Oatfield Wind Farm

Flood Risk Assessment (FRA)

604569 R01 (01)

December 2023

RSK GENERAL NOTES

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

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FLOOD RISK ASSESSMENT

1 Introduction

RSK Ireland was commissioned to carry out a Flood Risk Assessment by Orsted Onshore Ireland Midco Ltd (the Client). This report presents the findings of the flood risk assessment of the proposed Oatfield Wind Farm and grid connection (the proposed development) which comprises an eleven-turbine wind farm on a 296 hectare site located in Co. Clare, approximately approximately 1.3km to the South of Broadford, 4.7km to the East of Sixmilebridge, 7.6km North of Ardnacrusha, 9.2km North of Limerick, and 19.7km South of Ennis. This Flood Risk Assessment report has been prepared to accompany a planning application for the proposed development to Clare County Council.

This flood risk assessment has been carried out in accordance with the Department of Housing and Local Government (DEHLG) and the Office of Public Works (OPW) guidelines "The Planning System and Flood Risk Management Guidelines for Planning Authorities" (November 2009). It identifies and sets out possible mitigation measures against potential risks of flooding from various sources. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater and human/mechanical error.

RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public and private sectors. More information can be found at www.rskgroup.com.

2 Sources of information

2.1 Desk Study

2.1.1 EPA

The Environmental Protection Agency (EPA) Maps Application was consulted to identify to local hydrology around the vicinity of the site along with specific Water Framework Directive (WFD) status and risks for the referenced waterbodies[1]. [Accessed Nov 2023]

2.1.2 Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Southwestern Catchment Flood Risk Management Plan (CFRAM) study, were consulted to determine present-day risks to flooding in relation to the proposed development. The Office of Public Works (OPW) mapping study for Ireland is available on their website; floodinfo.ie[2]. [Accessed Nov 2023]

2.1.3 Google Earth Pro

National Grid Reference and topography mapping of the study site setting was drawn from Google Earth Pro (2022) TerraMetrics; version 7.3 (beta), Oatfield, Co. Clare, Ireland. Western

[1] EPA Unified GIS Application (2022)

[2] OPW Flood Maps and Catchment Flood Risk Assessment and Management (CFRAM) Programme (2022)

Portion 52°76’56.00” E -8°68’60.21” N, Eastern Portion 52°78’55.43” E -8°64’13.28” N, Eye alt 2.95 km. Places layers. SIO, NOAA, US Navy, NGA, GEBCO. [Accessed Nov 2023]

2.1.4 GSI

Geological Survey Ireland Spatial Resources from the Department of the Environment, Climate and Communications, were utilised to determine the Site’s hydrogeology, site-specific aquifer and vulnerability, borehole/well information, soil and subsoils data as well as Corine 2018 land use classification[3]. [Accessed Nov 2023]

2.1.5 OSI

Records from the National mapping agency of Ireland, the Ordnance Survey, were studied, on the websites interactive GeoHive Map Viewer (i.e., First Edition 6-inch map (1839-1842)) to determine the Site’s flood history[4]. [Accessed Nov 2023]

3 Site Description

3.1 Location

- Site Name: Oatfield Wind Farm Project (Wind Farm and Grid Connection Route (GCR))
- Site Irish Transverse Mercator (ITM) Reference for Eastern Portion: 556738.708 670696.765
- Site Irish Mercator (ITM) Reference for Western Portion: 553702.937 668505.632

The site of the Proposed Development is located in the Oatfield and Gortacullin areas. At the nearest point, the Proposed Development site is approximately 1.3km to the South of Broadford, 4.7km to the East of Sixmilebridge, 7.6km North of Ardnacrusha, 9.2km North of Limerick, and 19.7km South of Ennis.

The Turbine Delivery Route (TDR) connects to Foynes port – this assumes use of the new Killaloe bypass.

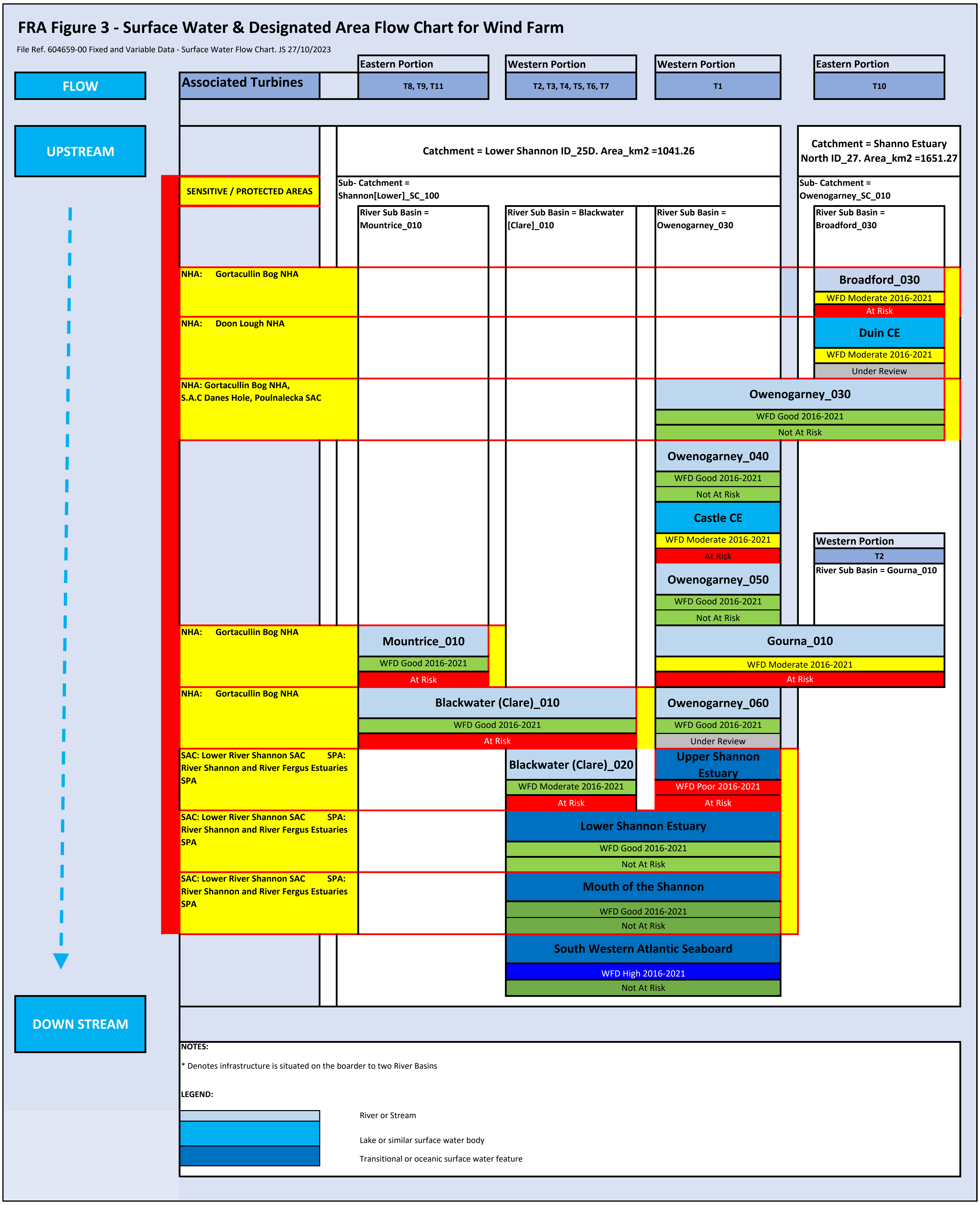
3.2 Site Hydrology

Surface water networks associated with particular turbine locations are presented in the Surface Water Flow Chart in **Figure 1**.

[3] Geological Survey Ireland Spatial Resources (2022)

[4] Government of Ireland and Ordnance Survey Ireland (2022)

Figure 1: Surface water flow network for Turbine Locations (RSK)



The Proposed Development is situated within the Lower Shannon Catchment (Code:25; Area 1041.26km^2) and Shannon Estuary North (ID: 27; Area: 1,651.27km^2).. The Grid Connection Route 'Loopin1' is situated solely in the Lower Shannon Catchment.

Surface water runoff associated with the wind farm site drains into two sub catchments and/or five river sub basins, or nine no. rivers and two Loughs:

- Sub Catchment: Shannon [Lower]_SC_100, River Sub Basins: Mountrice_010, Blackwater [Clare]_010 and Owenogarney_030
- Sub Catchment: Owenogarney_SC_010; River Sub Basins: Broadford_030 and Gourna_010

The Grid Connection Route 'Loopin1' drains into one sub catchments and river sub basins, or seven no. rivers:

- Sub Catchment: Shannon [Lower]_SC_100; River Sub Basin: Blackwater (Clare)_010, Blackwater (Clare)_020, Shannon (Lower)_060, Ballynaclogh_010.

All surface waters draining from the site eventually combine in the Upper Shannon Estuary, from which waters eventually flow to the Lower Shannon Estuary, through to Mouth of the Shannon and into the Southwestern Atlantic Seaboard.

In terms of local drainage and non-mapped surface water features the site characterised by extensive artificial drainage networks including in association with forestry, agricultural and land reclamation / improvement works. These drainage features flow follows the topography, which eventually was a south westerly direction then ends.

3.3 Site Soil & Subsoil Geology

Soils

Consultation with available soil maps indicate a number of soil types at the site location including Blanket peat (BktPt) and 'Acid Shallow, lithosolic or podzolic type soils potentially with peaty topsoil' (AminSRPT) in the eastern portion. The western portion is a mix of 'Acid Deep Poorly Drained Mineral' (AminPD) soil covering large areas with smaller pockets of 'Acid Poorly Drained Mineral Soils with Peaty Topsoil' (AminPDPT), 'Acid Deep Well Drained Mineral' (AminDW), and 'Acid Shallow Well Drained Mineral' (AminSW) soil also mapped.

The GCR 'Loopin1' has a similar soil composition to that of the site, consisting of number of soil types along the proposed grid connection route:

'Acid Poorly drained mineral soils with peaty topsoil - Derived from mainly non-calcareous parent materials'. 'Mineral Alluvium', 'Shallow Well Drained Mineral - Derived from mainly non-calcareous parent materials', and some Blanket Peat. 'Acid Deep Well Drained Mineral - Derived from mainly non-calcareous parent materials', 'Acid Shallow, lithosolic or podzolic type soils, 'Acid Deep Poorly drained mineral - Derived mainly non-calcareous parent materials'. This was assessed consulting with available soil maps.

Subsoils

In consultation with available maps (EPA) show subsoils underlying the site include peat (BktPt), TDSs sandstone till (Devonian) and TLPSsS, sandstone and shale till (Lower Paleozoic).

