the Proposed Development site is dominated by blanket peat with some alluvium mapped along the course of the River Crana which flows along the north-western boundary of the site. A local

subsoils map of the area is attached as

Figure C.

Peat depths recorded at the wind farm site ranged from 0 to >5.6m with an average of approximately 2m. Over 60 percent of peat depth probes recorded peat depths of less than 2.0m and with 85% been less than 3m. The peat depths recorded at the turbine locations varied from 0.5 to 3.2m with an average depth of 2m.

Peat depth distribution analysis shows almost 30% of the peat depths were between 2 and 2.5m with 56% below 2.5m and 85% below 3.5m.

With respect to the existing and proposed access roads, peat thicknesses are typically less than 2m with localised depths of 4m.
Trial pits were carried out at the proposed borrow pit area (6 no.) and at 6 no. various locations around the wind farm site. Based on the Partical Size Distribution analysis of the samples taken from the trial pits, the subsoils encountered were typically silty sandy GRAVEL or gravelly SILT.

Based on the GSI bedrock mapping the bedrock formation underlying the proposed development site is the Fahan Grit Formation which comprises pale grey grit with psammitic schist. The bedrock is poorly exposed within the proposed wind farm site. The site is also mapped as being intercepted by a southwest/northeast orientated bedrock syncline axis.

3.4 HYDROGEOLOGY

The Precambrian quartzites, gneisses and schists, which are mapped to underlie the Proposed Development site are classified by the GSI (www.gsi.ie) as a Poor Aquifer (Pl), having bedrock which is generally unproductive except for local zones.

The Precambrian rocks of this area have no inter-granular permeability; groundwater flow occurs in fractures and faults; in-filling of fractures is to be expected. The permeability of individual fractures and the degree of interconnection will be generally low, with fracturing confined to local zones.

Permeability is highest in the upper few metres but generally decreases rapidly with depth. In general, groundwater flow is concentrated in the upper 15m of the aquifer, although deeper inflows from along fault zones or connected fractures can be encountered. Significant yields can be obtained where boreholes are drilled into known fault zones. In these rocks groundwater flow paths are expected to be relatively short, typically from 30-300m, with groundwater discharging to small springs, or to the streams that traverse the aquifer. Flow directions are expected to approximately follow the local surface water catchments (GSI, 2004).

