APPENDIX 9-1

FLOOD RISK ASSESSMENT

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PROPOSED MAUGHANACLEA RENEWABLE ENERGY DEVELOPMENT, CO. CORK

SITE SPECFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

MKO

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

DOCUMENT INFORMATION

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

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO to complete a site-specific Flood Risk Assessment (FRA) for the proposed Maughanaclea Renewable Energy Development, Co. cork. A site location map is shown as **Figure A** below.

The 'Proposed Wind Farm' refers to the 14 no. turbines and supporting infrastructure, including the proposed on-site 110kV substation (detailed description provided in Chapter 4 of the EIAR).

The 'Proposed Grid Connection' refers to the 110kV underground cabling connection from the proposed on-site 110kV substation to the existing Dunmanway 110kV Substation which has a length of 20.5km. The Proposed Grid Connection will facilitate the connection of the Proposed Wind Farm to the national electricity grid.

Where 'the Site' is referred to, this relates to the primary study area for the Proposed Project EIAR, as delineated by the EIAR Site Boundary and includes both the Proposed Wind Farm site and Proposed Grid Connection route.

The 'Proposed Wind Farm site' refers to the portion of the Site surrounding the Proposed Wind Farm but excluding the portion of the Site surrounding the Proposed Grid Connection underground cabling route.

The following assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009) and is submitted in supported of the Proposed Project EIAR.

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/Hydrologist with over 24 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 Wind Farm, Cahermurphy Wind Farm, and Seven Hills Wind Farm, and over 100 other wind farm related projects across the country.

David Broderick (P. Geo., BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 19 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 hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections and flood risk assessments for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Carrigarierk Wind Farm, Curraglass Wind Farm, Esk Wind Farm and Shehymore Wind Farm, and over 60 other wind farm related projects across the country.

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 surface water catchment and existing site drainage;
- Section 4 presents a site-specific flood risk assessment (FRA) undertaken for the Site which was carried out in accordance with the above-mentioned Guidelines;
- Section 5 presents responses to local authority planning policy and determines if there is a requirement for a Justification Test; and,
- Section 6 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/WFD hydrology maps;
- OPW CFRAM & National Indicative Fluvial Mapping (NIFM);
- Cork County Development Plan 2022 – 2028; and,
- Site walkovers and drainage surveys conducted by HES on 5th & 6th September 2024 and 26th February, 13th March & 9th April 2025.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

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

2.2 SITE LOCATION AND TOPOGRAPHY

The Proposed Wind Farm site is located approximately 2.8km to the east of Kealkill from the nearest turbine (T14), within the Maughanaclea Hills which is an upland area characterised by rocky outcrops, upland peat and forestry plantations. At lower elevations on these hills there is typically a transition into improved grassland and wet heathland.

The Proposed Wind Farm site comprises two clusters of turbines which are separated by the Owngar River Valley which drains westerly towards Kealkill village.

The northern turbine cluster, which has 6 no. proposed turbines (T1 – T6), is dominated by open upland peat and improved grassland with a smaller section of coniferous forestry on the upper elevations. The proposed turbines are distributed across a southwest-northeast trending topographic ridgeline where the ground slopes steadily both to the north and south of the ridgeline.

Ground elevations within the northern turbine cluster of Proposed Wind Farm site range between approximately 212m OD to 348m OD (metres above Ordnance Datum) at the proposed turbine cluster. Two turbines (T1 & T2) are located in coniferous forestry while the other four are located in upland peat/heathland/improved grassland.

The southern turbine cluster of the Proposed Wind Farm site, which has 8 no. proposed turbines (T7 – T14), is dominated forestry and open upland peat with a smaller section of improved grassland. The proposed turbine locations straddle a topographic ridgeline extending to the west of the Maughanaclea Hills where ground elevations at the proposed turbine locations in the southern turbine cluster ranging between 212m and 376m OD, which slopes away to the north and south of the ridgeline.

Five turbines are located in forestry (T7 – T11), two in improved grassland (T12 & T13) and one in upland peat (T14). The two turbine clusters of the Proposed Wind Farm site will be connected by 33kV underground cabling that will require a new watercourse crossing on the Owngar River.

The Proposed Grid Connection connects the proposed 110kV onsite substation located in the Proposed Wind Farm site's southern cluster to the existing 110kV substation at Dunmanway, located approximately 13km to the southeast of the Proposed Wind Farm site ('as the bird flies'). The Proposed Grid Connection, which is 20.5km in length, follows public roads R585, L4909, L-4609, L-4615, R587, and the R586.

Current land-use on the Proposed Wind Farm site is predominantly commercial forestry, with agricultural pastures and rough grazing also present. Current land-use along the Proposed Grid Connection comprises of the public road corridor, public open space, pastures, and private land principally used by agriculture.

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

2.3 PROPOSED PROJECT DETAILS

The Proposed Project (Proposed Wind Farm site and Proposed Grid Connection) is described in full in Chapter 4 of the accompanying EIAR.

Where the 'Proposed Wind Farm' is referred to, this refers to the 14 no. turbines and associated foundations and hard-standing areas, 110kV substation, access roads, 3 no. temporary construction compounds, met mast, underground cabling, peat and spoil management areas, wind farm drainage, tree felling, 4 no. borrow pits, Biodiversity Management and Enhancement Areas and all ancillary works.

The 'Proposed Grid Connection' relates to the 20.5km 110kV underground cabling route to existing Dunmanway110kV electrical substation.

