HYDRO ENVIRONMENTAL SERVICES
22 Lower Main St
Dungarvan
Co.Waterford
Ireland
tel: +353 (0)58 44122
fax: +353 (0)58 44244
email: info@hydroenvironmental.ie
web: www.hydroenvironmental.ie

PROPOSED CARRIG RENEWABLE ENERGY WIND FARM, CO. TIPPERARY

FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

MKO

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

DOCUMENT INFORMATION

Document Title:	**Proposed Carrig Renewable Energy Wind Farm Co. Tipperary– Flood Risk Assessment**
Issue Date:	**18th September 2023**
Project Number:	**P589-0**
Project Reporting History:	**None**
Current Revision No:	**P1589-0_ FINAL_F1**
Author(s):	**Michael Gill** **David Broderick** **Jenny Law**
Signed:	 **Michael Gill B.A., B.A.I., M.Sc., MIEI** **Managing Director – Hydro-Environmental Services**

Disclaimer:
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

TABLES IN TEXT

1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) was engaged by MKO Ireland to undertake a Site-Specific Flood Risk Assessment (FRA) for the proposed Carrig Renewable Energy Windfarm, Co. Tipperary. A site location map is shown below as **Figure A** below.

In summary, the Proposed Development site which includes 7 no. turbines, substation and underground grid connection is located at Carrig (and surrounding townlands), situated approximately 9km to the northeast of Borrisokane, Co. Tipperary.

The term 'Proposed Development site' refers to the lands within the EIAR/planning application boundary for the proposed wind farm development and grid connection.

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

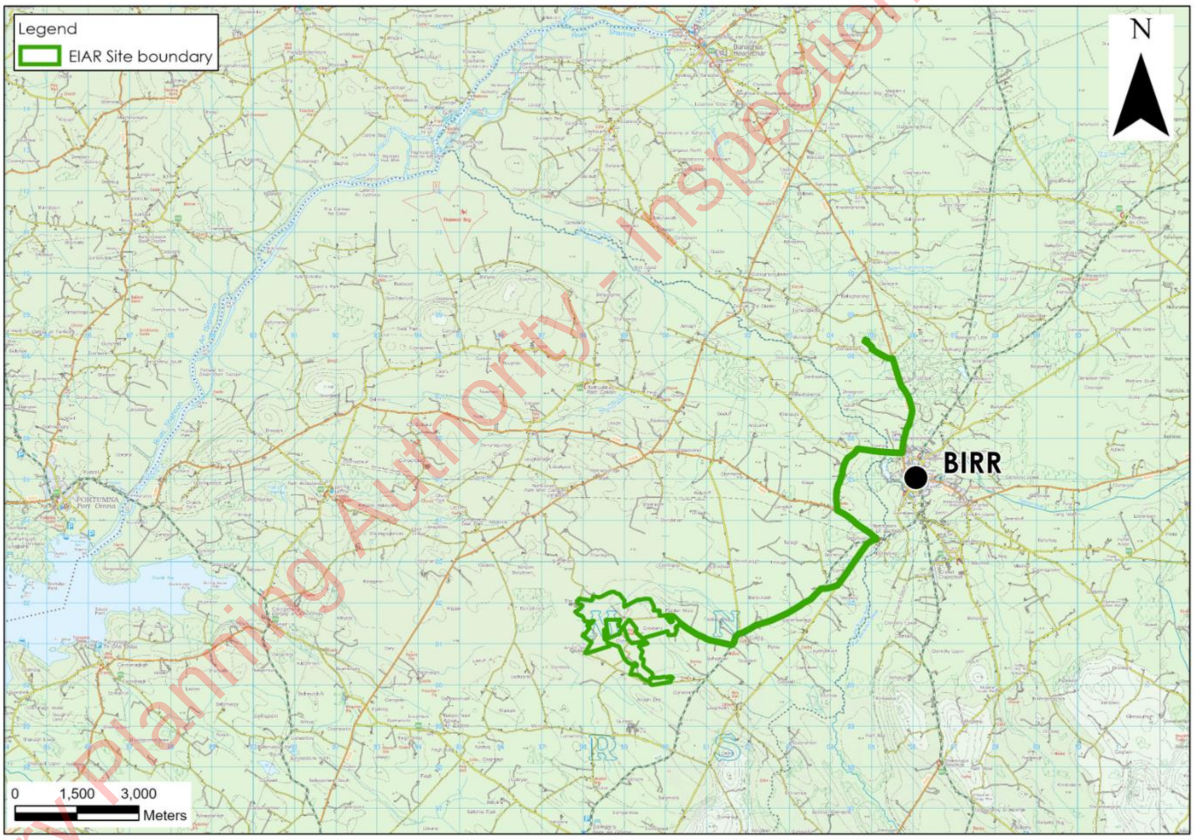

Figure A: Site Location Map

1.2 STATEMENT OF QUALIFICATIONS

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.

Michael Gill P.Geo (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous geological, hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design and surface water/groundwater interactions. For example, Michael has worked on the EIS for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

David Broderick P.Geo (BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 17 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and geological, hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Derrykillew WF, and Oweninny WF, and over 60 other wind farm related projects across the country.

Jenny Law (BSc, MSc) is an Environmental Geoscientist holding a first honours degree in applied Environmental Geosciences from the University College Cork. Jenny has assisted in the preparation of the land, soils and geology and hydrology chapters for various environmental impact assessment reports, hydrological impact assessments, Water Framework Directive Assessment reports and Flood Risk Assessment reports for a variety of projects including wind farm developments and strategic housing developments.