3.4 Site Hydrogeology

Consultation with GSI Groundwater maps (2023) indicate that the western portion of the wind farm site (encompassing the location of T1 – T7) is underlain by a 'Poor Aquifer (Pl)' that is, bedrock which is generally unproductive except for local zones and small areas of aquifers with classifications of 'Locally Important Aquifer (LI)'. The eastern portion (encompassing T8 – T11) of the development is underlain by a 'Locally Important Aquifer (LI)' that is, bedrock which is moderately productive only in local zones.

The GCR 'Loopin1' is underlain by the same classification of aquifers (PI and LI) as the development.

3.5 Groundwater Vulnerability & Recharge

The GSI Groundwater Map Viewer (2023) indicates that the wind farm site is underlain by areas classified as 'Rock near surface or Karst (X)'; 'Extreme (E)'; 'High (H)'; and 'Moderate (M)' vulnerability rating. The proposed location of T1, T3, T6, T10 and T11 have been mapped as areas with 'Rock near surface (X)' vulnerability rating. The proposed locations of T2, T4, T5, T7, T8 and T9 are in areas of 'Extreme (E)' vulnerability,

The GCR 'Loopin1' similarly traverse land with groundwater vulnerability ratings ranging from 'Low' to 'Moderately Vulnerable' to 'Extreme Vulnerability' 'Rock near surface'.

Areas of the site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 200mm effective rainfall.

The site is characterised by low recharge rates across the site and high surface water run off rates which can surplus the recharge capacity in the underlying bedrock aquifer. This implies that, particularly during seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the site will drain off the site as surface water runoff, and the rejected recharge water volumes will likely discharge to surface waters relatively rapidly and locally. As such, the surface water network associated with the site is characterised as having a rapid hydrological response to rainfall.

3.6 Proposed Development

The key components of the Proposed Development are listed below:

- The wind farm which consists of 11 wind turbines (4 turbines across the Eastern Development Area (Eastern DA) and 7 turbines across the Western Development Area (Western DA));
- The grid connection route and underground cables (also referred to as GCR and UGC); and,
- The turbine delivery route (TDR).

The term 'Proposed Development' collectively describes the above three components. Further information about the Proposed Development is presented in **EIAR Chapter 5: Description of the Proposed Development**.

4 Flood Risk Assessment

4.1 Introduction

4.1.1 Guidelines for FRAs

The Flood Risk Assessment Report RSK Ireland will prepare follows the guidelines set out in the DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management published in November 2009. This assessment will address where surface water, groundwater, tidal, fluvial and pluvial water within or around the site boundary comes from (i.e., the source), how and where it flows (i.e., the pathways) and the people and assets affected by it (i.e., the receptors). This stage aims to quantify the risk posed to the development and to the surrounding environment by this Development.

In line with DEHLG Guidelines for Planning Authorities – Flood Risk Management (2009);

Flood Risk Assessment Stage 1

As per Flood Risk Management (FRM) Guidelines the purpose of Stage 1 is to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and local area plans (LAP's) or a proposed development site that may warrant further investigation at the appropriate lower-level plan or planning application levels;

Flood Risk Assessment Stage 2

Stage 2 Initial flood risk assessment – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped; and

Flood Risk Assessment Stage 3

Stage 3 Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

Sources of Flooding

The components to be considered in the identification and assessment of flood risk are:

- Tidal flooding from high sea levels. Flooding occurs when sea levels along the coast or in estuaries exceed neighbouring land levels, or overcome coastal defences where these exist, or when waves overtop the coastline or coastal defences.
- Fluvial flooding from water courses. Flooding occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains). This can arise where the runoff from heavy rain exceeds the natural

capacity of the river channel and can be exacerbated where a channel is blocked or constrained or, in estuarine areas, where high tide levels impede the flow of the river out into the sea. While there is a lot of uncertainty on the impacts of climate change on rainfall patterns, there is a clear potential that fluvial flood risk could increase into the future.

- Pluvial flooding from rainfall / surface water. Flooding occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural or man-made hollows and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system. This type of flooding is driven in particular by short, intense rainstorms.
- Ground Water flooding from springs / raised ground water. 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 results from the interaction of site-specific factors such as local geology, rainfall infiltration routes and tidal variations. While the water level may rise slowly, it may cause flooding for extended periods of time. Hence, such flooding may often result in significant damage to property or disruption to transport. In Ireland, groundwater flooding is most commonly related to turloughs in the karstic limestone areas prevalent in particular in the west of Ireland.
- Human/mechanical error –flooding due to human or mechanical error. Flooding can also be caused by the failure or exceedance of capacity of built or man-made infrastructure, such as bridge collapses, from blocked piped sewerage networks, or the failure or over-topping of reservoirs or other water-retaining embankments (such as raised canals).

4.1.2 Assessing Flood Risk

The two components of flood risk, as outlined in the FRM Guidelines, are the likelihood of flooding and the potential consequences arising from planned works; expressed as:

Flood Risk = Probability of flooding x Consequences of flooding

- *Likelihood of flooding is normally defined as the percentage probability of a flood of a given magnitude or severity occurring or being exceeded in any given year. For example, a 1% probability indicates the severity of a flood that is expected to be exceeded on average once in 100 years, i.e., it has a 1 in 100 (1%) chance of occurring in any one year.*
- *Consequences of flooding depend on the hazards associated with the flooding (e.g., depth of water, speed of flow, rate of onset, duration, wave- action effects, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g., the age profile of the population, the type of development, presence and reliability of mitigation measures etc).*

4.1.3 Assessing Likelihood of Flood Risk

In the FRM Guidelines, the likelihood of a flood occurring in an area is identified and separated into Flood Zones presented in **Figure** below, which indicate a high, moderate or low risk of flooding from fluvial or tidal sources, defined as follows:

- Flood Zone A - Where the probability of flooding is highest (greater than 1% Annual Exceedance Probability (AEP) or 1 in 100 for river flooding and 0.5% AEP or 1 in 200 for coastal flooding) and where a wide range of receptors would be located and therefore vulnerable;
- Flood Zone B - Where the probability of flooding is moderate (between 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 for coastal flooding); and
- Flood Zone C - Where the probability of flooding is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding).

Figure 2: Indicative Flood zone map from (Dept of Housing, Local Government and Heritage, 2009)

As outlined in the FRM Guidelines, future developments must avoid where possible areas at risk of flooding, The FRM Guidelines categorises all types of development as either; 1. Highly Vulnerable, 2. Less Vulnerable and 3. Water Compatible e.g., flood infrastructure, docks, amenity open space (**Figure 3**). As the development of the Oatfield Wind Farm is essential infrastructure including electricity substations, it is considered a 'Highly vulnerable development' and locating within Flood Zone C is recommended i.e. outside of Probable Flood Zones A (1 in 100) and B (1 in 1000).

Figure 3: Classification of vulnerability of different types of development (OPW, 2009)

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).

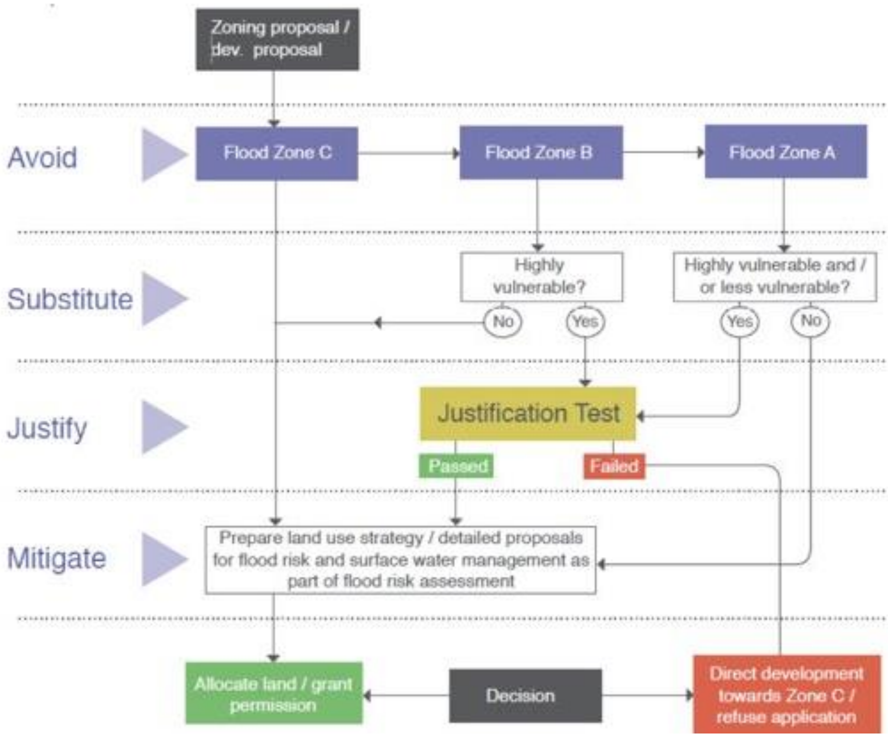
*Uses not listed here should be considered on their own merits

Presented in **Figure 4,** from the OPW (2009), a Justification Test is a guiding document that aims to determine the appropriateness of a particular development in areas that may be at risk of flooding. A Justification Test is required to assess such proposals in the light of proper planning and sustainable development objectives. As outlined in **Figure** there is a sequential approach to mechanism in planning process (OPW, 2022), depending on the Flood Zone and the Justification Test.

Figure 4: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification test (OPW, 2009)

	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

Figure 5: Sequential approach to mechanism in planning process (OPW, 2022)



4.2 Stage 1 – Flood Risk Identification

The flood risk identification stage was carried out in order to establish whether a flood risk exists within the boundaries of the proposed development or the surrounding vicinity.