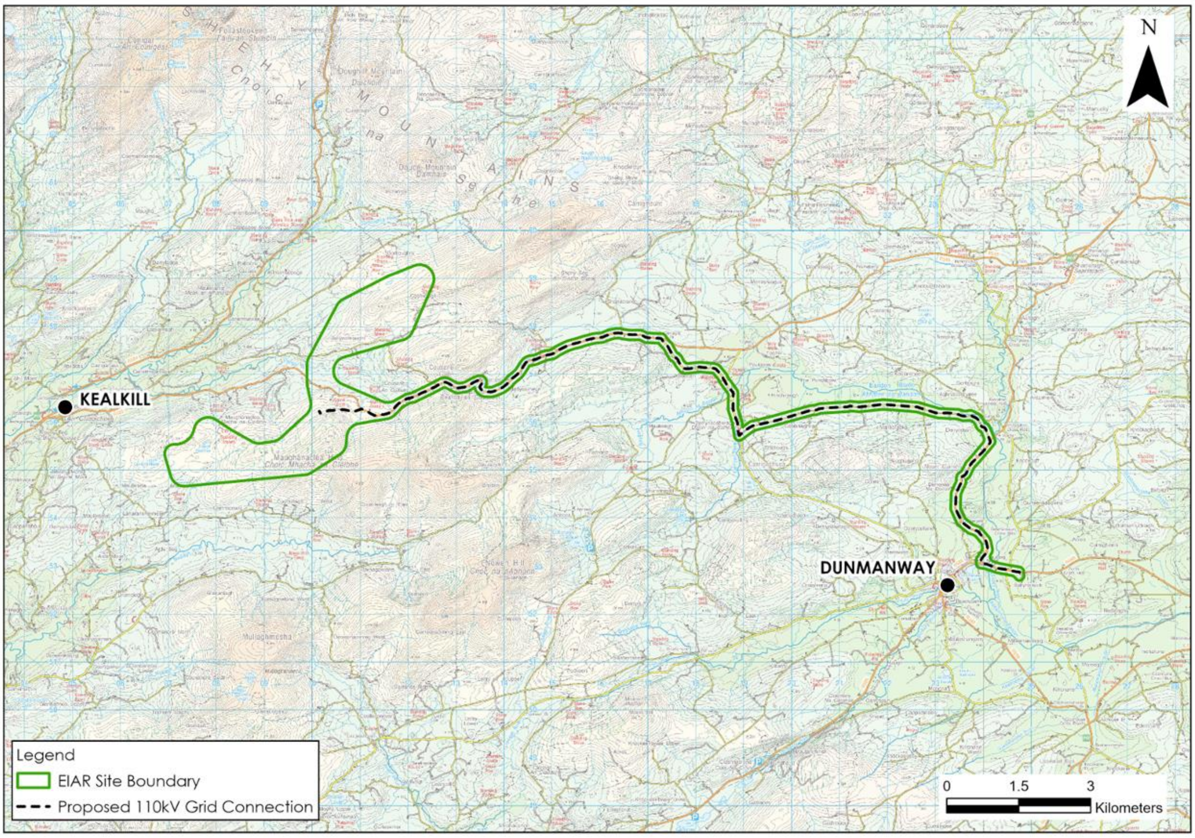

Figure A: Site Location Map

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

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

3.2 HYDROLOGY

3.2.1 Regional and Local Hydrology

Regionally, the Proposed Wind Farm Site is located in the WFD Dunmanus-Bantry-Kenmare Surface Water Catchment within Hydrometric Area No. 21 of the South Western River Basin District.

Locally the Proposed Wind Farm Site is contained within 2 sub-catchments; the Coomhola_SC_010 and the Mealagh_SC_010 where there are 11 no. and 3 no. proposed turbines respectively.

Within the Coomhola_SC_010, the Proposed Wind Farm site drains into the Owvane River catchment with 11 no. proposed turbines located in this catchment (T1 – T9, T12 and T13). The Owvane River drains into Bantry Bay approximately 10km downstream of the Site.

Within the Mealagh_SC_010, the Proposed Wind Farm site drains into the Mealagh River catchment with 3 no. proposed turbines located in this catchment T10, T11 and T14). The Mealagh River also drains into Bantry Bay approximately 10km downstream of the Site.

Within the Owvane River catchment, the northern cluster is located within 2 river sub-basins: the Owvane (Cork)_010 and the Owngar (Cork)_010, while the southern cluster is located only in the Owngar (Cork)_010. Two turbines (T1 and T2) are located in Owvane (Cork)_010 and nine turbines (T3 – T9, T12 and T13) in the Owngar (Cork).

As stated above, the Owngar River valley separates the northern and southern clusters of the Proposed Wind Farm site. The Owngar River flows into the Owvane River approximately 2km downstream of the Proposed Wind Farm site.

Within the Mealagh River catchment, the southern cluster is located in the Mealagh_010 sub-basin only.

With the exception of 2.9km length at the Proposed Wind Farm site, the Proposed Grid Connection cable route is located mainly in the Bandon River catchment where it passes through the Bandon_SC_010 to Bandon_SC_030 sub-catchments.

The 2.9km length of Proposed Grid Connection cable at the Proposed Wind Farm site, including the proposed 110kV substation, is located in the Coomhola_SC_010 which drains locally to the Owngar River (Owngar (Cork)_010).

