APPENDIX 9-1

FLOOD RISK ASSESSMENT

HYDRO ENVIRONMENTAL SERVICES

22 Lower Main St
Dungarvan
Co.Waterford
Ireland

tel: +353 (0)58 44122
fax: +353 (0)58 44244
email: info@hydroenvironmental.ie
web: www.hydroenvironmental.ie

PROPOSED CARROW WIND FARM, CO. TIPPERARY/CO. LIMERICK

SITE SPECIFIC FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:

MKO

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

DOCUMENT INFORMATION

Document Title:	**Proposed Carrow Wind Farm, Co. Tipperary and Co. Limerick** **Site Specific Flood Risk Assessment**
Issue Date:	**18th March 2026**
Project Number:	**P1685-0**
Project Reporting History:	**-**
Current Revision No:	**P1685-0_ FINAL_F0**
Author(s):	**Michael Gill** **David Broderick** **Nitesh Dalal**
Signed:	**Michael Gill B.A., B.A.I., M.Sc., MIEI** **Managing Director – Hydro-Environmental Services**

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

TABLE OF CONTENTS

FIGURES IN TEXT

TABLES IN TEXT

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 Carrow Wind Farm, Co. Tipperary, with the Proposed Grid Connection located in both Co. Tipperary and Co. Limerick.

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 Battery Energy Storage System (BESS), Biodiversity Enhancement and Management Plan (BEMP) measures and Turbine Delivery Route (TDR) accommodation works.

The 'Proposed Grid Connection' refers to the 110kV on-site substation and 37.6km underground 110kV grid connection cabling connecting to the existing Killonan 110kV substation Co. Limerick, and all ancillary works and apparatus.

The Proposed Wind Farm and Proposed Grid Connection (Proposed Project) are described in detail in Chapter 4 of this EIAR.

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 and Proposed Grid Connection.

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 that 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 in hydrology and hydrogeology, including flooding assessment and surface water modelling. We routinely work on surface water monitoring and modelling and prepare flood risk assessment reports.

Michael Gill P.Geo (BA, BAI, Dip Geol., MSc, MIEI) is a Civil/Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. In addition, he has substantial experience in geological characterisation, peatland morphology, and surface water drainage design and SUDs design and surface water/groundwater interactions. Michael has worked on the EIS/EIAR for Seven Hills WF, Glenard WF, Derrinlough WF 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 Borrisbeg Wind Farm, Upperchurch WF Grid Connection and Knockroe Wind Farm, and over 60 other wind farm related projects across the country.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management. 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 Site;
- 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 with regard flood risk; 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);
- Tipperary County Development Plan 2022 –2028;
- Limerick County Development Plan 2022 – 2028;
- Site walkovers, investigations and drainage surveys conducted by HES on 4th, 5th & 8th June and 12th December 2024 and on 12th February and 21st October 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, which has a total area of approximately 830ha (hectares) is located approximately 2.4km south of the village of Hollyford and 4.3km north of the village of Dundrum, Co. Tipperary.

The Proposed Wind Farm site is in an upland setting and is dominated by coniferous forestry plantations along with agricultural pastural land, mixed forest and transitional woodland-shrub. Apart from 3 no. turbine locations (T1, T5 and T9), all other proposed turbine locations are situated in coniferous forestry. The Site is accessible via a network of local public roads, forestry tracks and farm tracks. Proposed turbine location T5 is in scrubland while turbines T1 and T9 are in grassland.

The Proposed Wind Farm site setting on the southern foothills of the Mauherslieve Mountains means that topography in the local area is hilly with the Proposed Wind Farm infrastructure spread across several stream valleys that drain southerly within or adjacent to the Proposed Wind Farm site. Ground elevations within the Proposed Wind Farm site range from ~376m OD (metres above Ordnance Datum) on the north to approximately 163m OD on the south. Slopes range from moderate to steep, with the steepest slopes being on the valley sides of the main the streams that drain the Proposed Wind Farm site.

The Proposed Grid Connection route includes for underground cabling from the proposed 110kV substation, located on the south of the Proposed Wind Farm site to the existing Killonan 110kV substation in the townland of Milltown, Co. Limerick. The proposed 110kV substation setting is rough grassland pastures.

The Proposed Grid Connection underground cable route, measuring approximately 37.6km in length, is primarily located within the public road corridor. Approximately 3.2km is proposed within National Roads, 15.5km proposed within Regional Roads, 16.9km proposed within Local Roads and approximately 2km proposed within agricultural land in Brittas, Co. Limerick. The length of Proposed Grid Connection underground cable route within County Tipperary and County Limerick is 12.5km and 25.1km respectively.

A Biodiversity Enhancement and Management Plan (BEMP) is proposed for areas of the Proposed Wind Farm site. This includes management of 30.2 ha of species rich grassland for marsh fritillary habitat enhancement, enhancement of approximately 3.3ha of semi-natural woodland habitat and planting of plant riparian woodland either side of mapped watercourses within the Proposed Wind Farm site.

TDR temporary accommodation works will be required at 8 no. locations to facilitate the delivery of turbine components and other abnormal loads to the Proposed Wind Farm site during the construction phase. The locations are along Regional Road R505 and local road L1283.

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

2.3 PROPOSED PROJECT DETAILS

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

The Proposed Wind Farm refers to the 14 no. turbines and associated foundations and hard-standing areas, BESS, TDR accommodation works, new and proposed access roads, 3 no. temporary construction compounds, 1 no. met mast, internal underground cabling, 3 no. spoil storage areas, wind farm drainage, tree felling, 2 no. borrow pits, BEMP and all ancillary works.

The "Proposed Grid Connection" relates to the 37.6km underground 110kV cabling route and the proposed 110kV substation.