Table: 1: Flood Risk Preliminary Screening Wind Farm

Flood Risk Preliminary Screening WF
(RSK File Ref. 604569-Hydro-R01-(01))
(SK, JS 12/10/2023)

Category		Annual Exceedance Probability (%)	Chance of Occurrence in any Given Year	Return Period (Years)	Considers Flood Defences	Considers Climate Change	Site Assessment Screening result, flood zone on site?	Comment
National Indicitive Fluvial Mapping Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed Yes	No	
National Indicitive Fluvial Mapping Present Day	Medium Probability	1	1 in 200	100	Assumed Yes	Yes	No	
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	
National Indicitive Fluvial Mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	
National Indicitive Fluvial Mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	No	
CCFRAM River (Fluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed No	No	
CCFRAM River (Fluvial) Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	No	
CCFRAM River (Fluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	No	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	No	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	Medium Probability	0.5	1 in 200	200	Assumed Yes	No	No	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	
CCFRAM Coastal Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	No	
CCFRAM Coastal Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	No	
CCFRAM Coastal Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	
CCFRAM PDF Maps							n/a	
National Coastal Flood Extents 2021 - Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	No	
National Coastal Flood Extents 2021 - Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	No	
National Coastal Flood Hazard Mapping PRESENT DAY	Low Probability	0.1	1 in 1000	1000	Assumed No	No	No	
National Coastal Flood Hazard Mapping PRESENT DAY	Medium Probability	0.5	1 in 200	200	Assumed No	No	No	
National Coastal Flood Hazard Mapping PRESENT DAY	High Probability	10	1 in 10	10	Assumed No	No	No	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	No	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	No	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	No	
National Coastal Flood Hazard mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	No	
National Coastal Flood Hazard mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	No	
National Coastal Flood Hazard mapping High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	No	
Drainage Map Current Sceanorio Drainage Map (Coastal Extent)	Current Probability				Assumed Yes	YES	No	
Drainage Map Mid Range Sceanorio Drainage Map (Coastal Extent)	High Probability	10	1 in 10		Assumed Yes	YES	No	
Drainage Map High End Future Sceanorio Drainage Map (Coastal Extent)	High Probability	10	1 in 10		Assumed Yes	YES	No	
Past Flood Events	**Single Occurance**				Assumed Yes	No	No	
Past Flood Events	**Reoccuring**				Assumed Yes	No	No	

Table 2: Flood Risk Preliminary Screening Grid Connection Routes

Flood Risk Preliminary Screening GCRs
(RSK File Ref. 604569-Hydro-R01-(01))
(SK, JS 18/12/2023)

Category		Annual Exceedance Probability (%)	Chance of Occurrence in any Given Year	Return Period (Years)	Considers Flood Defences	Considers Climate Change	Grid Connection Route Assessment Screening result, flood zone on site?	Comment
National Indicitive Fluvial Mapping Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed Yes	No	
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National Indicitive Fluvial Mapping Mid End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	No	
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	no	
National Indicitive Fluvial Mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	no	
National Indicitive Fluvial Mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	no	
CCFRAM River (Fluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed No	no	
CCFRAM River (Fluvial) Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	no	
CCFRAM River (Fluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	No	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	no	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	no	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	no	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	no	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	no	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	Medium Probability	0.5	1 in 200	200	Assumed Yes	No	No	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	No	
CCFRAM Coastal Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	no	
CCFRAM Coastal Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	no	
CCFRAM Coastal Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	no	
CCFRAM PDF Maps							no	
Ground Water Flooding Probability Maps	Low Probability	0.1	1 in 1000	1000	Assumed No	No	no	
Ground Water Flooding Probability Maps	Medium Probability	0.5	1 in 200	200	Assumed No	No	no	
Ground Water Flooding Probability Maps	High Probability	10	1 in 10	10	Assumed No	No	no	
National Coastal Flood Extents 2021 - Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	no	
National Coastal Flood Extents 2021 - Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	no	
National Coastal Flood Hazard Mapping PRESENT DAY	Low Probability	0.1	1 in 1000	1000	Assumed No	No	no	
National Coastal Flood Hazard Mapping PRESENT DAY	Medium Probability	0.5	1 in 200	200	Assumed No	No	no	
National Coastal Flood Hazard Mapping PRESENT DAY	High Probability	10	1 in 10	10	Assumed No	No	no	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	no	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	no	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	no	
National Coastal Flood Hazard mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	no	
National Coastal Flood Hazard mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	no	
National Coastal Flood Hazard mapping High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	no	
Drainage Map Current Sceanorio Drainage Map (Coastal Extent)	Current Probability				Assumed Yes	YES	no	
Drainage Map Mid Range Sceanorio Drainage Map (Coastal Extent)	High Probability	10	1 in 10		Assumed Yes	YES	no	
Drainage Map High End Future Sceanorio Drainage Map (Coastal Extent)	High Probability	10	1 in 10		Assumed Yes	YES	no	
Past Flood Events	**Single Occurance**				Assumed Yes	No	No	
Past Flood Events	**Reoccuring**				Assumed Yes	No	No	

Table 3: Flood Risk Preliminary Screening Turbine Delivery Route

Flood Risk Preliminary Screening TDR
(RSK File Ref. 604569-Hydro-R01-(01))
(SK, JS 12/10/2023)

Category		Annual Exceedance Probability (%)	Chance of Occurrence in any Given Year	Return Period (Years)	Considers Flood Defences	Considers Climate Change	Turbine Delivery Route Assessment Screening result, flood zone on site?	Comment
National Indicitive Fluvial Mapping Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed Yes	Yes	
National Indicitive Fluvial Mapping Present Day	Medium Probability	1	1 in 200	100	Assumed Yes	Yes	Yes	
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	Yes	
National Indicitive Fluvial Mapping Mid End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	Yes	
National Indicitive Fluvial Mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Yes	Yes	
National Indicitive Fluvial Mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	Yes	Yes	
CCFRAM River (Fluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	Assumed No	Yes	
CCFRAM River (Fluvial) Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	Yes	
CCFRAM River (Fluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	Yes	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	Yes	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	Yes	
CCFRAM River (Fluvial) Flood Extents Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	Yes	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	Yes	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	Yes	
CCFRAM River (Fluvial) Flood Extents High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	Yes	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	Yes	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	Medium Probability	0.5	1 in 200	200	Assumed Yes	No	Yes	
CCFRAM Rainfall (Pluvial) Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	Yes	
CCFRAM Coastal Flood Extents Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	Yes	
CCFRAM Coastal Flood Extents Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	Yes	
CCFRAM Coastal Flood Extents Present Day	High Probability	10	1 in 10	10	Assumed Yes	No	Yes	
CCFRAM PDF Maps								
Ground Water Flooding Probability Maps	Low Probability	0.1	1 in 1000	1000	Assumed No	No	No	
Ground Water Flooding Probability Maps	Medium Probability	0.5	1 in 200	200	Assumed No	No	No	
Ground Water Flooding Probability Maps	High Probability	10	1 in 10	10	Assumed No	No	No	
National Coastal Flood Extents 2021 - Present Day	Low Probability	0.1	1 in 1000	1000	Assumed Yes	No	Yes	
National Coastal Flood Extents 2021 - Present Day	Medium Probability	1	1 in 100	100	Assumed Yes	No	Yes	
National Coastal Flood Hazard Mapping PRESENT DAY	Low Probability	0.1	1 in 1000	1000	Assumed No	No	Yes	
National Coastal Flood Hazard Mapping PRESENT DAY	Medium Probability	0.5	1 in 200	200	Assumed No	No	Yes	
National Coastal Flood Hazard Mapping PRESENT DAY	High Probability	10	1 in 10	10	Assumed No	No	Yes	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	Yes	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	Yes	
National Coastal Flood Hazard mapping Mid Range Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	Yes	
National Coastal Flood Hazard mapping High End Future Sceanorio	Low Probability	0.1	1 in 1000	1000	Assumed Yes	YES	Yes	
National Coastal Flood Hazard mapping High End Future Sceanorio	Medium Probability	0.5	1 in 200	200	Assumed Yes	YES	Yes	
National Coastal Flood Hazard mapping High End Future Sceanorio	High Probability	10	1 in 10	10	Assumed Yes	YES	Yes	
Drainage Map Current Sceanorio Drainage Map (Coastal Extent)	Current Probability				Assumed Yes	YES	No	
Drainage Map Mid Range Sceanorio Drainage Map (Coastal Extent)	High Probability	10	1 in 10		Assumed Yes	YES	No	
Drainage Map High End Future Sceanorio Drainage Map (Coastal Extent)	High Probability	10	1 in 10		Assumed Yes	YES	No	
Past Flood Events	**Single Occurance**				Assumed Yes	No	Yes	
Past Flood Events	**Reoccuring**				Assumed Yes	No	Yes	

4.2.1 Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. First Edition 6-inch map (1839-1842) indicate that neither the site itself, nor the surrounding area are susceptible to flooding. The National Indicative Fluvial Mapping database (Present Day) operated by the OPW has identified all surface waterbodies draining the site: as not having low probabilty (0.1% AEP) or medium probability (1% AEP) risk to flood (**Figure 6a**). The National Indicative Fluvial Mapping database (Future Scenario) operated by the OPW has identified all surface waterbodies draining the site: as not having low probabilty (0.1% AEP) or medium probability (1% AEP) and high probability for risk to flood (**Figure 6b**).

The Grid Connection Route also has no low (0.1% AEP) or medium probability (1% AEP) risk of fluvial flooding.

Figure 6a: National Indicative Fluvial Maps, Present day, low and medium probability, not considering Climate Change (OPW,2023)