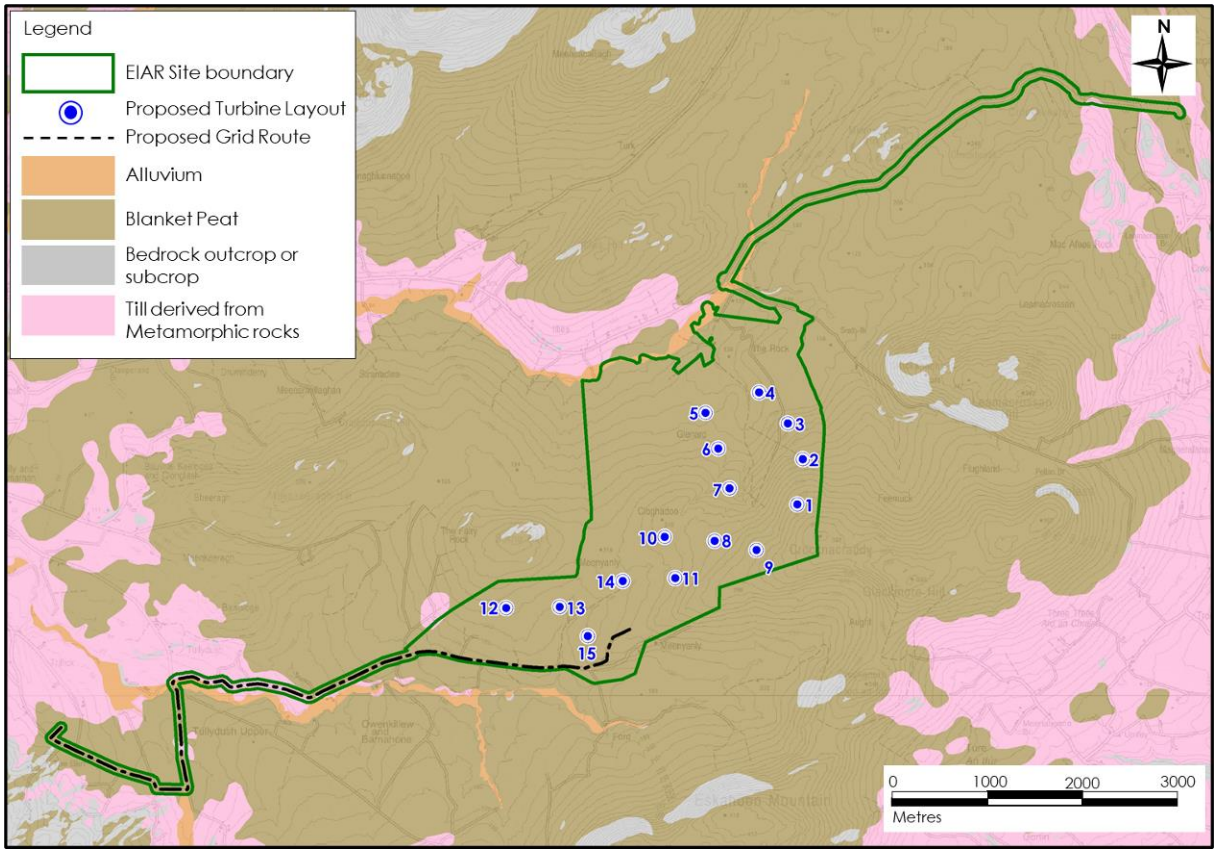

Figure C: Local subsoils map

3.5 DESIGNATED SITES & HABITATS

Within the Republic of Ireland designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). A designated site map for the area is shown as **Figure D.**

The Proposed Development site is not located within any designated conservation site, however there are downstream hydrological connections with some of the Natura 2000 sites as described below.

Lough Swilly, into which the wind farm site and grid connection drain is a designated SAC (Lough Swilly SAC) and pNHA (Lough Swilly including big isle, blanket Nook and Inch Lake).

The Donagh River drains into Trawbreaga Bay which is a SPA and which also forms part of the North Inishowen Coast SAC. The Cabry River drains into Lough Foyle which is a designated SPA in the foreshore area of Quigley's Point.

In the locality of the Proposed Development site there are two designated areas of upland blanket bog, Camowen River Bog NHA and Lllies Hill Bog NHA. Both NHAs are located less than 1km to the north of the Proposed Development. In addition both NHAs are located in catchments that are upstream of the Proposed Development site and therefore there is no hydrological connection between either of the NHAs and the proposed development.

