Prepared for;

Greensource, Jennings O' Donovan

Ballykett Windfarm (BWF)

Site Specific Flood Risk Assessment (SSFRA)

JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

Project no. 604008 BWF EIA

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Title: Ballykett Windfarm (Wind Farm Site) Site Specific Flood Risk Assessment

Client: Jennings O'Donovan

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Date:	06/12/2023	Date:	06/12/2023 28/03/2024
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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.

This work has been undertaken in accordance with the quality management system of RSK (Ireland) Ltd.

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Which must be considered as part of the mitigation measures proposed for the development

1 INTRODUCTION

RSK Ireland was commissioned to carry out a Flood Risk Assessment by Jennings O'Donovan & Partners (JOD, the Client) the Developer/s. The assessment is in support of the planning application for the Ballykett Wind Farm (BWF, the Development) in Co. Clare.

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) document *"The Planning Process and Flood Risk Management Guidelines for Planning Authorities"* published in November 2009. This Assessment 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. This report provides an assessment of the subject site for flood risk purposes only.

1.1 Statement of Authority

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 & private sectors. More information can be found at www.rskgroup.com. The principal members of the RSK EIA team involved in this assessment include the following persons:

- Project Manager & Lead Author: Jayne Stephens - B.S.c (Environmental Science), PhD (Environmental and Infection Microbiology). Current Role: Environmental Consultant
- Principal Environmental Consultant: Sven Klinkenbergh – B.Sc. (Environmental Science), P.G. Dip. (Environmental Protection). Experience c. 8 years
- Project Scientist: Mairéad Duffy - B.Sc. (Environmental Management), M.Sc. (Climate Change). Current Role: Graduate Project Scientist

2 SOURCES OF INFORMATION

2.1 Desk Study

During the Desktop assessment the following map sources were viewed:

2.1.1 EPA Maps

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) statuses and risks [1].

2.1.2 Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Kilrush Catchment Flood Risk Management Plan (CFRAM) were investigated 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[2].

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).*

2.1.4 GSI Maps

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].

2.1.5 OSI Maps

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].

2.2 Limitations

Reliance has been placed on factual and anecdotal data obtained from the sources identified. RSK cannot be held responsible any omissions, misrepresentations, errors or inaccuracies with the supplied information. New information, revised practices or

[1] EPA Unified GIS Application (2022)

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

[3] Geological Survey Ireland Spatial Resources (2022)

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

changes in legislation may necessitate the re-interpretation of the report in whole or in part.

All opinions expressed are based upon current design standards and policies in force at the date of this report. These standards may be subject to change with the passage of time.

The opinions expressed herein are intended to provide general guidance as to how a problem related to a particular development might be resolved. Given the paucity of the original information, and the often-indirect nature of information received, they should not be relied upon as absolute or definitive guidance as to any particular solution. Such conclusions can only sensibly be arrived at upon detailed design.

As a consequence of the above, RSK Ltd. will not be held liable for any consequential losses, howsoever caused, as a consequence of inaccurate missing, incomplete, or erroneous data contained in this report, nor any data capable of being subject to variable interpretation by means of its generalised nature.

3 SITE DESCRIPTION

3.1 Location

Site Name: Ballykett Windfarm (BWF) (Wind Farm Site)

Site Address: Ballykett, Kilrush, County Clare.

Site National Grid Reference: 101560, 157966

The proposed site is situated c. 3.5km north-east of the town of Kilrush, and 3km south-west of Coorraclare village, south-west Co. Clare.

The existing site topography is shown in **EIAR Chapter 9- EIAR Chapter** 9 - Figure 9.1. In terms of land use the Site is comprised mainly of agricultural, forestry and peatland with existing access tracks and some dwellings and farms / yards in the locality.

3.2 Site Description

The Development (**EIAR Chapter** 9 - Figure 9.1) will consist of the following main components:

- Erection of 4 no. 4-5MW wind turbines with an overall ground to blade tip height of 150m. The candidate wind turbine will have a rotor diameter of 136m and a hub height of 82m
- Construction of site access roads, crane hardstand areas and turbine foundations
- A new site entrance with access onto the L6132 road.
- Construction of a temporary site compound for use during construction.
- Construction of 1 no. permanent Met Mast of 82m overall height.
- Construction of new internal site access tracks and upgrade of existing site track, to include all associated drainage including new clear span bridge crossing of the Moyasta 27 stream.
- Development of a site drainage network
- Construction of 1 no. permanent Electrical substation.
- All associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation.
- Ancillary forestry felling to facilitate construction of the Development.
- All works associated with the permanent connection of the wind farm to the national electricity grid comprising a 110 kV underground cable in permanent cable ducts from the proposed, permanent, on-site substation and to the existing Tullabrack 110kV ESBN Substation.

- Vertical realignment of an existing crest curve on the L6132 local road in order to prevent grounding of abnormal load vehicles during delivery of turbine component.

A 10-year planning permission and 35 year operational life from the date of commissioning of the entire wind farm is being sought.

3.3 Site Hydrology

Surface water networks draining the site are mapped and presented in **EIAR Chapter 9** - **EIAR Chapter** 9 - Figure 9.2**a.** The Development and GCR is situated within the Shannon Estuary North Catchment (ID: 27, Area: c. 1651.27km^2). Surface water runoff associated with the Site drains into the Sub Catchment Wood SC 010, River Sub Basin Moyasta 010 and the Water Framework Directive Catchment Shannon Estuary North. The Turbine Delivery Route works situated across two catchments and they are as follows; Shannon Estuary North (ID: 27, Area: c.1651.27km2) and Mal Bay catchment (ID:28, Area: c. 846.56 km^2). Surface water networks that are associated with the Turbine Delivery Route are presented in Figure 9.2b. In terms of local drainage and non-mapped surface water features the site characterised by extensive artificial drainage networks including in association with agricultural and land reclamation/ improvement works, forestry drainage networks, and cut drains in peat and peat cutting activities.

3.4 Site Soil & Subsoil Geology

Consultation with published soil maps compiled by GIS/SIS and the EPA specify that soil types across the Site is Peat, further soils and subsoils information is presented in **Chapter 8 EIAR**.

3.5 Site Hydrogeology

The bedrock aquifers underlying the proposed Development and GCR have been assigned the GSI aquifer classification of Locally Important Aquifer (LI), that is; bedrock which is moderately productive only in local zones. Aquifers associated with the site are presented in **EIAR Chapter 9 - Figure 9.6a and 9.6b –Bedrock Aquifer.** There are no mapped karst features within 10km of the Development. The Turbine Delivery Route works is underlain by a 'Locally Important Aquifer – Bedrock' which is Moderately Productive only in Local Zones.

3.6 Groundwater Vulnerability & Recharge

Presented in **EIAR Chapter 9** - Figure **9.7a and 9.7b - Aquifer Vulnerability,** of Chapter 9 in the EIAR, consultation with the GSI Groundwater Map Viewer indicates that the site is underlain by areas classified by Moderate Productivity, Areas of the Site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 200 mm effective rain fall. The Site is characterised by low to very low recharge rates in overburden (soils/subsoils) and very low 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. The Grid Connection traverse land with groundwater vulnerability ratings ranging from 'Low Vulnerability' to 'Extreme Vulnerability' including 'X' which is described as "Rock at or near Surface or Karst" **Figure 9.7a.** The Turbine Delivery Route works traverses landed with groundwater vulnerability ratings from 'Moderate' to 'Extreme' including 'X' **Figure 9.7b**. The GCR is characterised by low to very low recharge rates in overburden (soils/subsoils) and very low recharge capacity in the underlying bedrock aquifer, this can also be applied to the section of the TDR works.

3.7 Proposed Development

The proposed development is comprised of 4 no. proposed turbines. Each portion of the site is connected via existing and proposed new access tracks which includes for connection to a substation at the site. The proposed development site is situated amongst rural agricultural land and forestry, however there are a number of established wind farms in the surrounding region. The proposed Grid Connection route for the Development is 1.7km 38kV connection to Tullabrack 110kV substation. It has been proposed that the turbine nacelle, towers, hubs and rotor blades will be landed at the port of Foynes. Co. Limerick. Road widening between Tullybrack Cross and the wind farm site entrance will be carried and to accommodate increased volumes of HGV vehicles associated with the construction of the wind farm. The road widening and verge strengthening are temporary works. The vertical realignment works are permanent.

3.8 Rainfall and Evapotranspiration

Rainfall data for the region associated with the Development site, GCR and TDR works 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 and 30 day or month duration (inferred using available data).
- Daily 2020 rain (specifically in relation to meteorological conditions at the time of site surveys).

Data from the meteorological stations listed in **Table 1** are used in this assessment[5]. Using data presented in **Table 2** and **Figure 1** storm event of 25 days duration with a 1 in 100 year return period is inferred to be 280.7mm. Rain fall amounts in the three days preceding baseline sampling events are presented in **Table 3.**

Table 1: Meteorological Stations (Met Eireann, 2022)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	SHYAN 1984 -2022	14
Rainfall (2020/21 Monthly/Daily)	SHYAN 1984 -2022	14
Evapotranspiration	Shannon Airport – 2019-2022 Minimum	62

[5] Met Eireann, Historical Data, Available at; www.met.ie, Accessed; 29th September 2022

Figure 1: 1 in 100 year rainfall return period (Met Eireann, 2022).