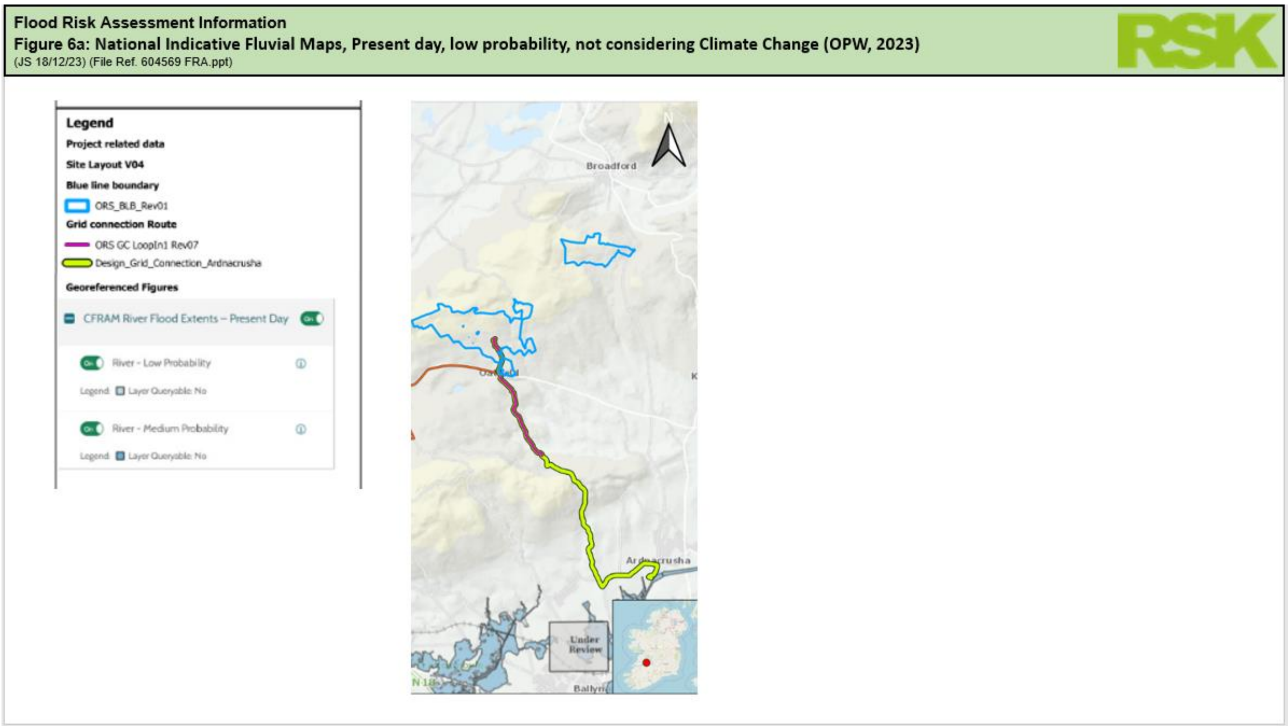
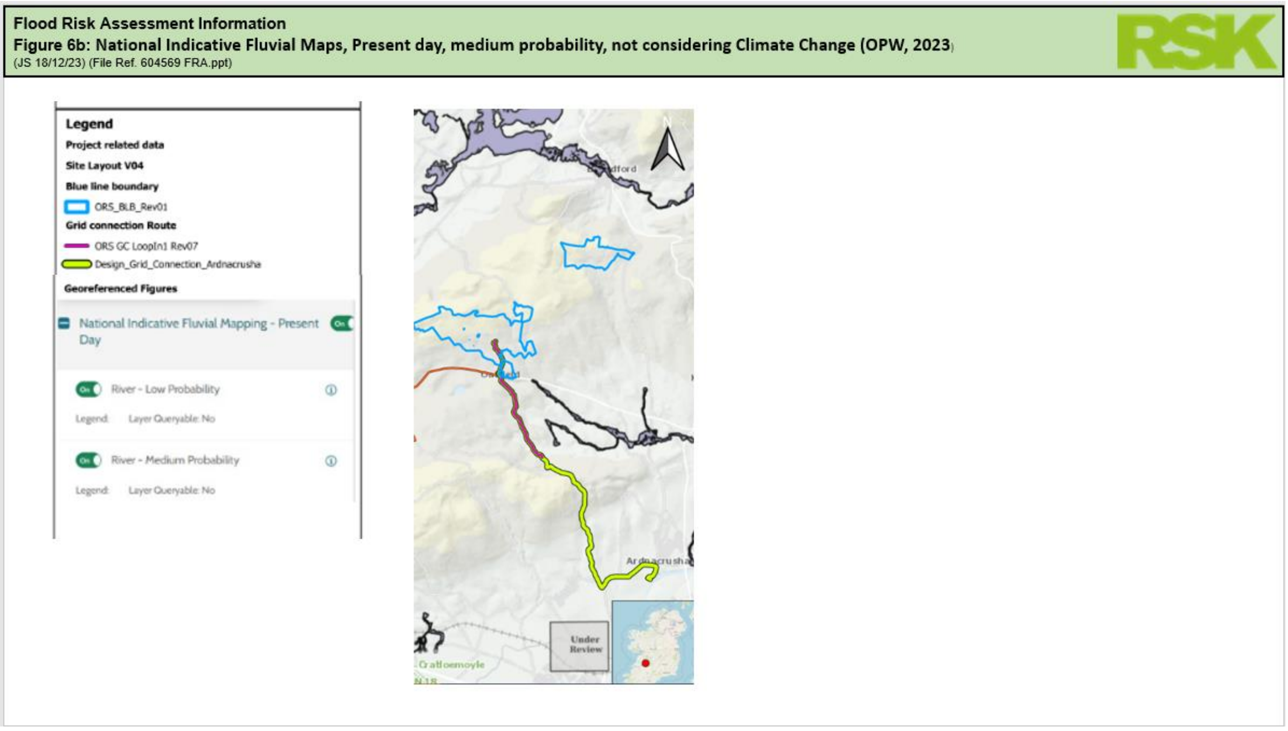
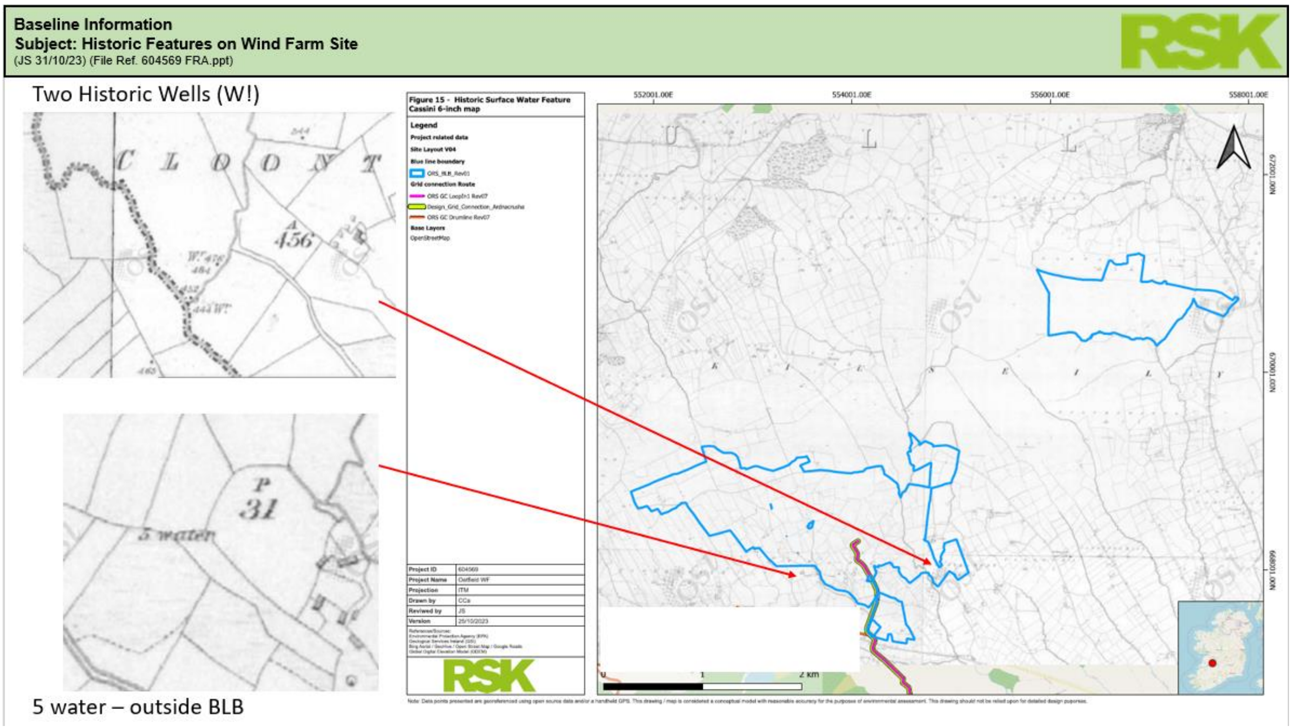


Figure 60b: National Indicative Fluvial Maps, Future scenario, low, medium and high probability, not considering Climate Change (OPW,2023)



Historic maps have not indicated any flooding on site, however there are mapped wells (**Figure 7).** There is no Past flood event on the OPW Database present at the wind farm site (**Figure** 71**13)**.

Figure 71: Historic Surface Water Feature Cassini 6-inch map



There is no fluvial flood risk associated with ‘Loopin1’ GCR.

4.2.2 Tidal Flooding

Tidal flooding is caused by elevated sea levels or overtopping by wave action. No coastal flood zones are identified at the site or surrounding area.

The South Western Atlantic Seaboard is located c.75km south west of the site. Due to both the inland nature and elevation of the proposed development site, the residual risk from tidal flooding is considered nil at the Wind Farm Site.

There is no tidal flood risk associated with ‘Loopin1’ GCR.

4.2.3 Fluvial Flooding

Fluvial flooding is caused by rivers, watercourses or ditches overflowing. Historic flood maps dating (1839-1842), were reviewed for the proposed development area and did not indicate a history of flooding at the site from small streams or tributaries found within or near site boundaries.

The most recent, comprehensive flood-maps, produced by the OPW (2016) under the South Western Catchment Flood Risk Assessment and Management (CFRAM) programme do not indicate any flood extents within the proposed site boundaries, therefore all areas outside the 0.1% AEP flood extent (the proposed development), are classified as Flood Zone C. CFRAM flood-maps confirm that the proposed development site is in Flood Zone C and is a suitable development for this area (**Figures 8a & 8b, 9a & 9b**).

Figure 82a: National Indicative Fluvial Maps, Present Day (OPW,2023)

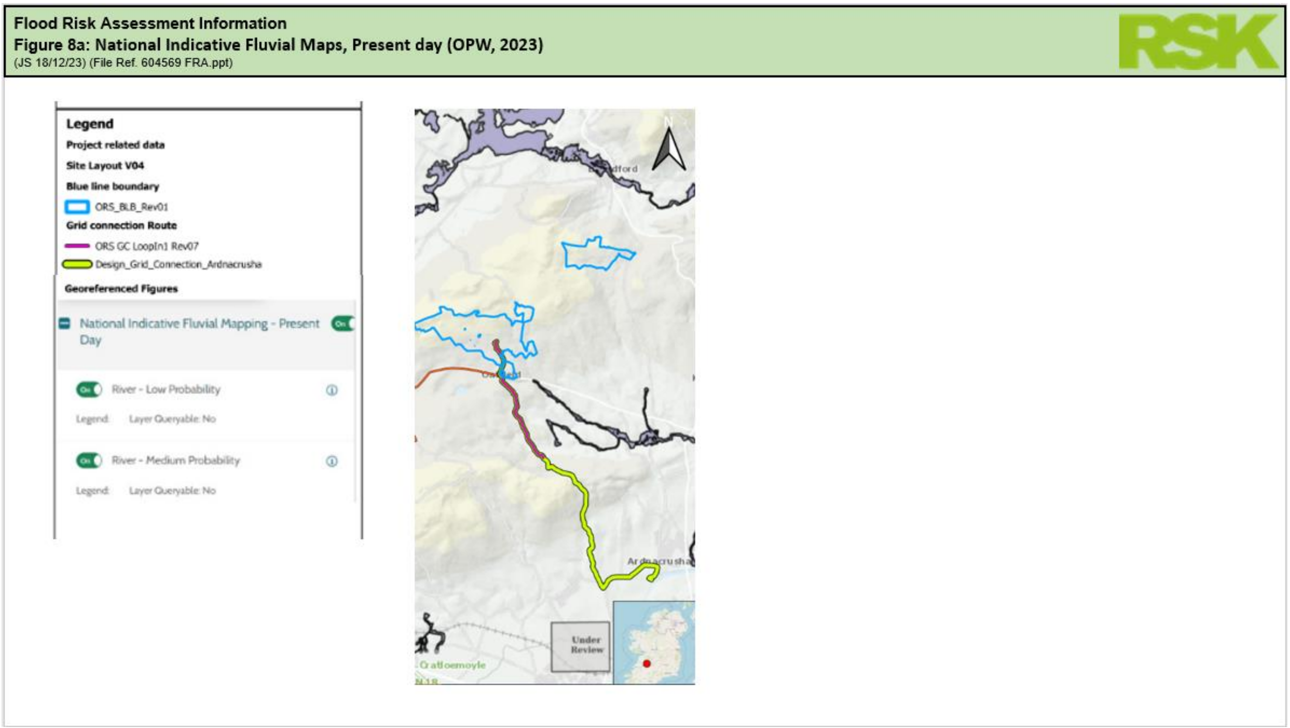


Figure 82b: National Indicative Fluvial Maps, Future scenarios, considering Climate Change (OPW, 2023)