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

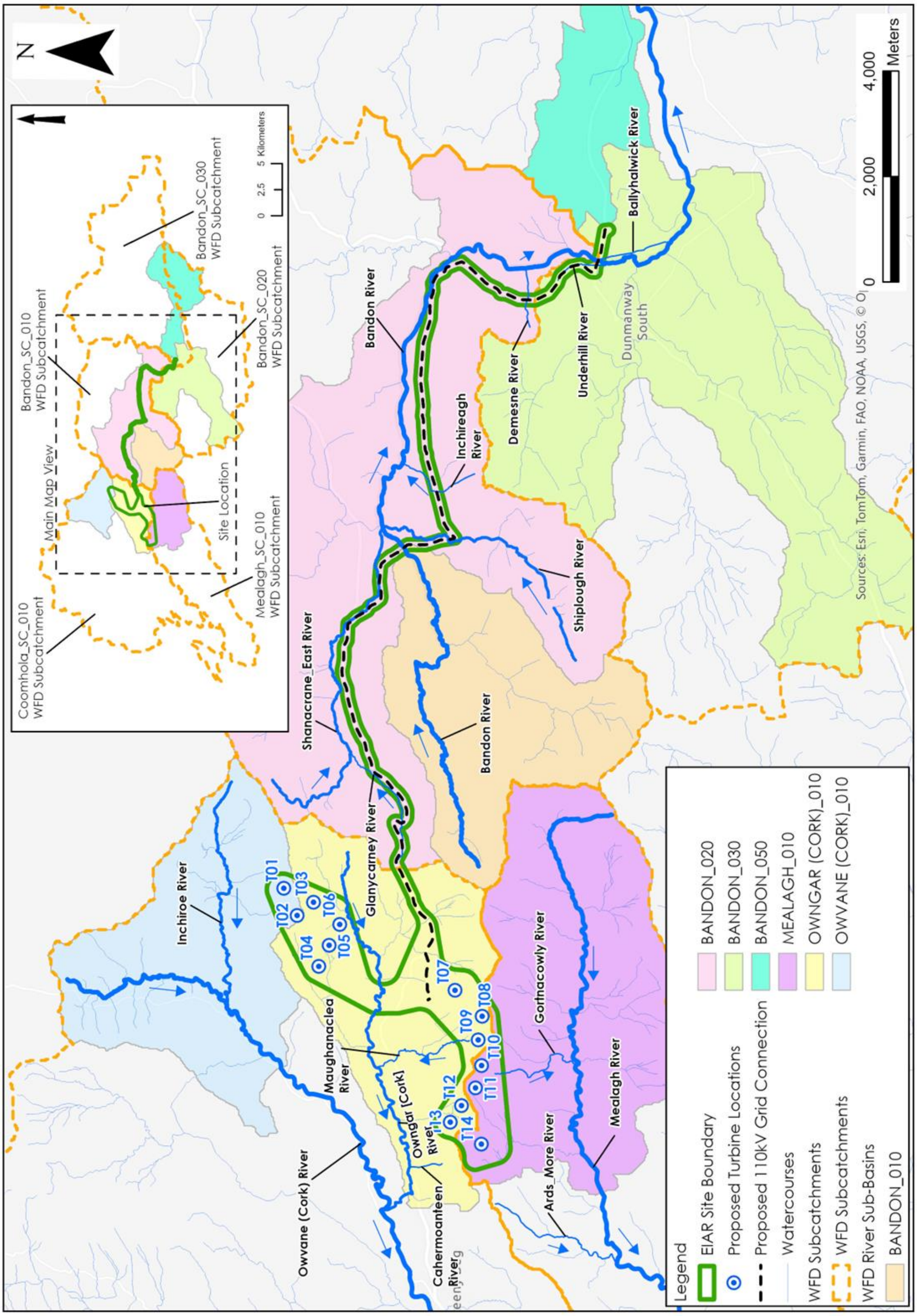

Figure B: Local Hydrology Map

3.2.2 Rainfall and Evaporation

Long term Average Annual Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (AAR) (1981-2010) recorded at Kealkill (Maughanaclea) ~1km southwest of the Proposed Wind Farm site is 1,939mm/year.

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 Proposed Wind Farm site ranges from 1,898 to 2,150 mm/year. The overall average annual rainfall is 2,024mm/year (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Cork Airport, ~54km east of the Proposed Wind Farm site. The long-term average PE for this station is 513mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Site is estimated as 487mm/year (which is 0.95 × PE).

The effective rainfall (ER)[2] represents the water available for runoff and groundwater recharge. The ER for the project site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 2,024mm/year – 487mm/year

ER = 1,537mm/year

Based on groundwater recharge coefficient estimates from the GSI (www.gsi.ie) an estimate of 200mm/year maximum annual recharge is given for the area of the Proposed Wind Farm site (recharge coefficient of ~13%). Recharge is capped at 200mm/year due to the poorly productive nature of the underlying bedrock aquifer which limits recharge (refer to EIAR Section 9.3.9 which deals with Site hydrogeology).

This means that the hydrology of the Proposed Wind Farm site is characterised by high surface water runoff rates (87%) and low groundwater recharge rates (13%). Therefore, conservative annual recharge and runoff rates for the Proposed Wind Farm site are estimated to be 200mm/year and 1,337mm/year respectively.

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 project 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 (5-year, 10-year, 30-year, 100-year).

[1] *Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.*
[2] *ER – Effective Rainfall is the excess rainfall after evaporation which produces overland flow and recharge to groundwater.*

Table A. Project Site – Return Period Rainfall Depths (mm)

	Return Period (Years)			
Storm Duration	**5**	**10**	**30**	**100**
5 mins	6.2	7.1	8.7	10.8
15 mins	8.7	11.7	14.3	17.6
30 mins	13.7	15.8	19.3	23.8
1 hour	18.5	21.3	26.0	32.0
6 hours	40.1	46.0	56.2	69.3
12 hours	54.0	62.0	75.7	93.4
24 hours	72.8	83.6	102.0	128.8
2 days	88.9*	100.8	120.7	145.9

3.3 GEOLOGY

A detailed description of the geology of the Site is presented in Chapter 8 of the EIAR (Land, Soils and Geology).

