APPENDIX 9-1

FLOOD RISK ASSESSMENT

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TAURBEG WIND FARM
EXTENSION OF OPERATIONAL LIFE

FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

TAURBEG LTD

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) was engaged by MKO Ireland (MKO), acting on behalf of the Applicant, to undertake a Flood Risk Assessment (FRA) for a planning application for the proposed extension of life of Taurbeg Wind Farm, Co. Cork (*i.e.* the Proposed Project).

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

This FRA is intended to supplement the Environmental Impact Assessment Report (EIAR) submitted as part of the Proposed Project application.

As detailed in Section 1.1.1 of the EIAR, this FRA uses for the following terminology: 'Proposed Lifetime Extension', 'the Site', the 'Proposed Offsetting Measures' and the 'Proposed Project'.

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., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Slievecallan WF, Cahermurphy (Phase I & II) WF, Carrownagowan WF, and Croagh WF and over 100 other wind farm related projects across the country.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 4 years' experience in environmental consultancy in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016) from University College Dublin. Conor has prepared the Land, Soils and Geology and Hydrology and Hydrogeology Chapters for numerous wind farm EIAR projects. Conor routinely completes WFD Assessments for a wide variety of projects including wind farms, quarries and proposed residential developments.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management in India. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016).

1.3 REPORT LAYOUT

This FRA report has the following format:

- Section 2 describes the site setting and details of the Proposed Project;
- Section 3 outlines the hydrological and geological characteristics of the local area;
- Section 4 presents a site-specific flood risk assessment (FRA) which was carried out in accordance with the above-mentioned guidelines;
- Section 5 Planning policy and responses to those policies outlined in this FRA and completes a justification test for the Proposed Project; and,
- Section 6 presents the FRA report conclusions.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Site and the Proposed Offsetting lands along with a description of the Proposed Project.

2.2 SITE LOCATION AND TOPOGRAPHY

Proposed Lifetime Extension- the Site
The Site is located 3.5km south of Rockchapel and 10.5km northwest of Newmarket, Co. Cork. The Site is located in the townlands of Taurbeg, Glasheenanargid, Foiladaun, Glennaknockane, Meentinny West, Taurmore. The Site has a total area of ~112hectares (ha).

The Site is located in an upland setting and is situated on the southern foothills of the Mullaghareirk Mountain range. Topography within the Site ranges from ~302 metres above Ordnance Datum (mOD) in the northeast to ~405mOD in the southwest. The lowest elevations are found in the northeast of the Site, at the existing entrance to Taurbeg Wind Farm. Topography rises to the west and there are three local peaks within the Site, one standing at an elevation of ~392mOD in the north, with two local peaks standing at ~405mOD further south.

The Site is drained by several streams which ultimately drain to the River Feale or River Blackwater rivers. The Site comprises of a mixture of renewable energy production, coniferous forestry, blanket peat (bogs) and transitional woodland/scrub, and farmland (grassland). The existing Taurbeg Wind Farm is accessed via the wind farm site entrance off the L5005, in the townland of Taurbeg and is served by a network of existing wind farm access roads.

Taurbeg Wind Farm comprises of 11 no. existing wind turbines, associated hardstands, access roads, grid cabling, on onsite substation and met mast. There are no changes to the existing wind farm infrastructure are proposed as part of the Proposed Lifetime Extension.

Proposed Offsetting Lands
The Proposed Offsetting lands are located in townlands of Coom and Knockatee, Co. Kerry, ~12km west/southwest of the existing Taurbeg Wind Farm. The Proposed Offsetting lands consist of 4 no. parcels of land proposed for hen harrier habitat restoration, 3 in the townland of Coom (Areas 1, 2 and 4) and 1 no. further north in the townland of Knockatee (Area 3). The Proposed Offsetting Measures comprise the permanent removal of c. 105.5 ha of coniferous plantation forestry and the restoration of c.17.7 ha of farmland for the benefit of hen harrier. The total area of the Proposed Offsetting lands is ~123.2ha.

The Proposed Offsetting lands are located on the slopes of Mount Eagle which stands at an elevation of 431mOD. Topography within the Proposed Offsetting lands is steeply sloping and ranges from ~200 to ~380mOD.

Areas 1, 2 and 4 within the Proposed Offsetting lands are located in an area dominated by coniferous forestry plantations. Area 3 is located in an agricultural field whilst the remaining lands (~105.5ha) are located in coniferous forestry plantations (Areas 1, 2 and 4).

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

2.3 DEVELOPMENT DETAILS

Planning permission is being sought for the Proposed Lifetime Extension of Taurbeg Wind Farm as permitted by Cork County Council under planning regulation ref N/2002/3608, for a further period of 10 years from the date of expiry (2026) per Condition no. 7 of the original planning

consent issued, with decommissioning of the wind farm at the end of the proposed extension period.

The Proposed Project is described in full in Chapter 4 of this EIAR and relates to the extended operation of all elements of the existing wind farm and the management of lands for the purposes of hen harrier.

There are no alterations proposed to the existing wind farm infrastructure, therefore, there are no requirements for construction works or reinstatement works for the Proposed Lifetime Extension.