1.3 REPORT LAYOUT AND METHODOLOGY

This FRA report has the following format:

- Section 2 describes the site setting and details of the Proposed Development;
- Section 3 outlines the hydrological and geological characteristics of the Lower Shannon Sub-catchments in which the Proposed Development is located;
- Section 4 describes the existing site drainage;
- Section 5 presents a site-specific flood risk assessment (FRA) undertaken for the proposed development which was carried out in accordance with the above-mentioned guidelines;
- Section 6 carried out a Justification Test for the Proposed Development; 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:

- OPW Flood Studies Update (FSU) Web Portal;
- Geological Survey of Ireland (GSI) maps on superficial deposits;

- EPA hydrology maps;
- OPW National Indicative Fluvial Mapping (NIFM);
- Tipperary County Development Plan 2022 – 2028;
- Site walkovers and surveys conducted by HES on 24th August 2022, 17th, 24th January, 25th March and 14th April 2023.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

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

2.2 SITE LOCATION AND TOPOGRAPHY

The wind farm site is a low-lying cutaway raised bog setting (basin peat) located 9km to the northeast of Borrisokane, Co. Tipperary. The town of Birr in County Offaly is located 6.5km to the northeast. Access to the wind farm site is from the N52 which is located approximately 1.5km to the east of the Proposed Development site.

The wind farm site, which has a total area of approximately 314ha, is predominantly cutaway raised bog with areas of agricultural grassland and forestry. The surrounding area is largely agricultural including a piggery development which is located immediately to the northwest of the wind farm site. The wind farm site is accessible via network of public roads which run through the site along with some bog tracks that give access to various turbary plots on the periphery of the bog.

The wind farm site is located in a low-lying area (surrounded by small hills) where the ground is largely flat and sits at approximately 60m OD. The ground level rises to 70m OD on the east and west of the wind farm site where small hills are present. This forms a subdued topographic divide running through the centre of the wind farm site which creates gentle falls to the north and south.

Most of the wind farm site is exposed cutaway raised bog (with pockets of intact bog towards the centre), however there is tree coverage on the bog particularly on the northeast, northwest and west. There is agricultural land on the southwest.

The proposed grid connection is to the Dallow substation, situated 2.5km north of Birr (Co. Offaly) and measures a total distance of 13.7km. The proposed underground route is located entirely along public roads.

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

2.3 PROPOSED DEVELOPMENT DETAILS

With regard the FRA, the following main development components were considered:

- 7 no. wind turbines with an overall tip height of 185m;
- Hardstands, access roads and met mast;
- 38kV electricity substation;
- Underground grid connection cable (13.5km) between the wind farm site and the existing Dallow 110kV substation near Birr;
- 2 no. temporary construction compounds;
- Permanent peat and spoil repository areas; and,
- Windfarm drainage infrastructure (i.e. settlement ponds, drains, swales etc).

A site layout map for the wind farm site is shown as **Figure B** below.

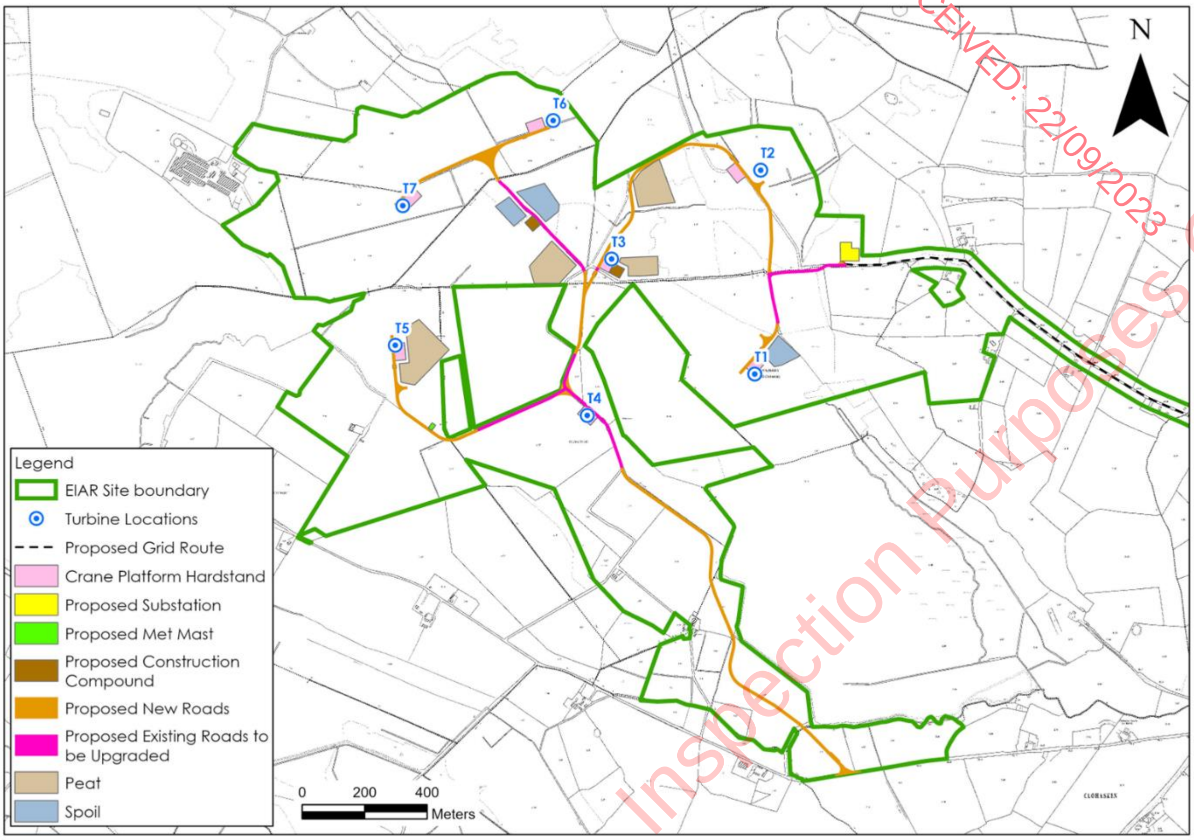

Figure B: Windfarm Layout Map

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

This section gives an overview of the geological, hydrological and hydrogeological characteristics Proposed Development site and local surface water catchments.

3.2 GEOLOGY

The published soil map (www.epa.ie) for the area shows that the wind farm site is dominated by Cut Peat (Basin Peats) with some basic deep well drained mineral soil on the east and southwest. All proposed wind farm site infrastructure is mapped to be underlain Cut Peat.