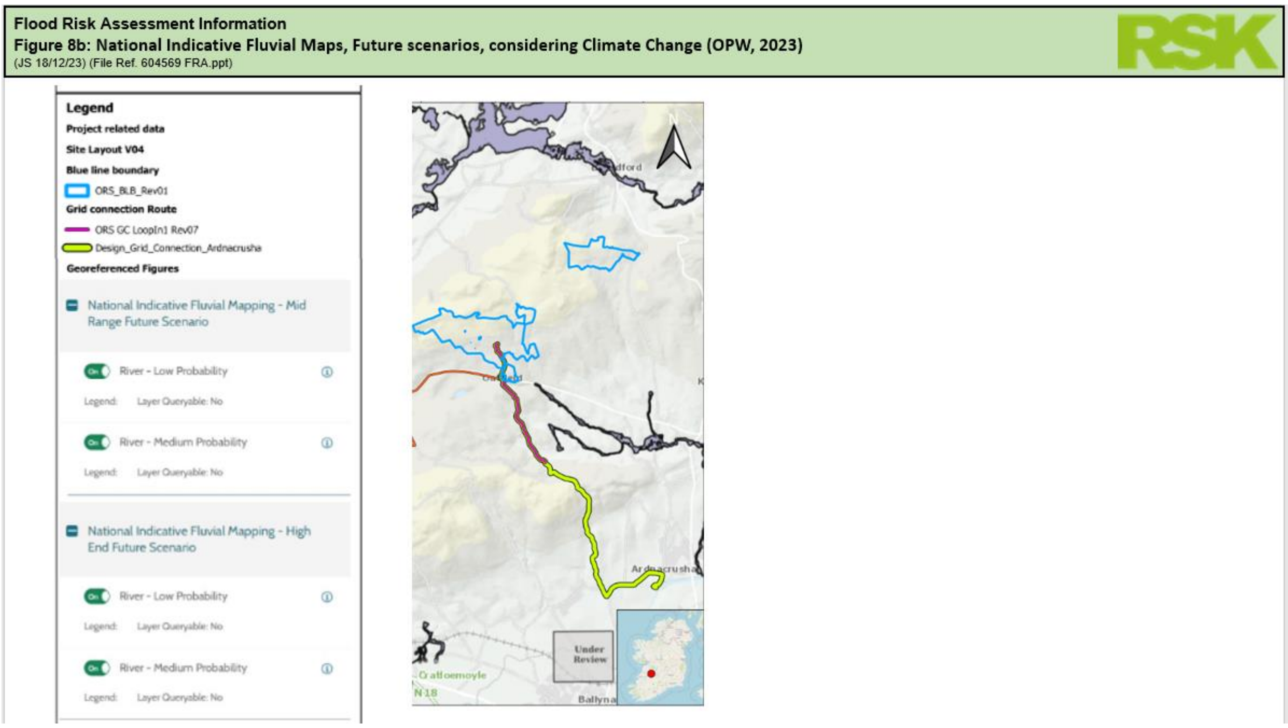


Figure 93a: River Flood extents Present day (OPW, 2023)

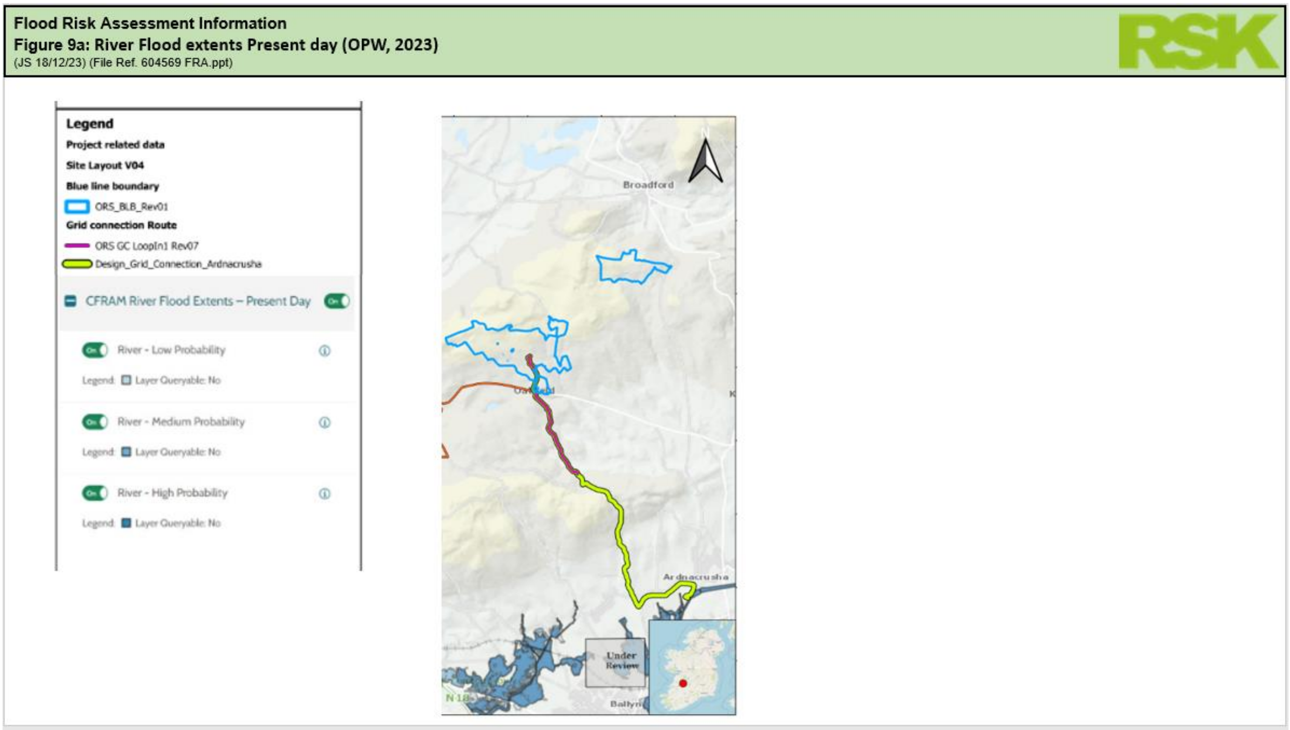
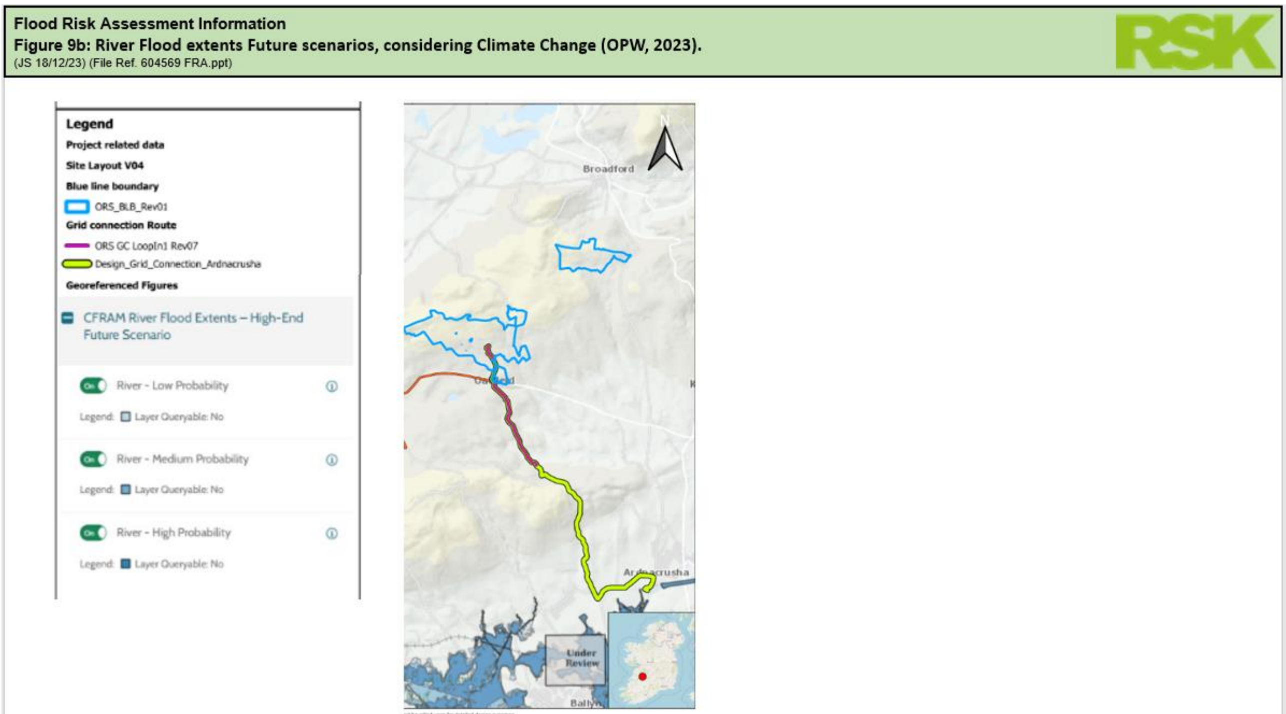


Figure 93b: River Flood extents Future scenarios, considering Climate Change (OPW, 2023).



Information gathered in the National Fluvial Indicative Maps of the present day identified no fluvial flood risks associated with 'Loopin1' Grid Connection Route (**Figure 9a and 9b)**.

There is no identified fluvial flood risk within or around the wind farm site boundary.

4.2.4 Pluvial Flooding

Pluvial flooding is usually caused by intense rainfall that may only last a few hours, often referred to as flooding from surface water. Surface water flooding can also occur as a result of overland flow or ponding during periods of extreme prolonged rainfall. During pluvial flooding events, water follows natural valley lines, creating flow paths along roads, through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low lying areas. It is generally noted, areas at risk from fluvial flooding will almost certainly be at risk from pluvial flooding. Pluvial flood maps produced as part of the OPW's CFRAM do not indicate pluvial flood zones at the development Site and the GCR, or surrounding area. Therefore, the residual risk from pluvial flooding is considered nil.

4.2.5 Groundwater Flooding

Groundwater flooding can occur on some sites in connection with high water tables and increased recharge following long periods of wet weather. Groundwater flooding typically occurs in areas underlain by limestone and where underlying geology is highly permeable with high capacity to receive and store rainfall. There has been no previously documented groundwater flooding within the site boundary (**Figure** 104**10**). According to the Geological Survey Ireland (GSI), Groundwater Flooding Probability Maps (2016-2019), there is no evidence of a Low, Medium or High Probability groundwater flooding event within the Site or near its vicinity or the GCR. Therefore, the residual risk from groundwater flooding is considered low.