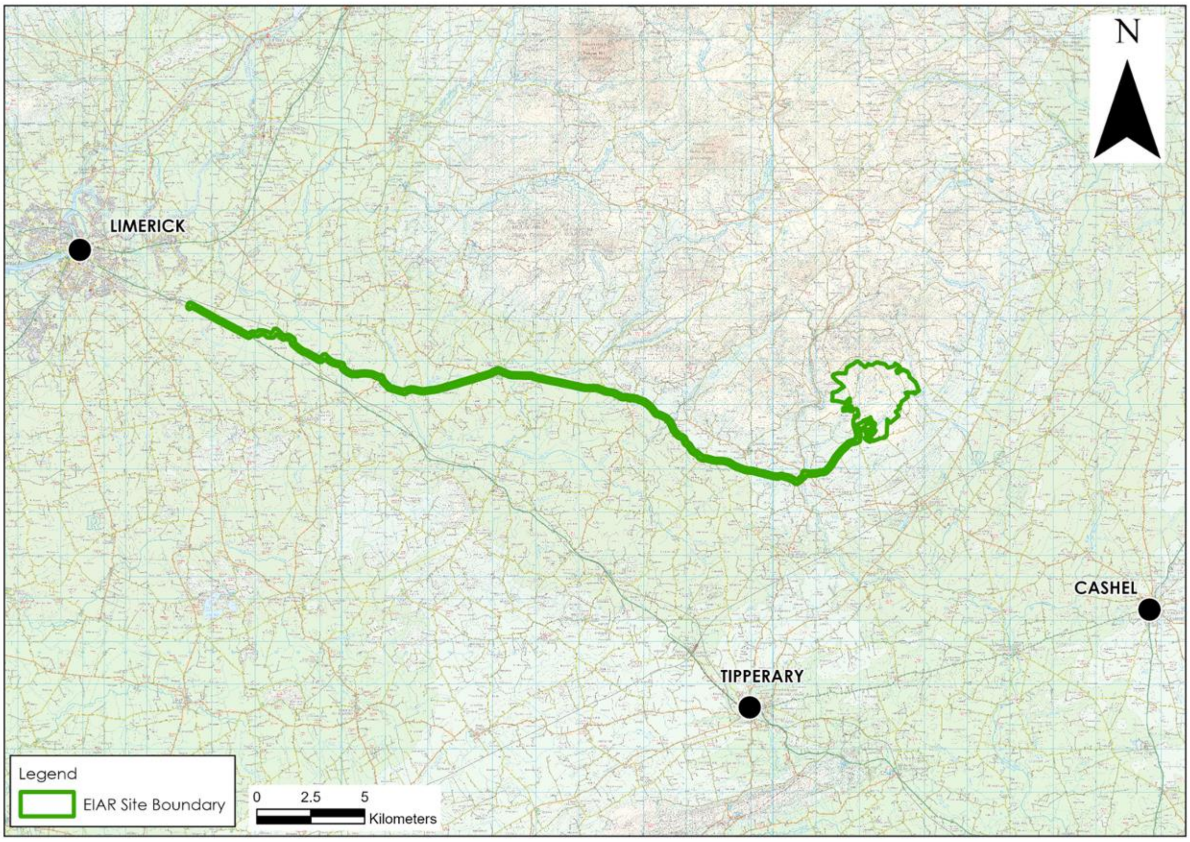

Figure A: Site Location Map

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

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

3.2 HYDROLOGY

3.2.1 Regional and Local Hydrology

Regionally, the Proposed Wind Farm site is located entirely within the River Suir catchment and more locally within the Multeen River surface water catchment within Hydrometric Area No. 16 of the South Eastern River Basin District).

More locally, the Proposed Wind Farm site is mapped to lie within 2 no. surface water sub-catchments. The western portion of the Proposed Wind Farm site is located in the Suir_SC_060 sub-catchment and more locally within the Multeen_010, Multeen_020 and Multeen_030 river sub-basins. All Proposed Wind Farm infrastructure is located in the Multeen_020 sub-basin.

The eastern portion of the Proposed Wind Farm site is mapped within the Multeen[East]_SC_010 sub-catchment and more locally within the Aughnaglanny_010 and Multeen (East)_030 sub-basin. All Proposed Wind Farm infrastructure is located in the Aughnaglanny_010 sub-basin.

The Multeen River discharges into the River Suir approximately 20km downstream of the Proposed Wind Farm site.

Regionally, the Proposed Grid Connection is located in the River Suir catchment and the River Shannon catchment. Within the River Suir catchment approximately 5.3km of the cable route and the 110kV substation are located in the Multeen River surface water sub-catchment within the Multeen_020 sub-basin.

Within the River Shannon catchment, the cable route is located in the Mulkear River sub-catchment (24km) and the Groody River catchment (8.3km).

The TDR works are located in the Multeen(East)_SC_010 and Suir SC_060 sub-catchments.