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 101560, Northing: 157966,

	Interval		Years													
DURATION	6months	1year	2	3	4	5	10	20	30	50	75	100	150	200	250	500
5 mins	3.2	3.8	4.1	4.5	4.8	5.0	5.6	6.2	6.6	7.1	7.5	7.8	8.3	8.6	8.9	N/A
10 mins	4.4	5.3	5.7	6.3	6.7	6.9	7.8	8.6	9.2	9.9	10.5	10.9	11.5	12.0	12.4	N/A
15 mins	5.2	6.2	6.7	7.4	7.8	8.2	9.2	10.2	10.8	11.6	12.3	12.8	13.6	14.1	14.6	N/A
30 mins	6.8	8.1	8.7	9.6	10.2	10.6	11.8	13.1	13.9	15.0	15.8	16.5	17.5	18.2	18.8	N/A
1 hours	8.8	10.5	11.3	12.4	13.2	13.7	15.3	16.9	18.0	19.3	20.4	21.3	22.5	23.4	24.1	N/A
2 hours	11.4	13.6	14.7	16.1	17.0	17.7	19.8	21.9	23.2	24.9	26.3	27.4	28.9	30.1	31.0	N/A
3 hours	13.3	15.9	17.1	18.7	19.8	20.6	23.0	25.4	26.9	28.9	30.5	31.7	33.5	34.9	35.9	N/A
4 hours	14.9	17.7	19.0	20.9	22.0	22.9	25.5	28.2	29.9	32.1	33.9	35.2	37.2	38.7	39.9	N/A
6 hours	17.3	20.6	22.1	24.3	25.6	26.6	29.7	32.8	34.7	37.2	39.3	40.9	43.2	44.9	46.2	N/A
9 hours	20.2	24.0	25.8	28.3	29.8	31.0	34.5	38.1	40.3	43.2	45.6	47.4	50.0	52.0	53.5	N/A
12 hours	22.6	26.7	28.7	31.5	33.2	34.5	38.4	42.3	44.8	48.0	50.6	52.6	55.5	57.7	59.4	N/A
18 hours	26.3	31.1	33.4	36.6	38.6	40.1	44.6	49.2	52.0	55.6	58.7	61.0	64.4	66.9	68.8	N/A
24 hours	29.3	34.7	37.2	40.8	43.0	44.6	49.6	54.7	57.7	61.8	65.2	67.8	71.5	74.2	76.4	83.7
2 days	37.5	43.9	46.9	51.0	53.6	55.5	61.3	67.1	70.7	75.4	79.3	82.1	86.3	89.4	91.9	100.0
3 days	44.6	51.8	55.2	59.9	62.8	65.0	71.4	78.0	81.9	87.1	91.4	94.6	99.2	102.6	105.4	114.3
4 days	51.0	59.1	62.8	68.0	71.2	73.6	80.7	87.8	92.1	97.8	102.5	105.9	111.0	114.7	117.6	127.3
6 days	62.9	72.4	76.8	82.8	86.5	89.3	97.5	105.7	110.7	117.2	122.6	126.5	132.3	136.5	139.9	150.9
8 days	73.9	84.7	89.7	96.4	100.7	103.7	113.0	122.2	127.8	135.1	141.0	145.4	151.8	156.5	160.3	172.4
10 days	84.4	96.3	101.9	109.4	114.0	117.4	127.6	137.8	143.9	151.8	158.4	163.2	170.2	175.3	179.4	192.7
12 days	94.5	107.6	113.6	121.8	126.9	130.6	141.7	152.7	159.3	167.9	175.0	180.2	187.7	193.3	197.7	212.0
16 days	114.0	129.2	136.2	145.6	151.5	155.7	168.5	181.1	188.7	198.5	206.6	212.5	221.1	227.4	232.4	248.6
20 days	132.8	150.0	157.8	168.5	175.1	179.9	194.2	208.3	216.8	227.8	236.8	243.4	252.9	259.9	265.5	283.4
25 days	155.7	175.2	184.2	196.2	203.7	209.1	225.2	241.1	250.7	263.0	273.1	280.5	291.2	299.0	305.2	325.2

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

Table 2: EIA Specific Assessment Data (Met Eireann, 2022)

Category	Value
Average Annual Effective Rainfall (GSI) (mm/year)	670.4
1 in 100 Year Rainfall Event (25 day duration) (mm/month)	280.5
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	21.3
Minimum monthly evapotranspiration (mm/month)	12.2

Table 3: Rainfall Events Prior to Sampling (Met Eireann, 2022)

Dry Sampling	SW 1 13/09/2022 (mm)	Wet Sampling	SW 2 25/10/2022 (mm)
10/09/2022	15.2	22/10/2022	1.2
11/09/2022	1.2	23/10/2022	13.6
12/09/2022	0	24/10/2022	3.2
Total before sampling event (mm)	16.4	Total before sampling event (mm)	18

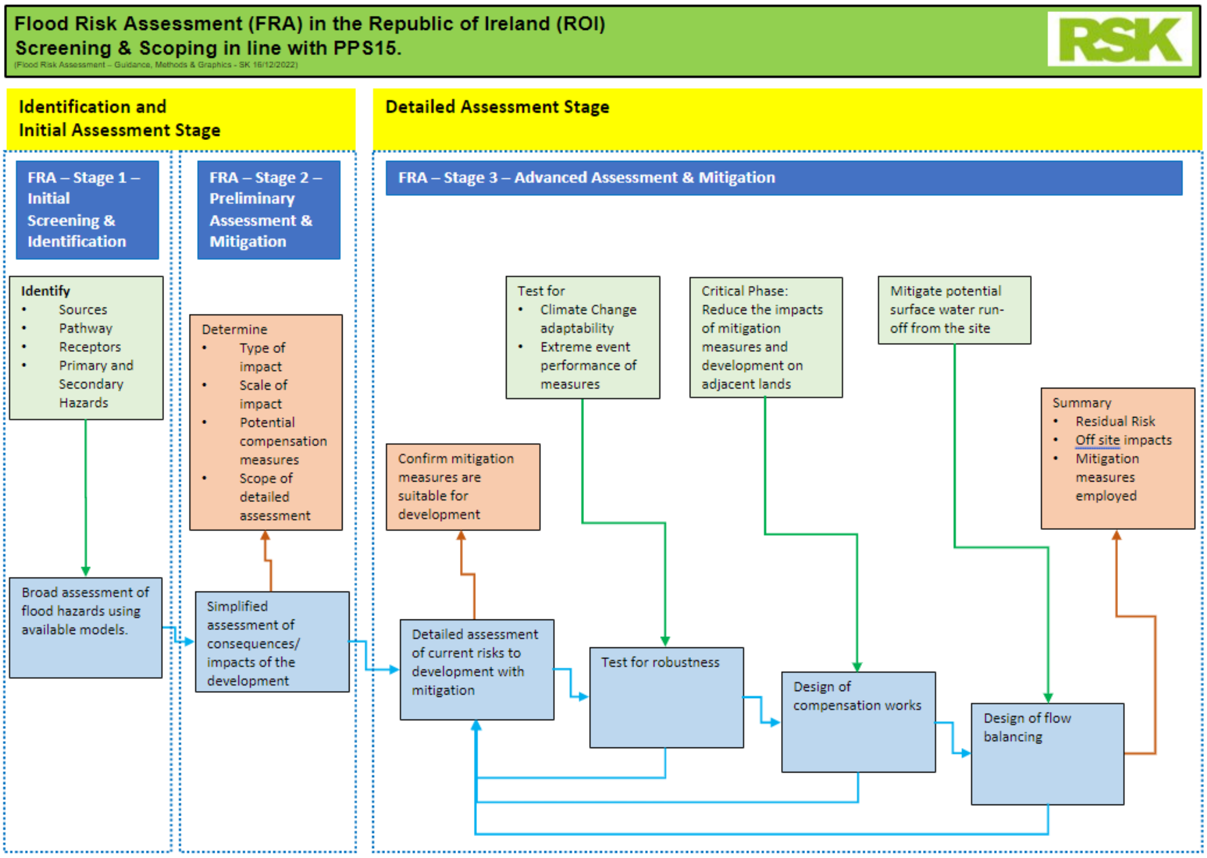
4 FLOOD RISK ASSESSMENT

4.1 Introduction

4.1.6 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 and groundwater 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.

Figure 2: Scoping and Screening for an FRA in ROI



Source / Adapted from: OPW (2009) Planning & Flood Risk Mgt Guidelines for Planning Authorities – Appendices (https://assets.gov.ie/111239/83edbb65-e756-4d29-bddc-1651048914ee.pdf)

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

Flood Risk Assessment Stage 1- Initial Screening & Identification

Stage 1 Initial Screening and Identification – 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 LAP's or a proposed development site that may warrant further investigation at the appropriate lower level plan or planning application levels Figure 2.

Flood Risk Assessment Stage 2 – Preliminary Assessment & Mitigation

Stage 2 Preliminary Assessment & Mitigation – 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 consequences of the development should be scoped Figure 3.