Regional baseline geological data is available from the GSI through their online map viewer (www.gsi.ie).

The bedrock across the Proposed Wind Farm site is mapped as SILTSTONE, MUDSTONE and SANDSTONE variations. Subsoils are predominantly mapped as bedrock outcrop or subcrop (i.e. shallow or exposed bedrock) with pockets of blanket peat. Lower down on the slopes there is a transition into glacial tills derived from Devonian and Carboniferous sandstones and shales.

The Proposed Wind Farm site investigations and geotechnical assessments were extensive and consisted of 640 peat depth probes, 16 no. trial pits and 3 no. bedrock rotary core boreholes. The geological setting of the Proposed Wind Farm site has been thoroughly investigated, and the geological/hydrogeological setting is fully understood.

Site investigations and geotechnical assessments are summarised as follows:

- The results of the geotechnical peat stability analysis showed all locations to have low to negligible risk of peat instability and the Site is suitable for the Proposed Project;
- Peat depths recorded across the Proposed Wind Farm site ranged from 0 to 4.5m with an average depth of 0.6m, which is considered shallow for blanket bog;
- Approximately 78% of recorded peat depths were less than 1m and 95% of less than 2.0m;
- The peat depths recorded at the turbine locations varied from 0.1 to 2.1m with an average depth of 0.8m (this is considered shallow peat);
- With respect to the new proposed access roads, peat depths are typically less than 1.0m (average 0.6m) and therefore most roads will be constructed by excavate and replace method;
- At the 4 no. proposed borrow pit locations, peat depths are shallow (0.1 to 1.5m);
- No evidence of past failures or any significant signs of peat instability were noted on site by FT at the time of the geotechnical walkover surveys;

- The geotechnical hand vane results indicate undrained shear strengths in the range 10 to 55kPa, with an average value of about 25kPa;
- The strengths recorded would be typical of well drained peat as is present on the Proposed Wind Farm site;
- Mineral subsoils were typically described as silty, sandy GRAVEL with occasional SILT and SAND dominated subsoil. The GRAVEL in particular is likely to have originated from weathering of the underlying shallow bedrock;
- Refusal on bedrock (presumed) was recorded in all 16 no. trial pits with depth to bedrock ranging from 0.2m and 3.5m with an average of 1.5m;
- Depth to bedrock at turbine locations where trial pits were carried out ranged between 0.6 and 3.5m with an average of 1.5m;
- Trial pits were carried out at 6 no. proposed turbine locations (T3 – T6, T12 & T13) as these were the only turbines that could be accessed by an excavator;
- The bedrock was typically described as weathered SANDSTONE or SILTSTONE over strong SANDSTONE or SILTSTONE;
- The investigations indicate that deep overburden excavations will not be required due to the shallow depth of competent bedrock strata;
- No bedrock joints, fissures, fractures faults (groundwater bearing structures) were identified by the investigation drilling; and,
- The drilling demonstrates that the bedrock proposed for extraction at the 4 no. proposed borrow pits is strong, competent and fit for the purpose of rock extraction and follow-on permanent storage of peat and spoil.

3.4 SITE DRAINAGE

3.4.1 Existing Site Drainage

Due to the elevation of Proposed Wind Farm site, natural watercourses that emerge from the Site are small 1st order watercourses (i.e. headwater mountain streams draining small, localised catchments). Refer to **Figure C** below for drainage mapping at the Proposed Wind Farm site.

The northern turbine cluster of the Proposed Wind Farm site has 4 no. unnamed 1st order streams that drain the Site. The 3 no. streams draining south / south-westerly are headwater streams of the Owngar River and the other 1 no. headwater stream drains northeasterly into the Gortloughra River which is a tributary of the Owvane River. There is 1 no. proposed new watercourse crossing in the northern turbine cluster which is on a headwater stream of the Owngar River.

The southern turbine cluster of the Proposed Wind Farm site sits on catchment divide between the Owngar River to the north and the Mealagh River to the south. There are several headwater streams emerging from the southern turbine cluster that enter the Owngar River and Mealagh River within a 1km distance of leaving the Site boundary.

There are 2 no. existing watercourse crossings along forestry tracks (proposed for upgrade for Proposed Wind Farm site access) in the southern cluster where these streams drain northerly into the nearby Owngar River.

There are 3 no. proposed new watercourse crossings, where 2 no. drain northerly into the Owngar River and 1 no. draining south-westerly into the Mealagh River.

In addition to the above, the is a proposed new watercourse crossing on the Owngar River itself to facilitate the 33kV cable and proposed access road connecting the Proposed Wind Farm northern and southern turbine clusters to the proposed 110kV onsite substation.

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 forestry access roads. Manmade drains were also recorded along the boundaries of some of the agricultural lands during walkover surveys.

Along the Proposed Grid Connection there are 11 no. EPA mapped watercourses. This includes no. 2 existing culvert/bridge crossings in the Owngar (Owvane) River catchment and 9 no. existing culvert/bridge in the Bandon River catchment (which includes 2 no. bridge crossings over the Bandon River itself).

3.5 DESIGNATED SITES & HABITATS

Within the Republic of Ireland, designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). The Proposed Wind Farm site is not located within or adjacent to any designated conservation site.