A regional hydrology map is shown below as **Figure B.**

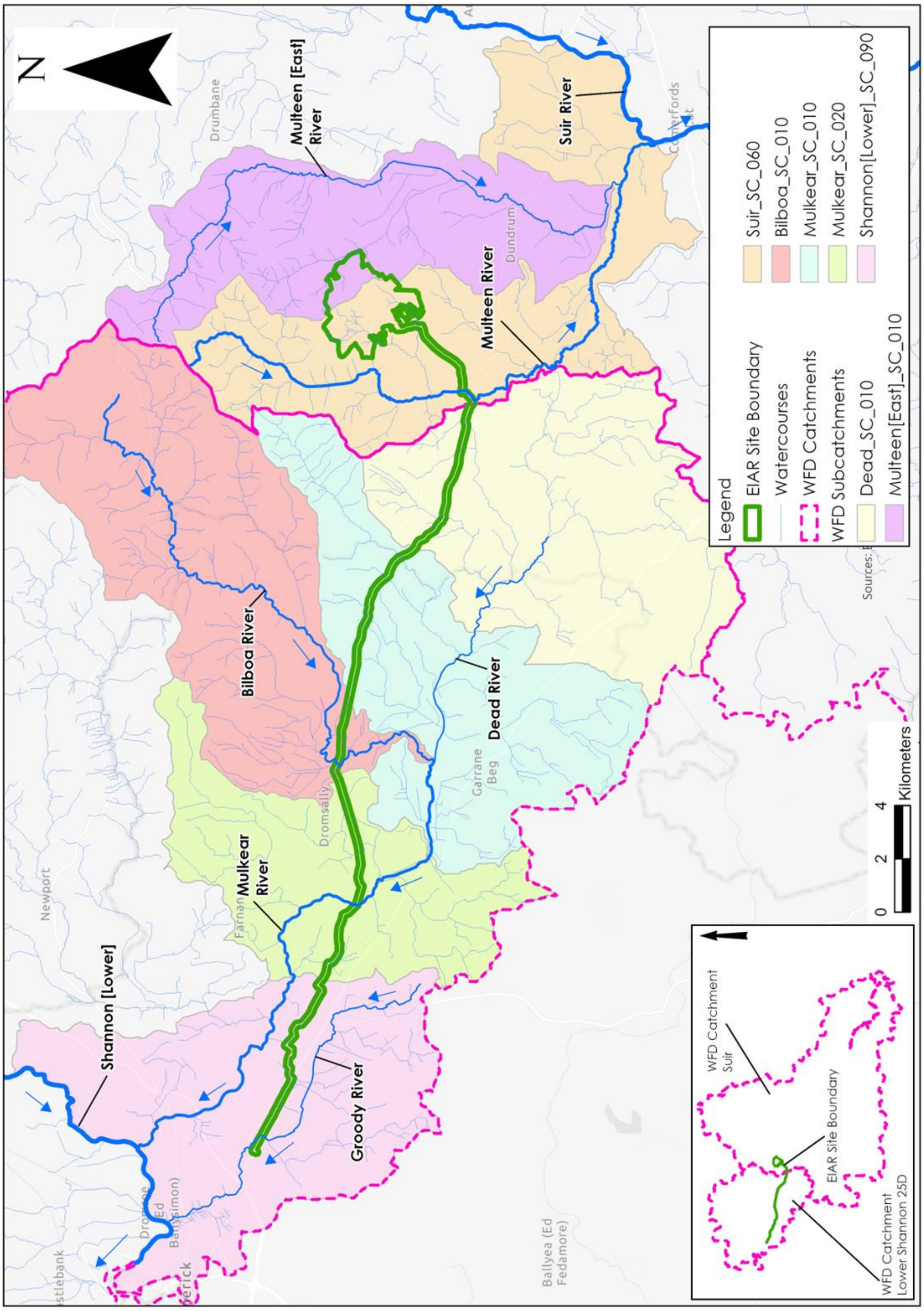

Figure B: Regional Hydrology Map

3.2.2 Rainfall and Evaporation

The SAAR (Standard Average Annual Rainfall) recorded at Dundrum (Kilpatrick), the closest rainfall station to the Site with long term SAAR data, is 1,073mm/year (www.met.ie). The Dundrum (Kilpatrick), rainfall station is located ~3.3km south of the Proposed Wind Farm.

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 ranges from 1,327 to 1,540mm/year. The average annual rainfall is 1,434mm/yr (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 Shannon Airport, approximately 55km west of the Proposed Wind Farm. The long-term average PE for this station is 543mm/year. This value is used as a best estimate of the PE at the Proposed Wind Farm. Actual Evaporation (AE) at the Proposed Wind Farm is estimated as 516mm/year (which is 0.95 × PE).

Using the above figures, the effective rainfall (ER)[2] for the Site is calculated to be (ER = SAAR – AE) 918mm/year.

Based on groundwater recharge estimates from the GSI (www.gsi.ie), the recharge coefficient ranges from 22% to 25% at the Proposed Wind Farm. The majority of the Proposed Wind Farm site has a recharge coefficient of 22%. Hence 23% is taken as the weighted average recharge coefficient and therefore 77% as the runoff coefficient for the Proposed Wind Farm.

Therefore, annual recharge and runoff rates for the Proposed Wind Farm are estimated to be 211mm/year and 707mm/year respectively. This means that the hydrology of the Proposed Wind Farm is characterised by higher surface water runoff rates and lower groundwater recharge rates.

Recharge coefficients do not apply to the Proposed Grid Connection cable route due to proposed route along the carriageway of public roads (i.e. artificial surface).

Climate change projections for Ireland are provided by Regional Climate Models (RCM's) downscaled from larger Global Climate Models (GCM's). Projections for the period 2041-2060 (mid-century) are available from Met Eireann. The data indicates a projected decrease in summer rainfall from 0 to 13% under the medium-low emission range scenario and an increase in the frequency of heavy precipitation events of ~20%. In total the projected annual reduction in rainfall near the Proposed Wind Farm site is ~8% under the medium-low emission scenario and the high emissions scenario

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

	Return Period (Years)			
Duration	**5**	**10**	**30**	**100**
5 mins	6.6	8	10.7	14.4
15 mins	10.8	13.2	17.5	23.6
30 mins	13.8	16.7	21.9	29.2
1 hours	17.6	21.1	27.4	36.1
6 hours	33.3	39	49.1	62.5
12 hours	42.6	49.5	61.5	77.2
24 hours	54.4	62.7	77	95.5
2 days	65.8	74.8	90.1	109.5

3.3 GEOLOGY

The GSI subsoils map (www.gsi.ie) shows that the dominant subsoil type within the Proposed Wind Farm is till derived from Lower Palaeozoic sandstones and shales. Bedrock outcrop or subcrop is mapped to occur predominantly on the northern and northwestern areas of the Proposed Wind Farm suggesting shallow depths of till over bedrock.

Bedrock outcrop or subcrop is also mapped along sections of both the Lackenacoombe Stream and Glasheenyreagha Stream which present as bedrock escarpments along the stream valley sides. Till derived from Lower Palaeozoic and Devonian sandstones are mapped on the eastern and southeastern fringes of the Proposed Wind Farm.

The GSI subsoil mapping along the Proposed Grid Connection route shows till derived from Devonian Sandstones (TDSs), gravels derived from Lower Palaeozoic and Devonian Sandstones (GLPDSs) and till derived from limestones (TLs) with small areas underlain by Till derived from Lower Palaeozoic Sandstones and Shales (TLPSsS), Cut over raised peat (Cut) and Alluvium (A). Due to the Proposed Grid Connection cable route being primarily along public roads, the proposed works will not significantly interact with the natural subsoil, apart from the offroad section and at the 110kV substation.