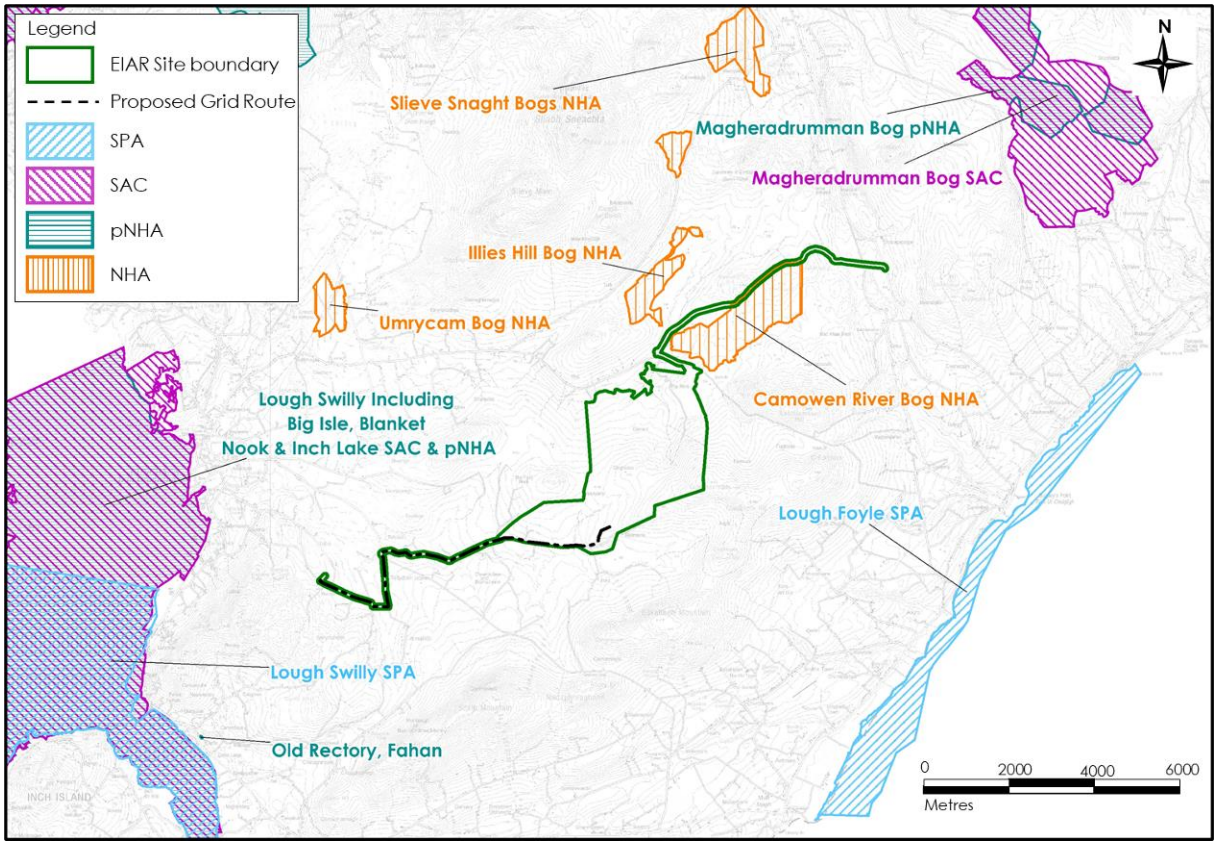

Figure D: Designated Sites Map

4. SITE SPECIFIC FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (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.

A stage 1 assessment of flood risk requires an understanding of where the water comes from (*i.e.* the source), how and where it flows (*i.e.* the pathways) and the people and assets affected by it (*i.e.* the receptors). It is necessary to identify whether there may be any flooding or surface water management issues related to the proposed site that may warrant further detailed investigation.

As per the guidance (DOEHLG, 2009), the stage 1 of a flood risk assessment comprises:

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

Further to this, a stage 2 assessment involves the confirmation of sources of flooding, appraising the adequacy of existing information and determining what surveys and modelling approach may be required for further assessment.

4.2 FLOOD ZONE MAPPING

Flood zones are geographical areas within which the likelihood of flooding is in a particular range. There are three types or levels of flood zones defined for these purposes according to OPW guidelines:

- Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% 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% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% 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% 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.

4.3 FLOOD RISK IDENTIFICATION

4.3.1 Soils Maps – Fluvial Maps

A review of the soil types in the vicinity of the Proposed Development 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.

Based on the EPA/GSI soil map for the area it appears that there are areas of mineral alluvium soils (fluvial deposits) mapped along the River Crana. No areas of Alluvium are mapped along any other rivers or tributaries of the Crana.

There is no significant Alluvium deposition that would be associated with a flood plain or a large geographical area prone to flooding.

4.3.2 Historical Mapping

There is no text on local available historical OSI 6" or 25" mapping for the proposed site that identify areas that are "*prone to flooding*". No areas were identified on either 6" or 25" historical maps.

4.3.3 OPW National Flood Hazard Mapping

No recurring flood incidents within the EIAR site boundary or immediately downstream were identified from OPW's Flood Hazard Mapping (refer to

Figure E below). The closest mapped recurring flood eventis located at Ballymagae near Buncrana, ~8km west of the site, on a small tributary of the Crana River. This appears to be very localised flooding from a small tributary river/stream.