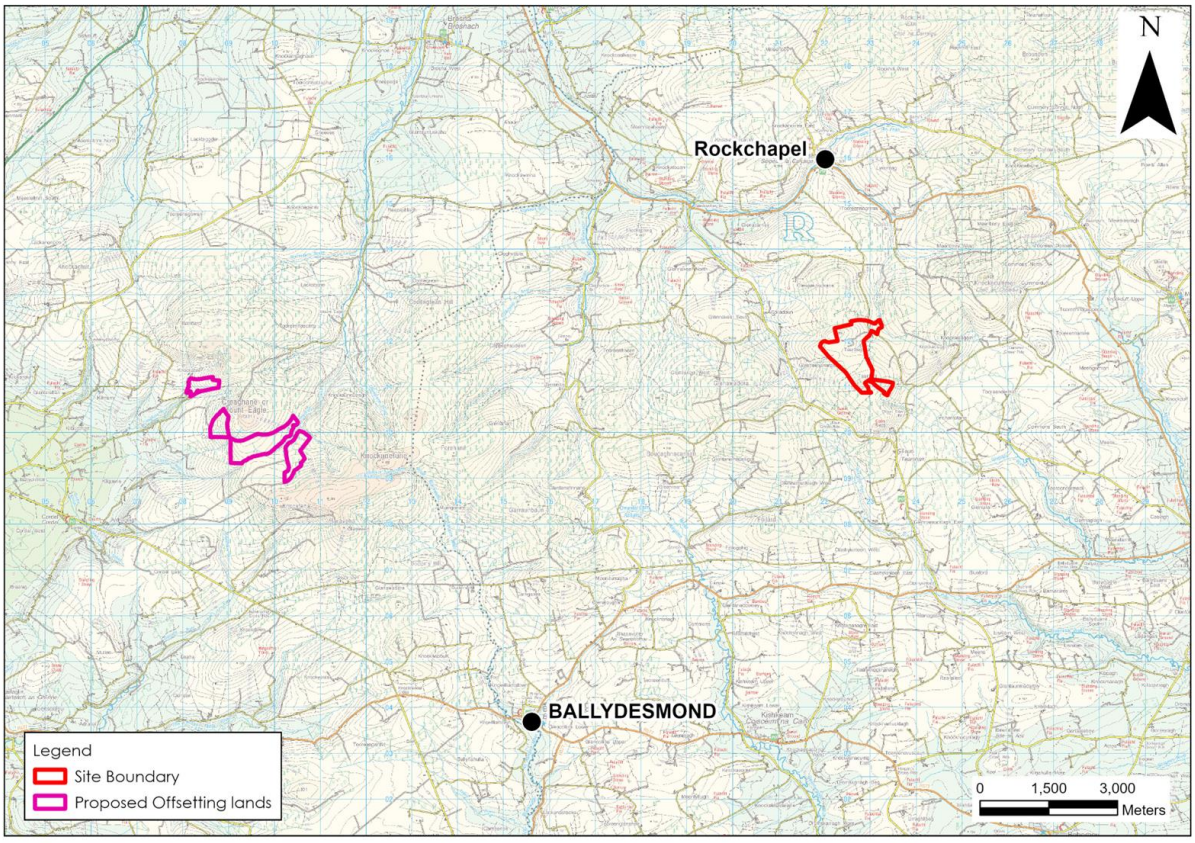

Figure A: Site Location Map

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics of the region and the Site.

3.2 HYDROLOGY

3.2.1 Regional and Local Hydrology

Proposed Lifetime Extension

Regionally, the Site is located in 2 no. regional surface water catchments. The vast majority of the Site, including 10 of 11 no. existing turbines associated with the Taurbeg Wind Farm are located in the Tralee Bay-Feale surface water catchment within Hydrometric Area No. 23 of the Shannon River Basin District. Meanwhile, the south of the Site, including 1 no. existing turbine, is mapped within the Blackwater (Munster) surface water catchment within Hydrometric Area No. 18 of the South Western River Basin District.

More locally, within the Feale_SC_010 WFD river sub-catchment, the Site is located in 2 no. WFD river sub-basins. 8 no. turbines and the existing substation location are mapped in the Feale_010 WFD river sub-basin whilst 2 no. turbines are mapped in the Glenacarney_010 WFD river sub-basin to the west. Within the Feale_010 WFD river sub-basin, 2 no. 1st order streams emerge from within the Site, referred to by the EPA as the Knockahorrea East and the Glennaknockane streams. These streams flow to the east and merge to the east of a local road on the boundary between the townlands of Taurbeg and Glennaknockane. This watercourse then flows to the north and discharges into the Feale River at Rockchapel, ~3.2km to the north. Meanwhile, within the Glenacarney_010 WFD river sub-basin, the Glasheenanargid stream flows to the west and discharges into the Glenacarney River ~600m west of the Site. The Glenacarney River flows to the north and discharges into the Feale River ~3.8km to the northwest. The Feale River continues to flow to the northwest and discharges into the Feale Estuary to the west of Listowel.

More locally within the Dalua_SC_010 WFD river sub-catchment, the Site is mapped within the Owenkeal_010 and Glenlara_010 WFD river sub-basins. No infrastructure associated with the existing Taurbeg Wind Farm is located in the Owenkeal_010 WFD river sub-basin, while 1 no. turbine (T10) is located in the Glenlara_010 WFD river sub-basin. 2 no. streams drain the Site discharge into the Glenlara River ~2.5km to the southeast. The Glenlara River continues to flow to the southeast and discharges into the Dalua River to the west of Newmarket Town. The Dalua River discharges into the Allow River at Kanturk, ~16km to the southeast.

Proposed Offsetting Measures

The Proposed Offsetting lands are located in 2 no. regional surface water catchments. In the west the Proposed Offsetting lands are located in the Laune-Maine-Dingle Bay regional surface water catchment (Hydrometric Area 22) while the southeast is mapped in the Tralee Bay Feale regional surface water catchment (Hydrometric Area 23).