Flood Risk Assessment Stage 3 – Advanced assessment & Mitigation

Stage 3 Advanced assessment & Mitigation – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential residual flow to a proposed or existing development or land to be zoned, of its potential impact on flood risk. Confirm the effectiveness of any proposed mitigation measures Figure 4.

4.1.7 Sources of Flooding

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

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).

4.1.8 Scoping & 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).

4.1.9 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 Error! Reference source not found., 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 3: Indicative flood zone map (OPW, 2009)

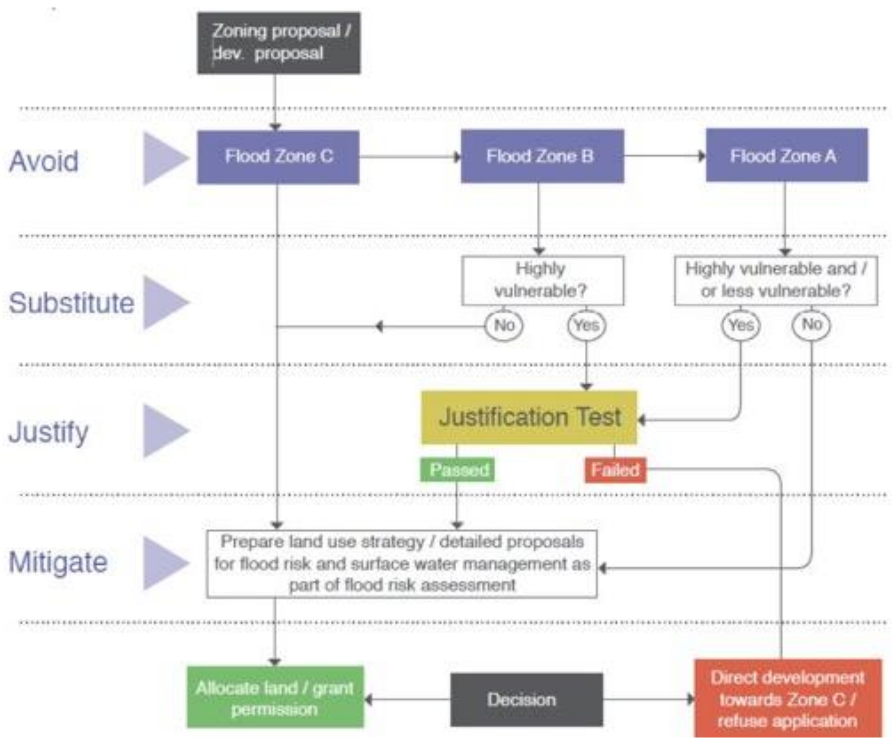
As outlined in the FRM Guidelines, future developments must avoid where possible areas at risk of flooding. The FRM Guidelines categorises all types of development as either; 1. Highly Vulnerable, 2. Less Vulnerable and 3. Water Compatible e.g., flood infrastructure, docks, amenity open space (Error! Reference source not found.**4**). As the development of the Ballykett Wind Farm Development 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).

Presented in **Figure 5** 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.

Figure 5: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification

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



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.

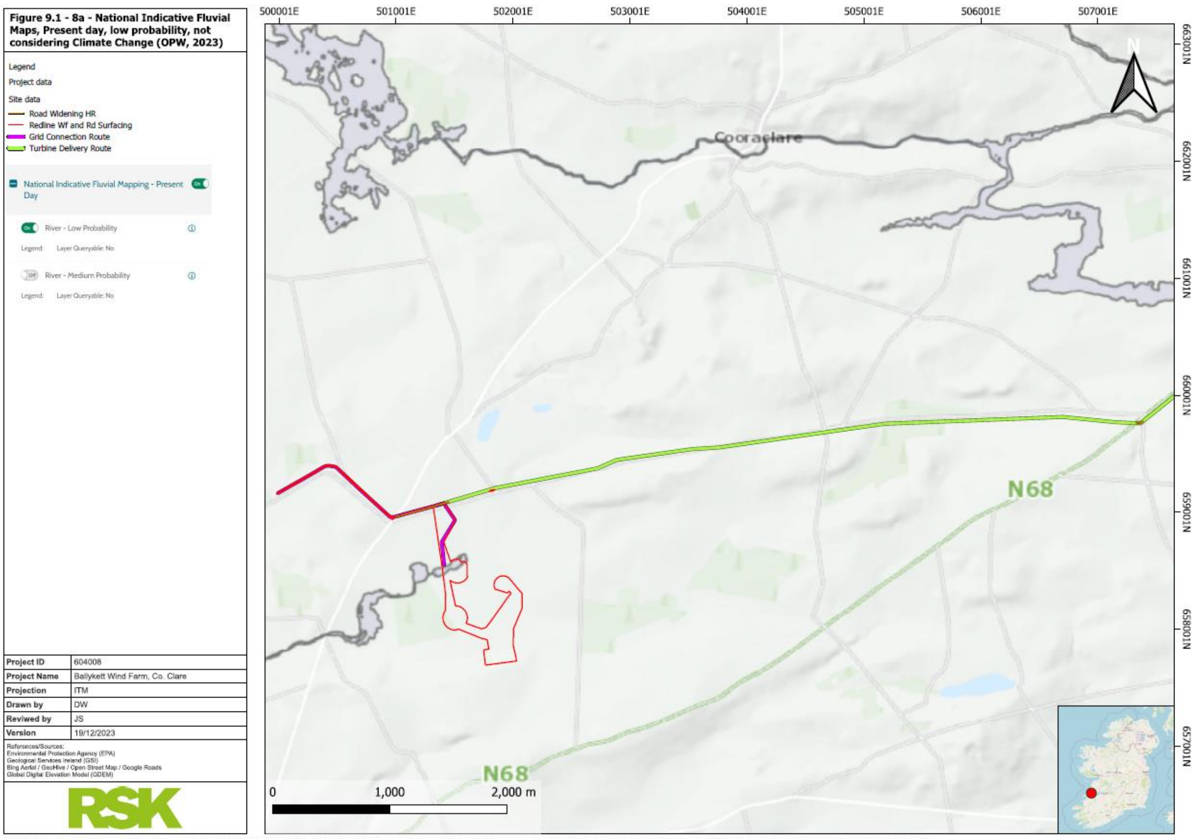
Flood Risk Preliminary Screening GCRs
(RSK File Ref. 604008-Hydro-R01-(01))
(SK, JS 07/12/2023)

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

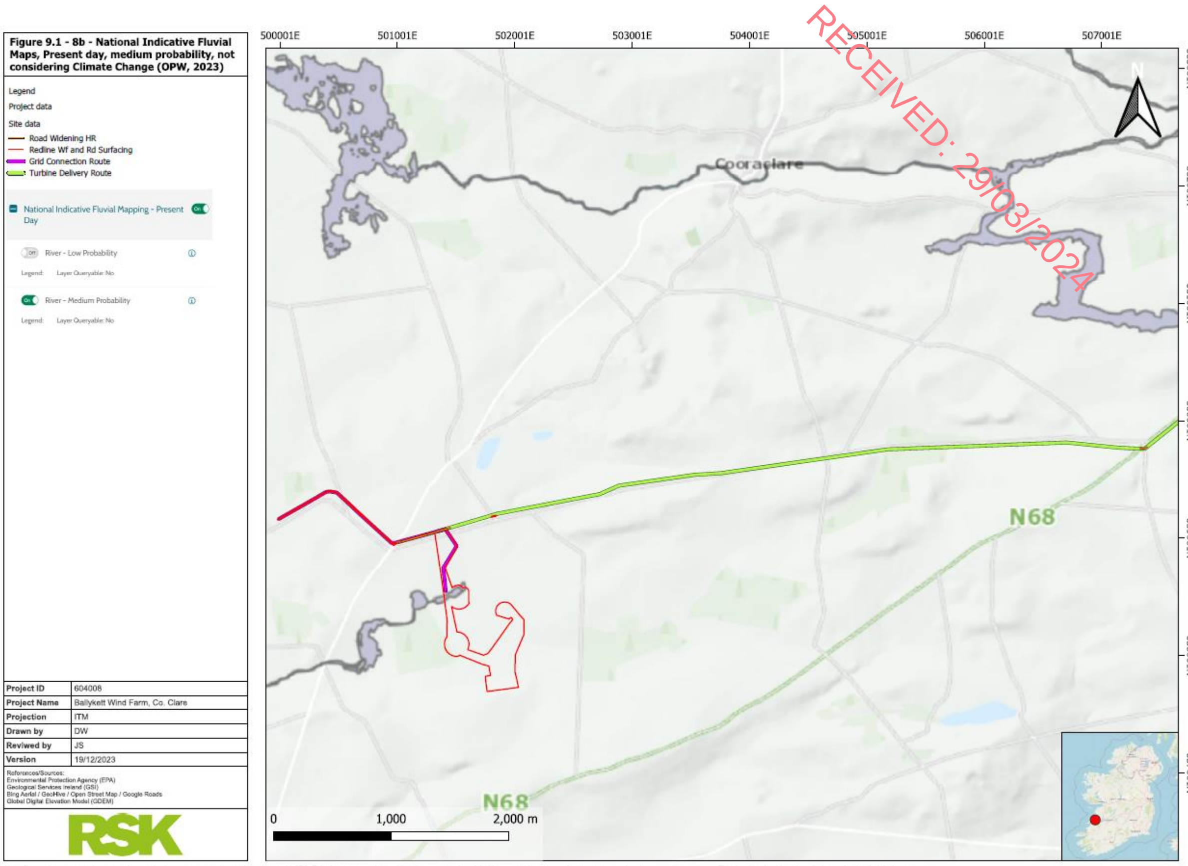
4.2 Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. Map Genie map (1829-1842) indicate that neither the site itself, the GCR, TDR works or the surrounding area are susceptible to flooding.