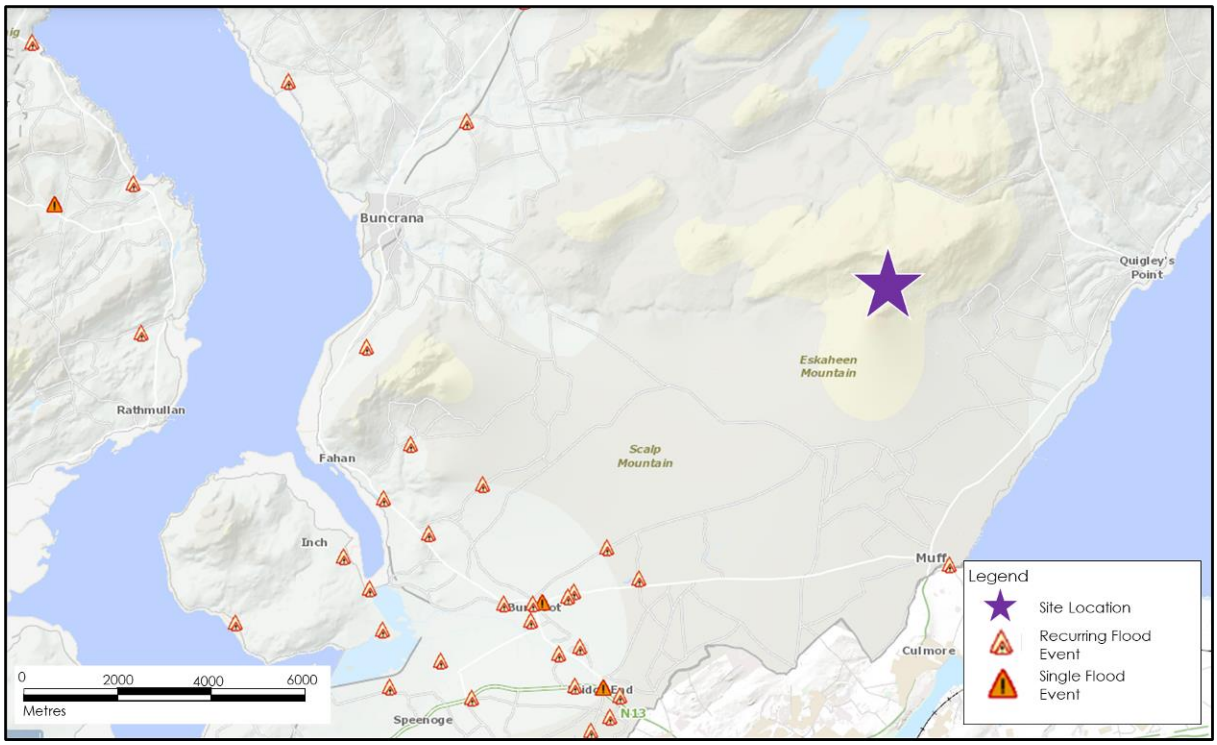

Figure E: OPW Flood Hazard Mapping (www.floods.ie)

4.3.4 CFRAM/OPW's River Flood Extents & Indicative Fluvial Flood Mapping

There is no OPW River Flood Extents Mapping available for the area of the Proposed Development site and therefore the OPW National Indicative Fluvial Mapping was consulted which has estimated fluvial flood zones for the Crana River and the Mill River (refer to **Figure F** below).

Based on the National Indicative Fluvial Mapping, the 100-year and 1000-year flood zone of the Crana River extend into the most north-western, low-lying part of the wind farm site (The north-western part of the wind farm site is bounded by the Crana River). However, there is no proposed wind farm infrastructure on the most north-western part of the wind farm site. The closest proposed infrastructure (T5) is ~0.5km from the mapped flood zone.

All proposed wind farm infrastructure is located above the mapped 1000-year flood level and therefore all infrastructure is located in Flood Zone C (Low Risk).