Trial pits (28 no.) were carried out at various locations across the Site to provide information on the ground conditions, depth to bedrock, bedrock competency. Mineral subsoils most encountered were SILT, CLAY or SILT/CLAY combinations and typically presented as very firm to firm, slightly sandy, slightly gravelly and occasionally interbedded with SAND layers.

The subsoils are consistent with the underlying parent material (i.e. sandstone/siltstone bedrock). Refusal on bedrock (presumed) during trial pitting was recorded in 18 of the 28 no. trial pits (64%).

The depth to bedrock at the 18 no. locations ranged between 0m and 3.3m with an average of 1.8m. Trial pits that encountered bedrock were distributed throughout the Site indicating relatively shallow bedrock across the overall Site. At these ground elevations shallow bedrock would be expected and is consistent with GSI mapping (i.e. bedrock outcrop or subcrop).

A subsoil geology map for the Proposed Wind Farm is shown as **Figure C.**

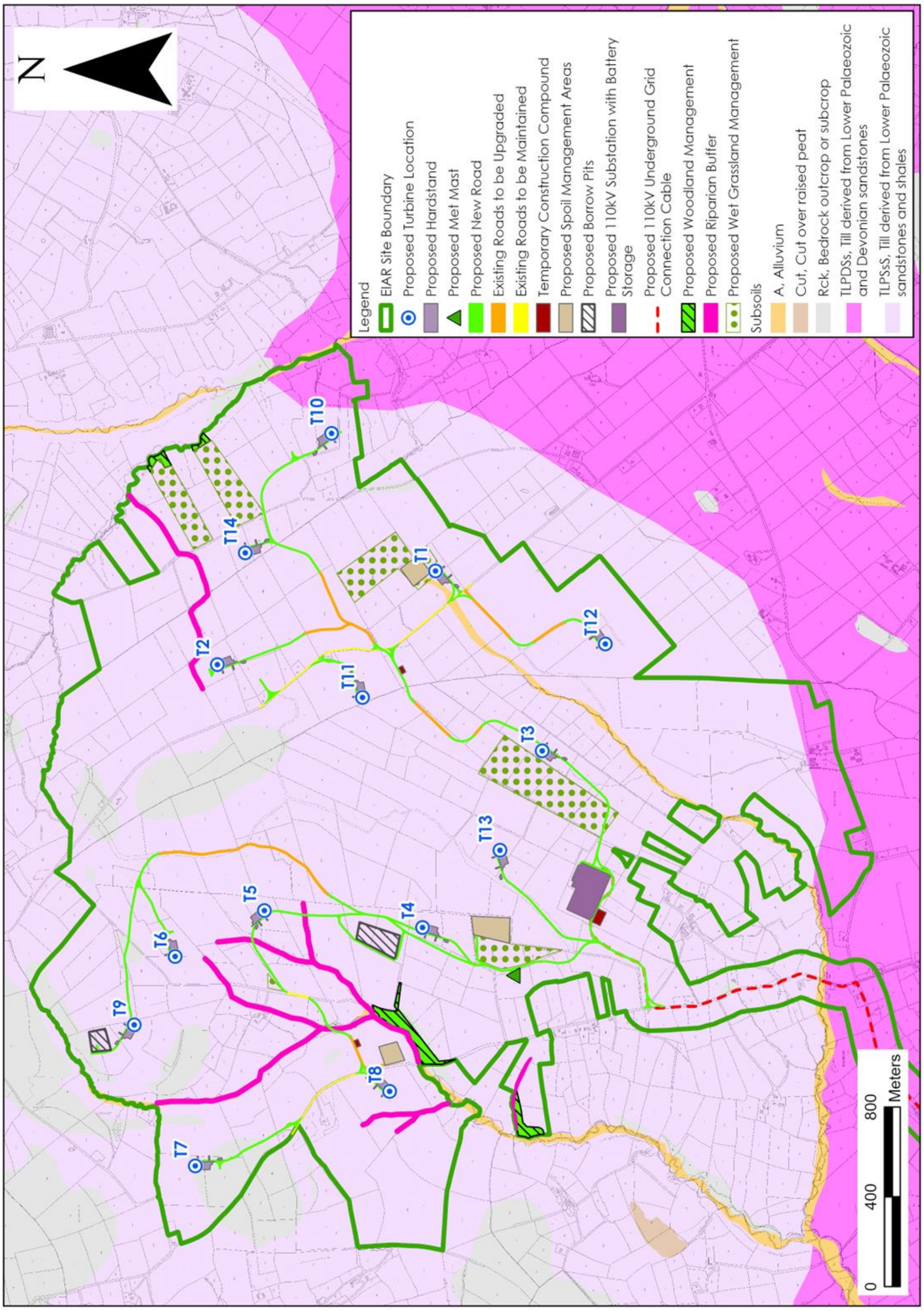

Figure C: GSI Subsoil Mapping

3.4 SITE DRAINAGE

3.4.1 Existing Site Drainage

The western and central portions of the Proposed Wind Farm site are drained by the Lackenacoombe Stream where several headwater (1st order) streams emerge from the northwest of the Proposed Wind Farm site. The southwestern portion of the Proposed Wind Farm site is drained by the Glasheenyreagha Stream which emerges from two headwater streams at the southern end of the Proposed Wind Farm site. Refer to **Figure D** below for existing drainage at the Proposed Wind Farm site.

Within the Proposed Wind Farm site there is an existing bridge crossing along public roads on both the Lackenacoombe Stream and the Glasheenyreagha Stream.

The Lackenacoombe Stream and Glasheenyreagha Stream flow off-site to the southwest and merge approximately 1.2km downstream of the Proposed Wind Farm site, prior to flowing into the Multeen River a further 2km downstream.

The eastern portion of the Proposed Wind Farm site is drained by Aughnaglanny River which flows southerly along the eastern boundary of the Proposed Wind Farm site. Two headwater streams of the Aughnaglanny River emerge from within the Proposed Wind Farm site. The Aughnaglanny River flows into the Multeen River approximately 5km downstream of the Proposed Wind Farm Site.