The nearest SAC to the Proposed Wind Farm site is Derryclogher (Knockboy) Bog SAC and pNHA (Site Code: 001873) which is located 7.6km to the northwest of the Site. The nearest NHA to the Proposed Wind Farm is Conigar Bog NHA (Code: 002386) which is located 5km to the northwest. Hydrological and hydrogeological connections to these designates sites are assessed in Chapter 9 of the EIAR (Hydrology and Hydrogeology).

The nearest SAC to the Proposed Grid Connection is the Bandon River SAC. The Proposed Grid Connection intercepts the mapped Bandon River SAC where it runs near the Bandon River, albeit the route is within the carriageway of regional roads at this location and therefore cannot directly affect the SAC.

Also local to the Proposed Grid Connection is Bandon Valley South of Dunmanway SAC (Code: 001035). The designated site is located immediately downstream of where the Proposed Grid Connection crosses the Bandon River via a bridge at Dunmanway.

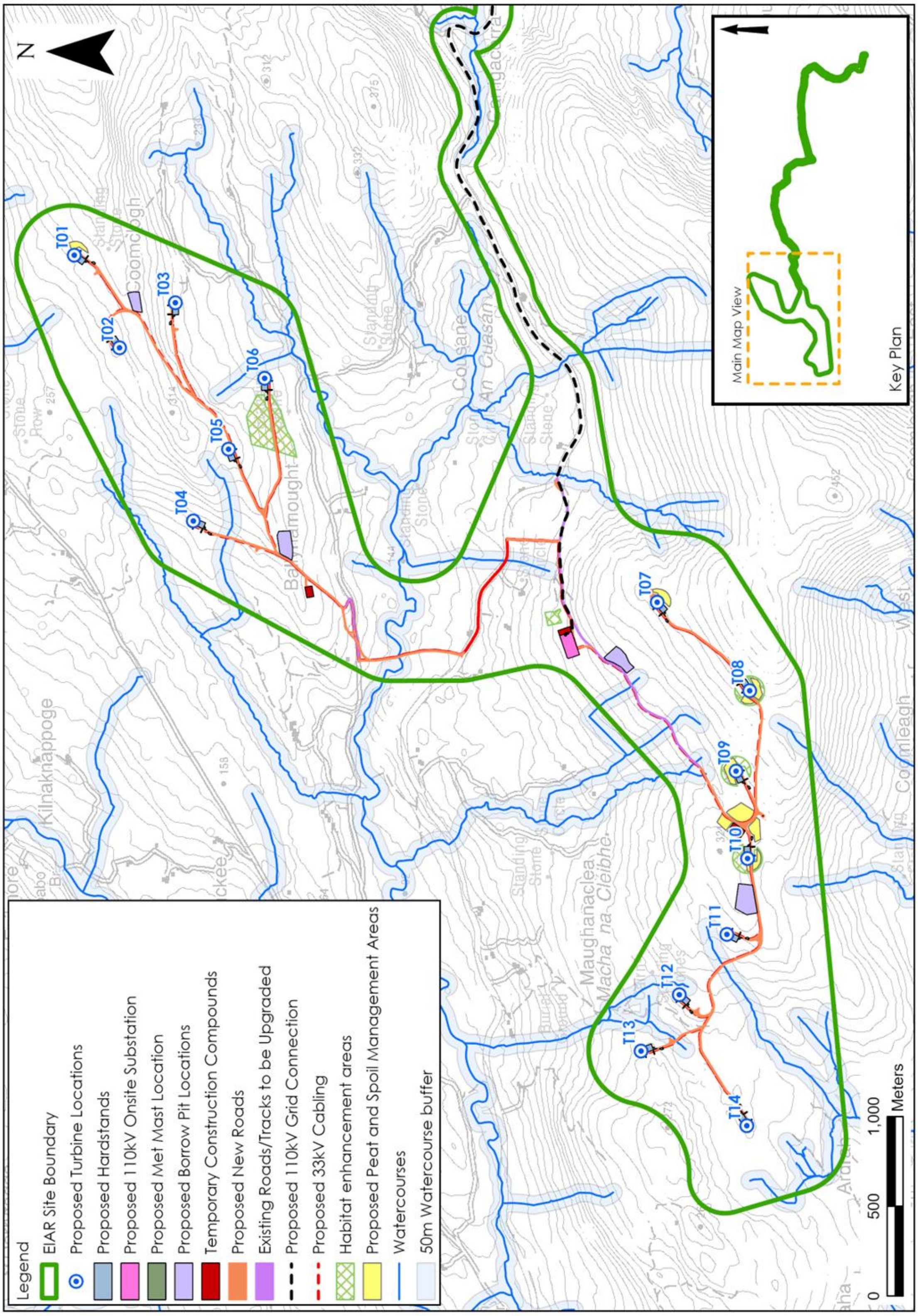

Figure C: Site Drainage Map

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. 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 (DOEHLG, 2009) provide direction on flood risk and development. The DOEHLG, 2009 Guidelines recommend a precautionary approach when considering flood risk management and the core principle of the DOEHLG, 2009 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 DOEHLG, 2009 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 DOEHLG, 2009 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 DoEHLG, 2009 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 DoEHLG, 2009 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 potentially 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 mapping for the Site that identify lands that are "liable to flood".

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 map for the area of the Proposed Wind Farm site, alluvium soils mapped are along the Owngar River which flows at a low-lying location between the northern and southern turbine clusters. Proposed Project infrastructure in this area mapped as alluvium soils is limited to the 33kV underground cable route and proposed access road which connects the two clusters.