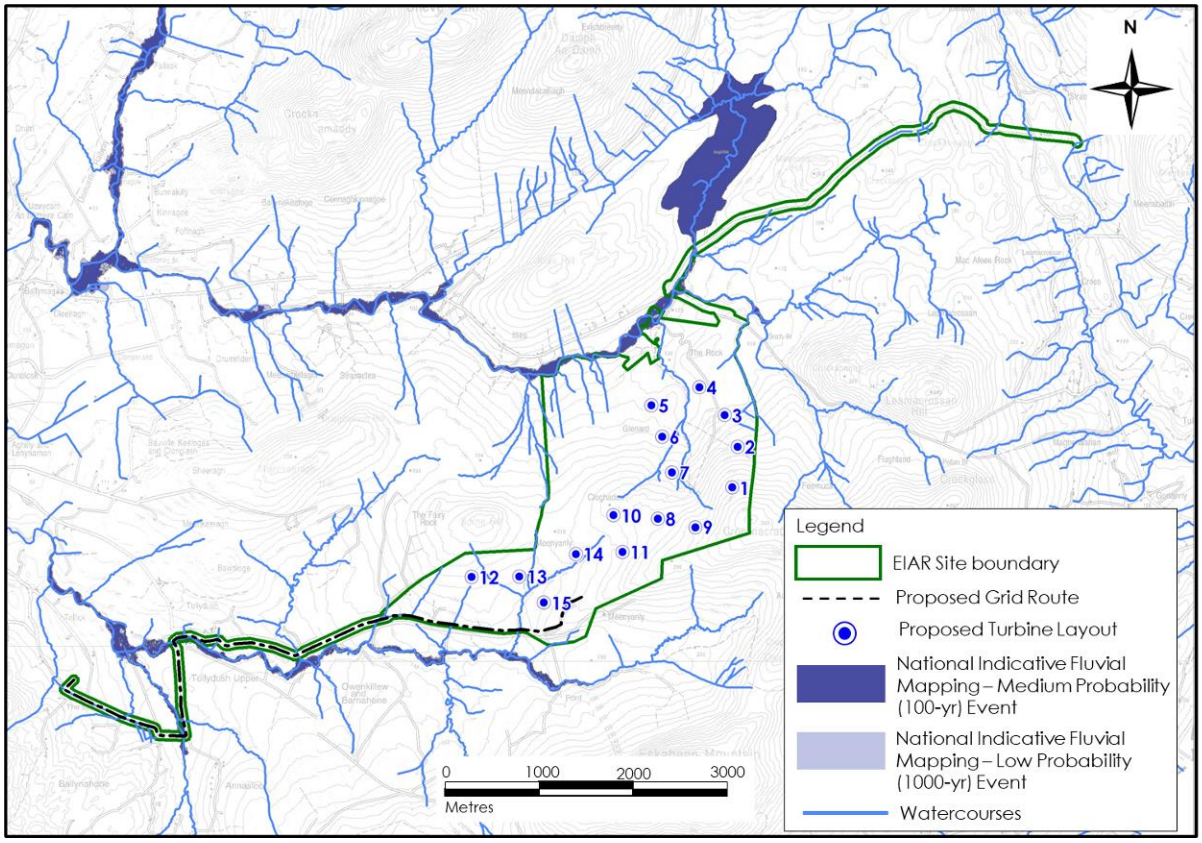

Figure F: OPW National Indicative Flood Mapping

4.3.5 Groundwater Flooding

Based on the GSI Groundwater Flooding Prabability Mapping, there are no mapped groundwater flood zones in the area of the Proposed Development site.

4.3.6 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, no parts of the proposed wind farm infrastructure are mapped within any fluvial flood zones (Flood Zones A - B).

All proposed wind farm infrastructure is located above the mapped 1000-year flood level and therefore all infrastructure is located in Flood Zone C (Low Risk).

4.4 INITIAL FLOOD RISK ASSESSMENT

4.4.1 Site Survey

Detailed walkover surveys of the proposed site were undertaken by HES on 22nd & 23rd October 2019, 13th February and 3rd June 2020, and 25th & 26th May 2021.

The forestry drains are the primary drainage routes towards the natural streams on the development site, but the flows in these drains are generally low and this is due to the relatively good natural drainage at the site.

As discussed above, several rivers have their upper reaches (mainly 1st /2nd order streams) within the proposed development site and these then merge before flowing off site (i.e. Glenard River).

Monitoring of stream discharge of the main streams within and downstream of the site was undertaken on several occasions at 8 no. monitoring locations (SW1 – SW8, refer to **Figure B** for locations) between October 2019 and May 2021 and these data is presented in **Table B** above.

All the higher flows measured during the period were in bank flows (i.e. contained within the channel).

During the walkover surveys and flow monitoring of the site there was little evidence of past out of bank flow from within the various river channels. During targeted visits following considerable rainfall in the prior day/s, high flows were observed within the rivers, with many estimated to be several multiples of the typical dry weather flow. No widespread or localized flooding was observed during these site visits, all flow was contained within the channels.