Similarly, the GSI subsoil mapping(www.gsi.ie) shows that the wind farm site is underlain predominantly by Cutover Raised Peat along with till derived from limestones. A localised pocket of gravels derived from limestones is mapped to the west of proposed turbine location T5. All proposed wind farm site infrastructure is mapped to be underlain by Cutover Raised Bog with the exception of a short section of proposed access road on the southwest of the wind farm which is mapped as limestone tills.

Measured peat depths range from 0 - 4.49m across the wind farm site, with an average depth of 1.6m recorded. Where peat was encountered it was typically described as spongy, dark brown, pseudo-fibrous peat.

Peat depths are greatest in the northeast of the wind farm site (around turbine locations T2 and T6) where peat depths range between approximately 2 and 4.5m. Peat depths on the northwest of the wind farm site (around turbine locations T5 and T7) are typically shallower where they range from between 0.5 and 2m and then thin out where bordered by agricultural land. Peat is generally absent or very shallow on the southwest of the wind farm site. (i.e. along the main site entrance road) where there is improved agricultural grassland. Peat is also absent on the far east of the wind farm site at the proposed substation location.

Peat depths at the turbine locations ranged between 0.6 (T4) and 3.7m (T2) with an average peat depth of 2.3m. Approximately 32% (49 no.) of the peat depths were less than 0.5m while 81% (126 no.) were less than 2m. Overall the peat depths would be considered shallow for midlands basin peat.

The trial pits, which ranged between 1.8m and 4m in depth, encountered mainly CLAY or SILT dominated subsoils which were typically described as gravelly and sandy with cobble and boulder content (glacial tills derived from limestone) below the peat or topsoil layer.

The total thickness of mineral subsoils over bedrock (i.e. depth to bedrock) was only confirmed in 2 no. of the 15 no. trial pits. These trials pits were located at proposed turbine T3 (TP03) and at the construction compound (TP04). Limestone bedrock was confirmed at 1.8mbgl at turbine T3 and 2.8mbgl at the construction compound. Mineral subsoils below the peat at turbine T3 are absent and peat sits directly on bedrock.

The mapped limestone bedrock in the area comprises Dinantian Pure Unbedded Limestones, Pure Bedded Limestones and Upper Impure Limestones.

3.3 HYDROLOGY

3.3.1 Rainfall and Evaporation

The Long-term-Average rainfall recorded at Birr, the closest rainfall station at approximately 6.5km northeast of the windfarm site, is 849mm (www.met.ie).

The average potential evapotranspiration (PE) is also recorded at Birr and is taken to be 445mm (www.met.ie). This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 423mm/year (which is 0.95 × PE). Using the above figures, the effective rainfall (ER)[1] for the area is calculated to be (ER = LTA – AE) ~426mm/year.

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 Proposed Development 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 A. Carrig – Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	3.9	6.8	12.1	17.3
15 mins	6.4	11.2	19.8	28.3
30 mins	8.1	13.7	23.3	32.3
1 hours	10.3	16.7	27.3	36.9
6 hours	19.2	28.0	41.1	52.1
12 hours	24.5	34.2	48.1	59.5
24 hours	31.1	41.7	56.4	68.0
2 days	38.5	50,5	66.5	79.0

3.3.2 Regional and Local Hydrology

Regionally the Proposed Development site is located in the Lower River Shannon surface water catchment within Hydrometric Areas 25A and 25B of the Shannon International River Basin District.

On a more local scale, the Proposed Development site is located entirely within the LittleBrosna_SC_020 sub-catchment (Little Brosna River catchment). The Little Brosna River flows to the east of the wind farm site at a downstream distance of approximately 5.5km. The Little Brosna River flows into the Shannon River approximately 22km downstream of the wind farm site. The grid connection crosses over the Little Brosna River northwest of Birr Town.

The Proposed Development site drains directly into the Little Brosna River via several local river waterbodies as described below in Section 3.3.3. A local hydrology map is shown as **Figure C** below.