Within the Lackenacoombe Stream catchment there are 6 no. new proposed watercourse crossing locations and 2 no. existing crossings (along forestry tracks) required for the Proposed Wind Farm access roads. Within the Glasheenyreagha Stream catchment and Aughnaglanny River catchment 2 no. and 1 no. proposed new crossings are required respectively.

Along the Proposed Grid Connection cable route there are 35 no. watercourse crossings with 23 no. of these being EPA mapped watercourses. All 35 no. crossings are existing culverts or bridges where works are required to accommodate the Proposed Grid Connection cable within or underneath the crossing structure. No in-stream works are required at any of the Proposed Grid Connection watercourse crossing locations.

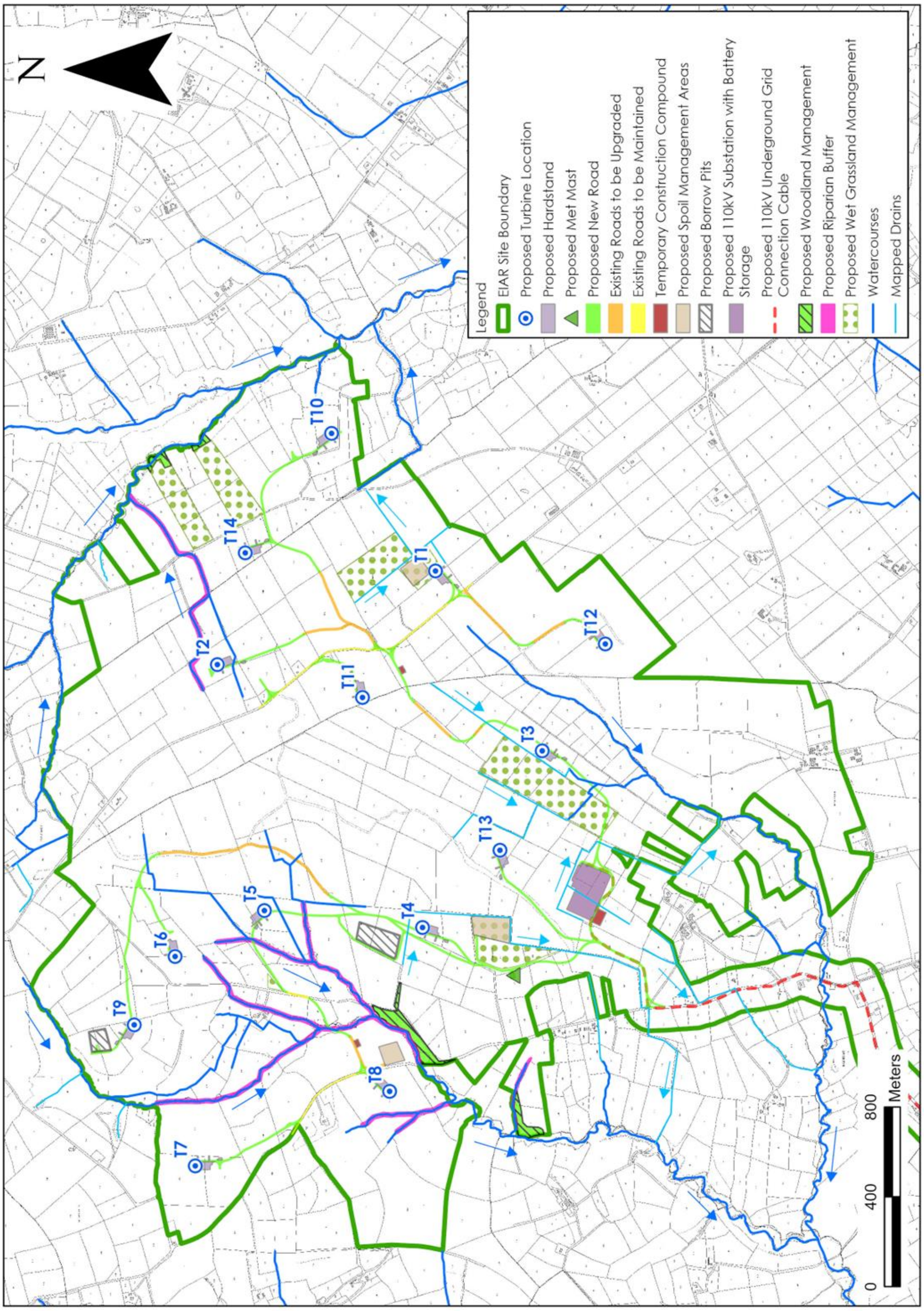

Figure D: Proposed Wind Farm Existing Drainage

3.5 DESIGNATED SITES & HABITATS

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

Aughnaglanny Valley pNHA (Site Code: 000948) is located immediately to the east of the Proposed Wind Farm site where the Aughnaglanny River flows close to the eastern Site boundary. The eastern fringes of the Proposed Wind Farm site are within the mapped pNHA boundary but there is no Proposed Wind Farm infrastructure within the pNHA.

The Multeen River located immediately downstream of the Proposed Project site forms part of the Lower River Suir SAC (002137).

Many of the sub-catchments that the Proposed Grid Connection cable pass through form part of the Lower River Shannon SAC (Site Code: 002165). These include the Cahernahallia River, Bilboa River and Mulkear River.

The Proposed Grid Connection cable route intercepts the Lower River Shannon SAC at three locations where its crosses the Cahernahallia River, Bilboa River and Mulkear River via existing road and bridge structures.

Similarly, TDR works at Location 1 (Camus Bridge on River Suir) is located adjacent to the Lower River Shannon SAC. The works at this location are taking place in the front garden of the house on that bend which is outside the SAC.

There are a number of pNHA designated marshes to the south of the Proposed Grid Connection route near Cappawhite; namely Kilbeg Marsh, Philipston Marsh and Ballyneil Marsh. The Proposed Grid Connection follows a local public road at this location.

4. SITE SPECIFIC FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following flood risk assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). The basic objectives of these guidelines are to:

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

4.2 FLOOD RISK ASSESSMENT PROCEDURE

This section of the report details the site-specific flood risk assessment carried out for the proposed windfarm 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 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 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 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.