4.4.2 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the proposed site can be described using the Source – Pathway – Receptor Model ("S-P-R"). Given the generally steep topography at the site which decreases the potential for pluvial flooding, the primary potential source of flooding in this area, and the one with most consequence for the proposed site, is fluvial. The primary potential pathways, in the most likely order of significance, would be overbank flooding of the main streams flowing through the site during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.4.3 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 site proposed for development. The potential sources of flood risk for the proposed site are outlined and assessed in **Table D.**

Table D: S-P-R Assessment of Flood Sources for the proposed site

Source	Pathway	Receptor	Comment
Tidal	Not applicable	Land and infrastructure.	The proposed site is ~7km from the coast and there is no risk of coastal flooding.
Fluvial	Overbank flooding of the main streams passing through the site	Land and infrastructure.	There is no proposed infrastructure mapped within a fluvial flood zone. All turbines, compounds, substation and borrow pits are at least 50m from a watercourse.
Pluvial	Ponding of rainwater on site	Land and infrastructure.	There is very little risk of pluvial flooding within the proposed site as drainage moves relatively freely.
Surface water	Surface ponding/ Overflow	Land and infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land and infrastructure.	Based on local hydrogeological regime and PFRA mapping, there is no apparent risk from groundwater

			flooding.

4.5 REQUIREMENT FOR A JUSTIFICATION TEST

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test[2] is shown in **Table E** below.

The proposed wind farm can be categorised as "Highly Vulnerable Development" as electricity generating infrastructure will be present. However, as stated above, the site, including any proposed infrastructure is not located in a mapped Flood Zone and therefore the proposed development is appropriate from a flood risk perspective (refer to **Table E** below).

[2] *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).*

Table E: 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**
Less vulnerable development	Justification test	Appropriate	Appropriate
Water Compatible development	Appropriate	Appropriate	Appropriate

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

5. PLANNING POLICY AND JUSTIFICATION TEST

5.1 PLANNING POLICY AND CDP

The following policies (**Table F**) are defined in the Donegal County Council CDP 2018-2024 in respect of flooding, and we have outlined in the column to the right how these policies are provided for within the proposed development design:

Table F: CDP Policy on flooding and reference to relevant sections of this FRA report

No.	Policy	Development Design Response
FP1:	It is a policy of the Council to ensure that all development proposals comply with 'The Planning System and Flood Risk Management -Guidelines for Planning Authorities', November 2009, DoEHLG. In doing so the planning authority shall: 1. Assess developments in accordance with the Sequential approach and precautionary principle set out the in the Planning System and Flood Risk Management -Guidelines for Planning Authorities'; and 2. Utilise the Draft Flood Risk Management Plans (and any associated flood risk mapping) prepared as part of the CFRAMS programme, or any other flood risk datasets or mapping it considers appropriate, in assessing flood risk.	The DoEHLG Guidelines document and CFRAMS mapping used within development design process and in this assessment.
FP2	It is a policy of the Council to require applicants/developers to submit, where appropriate, an independent 'Flood Risk Assessment' in accordance with the Flood Risk Management Guidelines, DEHLG, 2009 or any subsequent related publication and/or 'Surface Water Drainage Calculations', from suitably qualified persons.	As outlined in this FRA.
FP3	It is a policy of the Council to require applicants/developers to submit, where appropriate, evidence of compliance with the Justification test set out in S5.15 of The Planning System and Flood Risk Management -Guidelines for Planning Authorities' (DoEHLG 2009) or any subsequent related publication	As outlined within this FRA in **Section 4.4.3 and 5.2**.
FP4	It is a policy of the Council not to permit development where flood or surface water management issues have not been, or cannot be, addressed successfully and/or where the presence of unacceptable residual flood risks remain for the development, its occupants and/or property or public infrastructure elsewhere including,inter alia, up or downstream.	As outlined in this FRA.
FP5	It is a policy of the Council to promote the use of Sustainable Urban Drainage Systems (SUDs), flood attenuation areas, the controlled release of surface waters and use of open spaces and semi permeable hard surfaces for appropriate development proposals.	SUDs methods included within WF drainage design (see **Section 6**).
FP6	It is a policy of the Council to consider the development of long and short-term flood remediation works, including embankments, sea defences, drainage channels, and attenuation ponds to alleviate flood risk and damage to	N/A

	livelihoods, property and business subject to environmental considerations including potential impact on designated shellfish water and, fresh water pearl mussel catchment areas, compliance with Article 6 of the Habitats Directive, best practicein Coastal Zone Management and the Marine Resource and Coastal Management policies of this Plan.	
› **FP7**	› It is a policy of the Council not to permit developments which would hinder the maintenance of river or drainage channels.	› No impact on rivers/drainage channels. Mitigations measures included within **Section 6**.