OPW flood maps do not indicate historic flooding with the exception of coastal flooding a significant distance downstream of the Site. The National Indicative Fluvial Mapping database (Present Day) operated by the OPW has identified all surface waterbodies draining the site, GCR and TDR works: as not having low probabilty (0.1% AEP) or medium probability (1% AEP) risk to flood (**Figure 8a**). The National Indicative Fluvial Mapping database (Future Scenario) operated by the OPW has identified all surface waterbodies draining the site, GCR and TDR works: as not having low probabilty (0.1% AEP) or medium probability (1% AEP) and high probability for risk to flood (**Figure 8b**)

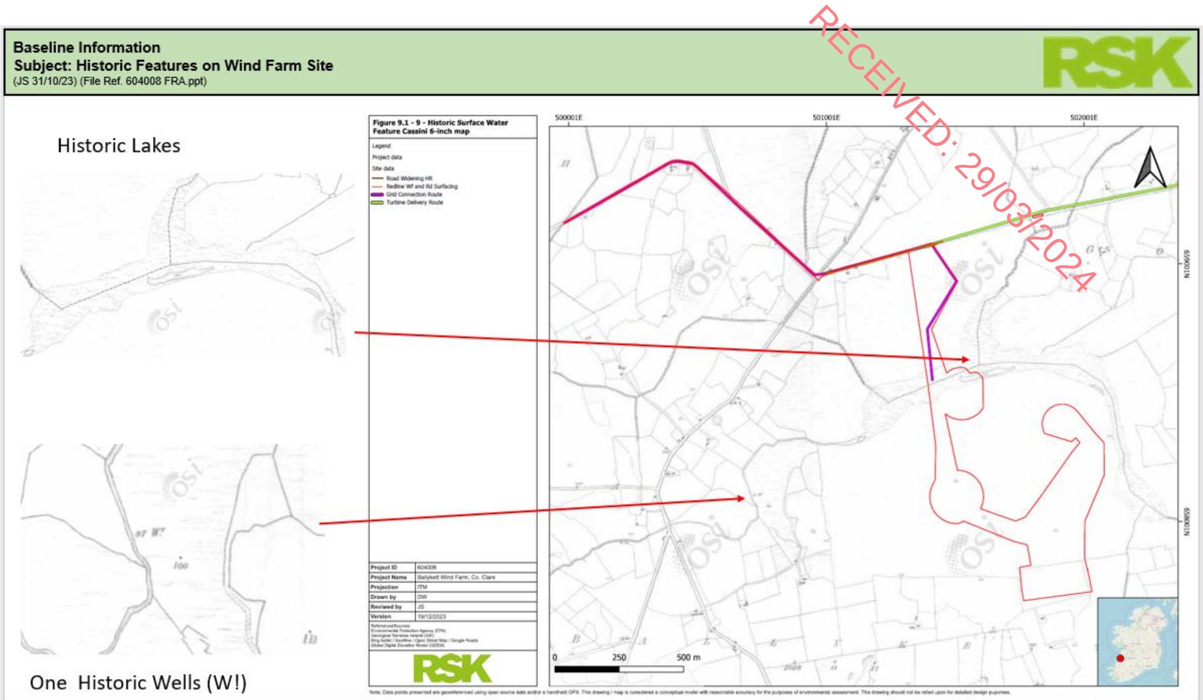


Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design puporses.



Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design purposes.

Ordnance Survey Ireland's (OSI's) National Townland and Historical 6 and 25 inch maps were also consulted for potential evidence of historical references to flooding at the Site. These historical maps do not provide any references to lands within or adjacent to the Site boundary being prone to flooding, however there is a historic well outside the redline boundary and two historic waterbodies, one of which is in close proximity to T1 (**Figure 9**).



4.3 Tidal Flooding

Tidal flooding is caused by elevated sea levels or overtopping by wave action. No coastal flood zones are identified at the site. Kilrush Creek Marina is located approximately 4km to the south of the Site.

Tidal flood risk is now screened out of this assessment for the Wind Farm Site, GCR and the TDR works.

4.4 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. Fluvial flood maps produced as part of the OPW's National Indicative Fluvial Mapping (NIFM) indicates fluvial flood zones at the Development Site and the GCR (**Figure 10).** However river flood extents in present day and future scenarios, indicate no flood zones (**Figure 11**). The most recent, comprehensive flood-maps 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.

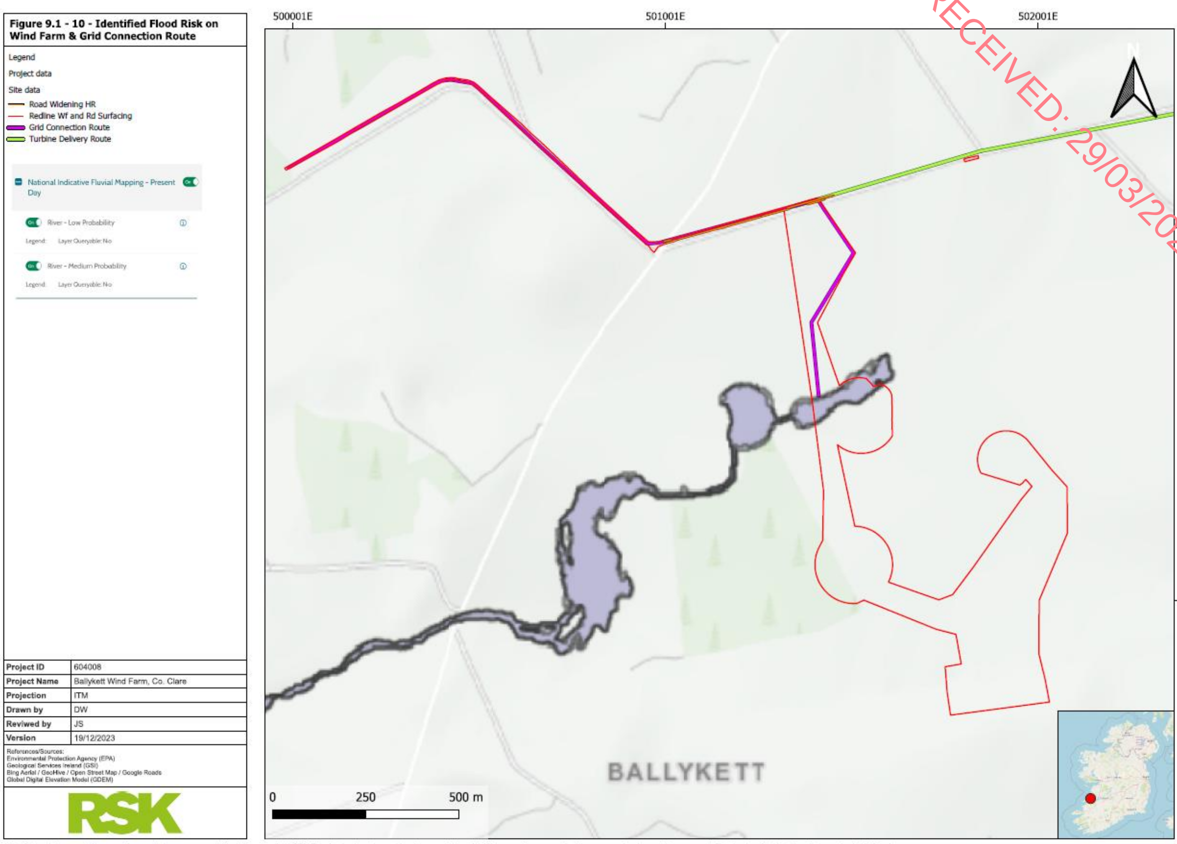


Figure 9.1 - 10 - Identified Flood Risk on Wind Farm & Grid Connection Route

Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design purposes.