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

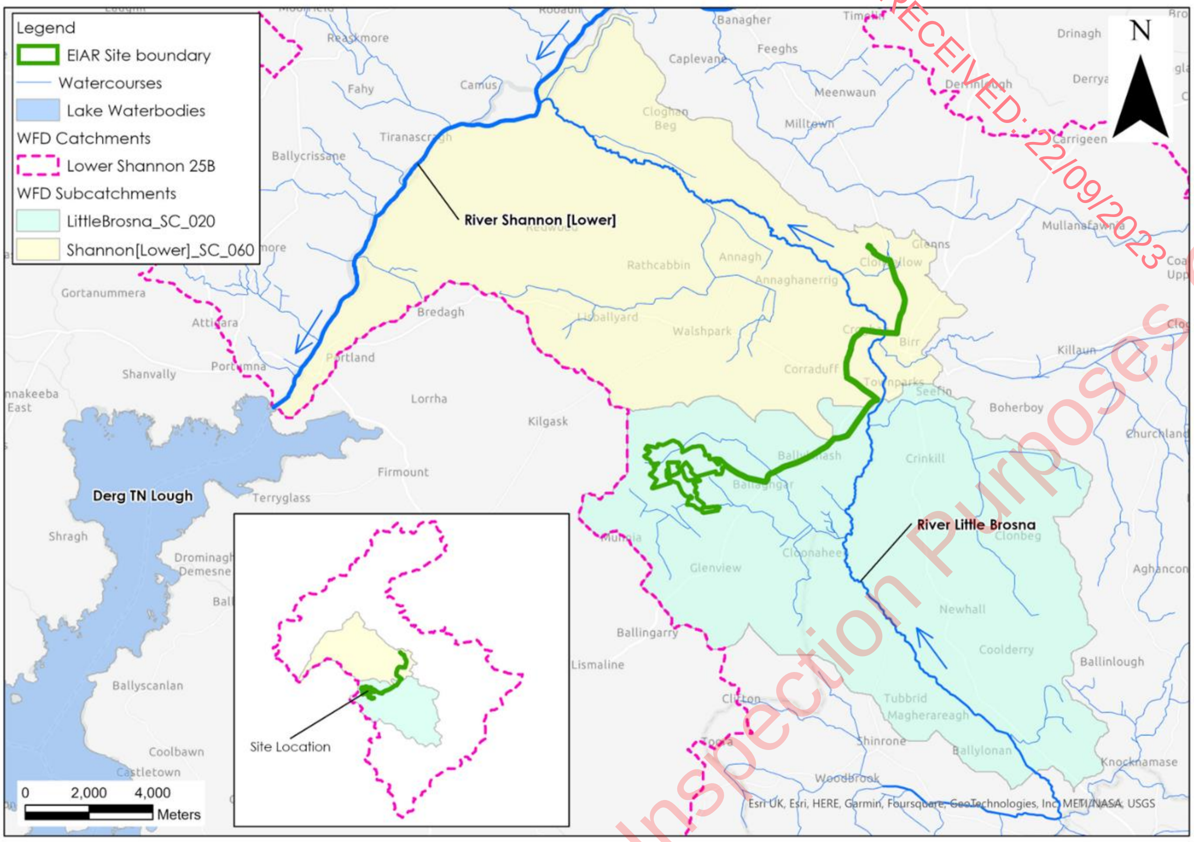

Figure C: Local Hydrology Map

3.3.3 Windfarm Site Drainage

The wind farm site drains to the Little Brosna River via 3 main river waterbodies. The Fadden Beg Stream on the north and the Holy Well Clohaskin Stream and Fadden More Stream on the south.

The northern portion of the wind farm site (including 6 no. of the 7 no. proposed turbine locations) is drained by the Faddan Beg Stream (EPA Code: 25F29) which flows through the northwestern section of the wind farm site.

The Faddan Beg Stream is a first order stream that rises to the west of the wind farm site and then flows along the northern edge of the cutaway raised bog on which many of the proposed turbines are located. The bog is significantly cutaway and has turbary plots that extend into the central portion of the bog. There are several drainage outfalls from the cutaway raised bog that flow northerly towards the Faddan Beg Stream as it passes through the wind farm site. The portion of the wind farm site to the north of the Faddan Beg Stream is largely covered by a coniferous forest which has a network of large land drains that flow to the southeast towards the Faddan Beg Stream.

The Faddan Beg Stream is joined by a second (unnamed) first order stream that emerges from the southwestern portion of the wind farm site and then flows along the south-eastern edge of the cutover raised bog before merging with the Faddan Beg Stream close to the northern boundary. The unnamed stream also drains some agricultural land located to the south of the cutaway raised bog.

The southern portion of the wind farm site drains to the Holy Well Clohaskin Stream (EPA Code: 25F29), which is a second order stream, that flows to the east close to the southern boundary of the wind farm site. The Holy Well Clohaskin Stream is fed by a smaller first order stream (Fadden More Stream) that flows along the south-eastern boundary of the wind farm site.

Proposed wind farm infrastructure in the southern portion of the wind farm site that drains to the Holy Well Clohaskin Stream include 1 no. turbine (T1) along with the site entrance and main access road. There is an area of commercial bog cutting in the southeast of the wind farm site that also drains to the Holy Well Clohaskin Stream and Fadden More Stream.

3.4 DESIGNATED SITES & HABITATS

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

The land surrounding the wind farm site has several designations due to the presence of numerous raised bogs which were once interconnected but have now been separated by roads and areas of reclaimed cutover bog. These boglands include the following designated sites:

- The Ballyduff/Clonfinane Bog SAC and pNHA (Site Code: 000641) is mapped approximately 130m to the north of the windfarm site.
- Further northeast (~2.3km) from the Proposed Development the Killeen Bog NHA (Site Code: 000648) is mapped.
- The Arragh More (Derrybreen) Bog SAC (Site Code: 002207) is located approximately 0.5km west of the wind farm site. The Arragh More Bog has also been designated as an NHA (Site Code: 000640) and has a greater mapped extent than the Arragh More (Derrybreen) Bog SAC. The Arragh More Bog NHA is located immediately adjacent the wind farm site to the west. The boundaries of the NHA are mapped ~200m east of T5.
- Approximately 1.8km west from the Proposed Development is the Kilcarren-Firville Bog SAC and pNHA (Site Code: 000647), described as a lowland raised bog complex containing a large area of uncut high bog.
- Sharavogue Bog SAC (Site Code: 000585) exists ~3.9km southeast of the wind farm site. The little Brosna River marks the western margin of the Sharavogue Bog SAC.

All watercourses draining the grid route flow in a westerly direction before discharging into the River Shannon. In this area the Shannon has the following designations: River Shannon Callows SAC and pNHA (Site Code: 000216) and Middle Shannon Callows SPA (Site Code: 004096).

4. SITE SPECIFIC FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following flood risk 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.

4.2 FLOOD RISK ASSESSMENT PROCEDURE

This section of the report details the site-specific flood risk assessment carried out for the Proposed Development and surrounding area. The primary aim of the assessment is to consider all types of flood risks and the potential impact on the development. As per the relevant guidance (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 potential risk to a proposed development*.

As per the Guidelines, 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.

Due to its inland location, coastal flooding is not applicable to the 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 storm water 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 level may rise slowly, it may be in place for extended periods of time. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life.

- Estuarial flooding may occur due to a combination of tidal and fluvial flows, i.e. 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 river banks.

The Flood Risk Management Guidelines provide direction on flood risk and development. The guidelines recommend a precautionary approach when considering flood risk management and the core principle of the guidelines 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:

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.

Once a flood zone has been identified for a site, the guidelines set out the different types of development appropriate to each identified zone (pg 25, Table 3.1 of the Guidelines). Exceptions to the restriction of development due to potential flood risks are provided for through the application of a Justification Test, where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated by the applicant.

The Justification Test 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 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 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 Soils Maps - Fluvial Maps

A review of the soil types in the vicinity of the wind farm 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 flood plain and hence the presence of these soils is a good indicator of potentially flood prone areas.

There are no mapped areas of mineral alluvium soil mapped along the watercourses of the streams within the wind farm site.