Within the Tralee Bay Feale regional surface water catchment, the Proposed Offsetting lands are mapped in the Feal_SC_030 WFD river sub-catchment and the Clydagh (Feale)_010 WFD river sub-basin. Within this sub-basin, the Proposed Offsetting lands are drained by the Glengarriff River which in the vicinity of the Proposed Offsetting lands is referred to by the EPA as the Tooreennascarty Stream. This stream flows to the northwest, immediately north of the Area 1 before it veers to the northeast. A tributary stream flows between the Proposed Offsetting lands before it discharges into the Glengarriff River. This river, also referred to by the EPA as the Clydagh River, continues to flow to the northeast, before it discharges into the Feale River near Clydagh Bridge, ~10.5km northeast of the Proposed Offsetting lands.

Within the Laune-Maine-Dingle Bay regional surface water catchment, the Proposed Offsetting lands are mapped in the Maine_SC_010 WFD river sub-catchment and the Shanowen (Maine)_010 WFD river sub-basin. Within this WFD river sub-basin, a 2nd order stream, referred to as the Knockatee Stream is mapped to flow to the south along the western border of Area 3 of the Proposed Offsetting lands. Meanwhile, the Croaghane Stream is mapped to flow to the west, ~30m to the south. These 2 no. streams merge to form the Croaghane River. Further to the south, the Proposed Offsetting lands are drained by the Cloone (Shanowen) River. The Cloone and Croaghane rivers flow to the west and merge to form the Shanowen River ~5.3km west of the Proposed Offsetting lands near Fairfield Bridge. The Shanowen River discharges into the Maine River near Castleisland.

A local hydrology map is attached as **Figure B**.

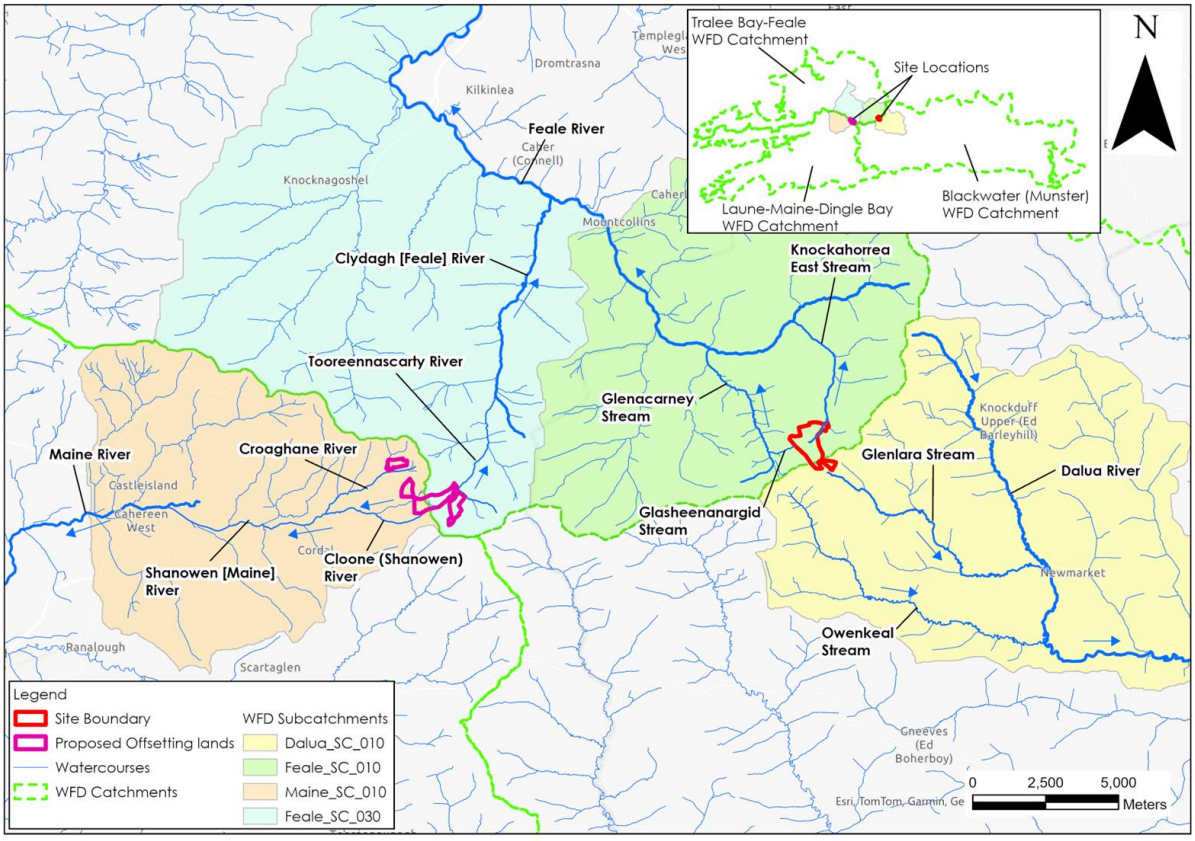

Figure B: Local Hydrology Map

3.2.2 Rainfall and Evaporation

The SAAR (Standard Average Annual Rainfall) recorded at Newmarket Garda Station, located ~7.6km to the southeast of the Site with long term SAAR data of 1,198mm (www.met.ie).

However, the AAR at Newmarket Garda Station may underestimate the actual AAR at the Site due to the elevation difference (the highest elevations at the Site (~405mOD) are ~250m higher than the elevation of Newmarket Garda Station (~157mOD).