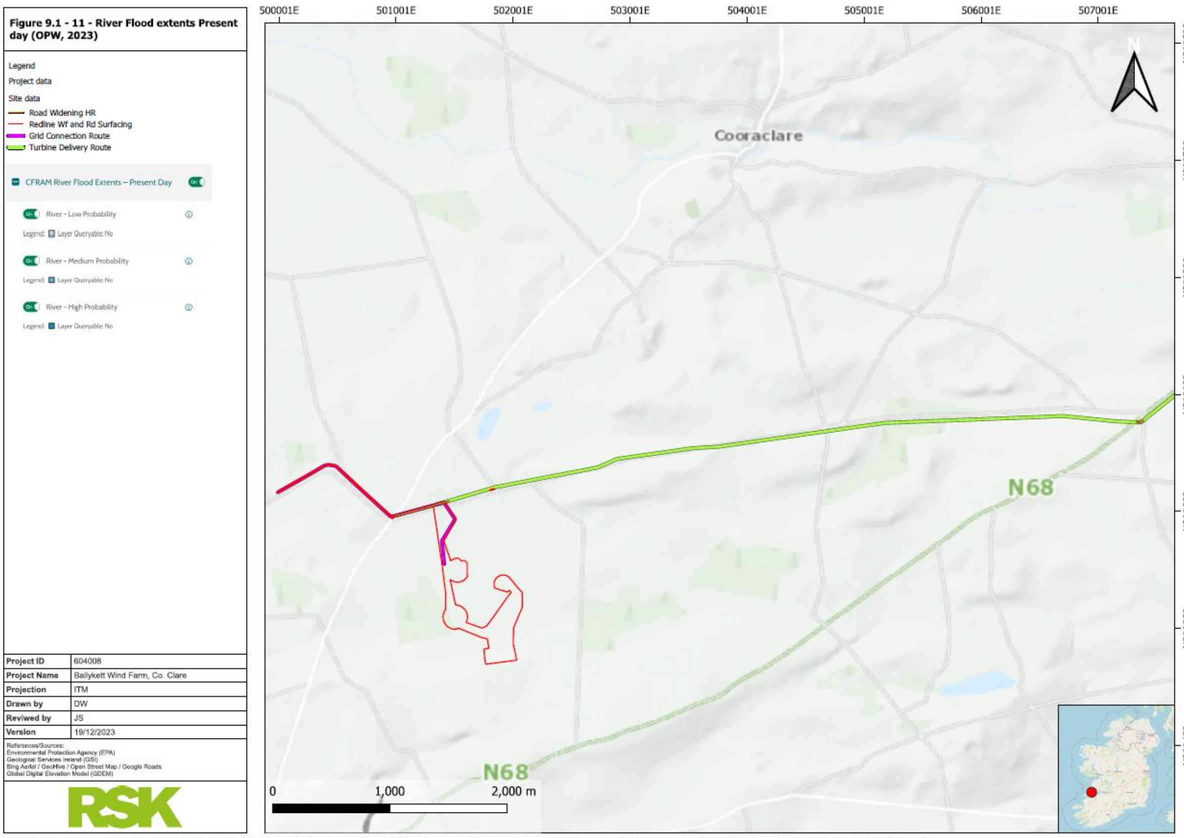


Figure 9.1 - 11 - River Flood extents Present day (OPW, 2023)

Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design purposes.

NOTE: OPW flood maps are intended for information only and are not to relied upon for detailed site assessment.

Fluvial flood risk will be assessed in further detail in the following sections.

4.5 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 GCRs, or surrounding area. Therefore, the residual risk from pluvial flooding is considered nil. 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. Therefore, the risk from pluvial flooding is considered High in the context of probable fluvial flood plains on site.

Pluvial flood risk is potentially impacted by developments whereby changes in surfaces, ground sealing, and the introduction of drainage networks will fundamentally modify surface water runoff patterns and rates, potentially exacerbating pluvial, and fluvial risk at on site or downstream receptors.

Fluvial flood risk will be assessed in further detail in the following sections.

4.6 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. The groundwater underneath the site is located within both a *Locally Important* Aquifer- Bedrock which is Moderately Productive only in Local Zones and a *Poor* Aquifer- Bedrock which is generally unproductive except for local zones. There has been no previously documented groundwater flooding within the site boundary. 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 GCRs. Therefore, the residual risk from groundwater flooding is considered low.

Groundwater flood risk is now screened out of this assessment.

4.7 Proposed Development

The proposed development comprising of new access tracks, hardstands and associated ancillary infrastructure will include land take (Agriculture / Forestry / Peatlands) and the replacement of vegetated lands and soils with relatively impermeable surfaces. This presents the potential for a net decrease in recharge potential (rain percolating through soils to groundwater) and increase in the hydrological response to rainfall (quantity and rate of surface water runoff) at the site, which will potentially adversely impact on flood risk areas within or downstream of the site. Works on the GCR consist of replacing existing sections of road and therefore no net decrease in recharge potential is expected. TDR works involve road widening and verge strengthening which will result in a decrease in recharge potential however, given the volumes this is perceived as a slight effect. The nearest Hydrometric stations for river discharge rates are presented in **Figure 12**.

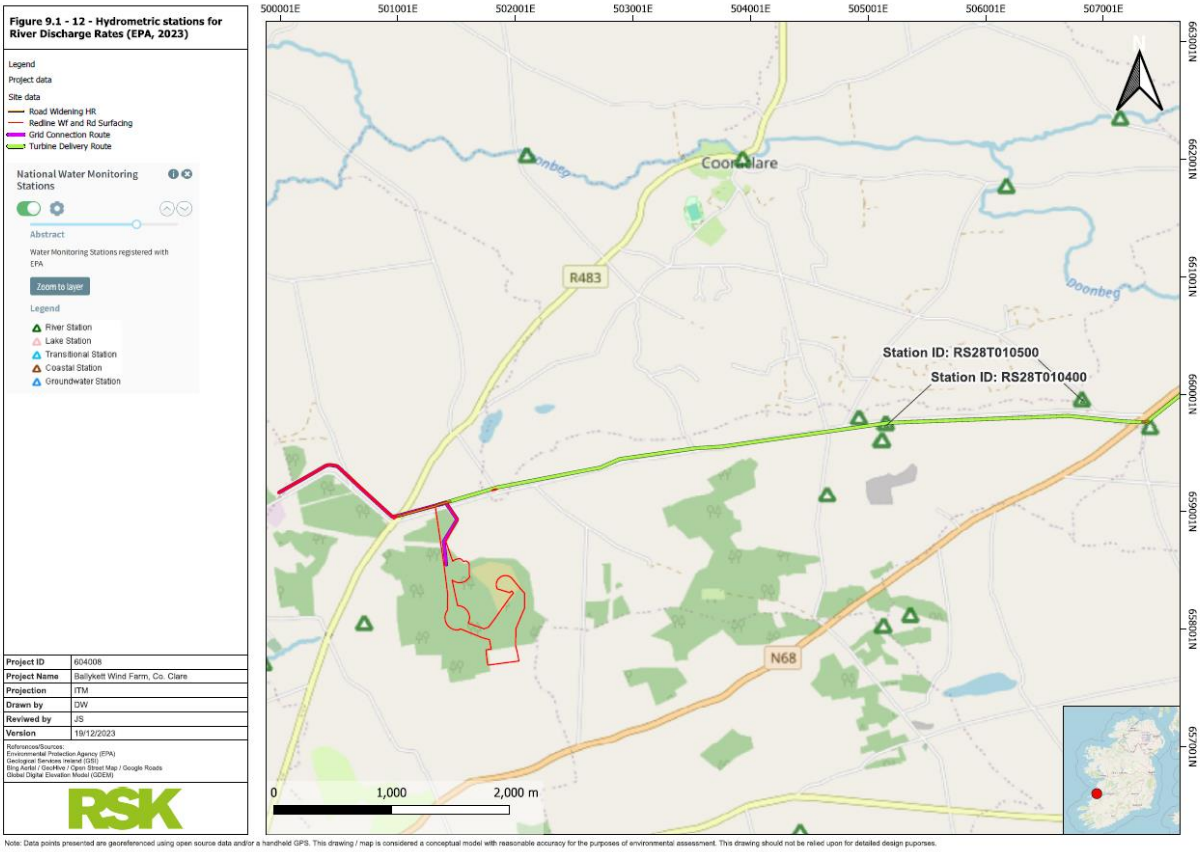


Figure 9.1 - 12 - Hydrometric stations for River Discharge Rates (EPA, 2023)

The Development layout includes a section of access crossing by means of a new watercourse crossing / bridge. This bring and a portion of associated access track is within mapped flood zones (A, B, C) associated with Moyasta river. The design of the proposed bridge and infrastructure can potentially lead to significant impacts to river hydro-morphology and exacerbate flooding on site, upstream, or downstream of the development. The TDR works are associated with the Doonbeg River, there are two stations downstream of these works (located on the map), these should be used to monitor potential effects.

4.8 Human and/or Mechanical Error

Construction of drainage channels and enhancement of existing drainage associated the Development have the potential to impact the hydrological regime at the Site. In particular human error related to poor design, or if poorly managed during construction phase of a development, the installation of drainage channels and associated infrastructure such as culverts or attenuation features can lead to excessive *wetting and/or drying* in areas of the site which does not conform to baseline conditions i.e., localised flooding or excessive draining. There is currently no mapped drainage on the OPW Drainage maps, that reside within the boundaries of the proposed site, however extensive forestry drainage was mapped on site, this can be seen in the constraints map **Figure 9.13a** of the **EIAR Chapter 9**.

4.9 FRA Stage 1 Conclusions

Flood Risk Screening for the proposed development is summarised in Table 4: Initial Screening and Scoping Stage 1 FRA.

Table 4: Initial Screening and Scoping Stage 1 FRA

FRA Stage 1	Initial Screening and Scoping				
	Tidal Flooding	**Surface Water**	**Fluvial Flooding**	**Groundwater flooding**	**Change to a water course**
Screening	The site is not affected by Tidal Flooding.	Surface Water run off on site is likely to increase on the site because of the increase in hardstanding areas. Mitigation measures will be discussed in Stage 2	The site is not in a mapped CCFRAM area. Although National Fluvial Indicative Mapping indicates that the site is at risk . Discussed further in Stage 2.	Groundwater flooding is unlikely to be an issue on site	Bridge is being built over the Moyasta River for the access track near Turbine 1.
Needs further consideration	**No**	**Yes**	**Yes**	**No**	**Yes**

This 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 evidence of historic flooding at the Site.