Figure 104: Past Flood events not considering Climate Change (OPW, 2023)

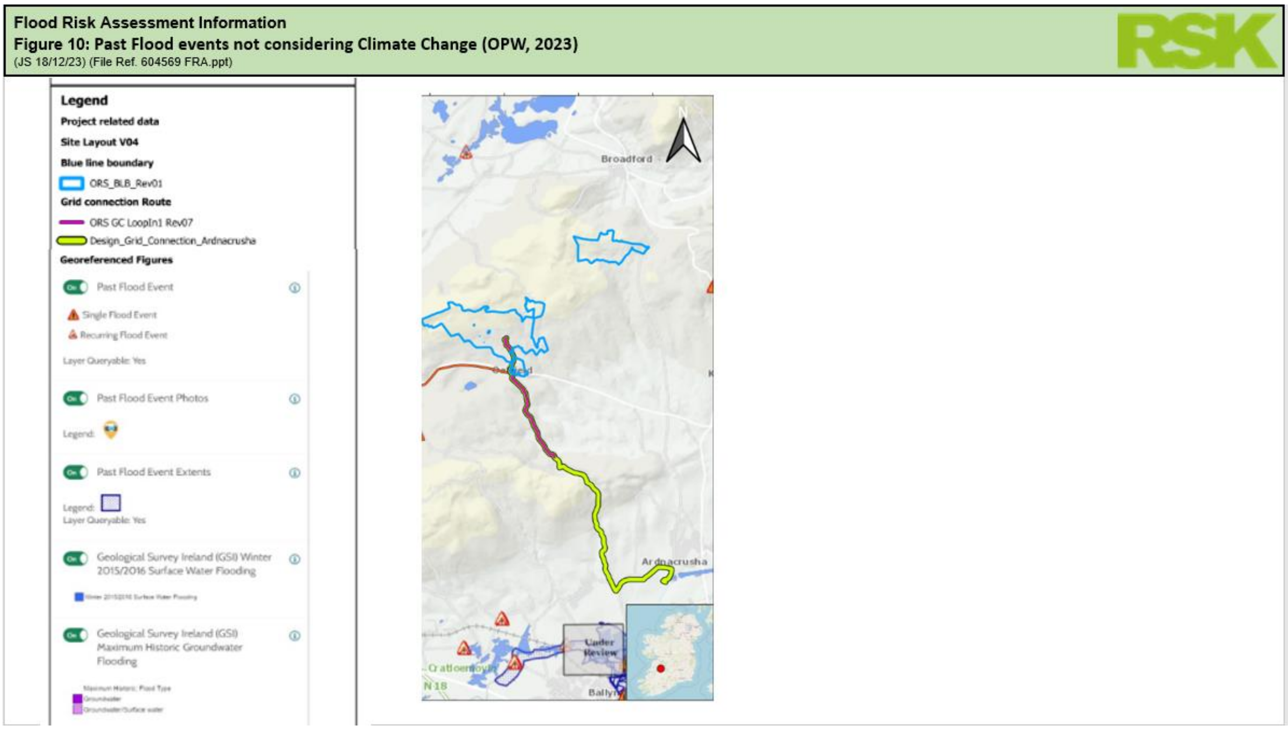
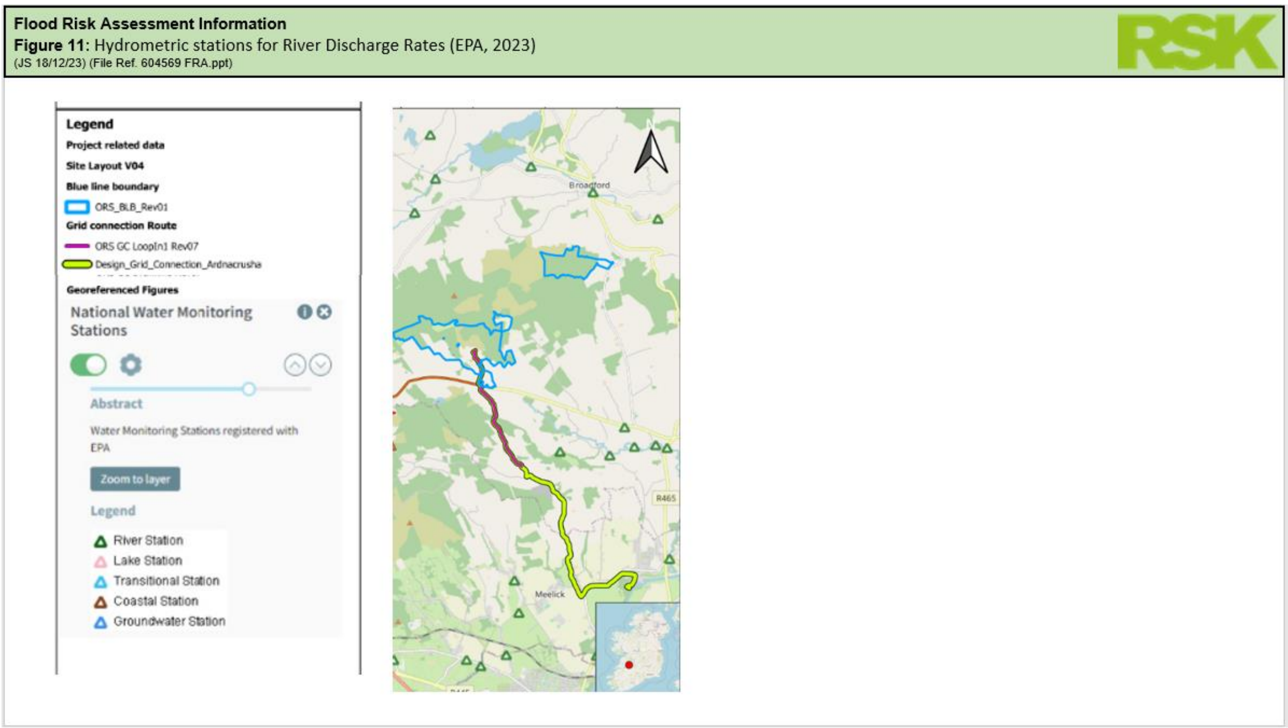


Figure 115: Hydrometric stations for River Discharge Rates (EPA, 2023)



4.2.6 Human and/or Mechanical Error

A Surface Water Management Plan (SWMP) has been developed as part of the scheme design and there will not be an increase in run-off from the site as a result of the scheme.

There is currently no mapped drainage on the OPW Drainage maps, that reside within the boundaries of the proposed site or associated with 'Loopin1' GCR.

4.2.7 Summary of Stage 1 Flood Risk Assessment

This Stage 1 Flood Risk Assessment was compiled and based on data presented in public records, in accordance with the guidelines set out in the DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management published in November 2009. From reviewing the available records there is no evidence of historic flooding in the areas surrounding the site (**Figure 7**), there is also no historic groundwater flooding events. Subsequent analysis GSI maps indicate no karst features within 250m of the site. Comprehensive flood-maps, produced by the OPW (2016) under the southwestern Catchment Flood Risk Assessment and Management (CFRAM) programme confirm that the proposed development resides in a Flood Zone C. The review of National indicative Fluvial maps identified no flood risks associated with 'Loopin1' Grid Connection Route.

4.2.8 Stage 1 Conclusion

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has **identified no flood hazards for the Wind Farm site or the preferred Grid Connection Route 'Loopin1'**. There **are flood risks associated with sections of the Turbine Delivery Route**, however these are local roads that will only be used in construction and decommissioning phases of the development. The nature of the development is industrial as opposed to residential or leisure, and as such, this type of development is categorized as a '**Less Vulnerable Development**', according to FRM Guidelines. Therefore, the development is considered an '**appropriate**' development for Flood Zone C.

4.3 Stage 2 – Initial Flood Risk Assessment

4.3.1 Assessing Potential Impacts of Development

As stated in the concluding remarks of Stage 1; the proposed development is considered an 'appropriate' development for Flood Zone C.

The southwestern Catchment Flood Risk Assessment and Management (CFRAM) programme did not indicate any flood extents within the proposed site boundaries or in the surrounding areas of the Grid Connection Route.

4.3.2 Assessing Potential Effects of Development – Increased Hydraulic Loading

Rainfall and Evapotranspiration

Rainfall data for the region associated with the development site has been assessed in terms of the following parameters;

Historical average and max monthly rainfall and effective rainfall. Effective rainfall is calculated as being rainfall minus evapotranspiration equals effective rainfall, or the amount of rainfall which will contribute to surface water runoff discharge volumes and/or groundwater recharge.

Potential significant storm events including events with a 1 in 100-year return period over 1 hour duration, 25 day duration.

The above storm events plus allowance (+20%) accounting for climate change.

Data from the meteorological stations listed in **Table 4: Meteorological Stations (Met Eireann, 2023)** are used in this assessment[5]. Using data presented in **Table 6: Met Eireann Return Period Rainfall Depths** (Irish Grid; Western Portion 153747, 168474, Eastern Portion 156783, 170665), storm event of 25 days duration with a 1 in 100-year return period is inferred to be 316.9mm. For the purpose of this assessment, predicted extreme or worst-case values are used, as presented in **Table 5: EIA Specific Assessment Data**.

Table 4: Meteorological Stations (Met Eireann, 2023)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	Shannon Airport	17.5
Rainfall (2022/23 Monthly/Daily)	Shannon Airport	17.5
Evaporation	Shannon Airport	17.5
Rainfall (2022/23 Monthly/Daily)	Ardnacrusha (Gen.Stn.No.2)	c.8km

Table 5: EIA Specific Assessment Data (Met Eireann, 2023)

Category	Value (mm Rain)
Average Annual Effective Rainfall (Long term) (mm/year)	1,227.1
Max monthly effective rainfall (mm/month)	190.2
1 in 100-Year Rainfall Event (25-day duration) (mm/month)	361.9
1 in 100-Year Rainfall Event (25-day duration) (mm/month) +20% Accounting for Climate Change	434.28
1 in 100-Year Rainfall Event (1 hour duration) (mm/hour)	35.9
1 in 100-Year Rainfall Event (1 hour duration) (mm/hour) +20% Accounting for Climate Change	43.08

[5] Met Eireann, Historical Data, Available at; www.met.ie, Accessed; October 2023