4.3.2 Historical Mapping

To identify those areas as being at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) were consulted. There was no identifiable map text on local available historical 6" or 25" mapping for the Proposed Development that would identify lands that are "liable to flood" within the area and the vicinity of the Proposed Development.

The L1075 local road that extends northwest from Carrig townland, approximately 2km east from the wind farm site, has been identified as land that is "liable to flood" within historical mapping. This does not affect the Proposed Development.

4.3.3 OPW Past Flood Event Mapping

No recurring flood incidents within the proposed wind farm site were identified from OPW's Past Flood Event Mapping (www.floodinfo.ie) as shown on **Figure D** below.

There are 3 no. of recurring flood incidents within a 5km radius of the wind farm site, all of which are known turloughs. The nearest turlough mapped as a recurring flood event is approximately 2.2km south of the wind farm at Guteen, Ballingarry, Co. Tipperary (Flood ID: 790). Approximately 2.6km west of the wind farm site is the turlough at Sluggary Pool, Kilgask, Co.

Tipperary (Flood ID: 782). The Liskeenan, Lismacroy turlough is mapped within the Liskeenan Fen SAC ~3km southwest of the wind farm site (Flood ID: 788).

Downstream of the wind farm site, recurring flood events (Flood ID: 2820 and 2828) are mapped on small stream in the vicinity of Birr Town. Further downstream recurring flooding incidents are located along the Little Brosna River between the townlands of Annagh and Clonrah and Glaster, approximately 17km downstream from the site. One of the recurring events is occurs when the river backs up from Shannon and floods lands during most winters on both sides of the Athlone Road [Flood ID 3774]. At Cloghran/Borrisokane Road there has historically been serious road flooding. Drainage works were carried out in the year 2000 and since then the flooding issue has been resolved [Flood ID 3775].

Downstream from the Proposed Development once the Holy Well Clohaskin and Faddan Beg streams pass the N52 National Road to the east of the site, they are mapped as an OPW Drainage District, *i.e.* an area where drainage schemes were constructed to improve land for agricultural purposes, by lowering water levels during the growing season to reduce waterlogging on the land beside watercourses known as callows. However, these maps are not definite and do not show all flood zone areas.

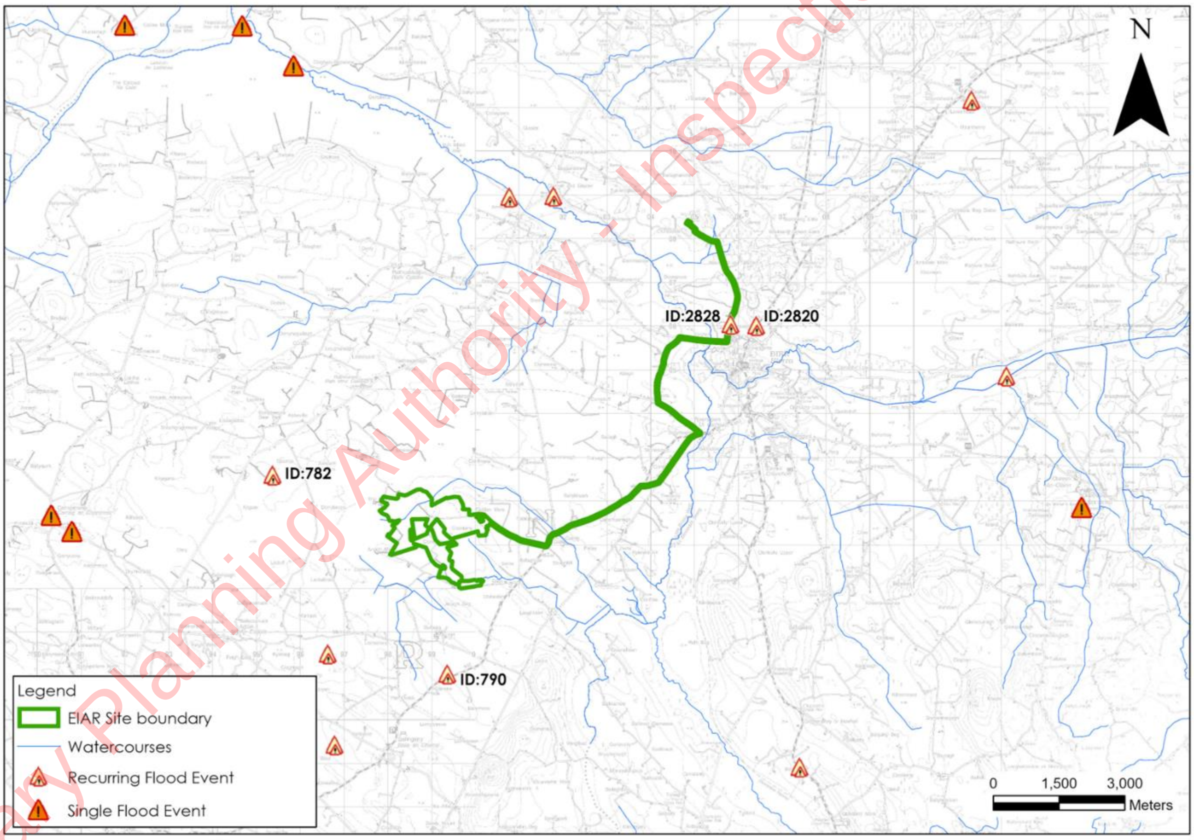

Figure D: OPW Flood Event Mapping

4.3.4 CFRAM Flood Extent Mapping

Where complete the Catchment Flood Risk Assessment and Management (CFRAM)[2] OPW Flood Extent Maps are now the primary reference for flood risk planning in Ireland. This mapping is currently only available for the Little Brosna River further downstream of the proposed wind farm site.

However, there is National Indicative Fluvial Mapping (NIFM) available for the Holy Well Clohaskin Stream and Faddan Beg Stream as discussed below.

4.3.4.1 National Indicative Fluvial Mapping (NIFM) River Flood Extent

National Indicative Fluvial Mapping has been completed for catchments greater than 5km² for which flood maps were not produced under the CFRAM Programme.