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 local area, alluvium deposits are mapped within the Proposed Wind Farm Site, along the Lackenacoombe and Glasheenyreagha streams. Alluvium soils are also mapped along the Aughnaglanny River which flows to the east of the Proposed Wind Farm site and the Multeen River that flows southwest of the Proposed Wind Farm site. There is no Proposed Project infrastructure located within mapped alluvium deposits apart from proposed watercourse crossing locations.

Based on the EPA/GSI soil map, alluvium deposits are mapped close to sections of the Proposed Grid Connection cable route at the larger watercourse crossing locations such as the Cahernahallia River, Bilboa River and Mulkear River.

However, due to the Proposed Grid Connection cable route being within the carriageway of public roads/bridge structures, the proposed infrastructure does not interact with mapped alluvium deposits.

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 ass shown on **Figure E** below.

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

The closest mapped past flood events are situated near Hollyford village northwest and upstream of the Proposed Wind Farm site, the nearest being a single flood event mapped south of Hollyford, ~1.4km from the Proposed Wind farm site (ID: 13914).

The nearest downstream past flood event is located in the townland of Cumask, at Dundrum Rossmore Bridge along the Multeen (East) River, ~3.6km southeast of the Proposed Wind Farm Site (ID:4357). According to the OPW Flood Hazard Mapping Programme Flood engineer notes; land and minor road flooding occurs approximately twice a year at this location.

There are several past flood events mapped along the Proposed Grid Connection cable route. However, due to the underground nature of the Proposed Grid Connection cable route, the cabling has no potential to affect/worsen fluvial flooding or be affected by flooding.

No lands within or in the immediate vicinity of the Proposed Wind Farm site are mapped as part of a major arterial drainage scheme 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.

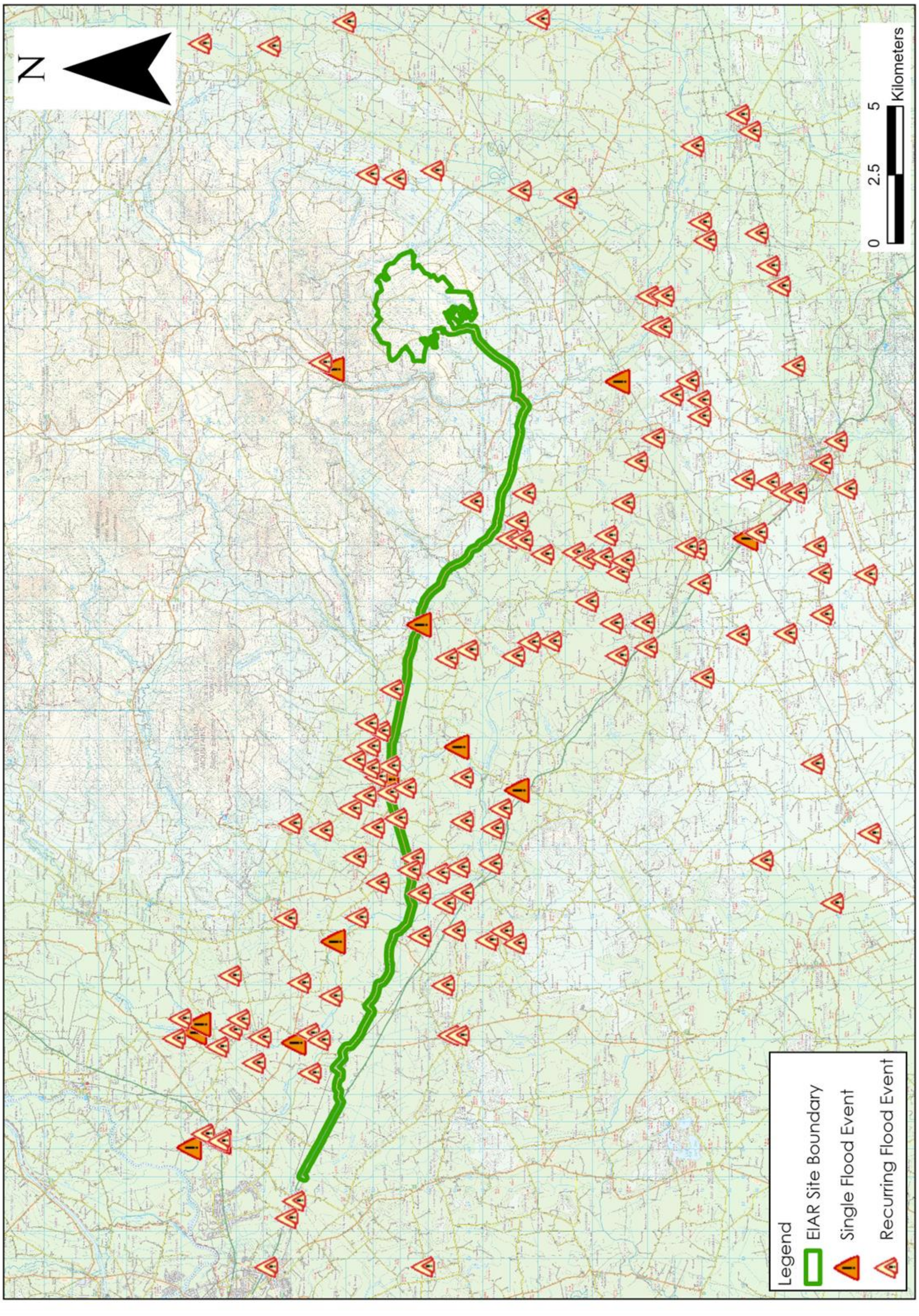

Figure E: OPW Past Flood Event Mapping

4.3.4 CFRAM – River Flood Extent Mapping

Catchment Flood Risk Assessment and Management (CFRAM)[3] 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 not been completed for the catchments local to the Proposed Wind Farm site (i.e. the Multeen River or its tributaries).

The closest mapped CFRAM fluvial flood zones for the present-day scenario downstream of the Proposed Wind Farm site are mapped along the River Suir ~20km downstream of the Proposed Project.