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Site ranges from 1,698 to 1,744mm/year. The average annual rainfall is

1,721mm/yr (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

The average potential evapotranspiration (PE) at Shannon Airport ~50km northeast of the Site is taken to be 562.6mm/yr (www.met.ie). The actual evapotranspiration (AE) is calculated to be 534mm/yr (95% PE). Using the above figures, the effective rainfall (ER)[1] for the area is calculated to be (ER = SAAR – AE) 1,187mm/yr.

In addition to average rainfall data, extreme value rainfall depths are available from Met Eireann. **Table A** below presents return period rainfall depths for the area of the 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. Taurbeg Wind Farm – Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	3.9	5.9	8.9	11.6
15 mins	6.4	9.6	14.6	19
30 mins	8.7	12.8	19	24.3
1 hours	11.8	17	24.8	31.3
6 hours	25.9	35.4	48.9	59.7
12 hours	35	47	63.6	76.7
24 hours	47.5	62.4	82.7	98.5
2 days	62.5	80.1	103.2	120.8

3.3 GEOLOGY

Proposed Lifetime Extension

The published Teagasc soils map (www.gsi.ie) for the area shows that the Site is predominantly overlain by blanket peat. Some areas of peaty poorly drained, mainly acidic mineral soils (AminPDPT) and acidic poorly drained mineral soils (AminDW) soils are mapped around the periphery of the Site. Meanwhile, shallow, rocky, peaty/non-peaty mineral complexes (AminSPRT) are mapped in the valley of a stream to the south of T7. In terms of the existing Taurbeg Wind Farm infrastructure, 10 no. turbines and the existing onsite substation are mapped in areas of blanket peat whilst T06 is mapped in an area of acidic poorly drained mineral soils.

Similarly, the GSI subsoil mapping (www.gsi.ie) shows that blanket peat is the dominant subsoil type at the Site. Some tills derived from Namurian sandstones and shales are mapped around the periphery of the Site. Meanwhile, an area of bedrock outcrop or subcrop is mapped along a natural watercourse to the south of T7. In terms of the existing Taurbeg Wind Farm infrastructure, 10 no. turbines and the existing onsite substation are mapped in areas underlain by blanket peat. T6 is mapped to be underlain by till derived from Namurian sandstones and shales. There are no alluvium subsoils mapped within the Site. Alluvium is mapped downstream along the Glenacarney, the Feale, the Glenlara and the Owenkeal Rivers.

The soils and subsoils at the Site have been confirmed by the completion of 10 no. gouge cores (HES 2024) and the excavation of trial pits by Whiteford Geoservices (2004).

Based on the GSI bedrock mapping (www.gsi.ie) the Site is underlain by 2 no. bedrock geological formations. The northern section of the Site is underlain by the Glenoween Shale Formation which is comprised of grey silty mudstones. Meanwhile, the south of the Site is underlain by the Cloone Flagstone Formation which is composed of greywackes, siltstones and silty mudstones. In terms of the existing Taurbeg Wind Farm infrastructure, a total of 9 no.

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

turbines and the onsite substation are mapped to be underlain by the Glenoween Shale Formation. Meanwhile, T10 and T11 are mapped to be underlain by the Cloone Flagstone Formation.

Proposed Offsetting Measures

The published Teagasc soils map (www.gsi.ie) shows that the Proposed Offsetting lands are predominantly overlain by blanket peat. However, Area 3 of the Proposed Offsetting lands in the townland of Knockatee is mapped to be overlain by acidic deep well drained mineral soils (AminDW), acidic poorly drained mineral soils (AminPD) and acidic shallow well drained mineral soils (AminSW).

The GSI subsoil map (www.gsi.ie) shows that the Proposed Offsetting lands are predominantly underlain by blanket peat. Meanwhile, till derived from Namurian sandstones and shales and bedrock outcrop or subcrop are mapped in Area 3 of the Proposed Offsetting lands in the townland of Knockatee. Some alluvial subsoils are also mapped along the Glengarriff Stream in the vicinity of the Proposed Offsetting lands.

A total of 107 no. peat probes were completed by GDG at the Proposed Offsetting lands with peat depths ranging from 0 to 3.2m, with a median peat depth of 1.6m.

In terms of bedrock, the Proposed Offsetting lands are underlain by the Glenoween Shale Formation and the Cloone Flagstone Formation.

3.4 SITE SURVEY AND DRAINAGE

The topography of the Site is mountainous, with protruding ridges of bedrock outcrop. Ground elevations slope in all directions and range from ~302 to 405mOD. Due to the local topography, the coverage of peat and low permeability of the underlying bedrock aquifer, the hydrology of the Site is characterised by a high density of surface water features.

The Site is drained by several streams which flow downslope before eventually discharging into the Feale River, to the north, and the Dalua River to the southeast.

In places the natural drainage is further facilitated by a network of manmade drains. These manmade drains are concentrated within the areas of coniferous forestry and along sections of the existing wind farm access roads.

Several of the hardstand areas have adopted an "over the edge" drainage approach (where no drains are located in the alongside hardstand areas) in conjunction with sections of roadside drainage swales. Site drainage measures installed during the construction phase (i.e. silt traps settlement and ponds) have since been removed as the Site has naturally revegetated overtime.