The National Indicative Fluvial Mapping for the present day shows the modelled extent of land that might be flooded by rivers (fluvial flooding) during a theoretical or 'design' flood event with an estimated probability of occurrence, rather than information for actual floods that have occurred in the past.

The National Indicative Fluvial Flood Map for the Present Day Scenario shows flooding along the Fadden Beg Stream and the Holy Well Clohaskin Stream which drain the northern and southern portions of the wind farm site respectively.

The medium (1% AEP, 1 in 100year) and low (0.1% AEP, 1 in 1,000yr) probability flood zones associated with these streams encroach upon only very small areas of the wind farm site close to the proposed site entrance.

The Mid-Range and High-End scenarios model potential flood zones associated with climate change and an increase in rainfall of 20% and 30% respectively. These modelled flood zones do not differ significantly from the Present Day Scenario.

The National Indicative Fluvial Flood Map show that a short section of proposed access road (~50m), close to the wind farm site entrance on the south of the site, is mapped inside a 100-year and 1000-year flood zone (Flood Zone A & Flood Zone B). The mapped fluvial flood zones associated with the Fadden Beg Stream on the north of the wind farm site do not effect any proposed infrastructure.

All other infrastructure (including all the turbines, substation, construction compound and peat/spoil storage areas) is located above the 1000-year flood level (i.e. Flood Zone C).

[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.

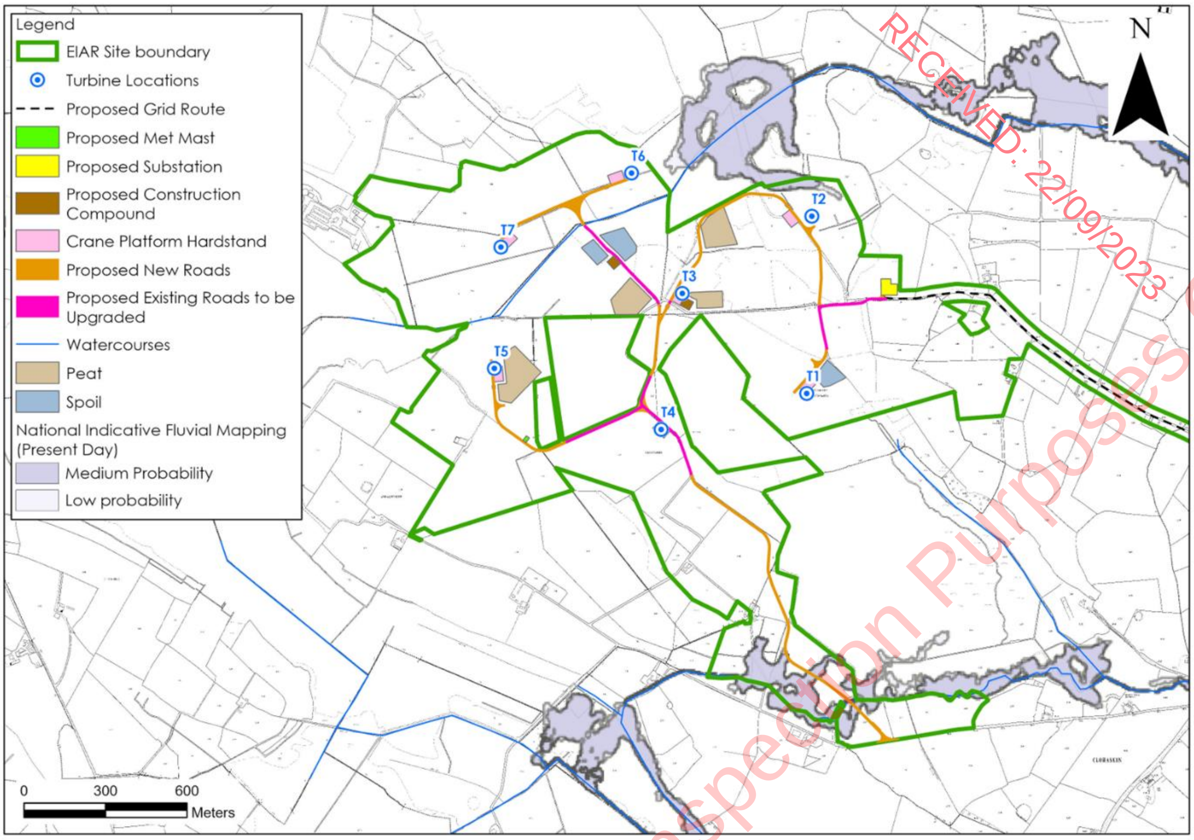

Figure E: NIFM Flood Mapping

4.3.4.2 Modelled Flood Scenarios Associated with Climate Change

It is likely that climate change will have significant impacts on flooding and flood risk in Ireland due to rising sea levels, increased winter rainfall and more intense rainfall. The CFRAM Programme has modelled flooding associated with potential future climate change scenarios.

These flood zones have also been modelled for 2 no. potential future climate change scenarios, with the Mid-Range and High-End Future Scenario flood extents generated using an increase in rainfall of 20% and 30% respectively.

No significant increase in potential flood extents within the wind farm site are mapped for NIFM Mid-Range Future Scenario extents and High-End Future Scenario extents.

These modelled future flood extents do not deviate significantly from the current scenarios described in **Section 4.3.4.1** above.

4.3.4.3 GSI Winter 2015/2016 Surface Water Flooding Maps

The Geological Survey of Ireland Historic Flood Maps show maximum observed extents of flooding, both groundwater and surface water, over various periods. The Maximum Historic Groundwater Flood Map shows maximum observed flood extents for locations of recurrent groundwater flooding in limestone regions. The map is primarily based on the winter 2015/2016 flood event, which in most areas represented the largest groundwater flood event on record.

Some flooding was recorded in the bog ~300m north of the wind farm site and likely resulted from pluvial flooding (*i.e.* surface water ponding after rainfall). Some very small areas of surface water flooding were also recorded in the agriculture lands to the south but these are very localised and do not encroach upon the wind farm site.

Winter 2015/2016 Surface Water Flooding areas are also mapped downstream from the proposed wind farm site along the watercourse of the Little Brosna River approximately 4km to the east of the site.