Fluvial flood zones A, B and C on site, and the proposed new watercourse crossing with the flood plain require FRA Stage 2.

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.

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has identified flood hazards for the proposed Development.

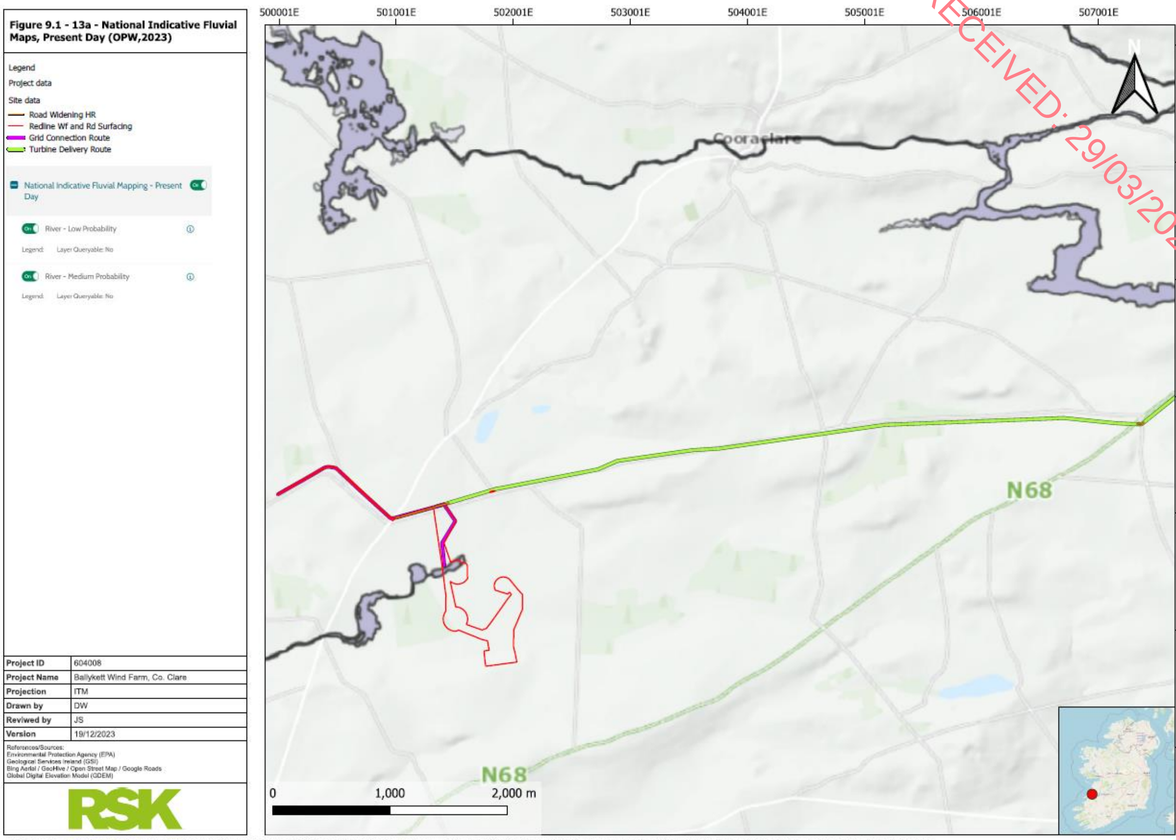
The proposed Development has the potential to lead to a net decrease in recharge potential and net increase in the hydrological response to rainfall at the site, potentially leading to adverse impacts on flood risk areas downstream of the site. The extent of the risk of flooding and potential impact of a development on flooding elsewhere (downstream) requires FRA Stage 2.

5 STAGE 2 – ACCESSING SURFACE WATER RUNOFF AND FLUVIAL FLOODING

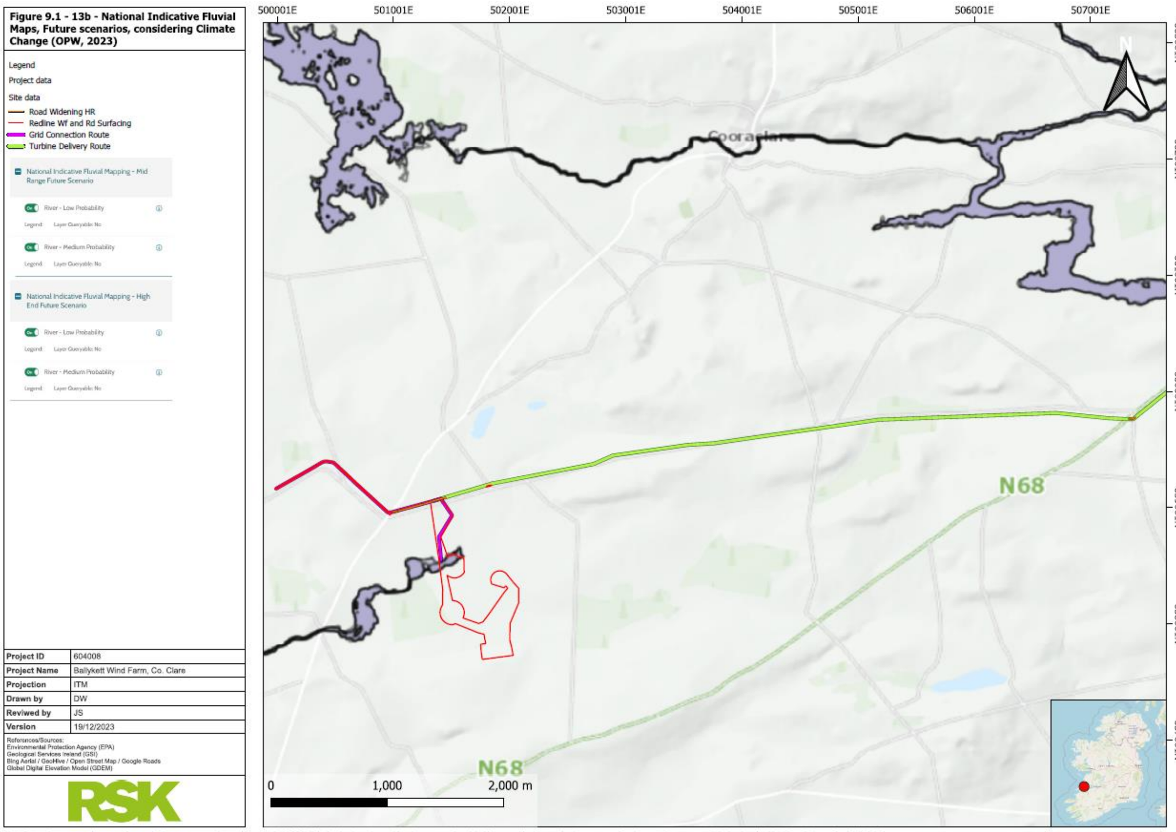
5.1 Fluvial Flooding

The OPW National Indicative Fluvial Maps (NIFM) interactive floodinfo.ie maps have been consulted with reference to fluvial (rivers and streams) flooding for both current day and future case scenarios. The medium and low probability present day scenarios relate to an annual exceedance probability (AEP) of 1% and 0.1% respectively. The medium and low probability present day scenarios reflect the odds of a theoretical extreme flood event occurring in a given year being 1:100 and 1:1000 respectively. Both a 1% and 0.1% AEP fluvial flood events are predicted within the Site boundary for the present-day scenario. These predicted flood extents continue downstream of the site to the Poulnasherry Bay. Given that the proposed drainage system outlined in the Surface Water Management Plan will result in increased attenuation of rainwater during heavy rainfall events, the potential risk of exacerbating a theoretical 1% or 0.1% AEP fluvial flood downstream of the proposed Site is expected to be negligible.

In an assessment of potential future flooding impacts on the proposed Development, the NIFM's "High-End Future Scenario" which models a 30% increase in rainfall resulting from climate change has been adopted as precautionary approach. The medium probability scenarios (AEP of 1%) has been reviewed at the Site for additional conservatism. There is a 1% AEP extreme fluvial flood events modelled within the Site boundary for the high-end future scenario. Similar to the modelled present-day scenario, the extents reach the entirety of the Moyasta River downstream of the Site to Poulnasherry Bay. The predicted extent of this High-End Future Scenario has been traced approximately and presented in (**Figure 13a** and **Figure 13b**)



Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design puporses.



Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design puporses.