Table 6: Met Eireann Return Period Rainfall Depths (Irish Grid;153747, 168474)[6]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 153747, Northing: 168474,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.8,	3.9,	4.5,	5.3,	5.9,	6.4,	7.8,	9.4,	10.5,	12.0,	13.3,	14.3,	15.9,	17.1,	18.1,	N/A ,
10 mins	3.9,	5.4,	6.3,	7.4,	8.3,	8.9,	10.9,	13.2,	14.6,	16.7,	18.6,	20.0,	22.1,	23.8,	25.2,	N/A ,
15 mins	4.6,	6.4,	7.4,	8.8,	9.7,	10.4,	12.8,	15.5,	17.2,	19.7,	21.8,	23.5,	26.0,	28.0,	29.7,	N/A ,
30 mins	6.1,	8.4,	9.5,	11.3,	12.4,	13.3,	16.2,	19.5,	21.6,	24.5,	27.1,	29.0,	32.1,	34.4,	36.3,	N/A ,
1 hours	8.1,	10.9,	12.4,	14.5,	16.0,	17.1,	20.6,	24.5,	27.0,	30.5,	33.6,	35.9,	39.5,	42.2,	44.5,	N/A ,
2 hours	10.7,	14.2,	16.0,	18.7,	20.5,	21.8,	26.1,	30.8,	33.8,	38.0,	41.6,	44.4,	48.6,	51.8,	54.5,	N/A ,
3 hours	12.6,	16.6,	18.7,	21.7,	23.7,	25.2,	30.0,	35.2,	38.6,	43.2,	47.2,	50.3,	54.9,	58.4,	61.3,	N/A ,
4 hours	14.1,	18.5,	20.8,	24.1,	26.2,	27.9,	33.1,	38.7,	42.4,	47.3,	51.6,	54.9,	59.8,	63.6,	66.7,	N/A ,
6 hours	16.6,	21.7,	24.2,	27.9,	30.3,	32.2,	38.0,	44.3,	48.3,	53.8,	58.5,	62.1,	67.6,	71.7,	75.1,	N/A ,
9 hours	19.6,	25.3,	28.2,	32.4,	35.1,	37.2,	43.7,	50.7,	55.1,	61.2,	66.4,	70.3,	76.3,	80.8,	84.5,	N/A ,
12 hours	22.0,	28.3,	31.4,	35.9,	38.9,	41.1,	48.2,	55.7,	60.5,	67.0,	72.6,	76.8,	83.2,	88.0,	91.9,	N/A ,
18 hours	25.9,	33.0,	36.6,	41.7,	45.0,	47.5,	55.3,	63.7,	69.0,	76.2,	82.3,	87.0,	93.9,	99.2,	103.5,	N/A ,
24 hours	29.1,	36.8,	40.7,	46.3,	49.9,	52.6,	61.1,	70.1,	75.7,	83.4,	90.0,	95.0,	102.4,	108.0,	112.6,	127.9,
2 days	36.5,	45.5,	49.9,	56.2,	60.3,	63.3,	72.8,	82.7,	88.9,	97.3,	104.4,	109.7,	117.7,	123.6,	128.5,	144.7,
3 days	42.9,	53.0,	57.9,	64.9,	69.4,	72.7,	83.0,	93.8,	100.5,	109.5,	117.2,	122.9,	131.4,	137.8,	142.9,	160.1,
4 days	48.8,	59.8,	65.2,	72.8,	77.6,	81.2,	92.4,	104.0,	111.1,	120.8,	128.9,	135.0,	144.0,	150.8,	156.2,	174.4,
6 days	59.6,	72.4,	78.5,	87.2,	92.7,	96.8,	109.4,	122.4,	130.4,	141.2,	150.2,	156.9,	166.9,	174.3,	180.3,	200.2,
8 days	69.6,	83.9,	90.8,	100.4,	106.5,	111.0,	124.9,	139.2,	148.1,	159.8,	169.6,	177.0,	187.8,	195.8,	202.3,	223.8,
10 days	79.0,	94.8,	102.3,	112.9,	119.5,	124.5,	139.5,	155.0,	164.6,	177.2,	187.8,	195.7,	207.3,	216.0,	222.9,	245.9,
12 days	88.1,	105.2,	113.4,	124.8,	131.9,	137.3,	153.5,	170.1,	180.3,	193.8,	205.1,	213.5,	225.9,	235.0,	242.4,	266.7,
16 days	105.6,	125.2,	134.6,	147.5,	155.6,	161.7,	180.0,	198.7,	210.1,	225.2,	237.8,	247.2,	260.9,	271.1,	279.2,	306.1,
20 days	122.5,	144.4,	154.9,	169.2,	178.3,	185.0,	205.2,	225.8,	238.4,	254.9,	268.7,	279.0,	293.9,	305.0,	313.9,	343.2,
25 days	142.9,	167.7,	179.4,	195.4,	205.5,	213.0,	235.5,	258.3,	272.2,	290.5,	305.7,	316.9,	333.4,	345.5,	355.3,	387.2,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

[6] Met Eireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods , Accessed; October 2022

Preliminary Water Balance Assessment

For the purposes of assessing changes in runoff at the site as a function of the development, the following data compiled from GIS mapping software is considered **(FRA Section 3 – Site Description)**;

- Turbine foundation and hardstands = c. 55,550m^2
- New access track / turning points / lay-by = c. 32,755m^2
- Substation / other Hardstand = c. 58564m^2
- 1 in 100-year rainfall event = c. 35.9mm of rainfall in 1 hour.
- Recharge capacity = 22.5 – 85% of Effective Rainfall (Note: This is considered a conservative value i.e., higher potential recharge coefficient in the range associated with the site. In areas of peat the recharge will be considerably less, and considering the capped recharge of the underlying bedrock aquifer the rate of recharge will likely be considerably less across the site, particularly during wet / winter months associated with elevated flood risk generally).
- There is limited river discharge rate (Q) including discharge percentile data available for surface water features associated with the site. However, consultation of the EPA Hydronet map viewer (**Figure 115**) indicates that the estimated River Discharge (Q) at
    - Blackwater (Clare)_010 Hydrometric station (ID:25_3216) situated c. 4.7 kilometres downstream of the site on the River Blackwater (Clare) has been observed to reach up to c. 0.387m3/second (January).
    - Gourna Hydrometric station (ID:27_635) situated c. 4.5 kilometres from site, has been observed to reach c. 0.279m3/second (December).
    - Owenogarney_030 Hydrometric station (ID:27_1213) situated c. 3.5 kilometres from the site has been observed to reach up to c. 5.512m3/second (January).
    - Broadford_010 Hydrometric station (ID:27_763) situated c. 2.3 kilometres from the site has been observed to reach up to c. 1.029m3/second (January).

This assessment is considered a simple preliminary water balance assessment for the purposes of qualifying and adding context to potential impacts of the development in terms of hydrological response to rainfall and flooding. It considers and uses site specific data as well as associated downstream attribute data. (Note: This is not considered advanced modelling for flood risk assessment (FRA Stage 3)).

Table 7 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1 in 100-year storm event.

Table 8 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1 in 100-year storm event relative to baseline conditions.

Table 7: Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Storm)

Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)																	
							Greenfield Scenario					Developed Scenario					
Micro Catchment	Category	Unit	Approx. Area Per Unit	Approx. Quantity	Approximate Area (m2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity. Percentage of Effective Rainfall (Conservative Value for Water Balanace Calc's)	Rejected Recharge / Runoff (m/hour Rain)	Runoff Discharge Rate (m3/hour)	Net Increase Runoff Discharge Rate (m3/sec)	Runoff Discharge Rate (m3/sec)	Recharge Capacity. Percentage of Effective Rainfall (Hardstand Areas assumed impermeable)	Rejected Recharge / Runoff (m/hour Rain)	Runoff Discharge Rate (m3/hour)	Net Increase Runoff Discharge Rate (m3/sec)	Runoff Discharge Rate (m3/sec)	Net Increase (m3/sec)
SW1	Turbines Hardstand	No.	4790	1	4790	0.0359	20.00%	0.02872	137.57	0.04		0.00%	0.0359	171.96	0.05		
SW1	New Access Track	m			888.05	0.0359	20.00%	0.02872	25.50	0.01		0.00%	0.0359	31.88	0.01		
SW1	**Subtotal**										0.05					0.06	**0.011**
SW2	Turbines Hardstand	No.	4790	3	14370	0.0359	20.00%	0.02872	412.71	0.11		0.00%	0.0359	515.88	0.14		
SW2	New Access Track	m			1,793.11	0.0359	20.00%	0.02872	51.50	0.01		0.00%	0.0359	64.37	0.02		
SW2	**Subtotal**										0.13					0.16	**0.032**
SW3	Turbines Hardstand	No.	4790	5.5	26,345.00	0.0359	20.00%	0.02872	756.63	0.21		0.00%	0.0359	945.79	0.26		
SW2	Met Mast	No.	64	1	64.00	0.0359	20.00%	0.02872	1.84	0.00		0.00%	0.0359	2.30	0.00		
SW3	Substation Hardstand	No.	273000	1	273,000.00	0.0359	20.00%	0.02872	7,840.56	2.18		0.00%	0.0359	9,800.70	2.72		
SW3	New Access Track	m			54,234.84	0.0359	20.00%	0.02872	1,557.62	0.43		0.00%	0.0359	1,947.03	0.54		
SW3	**Subtotal**										2.82					3.53	**0.705**
SW4	Turbines Hardstand	No.		0	-	0.0359	20.00%	0.02872	-	-		0.00%	0.0359	-	-		
SW4	New Access Track	m		0	-	0.0359	20.00%	0.02872	-	-		0.00%	0.0359	-	-		
SW4	**Subtotal**										-					-	**-**
SW5	Turbines Hardstand	No.	4790	0.5	2395	0.0359	20.00%	0.02872	68.78	0.02		0.00%	0.0359	85.98	0.02		
SW5	New Access Track	m		0	-	0.0359	20.00%	0.02872	-	-		0.00%	0.0359	-	-		
SW5	**Subtotal**										0.02					0.02	**0.005**
SW6	Turbines Hardstand	No.		0	-	0.0359	20.00%	0.02872	-	-		0.00%	0.0359	-	-		
SW6	New Access Track	m		0	-	0.0359	20.00%	0.02872	-	-		0.00%	0.0359	-	-		
SW6	**Subtotal**										-					-	**-**
													Total	**13565.892**	**3.77**	**3.77**	**0.754**

Table 8: Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes

Proposed Dvelopment Baseline Run off Volumes (1 in 100 Year Hour Storm Event)														
Proposed Development					Approximate Area (m2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity. Percentage of Effective Rainfall (Conservative Value for Water Balanace Calc's)	Rejected Recharge / Runoff (m/hour Rain)	Runoff Discharge Rate (m3/hour)	Runoff Discharge Rate (m3/sec)	Net Increase (m3/sec)	Net Increase as percentage against baseline micro catchment runoff (%)	Indicative High Water Discharge (Q) Rate <15km downstream. (m3/sec)	
SW1					22.51	0.0359	20.00%	0.02872	0.65	0.00	0.011	6306.98%	20.00	0.06%
SW2					71.04	0.0359	20.00%	0.02872	2.04	0.00	0.032	5688.03%	20.00	0.16%
SW3					244.43	0.0359	20.00%	0.02872	7.02	0.00	0.705	36170.26%	20.00	3.53%
SW4					5.48	0.0359	20.00%	0.02872	0.16	0.00	-	0.00%	20.00	0.00%
SW5					36.08	0.0359	20.00%	0.02872	1.04	0.00	0.754	261849.33%	20.00	3.77%
SW6					2.43	0.0359	20.00%	0.02872	0.07	0.00	-	0.00%	20.00	0.00%
								Total	**10.97**	**0.00**	**1.503**	49309.03%	**20.000**	7.51%

Water balance calculations allow for the addition of area for hardstand infrastructure required (land take) during the construction and operational phases of the development. This equates to approximately 144,009m^2. A 1 in 100-year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be c. 0.754m^3/second, or 0.191% relative to the site area (blueline boundary/381m^2). This net increase relative to the scale of the site or the scale of the associated catchment is considered an slight effect, no imperceptible or negligible impact of the development. With suitable mitigation measures, the pressure to the surface water bodies and sites downgradient can be reduced to a neutral impact.