CFRAM mapping is available for the Mulkear River where it shows fluvial flood zones along the Proposed Grid Connection cable route. However, due to the underground nature of the Proposed Grid Connection cable route, the cabling has no potential to affect fluvial flooding or itself be affected by flooding.

Refer **Figure F** below for CFRAM Flood Extent Mapping.

4.3.5 National Indicative Fluvial Mapping

The National Indicative Fluvial Mapping (NIFM) (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 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).

The NIFM flood extents for the Present Day Scenario are mapped in the immediate vicinity of the Proposed Wind Farm Site, as low and medium probability river flood zones are mapped along the Aughnaglanny River as it flows along the eastern boundary of the Proposed Wind Farm site and the Multeen River as it flows southwards to the west of the Proposed Wind Farm site.

Flood zones along the Aughnaglanny River do not extend far beyond the mapped channel of the Aughnaglanny watercourse at the Proposed Wind farm Site and hence do not encroach significantly within the Site itself.

Additionally, low and medium probability NIFM river flood zones are mapped 1km downstream of the Proposed Wind Farm site, along the lower reaches of the Lackenacoombe stream.

As such, the Proposed Wind Farm site, including all proposed infrastructure is located in Flood Zone C, where the probability of fluvial flooding is low (less than 0.1%).

NIFM flood zones are mapped along the Proposed Grid Connection cable route at the larger watercourse crossing locations such as the Mulkear River. However, due to the underground nature of the Proposed Grid Connection cable route, the cabling has no potential to affect fluvial flooding. NIFM flood zones for the present-day scenario are shown on **Figure F.**

[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.

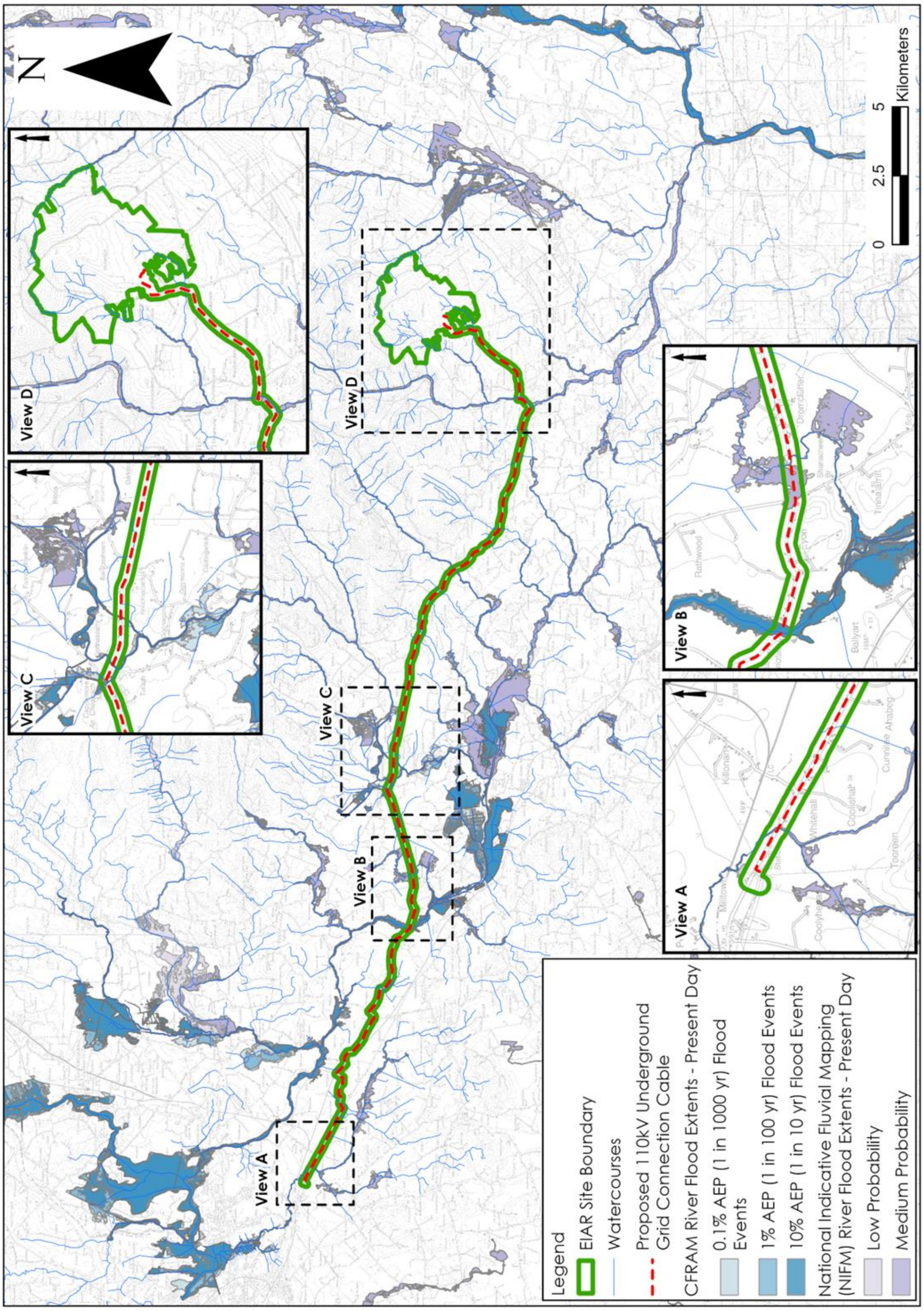

Figure F: OPW CFRAM & NIFM Flood Zones

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

The GSI Winter (2015/2016) Surface Water Flooding Map[4] 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 within the Site.

The nearest mapped surface water flood zones are mapped ~3.5km southwest of the Proposed Wind Farm site, at the location of unnamed lake waterbody.

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 Site.

4.3.8 Coastal Flooding

The Site is located ~50km inland from the sea and sits at an elevation of >163m OD.

Therefore, the Site 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.