Alluvium soils are also frequently mapped along the Proposed Grid Connection where it runs close to the Bandon River channel. However, due to the Proposed Grid Connection being within the carriageway of public roads, the proposed infrastructure does not interact with lands where alluvial soils are mapped.

4.3.3 OPW Past Flood Event Mapping

To identify those areas as being potentially at risk of recurring flooding, OPW's Past Flood Event mapping (www.floodinfo.ie) were consulted.

No recurring flood incidents within the Proposed Wind Farm site were identified from OPW's Past Flood Event Mapping.

The closest recurring flood event to the Proposed Wind Farm site is recorded at Goulnacullin (Flood ID:2890) which is ~3km east of the Proposed Wind Farm site in the Bandon River catchment. The source of the flooding is reported to be fluvial. The Proposed Wind Farm site is not located in the Bandon River catchment.

There are 2 no. single flood events recorded along the Owvane River >6km downstream of the Proposed Wind Farm Site, one at Bantry (Flood ID: 13339) in December 2015 and another at Ballylicky (Flood ID: 12094) in November 2009 and October 2013. The sources of flooding are reported to be the Owvane River.

Past flood events mapped in the vicinity of the Site are shown on **Figure D** below.

No areas within the Site are mapped as an OPW Drainage District (i.e. an area where drainage schemes to improve land for agricultural purpose) 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).

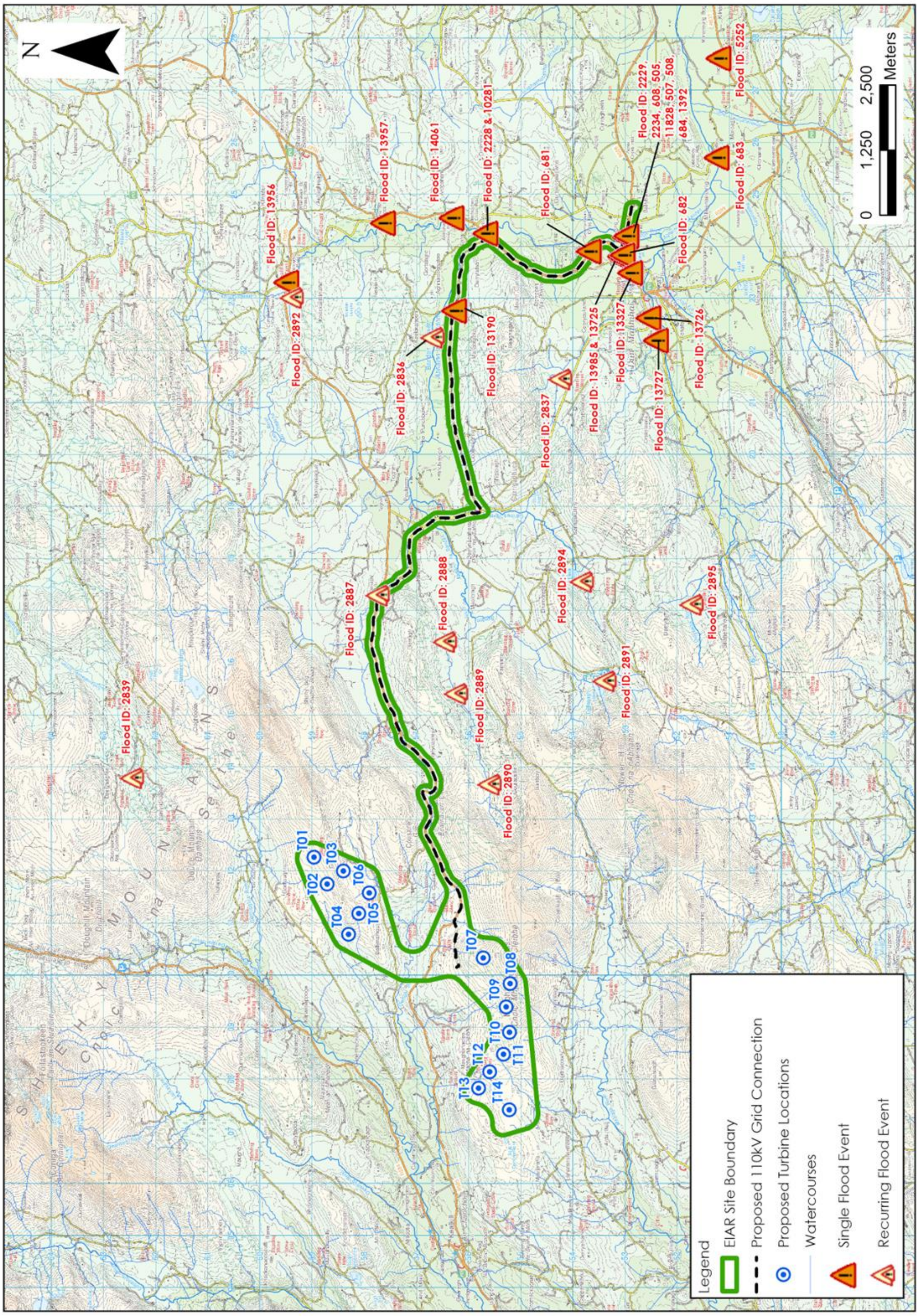

Figure D: OPW Past Flood Event Map

4.3.4 GSI Winter (2015/2016) Surface Water Flood Mapping

The GSI Winter (2015/2016) Surface Water Flooding Map[3] 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.