5.2 JUSTIFICATION TEST

Box 5.1 (**Table G** below) of "The Planning System and Flood Risk Management Guidelines" (PSFRM Guidelines) outlines the criteria required to complete the "Justification Test".

Table G: Format of Justification Test for Development Management

Box 5.1 Justification Test for Development Management (to be submitted by the applicant)
When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied: 1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines. 2. The proposal has been subject to an appropriate flood risk assessment that demonstrates: i. The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk; ii. The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible; iii. The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and iv. The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes. The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Note: *this table has been adapted from Box 5.1 of "The Planning System and Flood Risk Management Guidelines", (2009).*

Referring to Point 1 and Points 2 (i) to (iv) inclusive in Box 5.1 [of PSFRMG guideline document]:

1. The proposed development is currently in the planning process and has been deemed suitable for development by the applicant and design team following rigorous site investigation and assessment.
2. The proposal for 15 no. turbine wind farm and associated access tracks, construction compounds, sub-station, cable trench route, borrow pit grid connection, amenity pathways, carpark, turbine delivery route works areas and other ancillary works has been the subject of a Stage II flood risk assessment (this report) and this assessment has shown that:
   i. The development has been assessed to have no impact on flood risk elsewhere in the locality.
   ii. The proposed development will not impede the flow of surface water during extreme flood events. Drainage designs for the proposed development follow SuDS principles and will restrict discharge to greenfield runoff rates. It is therefore estimated that the development presents minimal risk to people, property, the economy and the environment. There will be no increase in flood risk on lands upstream or downstream of the application site (Refer to **Appendix 4-5** of the EIAR for the drinage plans);
   iii. The assessment has shown that there will be no residual risks to the proposed development or local area; and,
   iv. With respect to the above (flood risk management proposals) the proposed development is therefore compatible with the wider planning objectives of

the area. It does not alter the flood risk upstream or downstream of the proposed application site.

With regards to the proposed development site, it will generally remain flood free, but on very rare occasions there is a risk of shallow inundation from pluvial flooding, particularly in localised low points. However, due to the sloping nature of the ground in the area of the proposed footprint, no significant pluvial flooding is likely.

Surface water will be held on site, upslope ofaccess tracks, in shallow wet areas, in low lying areas, in silt traps and in settlement ponds. Surface water discharges from the site are attenuated and will be slowed down togreenfield runoff rates.

6. FLOOD IMPACT PREVENTION AND DRAINAGE MANAGEMENT

6.1 PROPOSED DRAINAGE

The site drainage system was designed integrally with the wind farm layout as a measure to ensure that the proposal will not change the existing flow regime across the site, will not deteriorate water quality and will safeguard existing water quality status of the catchments from wind farm related sediment runoff.

A fundamental principle in the drainage design is that clean water flowing in the upstream catchment, including overland flow and flow in existing streams, is allowed to bypass the works areas without being contaminated by silt from the works. The dirty water from the works areas is collected in a separate drainage system and treated by removing the suspended solids before discharging it to the downstream watercourse at greenfield rates. This minimises the volume of dirty water requiring treatment.

Existing streams intercepted by the proposed works area will be crossed by a clearspan culvert. New drains will be constructed to collect overland flow that is intercepted by the works areas or by new access roads. These will be constructed on the uphill side of the works and piped to the downhill side, bypassing the works areas. However, this will cause the normally dispersed flow to be concentrated at specific discharge points downstream of the works. In order to disperse this flow each clean water drain will be terminated in a discharge channel running parallel to the ground contours that will function as a weir to disperse the flow over a wider area of vegetation. This will prevent erosion of the ground surface and will attenuate the flow rate to the downstream receiving waters.

The resultant diversion of clean water runoff will ensure that the treatment system will only need to deal with construction related runoff. The treatment system consists of a series of settlement ponds that are located at each works site and at intervals along the access roads. The outflow from the settlement ponds will be allowed to disperse across vegetation and will become diluted through contact with the clean water runoff in the buffer areas before entering the downstream watercourses.

All new watercourses crossings structures and those existing proposed for upgrade will be designed to accommodate a 100-year flood event. A Section 50 application will be submitted to the OPW in advance of all crossing works proposed on OSI mapped watercourses.