Therefore, flood zones at the Site are unlikely to be significantly affected 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. Therefore, flood zones at the Site are unlikely to be significantly affected 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 cable route at watercourse crossing locations within the Mulkear River catchment. However, due to the underground nature of the Proposed Grid Connection cable route, the cabling has no potential to affect fluvial flooding or be affected by flooding.

[4] 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)*

The proposed 110kV substation component of the Proposed Grid Connection is located within Flood Zone C.

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.

Potential 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 Site.

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 is located in Fluvial Flood Zone C where there is a low risk of fluvial flooding 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 and ground elevation.

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[5] is shown in **Table C** below. This table is adapted from Table 3.2 of the PSFRM Guidelines (DoEHLG, 2009).

It may be considered that the Proposed Wind Farm as well as on-site 110kV substation can be categorised as "Highly Vulnerable Development", while the Proposed Grid Connection underground cable 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: 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.*

[5] *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

5.1 PLANNING POLICY AND CDP

The following policies are defined in the Tipperary County Development Plan (2022-2028) (**Table D**) and Limerick County Development Plan (2022-2028) (**Table E**) in respect of flooding, and we have outlined in the column to the right how these policies are provided for within the Proposed Wind Farm Site design:

Table D: Tipperary CDP Planning Policy/Objective and Responses

No.	Policy	Development Design Response
11-9	Assess all new developments (both within and without designated Flood Risk Zones) in line with the 'Staged Approach' and pre-cautionary principle set out in the Planning System and Flood Risk Management Guidelines for Planning Authorities, (DEHLG, 2009) and any amendment thereof	As outlined in this FRA
11-10	(a) Flood risk assessments shall incorporate consideration of climate change impacts and adaptation measures with regard to flood risk, and, (b) Flood risk management planning shall determine actions to embed and provide for effective climate change adaptation as set out in the OPW 'Climate Change Sectoral Adaptation Plan for Flood Risk Management' applicable at the time	As outlined in this FRA and **Section 4.3.9**
11-11	(a) Ensure that new developments proposed in 'Arterial Drainage Schemes' and 'Drainage Districts' do not result in a significant negative impact on the integrity, function and management of these areas. (b) Consult with the OPW in relation to proposed developments in the vicinity of Flood Relief Schemes and drainage channels and rivers for which the OPW are responsible, and to retain a strip on either side of such channels, where required, to facilitate maintenance access thereto. (b) Protect the integrity of any formal flood risk management infrastructure (see key flood risk infrastructure identified in Section 2.2 "Drainage, Key Flood Risk Infrastructure and Early Warning Systems" of the SFRA), thereby ensuring that any new development does not negatively impact any existing defence infrastructure or compromise any proposed new defence infrastructure	As outlined in this FRA

Table E: Limerick CDP Planning Policy/Objective and Responses

No.	Policy	Development Design Response
CAF P5	It is a policy of the Council to protect Flood Zone A and Flood Zone B from inappropriate development and direct developments/land uses into the appropriate lands, in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities 2009 (or any subsequent document) and the guidance contained in Development Management Standards and the Strategic Flood Risk Assessment (SFRA). Where a development/land use is proposed that is inappropriate within the Flood Zone, but that has passed the Plan Making Justification Test, then the development proposal will need to be accompanied by a Development Management Justification Test and Site-Specific Flood Risk Assessment in accordance with the criteria set out under The Planning System and Flood Risk Management Guidelines for Planning Authorities 2009 and Circular PL2/2014 (and any subsequent updates). This will need to demonstrate inclusion of measures to mitigate flood and climate change risk, including those recommended under Part 3 (Specific Flood Risk Assessment) of the Site Specific Plan Making Justification Tests detailed in the SFRA. In Flood Zone C, the developer should satisfy themselves that the probability of flooding is appropriate to the development being proposed and should consider other sources of flooding, residual risks and the implications of climate change.	As outlined in this FRA. No Highly vulnerable development is proposed in Flood Zone A or B
CAF O20	It is an objective of the Council to require a Site-Specific Flood Risk Assessment (FRA) for all planning applications in Flood Zones A and B and consider all sources of flooding (for example coastal/tidal, fluvial, pluvial or groundwater), where deemed necessary. The detail of these Site-Specific FRAs (or commensurate assessments of flood risk for minor developments) will depend on the level of risk andscale of development. The FRA will be prepared taking into account the requirements laid out in the SFRA, and in particular in the Plan Making Justification Tests as appropriate to the particular development site. A detailed Site-Specific FRA should quantify the risks, the effects of selected mitigation and the management of any residual risks. The assessments shall consider and provide information on the implications of climate change with regard to flood risk in relevant locations.	As outlined in this FRA. No Highly vulnerable development is proposed in Flood Zone A or B

5.2 PROPOSED PROJECT DRAINAGE

The proposed 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 Proposed Project related sediment runoff.

Overland flow rates are likely to be high 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 PROJECT 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;
    - Instances of recurring flooding were identified on OPW maps along the Proposed Grid Connection cable route but due to the underground nature of the cable, the proposed infrastructure cannot increase flood risk;
    - The GSI Winter 2015/2016 Surface Water Flooding and Groundwater flood Mapping provides no evidence of historical flooding at the Site;
    - No CFRAM or NIFM fluvial flood zones are mapped within the Proposed Wind Farm site;
    - Sections of the Proposed Grid Connection underground cable 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 on-site 110kV substation element of the Proposed Grid Connection is located in Flood Zone C at the Proposed Wind Farm.
- 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 Tipperary CDP and Limerick CDP (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.
Cawley, A.	1990	*The Hydrological Analysis of a Karst Aquifer System.* B.E., National University of Ireland.
CIRIA	2004	Development and Flood Risk – Guidance for the Construction Industry.
OPW	Not Dated	Construction, Replacement or Alteration of Bridges and Culverts. A Guide to Applying for Consent under Section 50 of the Arterial Act, 1945.
Institute of Hydrology	1994	Flood Estimation in Small Catchments.
Tipperary County Council	2022	Tipperary County Development Plan (2022-2028)
Limerick County Council	2022	Limerick County Development Plan (2022-2028)

© HYDRO-ENVIRONMENTAL SERVICES

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

www.hydroenvironmental.ie