The on-site roadways are constructed of permeable crushed stone and are cambered to direct runoff to roadside drains which run along the sides of the roads. This ensures that drainage channels have not formed on the roads, have not eroded the roadways and caused excessive sedimentation downstream. The roadside drains contain check-dams at regular intervals which reduce runoff rates. The roadside drains discharge to several outfall points which are designed in such a way that the natural hydrology of the area remained undisturbed.

3.5 DESIGNATED SITES & HABITATS

Proposed Lifetime Extension

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

The Site is mapped within the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA (Site Code: 004161).

Furthermore, the Site has downstream hydrological connections with designated conservation sites in the region as described below:

- The Lower River Shannon SAC (Site Code: 002165) is located downstream of the Site via the Knockaahorrea East Stream. The length of the hydrological pathway between the Site and the SAC is ~1.8km.

- The Blackwater River (Cork/Waterford) SAC (Site Code: 002170) is located downstream of the Site via the Glenlara River. The length of the hydrological pathway between the Site and the SAC is ~6.5km.

Even further downstream and distant from the Site (>40km straight line distance) there are several designated sites situated within or on the banks of the Blackwater River. These include:

- The Blackwater Valley (Killavullen) pNHA (Site Code: 001080);
- The Blackwater Valley (Ballincurrig Wood) pNHA (Site Code: 001793);
- The Blackwater Valley (Killathy Wood) pNHA (Site Code: 001795);
- The Blackwater Valley (Cregg) pNHA (Site Code: 001796);
- The Blackwater Valley (The Beech Wood) pNHA (Site Code: 001797);
- Blackwater River Callows pNHA (Site Code: 000073);
- Blackwater Callows SPA (Site Code: 004094);
- Blackwater River And Estuary pNHA (Site Code: 000072); and,
- Blackwater Estuary SPA (Site Code: 004028).

The Cashen River Estuary pNHA (Site Code: 001340) is also located downstream (>35km straight line distance) of the Site in the Tralee Bay-Feale Catchment.

Other designated sites within 10km of the Site include:

- Mount Eagle Bogs NHA (Site Code: 002449) is situated ~7.5km to the west; and,
- Lough Gay Bog NHA (Site Code: 002454) is located ~9.3km to the north.

<u>Proposed Offsetting Measures</u>
The Proposed Offsetting lands are also mapped within the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA.

The Proposed Offsetting lands are located immediately adjacent to the Mount Eagle Bogs NHA (Site Code: 002449). This NHA consists of four areas of blanket big adjacent to Mount Eagle and includes the summits of Mount Eagle, Knockfeha and Knockanefune. The Proposed Offsetting lands are located topographically downgradient of this NHA.

Within the Tralee Bay-Feale regional surface water catchment, the Proposed Offsetting lands are also located immediately upstream of the Lower River Shannon SAC (Site Code: 002165), the length of the hydrological flowpath between the Proposed Offsetting lands and the SAC is ~2km along the Glengarriff River.

Within the Laune-Maine-Dingle Bay regional surface water catchment, the Proposed Offsetting lands are located ~28km northeast (straight line distance) of the Castlemaine Harbour SAC (Site Code: 000343).

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 Site and surrounding area and Proposed Offsetting Lands. 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 development; and,
- *Detailed flood risk assessment – quantitative appraisal of potential risk to a 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 or Proposed Offsetting lands.

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 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 study area that would identify lands that are "liable to flood" within or in the vicinity of the Site or in the Proposed Offsetting lands.

4.3.2 Soils Maps - Fluvial Maps

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

Based on the EPA/GSI soil mapping for the local area, there are no alluvium subsoils mapped within the Site. Alluvium is mapped downstream along the Glenacarney, the Feale, the Glenlara and the Owenkeal Rivers. The closest mapped alluvial deposits to the existing infrastructure are located along the Glenacarney River ~1km west of T3.

The low permeability blanket peat soils/subsoils that are mapped throughout the Site result in high rates of surface water runoff and low rates of groundwater recharge, so the surface water predominantly flows into the streams that emerge within and near the Site.

With regards to the Proposed Offsetting Measures, some alluvial subsoils are also mapped along the Glengarriff Stream in the vicinity of the southern Proposed Offsetting lands. However, these mapped deposits do not extend any significant distance from the stream and therefore are not indicative of a floodplain.

4.3.3 OPW Past Flood Events Mapping

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

No recurring or historic flood incidents are recorded within the Site.

Within the Tralee Bay Feale catchment the closest mapped historic flood event is ~5km downstream of the Site at the confluence of the Knockahorrea East stream and the Feale River at Rockchapel. This event was recorded in August 1986 (Flood ID: 2414).

Within the Blackwater (Munster) catchment, a recurring flood event is mapped ~7km downstream of the Site along the R578 on the Glenlara River, near its confluence with the Dalua River. According to the Area Engineer Notes for Newmarket, the R578 road flooding occurs along a stretch of ~1km, resulting from high flows in River Dalua (Flood ID: 5153).

No areas within the Site are mapped as an OPW Drainage District, i.e. an area where drainage schemes to improve land for agricultural purposes were constructed or as Benefiting Lands, i.e. land identified by the OPW as potentially benefitting from the implementation of Arterial (Major) Drainage Schemes and an indicator of land subject to flooding and poor drainage.

Meanwhile, the OPW Past Flood Events Maps have no records of recurring or historic flood instances in the vicinity of the Proposed Offsetting lands.

Historic and recurring flood events in the vicinity and downstream of the Site and the Proposed Offsetting lands are shown on **Figure C** below.