GSI Winter (2015/2016) Surface Water Flooding Maps show a flooded area that coincides with a permanent unnamed lake waterbody in the northern turbine cluster of the Proposed Wind Farm site. There is no proposed development in the area where surface water flooding is mapped.

Additionally, GSI Winter (2015/2016) Surface Water Flooding Maps have recorded flood zones along the Bandon River flood plain adjacent to the Proposed Grid Connection.

However, due to the Proposed Grid Connection being within the carriageway of public roads, the proposed infrastructure does not interact with these mapped flood zones.

4.3.5 CFRAM River Flood Extents Mapping

Catchment Flood Risk Assessment and Management (CFRAM)[4] River Flood Extent Maps are now the primary reference for flood risk planning in Ireland and are more accurate than the National Indicative Fluvial Mapping (NIFM).

CFRAM mapping has only been completed for Bandon River as far upstream as Dunmanway town. The Proposed Grid Connection passes over the Bandon River floodplain within the carrigaway of the R586 regional road and its bridge crossing.

A map showing the CFRAM Mapping for the present-day scenario is included as **Figure E** below.

4.3.6 National Indicative Fluvial Mapping (NIFM)

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

The Present-Day Scenario has been generated using modelling methodologies based on historic flood data and does not consider 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.)

For the Present-Day Scenario, no medium (1 in 100) or low probability (1 in 1,000) fluvial flood zones have been mapped to encroach upon the Proposed Wind Farm site. The Proposed Wind Farm site is therefore located entirely within Fluvial Flood Zone C (low risk). The closest NIFM Fluvial flood zone to the Proposed Wind Farm site is mapped along the Owngar River downstream of the Site.

NIFM flood zones are mapped along the Proposed Grid Connection at watercourse crossing locations within the Bandon River catchment. However, due to the underground nature of the Proposed Grid Connection, the cabling has no potential to affect fluvial flooding.

[3] 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)*

[4] *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.*

A map showing the National Indicative Fluvial Mapping for the present-day scenario is also included on **Figure E** below.

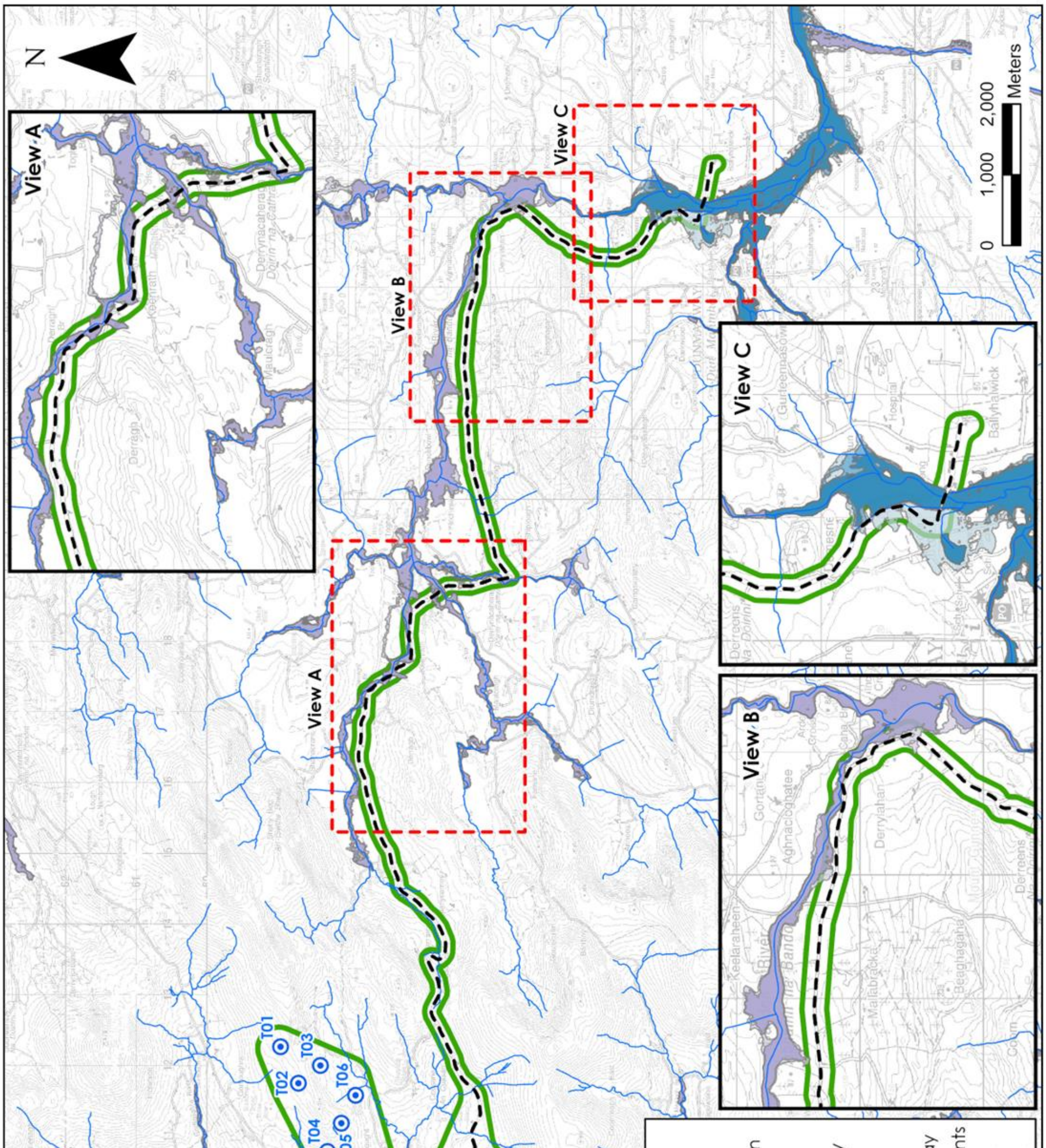

Figure E: CFRAM and NIFM Flood Zones

4.3.7 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the Proposed Wind Farm site or its vicinity. Due to the Proposed Wind Farm site's elevation and bedrock aquifer (poorly productive), groundwater flooding would not be anticipated.