6.2 PROPOSED ON-SITE RUNOFF ATTENUATION

The creation of impermeable areas within a development site has the effect of increasing rates of runoff into the downstream drainage system and this may increase flood risk and flood severity downstream. This applies particularly to urban areas that drain to closed pipe systems which do not have the capacity to cater for increased hydraulic loads. The proposed Glenard wind farm development is located within a large rural catchment with an open drainage system. The footprint of the impermeable areas and the associated increase in runoff rate is very small (0.077% increase) in the context of the catchment size and therefore represents a negligible increase in downstream flood risk. Notwithstanding the low increase in flood risk due to the development, the drainage system has been designed to prevent any increase in discharge rates above that which already exist in the undeveloped site.

The volume of water requiring attenuation relates to direct precipitation on the roads and hard-standing footprint only.

The proposed development footprint has been divided into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates based on the 10-year return period rainfall event (including 20% for climate change) were calculated for each catchment. These flows were then used to design settlement ponds for each drainage catchment.

The aim of the storm water attenuation measures is to limit the flow rate from the developed area to that which prevails on the undeveloped site. This is achieved by limiting the flow rate to the downstream receiving waters and temporarily storing the excess water that accumulates as a result. The developed surfaces have some permeability, and this reduces the attenuation requirement. Conventional attenuation systems use proprietary flow control units, but these can become blocked with debris and vegetation and require regular maintenance. They are therefore not appropriate for use within a forestry environment or where routine maintenance would not be practical.

It is proposed to provide the temporary storage within the drainage channels by creating stone dams within them at regular intervals. The spacing of the dams is typically 100m but depends on the channel slope, with steeper channels requiring shorter intervals. The dams, which are constructed with small sized aggregate, also reduce the flow rate through the drainage system and are an effective means of providing flow control. Silt fence also provide storage and flow control.

All runoff from the developed areas will be routed through settlement ponds downstream. The outflow from the settlement ponds will be released in a controlled and diffuse manner onto the vegetation or forestry floor where selected forestry rills willbe blocked to further promote diffusion of runoff. Therefore, the proposal will not increase the magnitude of the hydrograph peak. The control measures are passive as opposed to mechanical and do not require maintenance to ensure their ongoing effectiveness.

6.3 FLOOD IMPACT SCREENING FOR DESIGNATED SITES

Table H below provides a flood impact screening for local designated sites.

Table H: Flood Impact Screening for Local Designated Sites

Name	Site Code	Flood Risk Screening
Magheradrumman Bog SAC	000168	No increased flood risk. No hydraulic connection to site.
Lough Foyle SPA	004087	No increased flood risk. Attenuation measures for site discharge outlined above.
Lough Swilly SPA	004075	No increased flood risk. Attenuation measures for site discharge outlined above.
Camowen River Bog NHA	002405	No increased flood risk. The NHA is up-gradient of the wind farm site
Illies Hill Bog NHA	001127	No increased flood risk. No hydraulic connection to site.

7. REPORT CONCLUSIONS

7.1 CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the proposed wind farm development at Glenard, Co. Donegal. From this study:
  - No instances of historical flooding were identified in historic OS maps;
  - No instances of recurring flooding were identified on OPW maps within or immediately downstream of the proposed site; and,
  - No areas of the proposed site were identified within the OPW/CFRAM Flood Zones.
- The OPW National Indicative Flood mapping indicates that the Proposed Development site is not located within a flood zone;
- During the walkover surveys and flow monitoring at the site there was no evidence of out of bank flow from within the various stream/river channels. No widespread or even localized flooding was observed during these site visits;
- The proposed wind farm can be categorised as "Highly Vulnerable Development", however, all proposed infrastructure is located outside of areas mapped as Flood Zones and therefore the proposed development is appropriate from a flood risk perspective;
- The overall risk of flooding posed at the development site is estimated to be very low. A low risk would typically relate to the probability of being impacted by a 1000-year flood (*i.e.* the majority of the proposed development footprint located in fluvial Flood Zone C). The flooding risk at the proposed development site has an estimated AEP of <0.1%; and,
- In addition, the risk of the wind farm contributing to downstream flooding is also very low, as the long-term plan for the site is to retain and slow down drainage water to greenfield rates prior to release . Robust drainage measures on the site will include swales, silt traps, check dams, settlement ponds and buffered outfalls. Please refer to the hydrology Chapter of the EIAR for further details.

* *

8. REFERENCES

AGMET	1996	Agroclimatic Atlas of Ireland.
DOEHLG	2009	The Planning System and Flood Risk Management.
Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.