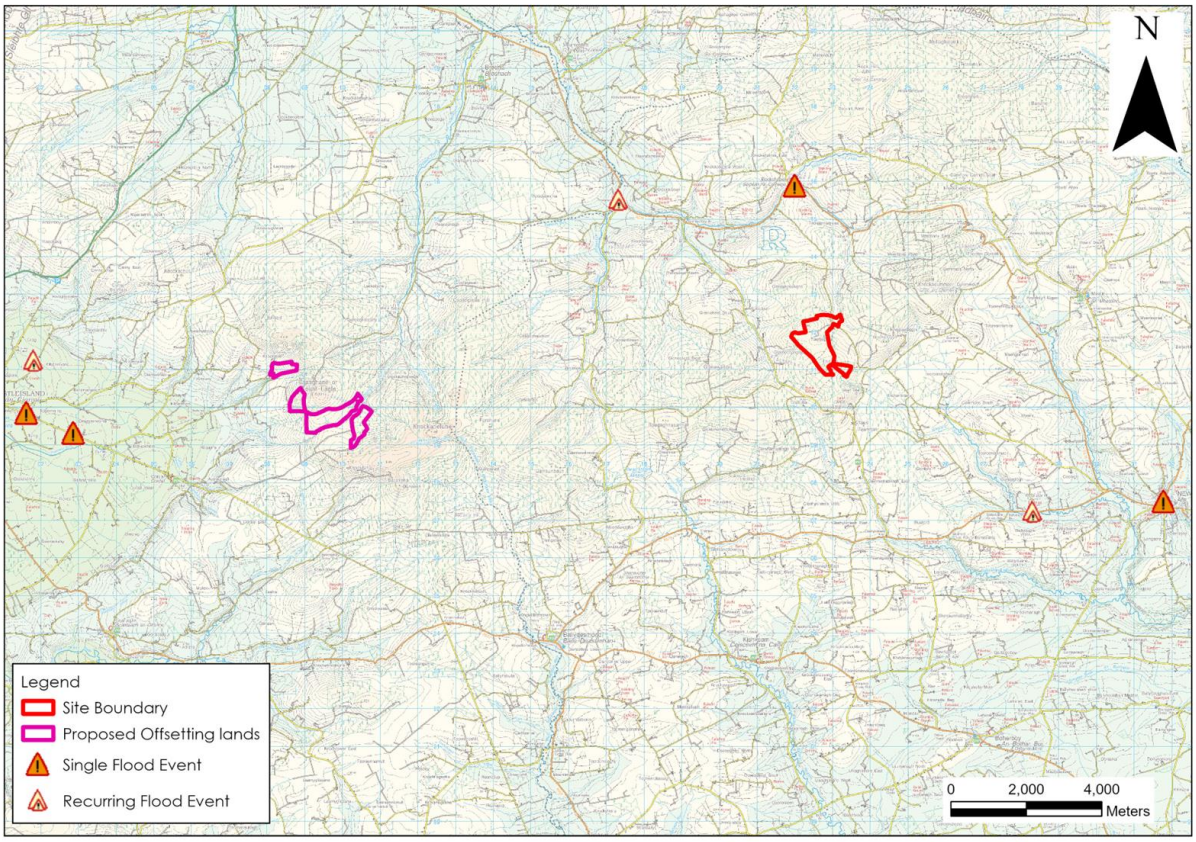

Figure C: OPW Past flood Events Map

4.3.4 GSI Winter (2015/2016) Surface Water Flooding Map

Furthermore, the GSI Winter (2015/2016) Surface Water Flooding Map[2] shows areas of fluvial and pluvial flood extents during the Winter 2015/2016 flood event, which was the largest recorded flood event in many areas.

The flood map for this event does not record any flood zones long the streams and watercourses which drain the Site or the Proposed Offsetting lands.

4.3.5 CFRAM Mapping – Fluvial and Pluvial Flooding

Catchment Flood Risk Assessment and Management (CFRAM)[3] OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA maps.

CFRAM mapping has not been completed for the area of the Site or the Proposed Offsetting lands. The closest CFRAM mapping to the Site has been completed along the Dalua River to the southeast of Newmarket town, ~11km to the southeast. The closest CFRAM mapping to the Proposed Offsetting lands has been completed along the River Maine at Castleisland.

4.3.6 National Indicative Fluvial Flood Mapping

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

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

The National Indicative Flood Mapping (NIFM) for the Present Day Scenario shows flooding along the Knockahorrea East stream and the Glenacarney River in the Tralee Bay Feale catchment downstream of the Site. Fluvial flood zones are also mapped along the Owenkeal and Glenlara Rivers that drain the south of the Site. The distances to these downstream flood zones are detailed below:

- ~2.2km downstream, along the Knockahorrea East River;
- ~2.4km downstream, along the Glenacarney River;
- ~2.6km downstream, along the Owenkeal River; and,
- ~2.7km downstream, along the Glenlara River.

However, the medium (1% AEP, 1 in 100yr) and low (0.1% AEP, 1 in 1,000yr) probability flood zones do not encroach upon the Site. The steep topography of the area, and the associated high gradients and deeply incised channels of the local streams, preclude any risk of fluvial flooding or out of bank flow.

Therefore, the Site is within the Fluvial Flood Zone C, where the probability of fluvial flooding is low (less than 0.1%). A fluvial map showing the National Indicative Fluvial Flood Mapping for the present day scenario is included as **Figure D** below.