5.1.10 Estimation of Flood Extent

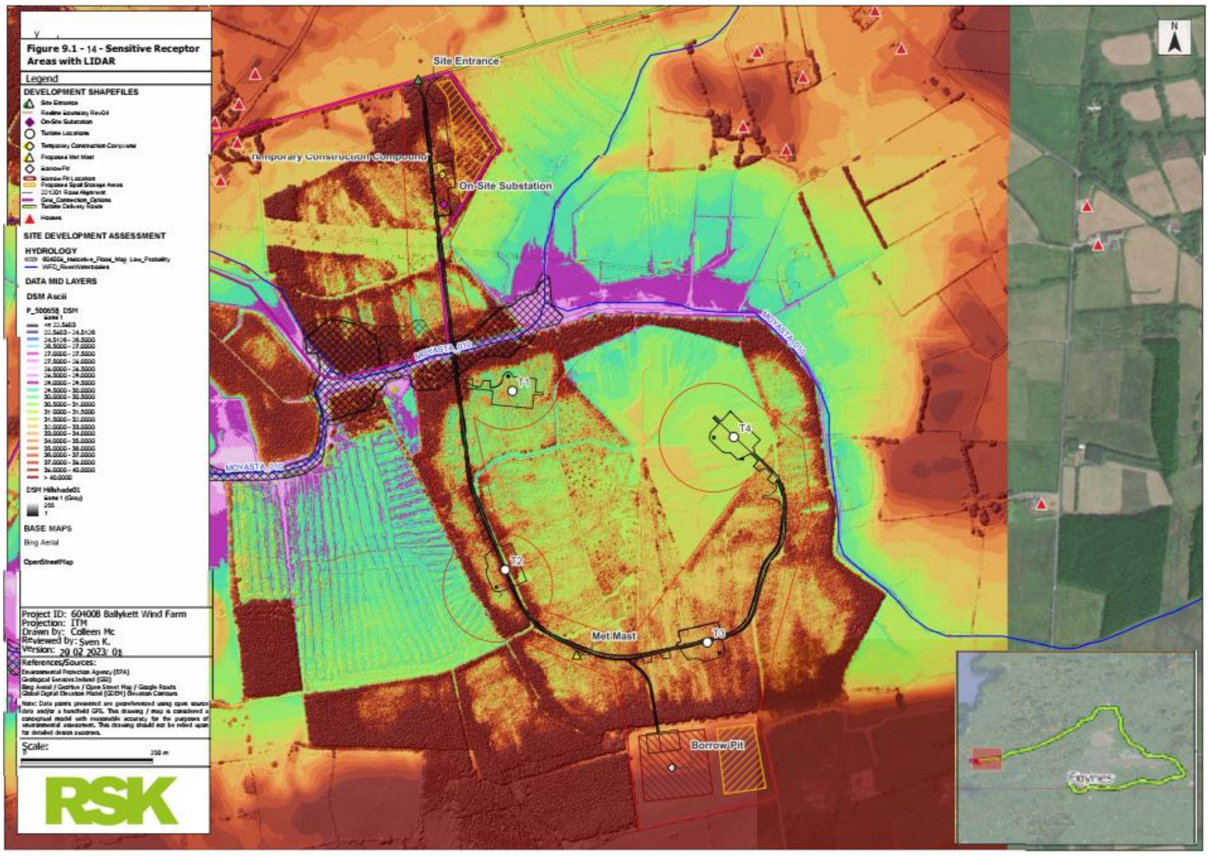
The National Indicative Fluvial Flood mapping was compared to the elevation data associated with the site. Global Data Elevation Model (GDEM) (opensource, low accuracy) and detailed LiDAR information provided was used in the assessment.

Ground level at the river bank / riparian ground level is approximately 28.0maOD.

The indicative flood extents are observed to be approximately 29.0maOD. Both GDEM and LiDAR elevation data generally aligns with this elevation. The actual 29 maOD elevation is presented in **Figure 14: Sensitive Receptors with LIDAR** as the upper 'light pink' coloured contour, aligning with NIFM flood extent trace north of T1.

An increased flood extent of 29.5 maOD (indicative worst case / considering climate change) is presented as the upper extent of the 'purple' elevation contour (**Figure 14**).

It is noted that both 29.0 and 29.5maOD flood heights will inundate relatively significant areas of flood plain. LiDAR data noise i.e. mature forestry restricts accurate assessment of flood prone areas within the site boundary however, fragmented data in areas of young forestry, scrub or open spaces indicate that the flood extent within the site is limited in line with the traced OPW NIFM extent or conservatively the extent of mature forestry as presented in **Figure 14**.



5.1.11 Existing Drainage & Anomalies

During site surveys embankments of approximately 1.0 to 1.5m height and apparently artificially formed with fill were observed along the river within the redline boundary of the Site. On the northern side the drainage north of the embankment diverts water to the eastern corner of the on-site forestry, before discharging to the river. On the southern side the forestry drains run through breaks in the embankment and discharge to the river. The presence of the fill embankments and apparent canalising / straightening of the river historically indicates attempts to implement local / regional flood alleviation measures. There is extensive forest drains on site, these are covered in further details in **EIAR Chapter 9 – Section 9.3 Baseline Description.** There is no mapped watercourse crossings along the GCR**.** Water crossings that are along the section of the TDR involving verge strengthening, flow from north to south and south to north.

5.1.12 Assessment of Sensitive Receptors

Receptors within or in close proximity to the mapped flood extent is limited to agricultural and forestry lands with associated non-essential infrastructure. Review of topography and dwellings detected by review of aerial imagery concludes that receptors in the proximity of the site are >5 m above conservative flood height of 29.5 maOD.

5.1.13 Proposed Development

The Development footprint i.e. access track and new bridge are situated within the mapped flood extent.

It is noted that all proposed turbine hardstands, sub-station and temporary compound are situated in areas >29.5 maOD.

The proposed drainage system outlined in the **Surface Water Management Plan in the CEMP, Appendix 2.1 of the EIAR** will result in increased attenuation of rainwater during heavy rainfall events. Surface water runoff from the developed areas of the Site will be attenuated in accordance with the principles of Sustainable Drainage Systems (SuDS). The management of surface water runoff will limit discharge from the Site to greenfield runoff rates. The potential risk of exacerbating theoretical downstream high end future scenario fluvial flood events is therefore expected to be negligible.

In addition to the proposed drainage design, a fundamental component of the Sites flood mitigation strategy will be achieved via mitigation through avoidance. All proposed design elements such as access roads, turbine locations, construction compound, substation, met mast etc. will all be positioned a minimum distance of 50m away from the Site's rivers and streams wherever possible. Main infrastructure units e.g. turbine hardstands will be positioned outside of probable flood plains.

The pre-existing Site access road which will be utilised to facilitate the construction phase is located south of an unnamed local road east of the R483. The Site access road will have only limited use during the operational phase due to the nature of the proposed Development. The Moyasta River is generally located at the lowest elevation across the Site and it is predicted to flood during any the above assessed current and future scenario fluvial flood events.

The flood risk identification assessment has identified a flood risk at the Site and the potential for exacerbating flood events on site, upstream and downstream of the site If proper mitigation measures are not implemented. The drainage design will ensure that surface water run-off from the Site will not increase the risk of flooding to downstream receptors. Mitigation by avoidance through design will also alleviate the risk of any potential flood risks. Having assessed the potential risks in the context of the Development and in accordance with the guidelines, there is a requirement to proceed further in the staged process of the flood risk assessment.

5.2 Flooding Events

Flood events that have occurred in close proximity to the site are highlighted in **Table 5.**

Table 5: Flooding Event Close to the Site

Flood ID	Flood Location Description	Flood Type	Flood Source	Distance to Project Location
12978	N67 Road at Moyasta	Single	Coastal Waters	7.62km west of the EIAR boundary along the N67 road.

5.3 Assessing Potential Effects of Development

5.3.14 Increased Hydraulic Loading / Runoff

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** and **EIAR Chapter 9 – Section 9.3 Baseline Description**):

- Turbine Foundation = c. 25.8m in diameter
- Turbine Hardstands = c. 2,770m^2 x 4 no. = 11,080m^2
- Existing Assess Track = c. 2,800 m^2
- New Access Track / Turning Points = c. 1,500m x 5m width = 7,500m^2
- Substation / other Hardstand = c. 1 no. = 1,171m^2
- Control Building = c. 17.49 m x 7.33 m = 128m2
- Met Mast = 10 m x 10 m = 100 m^2
- 1 in 100 year rainfall event = c. 21.3mm of rainfall in 1 hour.
- Recharge capacity = 4% of Effective Rainfall (GSI, 2023).

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 **Table 6**. (Note: This is not considered advanced modelling for flood risk assessment (FRA Stage 3)).

5.3.15 Developments in Flood Plains

Developments constructed in floodplains will likely displace a corresponding volume of flood waters during flood events, in turn potentially exacerbating flood risk downstream or upstream of the site. Similarly, the obstruction of overland flow of flood waters in flood plains will potentially lead to exacerbating flood risk on site, while also impacting upstream / downstream.

The volume of the Development or equivalent flood capacity volume has not been calculated as part of this assessment. This will be considered and mitigated against during the detailed design phase of the Development (FRA Stage 3).

Water balance calculations allow for the addition of area for hardstand infrastructure required (land take) during the construction and operational phases of the Development.

The proposed bridge construction must facilitate unimpeded discharge during a 1 in 100 year storm event, plus allowing for climate change (+20%).

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. 0.024m^3/sec or 86.4m^3/hour (or 0.12% increase). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but 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.