4.3.3 Mitigation Measures Associated with the Development

Flood Relief Schemes, outlined by the OPW, were in place for Sixmilebridge in 1998 and Foynes Coastal in 2017 but have since been completed. There is currently a Flood Risk Management Scheme, outlined by the OPW, in place for the Bunratty (OPW) and Limerick City & Environs Flood Relief Scheme, which are downstream of the site.

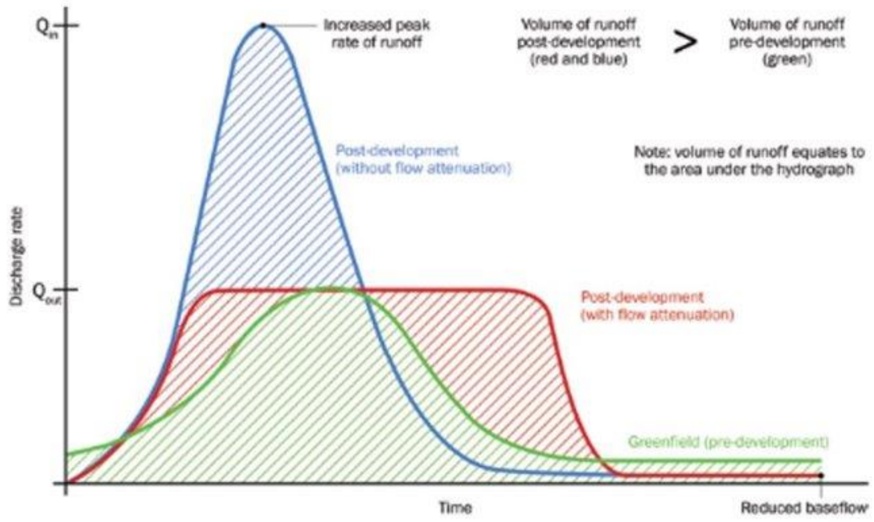
These include Measures Applicable in All Areas, which are detailed as:

Sustainable Urban Drainage Systems (SUDS). Objective: Planning authorities will seek to reduce the extent of hard surfacing and paving and require the use of sustainable drainage techniques to reduce the potential impact of development on flood risk downstream. A Hydrograph is presented in **Figure 12**, if SUDS measures are not in place following an increase in sealed land, rainfall and surface waters would peak following the blue peak. In development where SUDS measures are implemented the rainfall and surface water levels will follow the blueline as water is retained and released and a slower discharge rate.

The Grid Connection Route trench is temporary, and the existing road surface will be reinstated once the grid cable is installed. No increase in hardstanding is proposed. As such the road surface will not be permanently altered. The installation of the Grid Connection Route will not alter the prevailing or baseline hydrology at the existing Ardncrusha Substation and will have neither a positive or negative impact on this existing issue.

Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

Figure 12: Example of a hydrograph (CIRCA, 2015)



Future Flood Relief Schemes include Foynes

'A 1.26km long quay/sea wall is required to defend the AFA from the 0.5% AEP event. Floodgates would also be required at a number of locations along the wall to maintain access to the port.'

Under the 2019-2020 Work Programme of the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD) (European Union, 2018), the Working Group Programme of Measures has built on the previously developed guidance for supporting the implementation of Natural Water Retention Measures (NWRM) in Europe (European Commission, 2015).

The OPW and EPA Catchments Unit in conjunction with Local Authorities are actively adopting and promoting NWRM as part of a broader suite of mitigation measures that could contribute to the achievement of environmental objectives (WFD) set out in the second River Basin Management Plan (RBMP) (EPA Catchment Unit, 2020).

In the 2019-2020 work programme of CIS for the WFD (European Union, 2018), it was identified that River Basin Management and flood Risk Management are key to achieving the goals set out in the Sustainable Development Goals (SDG6).

Flood Relief Scheme and flood risk management Objectives such as Land Use Management and Natural Flood Risk Management are relevant to the proposed development, whereby; the assessment and design of proposed development will qualify and mitigate any potential adverse impact in terms of hydrological response to rainfall and flood risk within or downstream of the site. The objective of mitigation in this respect will be to achieve, at a minimum, a neutral impact, and to identify and promote beneficial impacts (net decrease in hydrological response to rainfall) at the site, particularly in terms of Natural Water Retention Measures (NWRM) as part of baseline conditions, namely; restoration of peatlands, wetlands and woodlands.

To mitigate any net change in hydraulic loading to surface waters during the construction and operational phase of the development, the following examples can be utilised where appropriate;

- Check dams, dams, other flow restricting infrastructure
- Collector drains
- Permanent stilling ponds
- Attenuation lagoons
- Buffered outfalls to vegetated areas
- Controlling dewatering flow/pump rates;
- Restricting pumped water discharge directly to drainage or surface water networks.
- Offline storage ponds, overland sediment traps,
- Floodplain and riparian woodland
- Riverbank restoration
- River morphology and floodplain restoration – removal of embankments, re-meandered river reach
- In stream structure – large woody debris
- Catchment woodlands
- Land and soil management practices – cover crops, cross contour hedgerows.

To mitigate for the increase in hardstanding on the wind farm site the actions below will be implemented.

An Environmental Manager / Ecological Clerk of Works (ECoW) with appropriate experience will be appointed for the duration of the construction phase to oversee the implementation of the CEMP.

Construction of the hardstanding areas for the turbines and the met mast will require the laying of geotextile material on the foundation surface, and placement of engineered stone and a top dressing, following excavation of soil, subsoil and rock as required, this will avoid any excess run off from the excavated area.

A 'just in time' delivery strategy will be in place for turbine blades to reduce the need for temporary set down areas.

Earthworks will be limited to meteorologically dry periods and will not occur during sustained or intense rainfall events to avoid suspended soils entering the surface water networks.

Planting of trees to ensure no increased flood risk elsewhere.

All drainage- related mitigation measures will form part of a robust Sustainable Drainage System (SuDS) on the site.

Drainage facilities will be provided to manage runoff from tracks, hardstanding areas, turbine bases, and spoil storage areas such as

- Silt Screens
- Interceptor Drains

- include the existing drainage network in designing and specify the treatment train and attenuation features, including improving, modifying, and constructing attenuation features in drainage channels.

Sustainable Drainage System (SuDS) on the Site.

- Collector drains and/or soil berms
- Buffered redistribution of clean runoff downgradient of the development footprint by means of culverts and buffered outfalls to vegetated areas.
- Attenuation features such as check dams, stilling ponds

Following development, the hardstands and crane pads will be grassed over, and the upgraded and new internal access tracks will be utilised to access farmlands.

The Development has the potential to result in increased volumes of runoff during the operational phases of the Development relative to baseline conditions. However, with the appropriate environmental engineering controls and mitigation measures, previously outlined, these potential impacts will be reduced.

The combined attenuation capacity of the proposed drainage infrastructure will be designed to attenuate net increase in water runoff as calculated in **Table 6**, including during extreme storm events relative to greenfield or baseline runoff rates. These mitigation measures required during the construction and operational phases will buffer the discharge rate and reduce the hydrological response to rainfall at the site, maintain (or improve) the hydrological regime at the site, in turn reducing loading on the receiving surface water drainage network. This will mitigate against the potential for rapid runoff and rapid hydrological responses to rainfall, lessening the likelihood to flooding of the drainage network or downstream of the development.

Mitigation measures will be considered and designed in line with engineering and construction best practices and methodologies, including the following guidance documents (non-exhaustive);

- Scottish Environment Protection Agency (SEPA) (2009) Flood Risk Management (Scotland) Act 2009 – Surface Water management Planning Guidance
- UK Department for the Environment, Food, and Rural Affairs (DEFRA) (2010) Surface Water Management Plan Technical Guidance
- Scottish Environment Protection Agency (SEPA) (2015) Natural Flood Management Handbook
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) The SuDS Manual (C753)

The following observations and recommendations are made with a view to ensuring mitigation measures are designed and deployed effectively;

The magnitude of potential net increase in runoff as a function for the development at the Site is considered an **adverse effect but not significant**, (flood risk areas downstream of the site and associated with a much larger catchment compared to the site boundary). In terms of detailed engineered design of the proposed development and with a view to applying mitigation measures adequately, it is recommended that drainage, attenuation and associated infrastructure is designed and specified by a competent water infrastructure engineer, which might include modelling of runoff in site drainage, to ensure that all aspects are sufficiently specified. Drainage modelling, including assessment of inundation rates, lag times and discharge rates, will be particularly useful in sensitive karst areas, or where particularly sensitive environmental attributes exist downstream, for example; ecological attributes where surface water runoff and surface water quality are linked.

Detailed design and specification of drainage, attenuation and associated infrastructure will be included in a detailed Surface Water Management Plan (SWMP) prior to the commencement of the construction phase which will include detailed development drainage layout and details regarding construction, maintenance, monitoring and emergency response. It is recommended that this is done in conjunction with relevant stakeholders including relevant authorities and other stakeholders such as landholders etc. in line with River Basin Management practices i.e., engagement at local level.

4.3.4 FRA Stage 2 – Conclusions

A 1 in 100-year storm event scenario results in a net increase of surface water runoff associated with the development, calculated to be c. 0.754m^3/second, or 0.19% relative to the approximate site area (blueline boundary). This net increase relative to the scale of the site or the scale of the associated catchment is considered an adverse but not significant effect of the development.

The proposed development will use the latest best practice guidance to ensure that flood risk within or downstream of the site is not increased as a function of the development, i.e., a neutral impact at a minimum. As a result of the mitigation measures outlined being followed there will be no impacts on hydrology offsite.

Considering the development does not acutely or significantly impact on a probable flood risk area, FRA Stage 3 including advanced flood modelling is not required. However, it is recommended to include drainage modelling during the detailed design phase of the development.

A detailed Surface Water Management Plan (SWMP) will be prepared prior to the construction phase commencing, with a view to ensuring that the surface water runoff at the site is managed effectively and does not exacerbate flood risk to the surrounding areas downstream. It is recommended that this is done in consultation with relevant stakeholders.

As the associated drainage - some of which is permeant for the lifetime of the development, will be attenuated for greenfield run-off, the proposed development will not increase the risk of flooding elsewhere in the catchment. Based on this information, the proposed development complies with the appropriate policy guidelines for the area and is at **no risk of flooding**.

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