[2] GSI *Historical flood mapping principally developed using Sentinel-1 Satellite Imagery from the European Space Agency Copernicus Programme as well as any available historic records (from winter 2015/2016 or otherwise)*
[3] *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.*

No NIFM flood zones are mapped in the immediate vicinity of the Proposed Offsetting lands. The closest mapped flood zones are located along the Glengarriff River (Clydagh River), ~900m downstream of the Proposed Offsetting lands, and along the Crooghane River, ~2.2km west of the Proposed Offsetting lands.

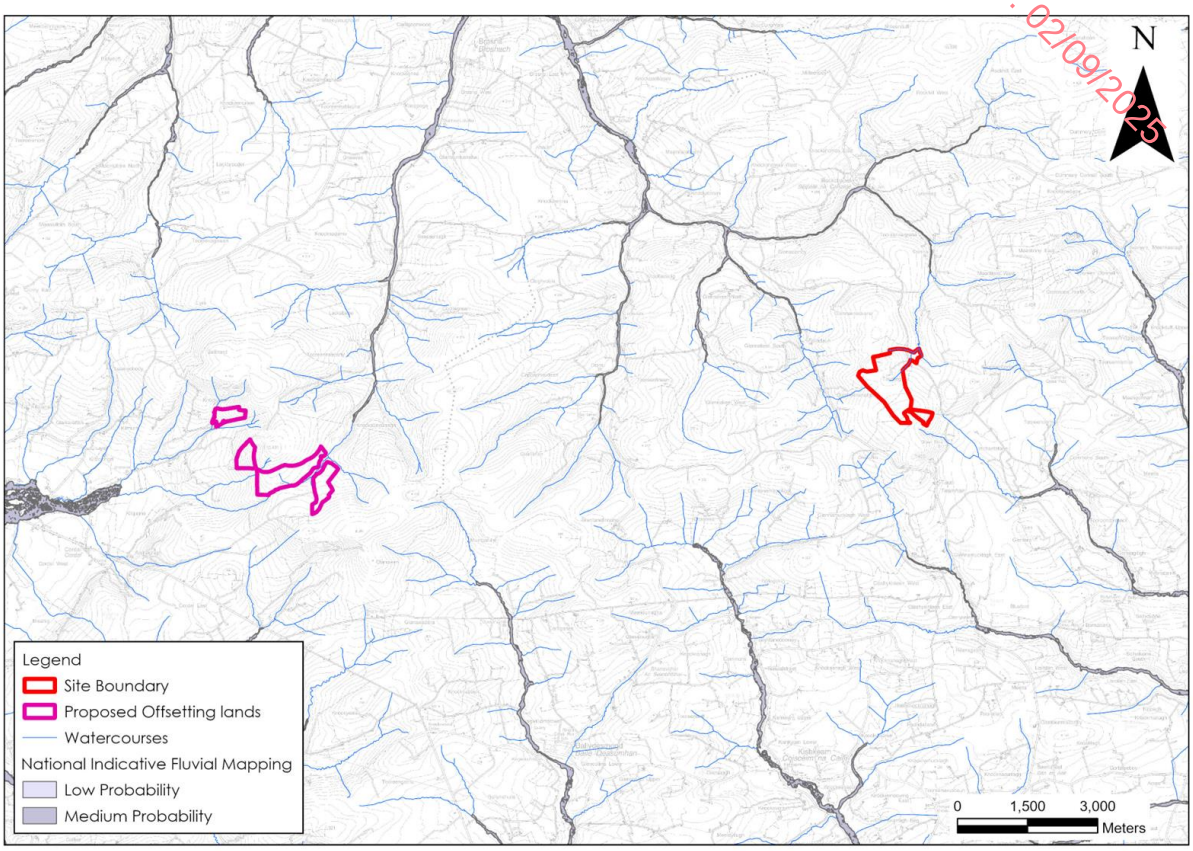

Figure D: OPW National Indicative Flood Mapping

4.3.7 Coastal Flooding

The Site is located ~40km inland and at an elevation of between ~290mOD to 405mOD. Furthermore, the Proposed Offsetting lands are distant from the coast and at elevations in excess of 200mOD.

Therefore, the Site and the Proposed Offsetting lands are not at risk of coastal (tidal) flooding.

4.3.8 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the Site or in the Proposed Offsetting lands.

4.3.9 Climate Change

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

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood extends based on a 30% increase in rainfall.

Both of these modelled flood extents show similar flood zones to the Present Day Scenario discussed above in **Section 4.3.6**. Therefore, flood zones at the Wind Farm Site are unlikely to be significantly impacted by future climate change.

4.3.10 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, it is apparent that the Site and the Proposed Offsetting lands are located in Flood Zone C and are at low risk of flooding.

4.4 INITIAL FLOOD RISK ASSESSMENT

4.4.1 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the Site and at the Proposed Offsetting lands can be described using the Source – Pathway – Receptor Model ("S-P-R"). The primary potential source of flooding in this area is fluvial, and more likely to occur downstream from the Site along the rivers and streams that drain the Site. The primary potential pathways, in the most likely order of significance, would be overbank flooding of the rivers downstream during significant rainfall events. The potential receptors in the area are infrastructure and land as outlined below.

4.4.2 Summary – Initial Flood Risk Assessment

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it would appear that flooding is unlikely to be problematic at the Site or downstream of the Site. The potential sources of flood risk for the Site are outlined and assessed in **Table B**.

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 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 and Proposed Offsetting lands are outlined and assessed in **Table B.**

Table B. S-P-R Assessment of Flood Sources.