4.3.8 Coastal Flooding

The Proposed Wind Farm is located at elevations of between 212 to 376m OD and is >8km from the coastline. Therefore, the Proposed Wind Farm is not at risk of coastal (tidal) flooding.

4.3.9 Climate Change

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

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood 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 Site are unlikely to be significantly impacted by future climate change.

The CFRAM flood mapping has also been completed for the Mid-Range and High-End Future Scenarios. Both of these modelled flood extents show similar flood zones to the Present Day Scenario discussed above in Section 4.3.5.

Therefore, flood zones at the 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 Proposed Wind Farm site is located in Fluvial Flood Zone C, where the probability of flooding is low.

NIFM and CFRAM flood zones are mapped along the Proposed Grid Connection at watercourse crossing locations within the Bandon River catchment. However, due to the underground nature of the Proposed Grid Connection, the cabling has no potential to affect fluvial flooding or be affected by flooding.

4.4 INITIAL FLOOD RISK ASSESSMENT

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it has been determined that flooding is unlikely to pose a high risk within the Site.

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 Project

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the rivers and streams that are close to some of the wind farm infrastructures.	Land & infrastructure	The Proposed Wind Farm site is located in Fluvial Flood Zone C where there is a low risk of fluvial flooding. The Site is drained by small 1st order streams. Some areas of the Proposed Grid Connection route are located within Flood Zone A or B, but due to the underground nature of the infrastructure, are not risk. The 110kV substation element is located in Flood Zone C.
Pluvial	Ponding of rainwater on site	Land & infrastructure	There is a low risk of significant pluvial flooding due to the extensive manmade drainage networks and sloping topography
Surface water	Surface ponding/ Overflow	Land & infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land & infrastructure	Based on local hydrogeological regime and topography, there is no apparent risk of groundwater flooding at the Site.
Coastal/tidal	Overbank flooding	Land, People, property	No coastal flooding will be possible at the Site due to distance to coast (>8km) and ground elevation.

4.5 JUSTIFICATION TEST

A matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test is shown in **Table C**. This table is adapted from Table 3.2 of the PSFRM Guidelines (DoEHLG, 2009).

It may be considered that the Proposed Wind Farm site including the proposed 110kV onsite substation can be categorised as "Highly Vulnerable Development", while the Proposed Grid Connection is a "Water Compatible Development" due to the subsurface nature of the sealed/insulated electrical cable.

Therefore, the Proposed Project is appropriate from a flood risk perspective, and a Justification Test is not required.

Table C: Matrix of Vulnerability versus Flood Zone

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification test	Justification test	**Appropriate**
Less vulnerable development	Justification test	Appropriate	Appropriate
Water Compatible development	**Appropriate**	**Appropriate**	**Appropriate**

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

5. PLANNING POLICY AND JUSTIFICATION TEST

5.1 PLANNING POLICY AND 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 proposed project design:

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

No.	Policy	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 at 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 11-15	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.	As Outlined in this FRA
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 - 'Flood Zone B' - avoid 'highly	As Outlined in this FRA

	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 (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; 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

5.2 PROPOSED DRAINAGE

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

Overland flow rates are likely to be significant, and the drainage system must be designed and managed properly if it is to work effectively. A fundamental principle in the drainage design is that clean water flowing in the upstream catchment, including overland flow and flow in existing streams and drains, is allowed to bypass the works areas without being contaminated by silt from the works. The dirty water from the works areas is collected in a separate drainage system and treated by removing the suspended solids before discharging it to the downstream watercourse. This minimises the volume of dirty water requiring treatment.

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

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

For new crossing works 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.

5.3 PROPOSED ON-SITE RUNOFF ATTENUATION

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

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

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

All runoff from the developed areas will be routed through settlement ponds downstream. The outflow from the settlement ponds will be released in a controlled and diffuse manner. Therefore, the Proposed Project will not increase the magnitude of the hydrograph peak. The control measures are passive as opposed to mechanical and do not require maintenance to ensure their ongoing effectiveness.

6. REPORT CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the Proposed Project. From this study:
  - No instances of historical flooding were identified in historic OS maps within the Proposed Wind Farm site;
  - No instances of recurring flooding were identified on OPW maps within the Proposed Wind Farm site;
  - The GSI Winter 2015/2016 Surface Water Flooding and Groundwater flood Mapping provides no evidence of historical flooding at the Proposed Wind Farm site;
  - No CFRAM or NIFM fluvial flood zones are mapped within the Proposed Wind Farm site;
  - Sections of the Proposed Grid Connection route pass through NIFM and CFRAM flood zones but this has no consequence or risk for the Proposed Project due to the underground and insulated nature of the infrastructure;
  - The proposed on-site 110kV substation element of the Proposed Wind Farm is located in Flood Zone C at the Proposed Wind Farm site.
- Therefore, the Proposed Project is appropriate from a flood risk perspective, and no Justification Test is required; and,
- This FRA fulfils the requirements for a site-specific flood risk assessment and is consistent with the recommendations made in the Cork County Development Plan (2022-2028).

* *

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

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