4.3.4.4 GSI Groundwater Flood Maps

Based on the GSI Groundwater Flood Maps the wind farm site is not mapped within any historic or modelled groundwater flood zones. Groundwater flood zones are mapped in the lands surrounding the wind farm site, predominantly to the west and are generally associated with mapped turloughs.

4.3.5 Summary – Flood Risk Identification

Based on the information gained through the flood identification process it is apparent that only very small areas of the wind farm site are potentially affected by fluvial flooding.

Minor fluvial flood zones are mapped along the Fadden Beg Stream on the north off the wind farm site, but all mapped flood zones along this watercourse are remote from all proposed infrastructure.

On the south of the wind farm site there are also mapped flood zones along the Holy Well Clohaskin Stream which encroach on short sections of proposed access roads.

However, the majority of the wind farm site resides within Flood Zone C including all turbine locations, the substation and peat/spoil storage areas.
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 within the Proposed Development site.

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process the sources of flood risk for the site are outlined and assessed in **Table B.**

Table B. S-P-R Assessment of Flood Sources for the Proposed Development

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the rivers and streams located within the wind farm site	Land & infrastructure	Minor Fluvial Flood Zone A and B are mapped on the north and south of the wind farm site. Only mapped flood zones on the south of the wind farm site encroach short sections of proposed access roads.
Pluvial	Ponding of rainwater on site	Land & infrastructure	There is risk of pluvial flooding within the proposed wind farm site due to the low permeability of the peat soils and subsoils overlying the wind farm site. The surface of the bog contains a network of peat and forestry drains with surface water outflows from the bogs. This existing drainage network has reduced the risk of pluvial flooding across much of the wind farm site. However, following periods of intense and prolonged rainfall events localised surface water ponding is still likely to occur in places.
Surface water	Surface ponding/ Overflow	Land & infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land & infrastructure	Based on local geological/ hydrogeological setting (i.e. peat

			with confined groundwater table), groundwater flooding at the site is unlikely.
Coastal/tidal	Overbank flooding	Land, People, property	Not applicable. The Proposed Site is a significant distance from the coast and therefore there is no risk of coastal flooding.

4.3.6 Proposed Windfarm Drainage

The development of the site means that there will be an increase in hardstand/roofed areas (i.e. substation). However, the existing green areas at the wind farm site are formed mainly from peat soils with a naturally high runoff potential. The proposed wind farm site is relatively flat, and the slope of the ground will dampen the limited potential for runoff.

Given the slope (or lack thereof) of the site, the surface water drainage, the small area of proposed development relative to the larger site area, there is limited to no potential for increase in runoff as a result of the proposed new access tracks/ hardstands areas etc (i.e. the proposed development footprint). Any potential small increase in runoff will be local to the development footprint, and any such small increases will be buffered/eliminated by the lack of gradient.

Nevertheless, the overarching objective of the proposed drainage measures is to ensure that all surface water runoff is comprehensively treated and attenuated such that no silt or sediment laden waters or deleterious material is discharged into the local drainage system. A Planning-Stage SWMP, incorporating the surface water drainage design has been prepared, see **Appendix 4-4 of the EIAR**, and incorporates the principles of Sustainable Drainage Systems (SuDS) through an arrangement of surface water drainage infrastructure. The SWMP has regard to Greenfield runoff rates and is designed to mimic same and is sufficient to accommodate a 1-in-10 year rainfall event.

While the SuDS is an amalgamation of a suite of drainage infrastructure; the overall philosophy is straightforward. In summary:-

- All surface water runoff will be directed to specially constructed swales surrounding all areas of ground proposed to be disturbed (including the area for the temporary storage of material);
- The swales will direct runoff into settlement ponds/silt traps where silt/sediment will be allowed to settle;
- Following treatment, clean water will be discharged indirectly to the local drainage network via buffered outfalls thus ensuring that no scouring occurs;
- All new watercourse crossings and culvert upgrades will be designed to accommodate a 100-year flood flow with allowance for at least 300m below the soffit structure.

The suite of surface water drainage infrastructure will include interception drains, collector drains swales, sedimats, flow attenuation and filtration check dams, settlement ponds/silt traps, and buffered outfalls.

The design criteria implemented as part of the SuDS are as follows:-

- To minimise alterations to the ambient site hydrology and hydrogeology;
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate, where possible, the existing hydrological environment of the site;
- To minimise sediment loads resulting from the development run-off during the construction phase;
- To preserve greenfield runoff rates and volumes;
- To strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed;

- To provide settlement ponds to encourage sedimentation and storm water runoff settlement;
- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally;
- To manage erosion and allow for the effective revegetation of bare surfaces;
- To manage and control water within the site and allow for the discharge of runoff from the site below the MAC of the relevant surface water regulation value; and,
- The high sensitivity of downstream receptors along with WFD status.

4.3.7 Flood Resilience Measures

The site-specific flood zone modelling (as shown in **Figure E** above) shows that only short sections of proposed access road will potentially be affect by fluvial flooding. The flood zones are mapped close to a proposed Holy Well Clohaskin Stream watercourse crossing on the south of the site. There is no record of flooding in this area based on the available historical mapping.

For all new crossing works on OPW mapped watercourses a Section 50 consent will be sought under Section 50 of the Arterial Drainage Act, 1945 to install a new culvert/bridge with the hydraulic capacity to accommodate a 100-year flood flows while maintaining at least a 300mm freeboard above the flood level.

Also, the proposed access road surface level will be close or at the existing ground level to prevent obstruction of surface water flow paths.

5. JUSTIFICATION TEST & PLANNING POLICY

5.1 PLANNING POLICY & COUNTY DEVELOPMENT PLAN

The following planning policies (**Table C**) are defined in the Tipperary County Council County Development Plan (CDP) 2022-2028 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. We note that the northern portion of the grid connection route is located within Co. Offaly. As the majority of grid connection works will be conducted along existing road developments, the Co. Offaly CDP was not consulted.