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the rivers and streams downstream of the Site	Land & infrastructure	The Site and the Proposed Offsetting lands are located in Fluvial Flood Zone C where there is a low risk of fluvial flooding.
Pluvial	Ponding of rainwater on Site	Land & infrastructure	There is slight risk of pluvial flooding at the Site and at the Proposed Offsetting lands due to the presence of impermeable blanket peat soils. However, the risk is very low as drainage moves relatively freely as a result of the sloping topography and the existing drainage.
Surface water	Surface ponding/ Overflow	Land & infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land & infrastructure	Based on local hydrogeological regime and GSI mapping, there is no risk of groundwater flooding at the Site or at the Proposed Offsetting lands.
Coastal/tidal	Overbank flooding	Land, People, property	The Site and the Proposed Offsetting lands are inland and stand at significant elevations above sea level. Therefore, there is no risk of coastal/tidal 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[4] is shown in **Table C** below.

It may be considered that the Site can be categorised as "Highly Vulnerable Development". However, as stated above, all wind farm infrastructure is located in Flood Zone C (Low Risk) and therefore the Site is appropriate from a flood risk perspective.

Table C: Matric 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.*

[4] *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).*

5. PLANNING POLICY AND JUSTIFICATION TEST

5.1 PLANNING POLICY AND COUNTY DEVELOPMENT PLAN

The following policies (**Table D**) are defined in Cork County 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 Site:

Table D: Cork County Council Planning Policy/Objective and Responses

No.	Policy/Objective	Development Design Response
WM 11-13 (a)	Protect the County's floodplains, wetlands and coastal areas subject to flooding as vital green infrastructure which provides space for storage and conveyance of floodwater, enabling flood risk to be more effectively managed and reducing the need to provide flood defences in the future.	No such areas identified in the Site.
WM 11-13 (b)	Ensure that development does not impact on wetland sites within river / stream catchments and seek the restoration of degraded wetlands	No such areas identified in the Site.
WM 11-14 (a)	Support the implementation of • the EU Flood Risk Directive (20010/60/EC) on the assessment and management of flood risks, • the Flood Risk Regulations (SI No 122 of 2010) • the Guidelines on 'The Planning System and Flood Risk Management' (2009) and • the recommendations of the South Western CFRAM study.	As Outlined in this FRA
WM 11-14 (b)	Application of the flood policies of this Plan shall be fully informed by the recommendations contained in the updated Strategic Flood Risk Assessment (June 2022) accompanying the Plan, including the conclusions of Justification Tests contained therein.	As Outlined in this FRA
WM 11-15	To require flood risk assessments to be undertaken for all new developments within the County in accordance with The Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009) and the requirements of DECLG Circular P12/2014 and the EU Floods Directive.	Not applicable as the it is not a new development.
WM 11-16	Take the following approach in order to reduce the risk of new development being affected by possible future flooding: • Avoid development in areas at risk of flooding; and • Apply the sequential approach to flood risk management based on avoidance, substitution, justification and mitigation of risk. • Where development in floodplains cannot be avoided, applications for development must meet the definition of Minor Development or have passed the Justification Test for Development Plans in the updated SFRA and can pass the Justification Test for Development Management to the satisfaction of the planning authority. • • Consider the impacts of climate change on the development. In areas where the Justification Test for Development Plans has not been applied, or has been failed, the sequential approach should be applied as follows: • In areas where there is a high probability of flooding - 'Flood Zone A' - avoid highly and less vulnerable development as described in Section 3 of 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' issued in November 2009 by DoEHLG. • In areas where there is a moderate probability of flooding -	Not applicable as the it is not a new development.

	'Flood Zone B' - avoid 'highly vulnerable development' described in section 3 of 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' issued in November 2009 by DoEHLG. • In areas where there is low probability of flooding – 'Flood Zone C' all uses may be considered subject to a full consideration of all flood risks.	
WM 11-17 (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.	As Outlined in this FRA
WM 11-17 (2)	The proposal has been subject to an appropriate flood risk assessment that demonstrates: a) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk; b) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible; c) 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; d) 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.	As Outlined in this FRA and Section 4.5

6. REPORT CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Lifetime Extension and the Proposed Offsetting Measures. From this study:
  - No instances of historical flooding were identified in historic OS maps within the Site or in the Proposed Offsetting lands;
  - No instances of recurring or historic flooding were identified on OPW maps within the Site or in the Proposed Offsetting lands;
  - No instances of recurring flood incidents were identified on OPW maps immediately in the Site or the Proposed Offsetting lands;
  - Neither the Site or the Proposed Offsetting lands are not identified within the OPW/CFRAM or NIFM Flood Zones; and,
  - The Site and the Proposed Offsetting lands are associated with Flood Zone C.
- 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;
- There has been no reported increase in downstream flood risk associated with the operational phase of the existing Taurbeg Wind Farm;
- The Taurbeg Wind Farm can be categorised as "Highly Vulnerable Development", however, all infrastructure is located outside of areas mapped as Flood Zones and therefore the proposed extension of life of the Taurbeg Wind Farm is appropriate from a flood risk perspective;
- The overall risk of flooding posed at the 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 entire area of the Site footprint is located in fluvial Flood Zone C). The flooding risk at the Site has an estimated AEP of <0.1%. All infrastructure is located within Flood Zone C; and,
- In addition, the risk of the Proposed Lifetime Extension or the Proposed Offsetting Measures contributing to downstream flooding is also very low. The long-term plan for the Site is to retain and slow down drainage water 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 Chapter 9 of the EIAR for further details.

* *

7. 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
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 (IH 124).
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.
Cork County Council	2022	County Cork Development Plan 2022-2028