Table 6a: Net Increase in Runoff as a function of the Development Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)

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)	
Ballykett WF					19,979.00	0.0213	20.00%	0.01704	340.44	0.09	0.024	25.00%	20.00	0.12%
								Total	340.44216	0.09	0.024	25.00%	20.00	0.12%

Table 7b: Net Increase in Runoff as a function of the Development per Micro-catchment and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)

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)																	
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.	2,770	4	11,080.00	0.0213	20.00%	0.01704	188.80	0.05		0.00%	0.0213	236.00	0.07		
SW1	Met Mast	No.	100	1	100.00	0.0213	20.00%	0.01704	1.70	0.00		0.00%	0.0213	2.13	0.00		
SW1	Substation	No.		1	1,171.00	0.0213	20.00%	0.01704	19.95	0.01		0.00%	0.0213	24.94	0.01		
SW1	Control Building	No.		1	128.00	0.0213	20.00%	0.01704	2.18	0.00		0.00%	0.0213	2.73	0.00		
SW1	New Access Track / hardstand	m	5	1,500	7,500.00	0.0213	20.00%	0.01704	127.80	0.04		0.00%	0.0213	159.75	0.04		
SW1	Subtotal										0.09					0.12	0.024
													Total	425.5527	0.12	0.12	0.024

5.4 Accessing the Artificial Modification to a watercourse

5.4.16 Building of a Bridge within a Flood Plain

In line with Section 50 of the Arterial Drainage Act 1945, If building, reconstructing or restoring any new or existing bridge over any water course consent must be sought from the Office of Public Works (OPW).

The construction of a bridge has the potential to change the hydrological characteristics of a river which include (OPW, 2019):

- Flood levels upstream of the bridge being increased due to the creation of a restricted water course.
- Flood levels downstream of the bridge being increased due to the removal of a beneficial restriction from the watercourse.
- Erosion of the watercourse and / or floodplain being initiated or accelerated due to the restriction increasing the flow velocity and turbulence.
- Deposition of material in the watercourse or on the floodplain due to a change in flow velocities and turbulence.
- Overland flow paths on the adjacent floodplain being blocked or diverted due to the construction of bridge approaches.

5.4.17 Hydraulic Design and Standards

According to the guide for Section 50 it is necessary that the designs/mitigation measures meets the standards set out in the guidance Error! Reference source not found.. **Table 8** below highlights the affected land category of the proposed Development.

Table 8: Level of Technical Analysis for Bridge Infrastructure (OPW, 2019)

Affected Land			Information Requirement
Undeveloped	Rural dwellings and Infrastructure	Urban dwellings and Infrastructure	
✓	✓	✓	Flood Level
-	○	✓	Flood Extent
✓	✓	✓	Detailed plan of structure and adjacent water course
○	○	✓	Cross section survey extending over the affected area
-	○	○	Aerial or ground based contour survey covering the affected area
✓	✓	✓	Estimation of design flood flow
-	○	✓	Estimation of desgin flood hydrograph
✓	✓	✓	Simple hydraulic calculations
-	○	✓	Numerical hydraulic model
-	○	✓	Flood Risk Assessment
-	○	○	Analaysis of alternative events that may be affected by the structure
○	○	○	Joint probability anyalsis combining fluvial and tidal events

✓	Likely to be required
○	May be required
-	Unlikely to be required

5.4.18 Rural Dwellings and Infrastructure

According to **Table 8** the proposed Development is in the Rural dwellings and infrastructure affected land category. **Figure 14** shows the houses that are upstream of the Development depicted as red triangles.

5.4.19 Information required under Section 50 of Arterial Drainage 1945

Detailed Plan of Structure and Adjacent Water Course

OPW Section 50 guidance gives examples of Hydraulically efficient Bridges and Culverts. These examples have been applied in the **Error! Reference source not found.** and must be considered as part of the mitigation measures proposed for the Development.

Hydraulic Calculations

The proposed bridge construction must facilitate unimpeded discharge during a 1 in 100 year storm event, plus allowing for climate change (+20%). In order to achieve this, and incorporating other reasons for similar mitigation, the proposed new watercourse crossing will be a single span structure with the maximum practical span distance (c. 10-12 m) between abutments. For context, the river at the site is approximately 2.0 m width. This will ensure ample space for storm discharge.

Storm discharge rates for the river at the bridge location will be calculated FRA Stage 3.

5.5 General Mitigation

Flood Relief Schemes, outlined by the OPW, are in place Moyasta (flood areas identified above). For areas within and upstream of flood zones in management areas mitigation includes *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 Error! Reference source not found.**15**, 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.

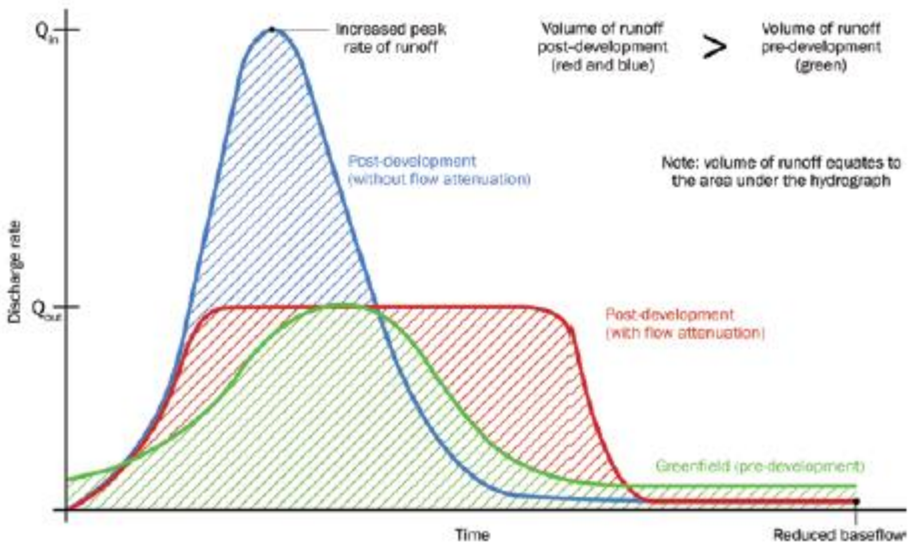
- Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of wetlands and woodlands), that can have benefits for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

Under the 2013-2015 Work Programme of the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD), and in response to the 2012 Blueprint to Safeguard Europe's Water Resources proposals, the Working Group Programme of Measures has 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).

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.

Figure 15: Example of a hydrograph (CIRCA, 2015)



5.5.20 Surface Water Runoff and Hydraulic Loading

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
- Rewetting peatlands
- 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.

The Development has the potential to result in increased volumes of runoff during the operational phase 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 of 7.05 l/sec (1 in 100 storm event) in water runoff, 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.

5.6 Detailed Design & Scoping FRA Stage 3

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
- 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 adverse. Therefore, FRA Stage 3 including advanced flood modelling with a view to ensuring significant risks to flood risk areas are managed and minimised, is required as part of SFRA. To ensure the detailed engineered design of the proposed Development complies with mitigation measures it is recommended that drainage, attenuation and associated infrastructure is designed and specified by a competent water infrastructure engineer, which will include modelling of runoff in site drainage to ensure that all aspects are sufficiently specified and robust. Drainage modelling, including assessment of inundation rates, lag times and discharge rates, will be particularly useful in sensitive peatland areas, or where particularly sensitive environmental attributes exist downstream, for example; ecological attributes where surface water runoff and surface water quality are linked (**EIAR Chapter 9**).

- 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.

The proposed Development will at a minimum reduce any net increase in runoff arising at the site. This will be calculated and modelled with a view to demonstrating effectiveness and robustness of drainage and SuDS infrastructure at the site (FRA Stage 3).

In line with flood management plans and the objectives associated measures and policies includes taking opportunities to improve and alleviate downstream or on-site flood risk as part of catchment wide planning policy. Establishing a robust drainage system can easily be modified to achieve a net benefit and reduction in the hydrological response at the site.

6 FRA STAGE 2 – CONCLUSIONS

The portion of the Development likely within a low probability flood plain is limited to a portion of site access track and a new watercourse crossing.

The design of the proposed new bridge and associated portion of site access track will be done in line with the requirements of appropriate guidelines, as presented in this report. The proposed bridge will be a free span type design and is shown on Planning Drawing No. 6777-JOD-BKWF-XX-DR-C-1206 which accompanies the application. As a result, the constructed bridge will allow adequate sizing and freeboard to facilitate peak flows and flood heights and maintain overland flow in the flood plain. Loss in flood zone capacity will be regained through appropriate measures, which will be consider in line with drainage and SuDS during the detailed design phase / FRA Stage 3.

A 1 in 100 year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to the Site area (Redline Boundary). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but imperceptible or negligible impact of the Development.

The proposed Development will include in its design and 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. This means that the attenuation capacity in the constructed drainage network associated with the Development will have capacity to attenuate the calculated net increase during a 1 in 100 year storm event.

Considering the development significantly impacts on a probable flood risk area, FRA Stage 3 including advanced flood / discharge modelling is required.

A detailed Surface Water Management Plan (SWMP) (to be based on the SWMP contained as part of the CEMP in Appendix 2.1 of the EIAR) 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.

A Section 50 application for the construction of the proposed new bridge will be completed prior to the construction phase to ensure that the site meets the standards set out by the OPW.

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.

7 REFERENCES

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