Table C: Tipperary County Council CDP Policy on flooding

No.	Policy	Development Design Response
11-9	Assess all new developments (both within and without designated Flood Risk Zones) in line with the 'Staged Approach' and pre-cautionary principle set out in the Planning System and Flood Risk Management Guidelines for Planning Authorities, (DoEHLG, 2009) and any amendment thereof, and the following:	Guidelines within DoEHLG document and CFRAM mapping used within development design process and in this assessment.
11-10	(a) Flood risk assessments shall incorporate consideration of climate change impacts and adaptation measures with regard to flood risk, and, (b) Flood risk management planning shall determine actions to embed and provide for effective climate change adaptation as set out in the OPW 'Climate Change Sectoral Adaptation Plan for Flood Risk Management' applicable at the time.	This document considers climate change impacts as future scenarios are described in **Section 4.3.4.2**
11-11	(a) Ensure that new developments proposed in 'Arterial Drainage Schemes' and 'Drainage Districts' do not result in a significant negative impact on the integrity, function and management of these areas.	As outlined in **Section 4.3.3**, no part of the proposed development is located within an 'Arterial Drainage Schemes' and 'Drainage Districts' and therefore have no potential to have a negative impact on the integrity, function and management of these areas.
11- F	To consider, as appropriate any new and/or emerging data, including, when available, any relevant information contained in the CFRAM Programme Flood Risk Management Plans.	This document considers CFRAM data available as described in **Section 4.3.4**

5.2 REQUIREMENT FOR A JUSTIFICATION TEST

The matrix of vulnerability versus flood zone is shown in **Table D** to illustrate appropriate development types or indicate when a Justification Test[3] is required. The detailed flood risk assessment has determined that the proposed wind farm site for the most part is within Flood Zone C, including highly vulnerable elements of the infrastructure including all the 7 no. turbines, the substation and the spoil/peat repository areas.

The National Indicative Fluvial Flood Map shows that a short section of proposed access road close to the wind farm site entrance on the south of the site, is mapped inside a 100-year and 1000-year flood zone. The proposed wind farm access roads can be categorised as "Less Vulnerable Development".

Therefore, a Justification Test is required for this part of the development within mapped flood zones. A justification test is outlined in **Table D** below for the Proposed Development.

Table D: 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.*

[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).*

6. JUSTIFICATION TEST

Box 5.1 (

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

Table E: 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 Figure 20 [of PSFRM guideline document]:

1. The Proposed Development has been deemed suitable for development by the applicant. The applicant is aware of the fluvial and pluvial flood risks associated with the areas of the proposed site, and they have included design layout responses to ensure avoidance of fluvial flood zones for the most sensitive elements of the proposed infrastructure. All proposed infrastructure with the exception of short sections of proposed access roads are located in Flood Zone C;

   Also, the site is located in an area deemed "Unsuitable" for wind energy development in the Tipperary WES. However, MKO's detailed site specific constraints assessment (Refer to Chapter 3 of the EIAR) and all of the rigorous assessments carried out as part of the design phase and the EIAR show that the site does have potential to accommodate a wind energy development.

2. The proposal for 7 no. turbine wind farm and associated access tracks, construction compound, spoil/peat storage areas, sub-station, 1 no. met mast, cable, grid connection, 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 and this largely due to the avoidance of fluvial flood zones;
   ii. The proposed development will not impede the flow of surface water during extreme flood events. Drainage designs for the proposed development follows

SuDS principles and adequately sized watercourse crossing structures to cope with peak floods. We conclude that the proposed 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 proposed development site;

iii. The flood assessment has shown that there will be no residual risks to the proposed development or the local area. Flood resilience proposals for new watercourse crossings and access roads are outlined above. All other elements of the development proposal are located outside of modelled flood zones; 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 for the large part remain flood free, but on rare occasions there is a minor risk of shallow inundation from pluvial flooding which will have no consequence for the Proposed Development.

7. REPORT CONCLUSIONS

- According to the NIFM mapping, the majority of the Proposed Development is mapped in Flood Zone C (Low Risk), including all 7 no. of the proposed turbines, the 38kV substation, temporary construction compound and all the spoil/peat storage areas.
- The National Indicative Fluvial Flood Map show that a short section of proposed access road close to the wind farm site entrance on the south of the site, is mapped inside a 100-year and 1000-year flood zone. The proposed wind farm access roads can be categorised as "Less Vulnerable Development" and a Justification Test is carried out for this element of the proposed infrastructure;
- The proposed development will have no impact on flood risk elsewhere in the locality and this largely due to the avoidance of fluvial flood zones for all sensitive aspects of the proposed infrastructure;
- The flood assessment has shown that there will be no residual risks to the proposed development or the local area. Flood resilience proposals for new watercourse crossings and access roads are outlined above. All other elements of the development proposal are located outside of mapped flood zones;
- A drainage plan, incorporating the principles of Sustainable Drainage Systems (SuDS)has been prepared for the wind farm site; and,
- This FRA fulfils the requirements for a site specific flood risk assessment and is consistent with the recommendations made in the Tipperary County Development Plan 2022-2028.

* *

8. REFERENCES

DOEHLG	2009	The Planning System and Flood Risk Management.
Natural Environment Research Council	1975	Flood Studies Report (& maps).
Cunnane & Lynn	1975	Flood Estimated Following the Flood Studies Report
Cawley, A.	1990	*The Hydrological Analysis of a Karst Aquifer System.* B.E., National University of Ireland.
CIRIA	2004	Development and Flood Risk – Guidance for the Construction Industry.
OPW	Not Dated	Construction, Replacement or Alteration of Bridges and Culverts. A Guide to Applying for Consent under Section 50 of the Arterial Act, 1945.
Institute of Hydrology	1994	Flood Estimation in Small Catchments.
Fitzgerald & Forrestal	1996	Month and Annual Averages of Rainfall for Ireland 1961 – 1990.
Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.

22 Lower Main Street, Dungarvan, Co. Waterford, X35 HK11
T: +353-(0)58-441 22 **F:** +353-(0)58-442 44 **E:** info@hydroenvironmental.ie

www.hydroenvironmental.ie