

Edenderry Gas Pipeline Flood Risk Assessment

April 2026

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Abbreviations

AEP.....	Annual Exceedance Probability
CFRAM	Catchment Flood Risk Assessment and Management
DoHELG	Department of the Environment, Heritage, and Local Government
DTM	Digital Terrain Model
EPA	Environmental Protection Agency
FRA.....	Flood Risk Assessment
GSI	Geological Survey of Ireland
LEAP	License and Enforcement Access Portal
LiDAR	Light Detection and Ranging
NWRA	Northern and Western Regional Assembly
RSES	Regional and Spatial Economic Strategy
OPW	Office of Public Works
RBD	River Basin District
RR	Rainfall-Runoff

1 Introduction

Under the Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009), the proposed development must undergo a Flood Risk Assessment (FRA) to ensure sustainability and effective management of flood risk.

1.1 Terms of Reference

JBA Consulting has been appointed by Fingleton White to prepare a Flood Risk Assessment (FRA) for a proposed 23.65km gas pipeline development including ancillary compounds in Co Meath and Co Offaly.

This Flood Risk Assessment (FRA) has been prepared in respect of the Proposed Development, consisting of the construction, commissioning, and operation of a c. 23.65-kilometre (km), 300-millimetre (mm) nominal bore (NB) underground steel gas transmission pipeline with a maximum operating pressure of 85 barg (the GNI 143 Ballykilleen Pipeline). The Proposed Development also includes associated ancillary fibre ducting, new offtake installation comprising a hot tap tie in location (the Kilwarden Offtake Installation) located in the townland of Kilwarden, Co. Meath, and new Above Ground Installation (the Ballykilleen AGI) located in the Edenderry Renewable Energy Complex located in Kilcumber, Co. Offaly. These elements collectively constitute the Proposed Development that is the subject of this EIAR.

1.2 Legislative Policy and Context

1.2.1 National

The National Planning Framework (NPF) and National Development Plan (NDP) form the backbone of Project Ireland 2040, which outlines long-term governmental ambition to improve Ireland. Sustainable development that delivers essential infrastructure such as housing, services, and utilities while minimising impact to the environment is at the heart of Project Ireland 2040. The NDP outlines several objectives related to the planning process and flood risk:

National Policy Objective 78: *Promote sustainable development by ensuring flooding and flood risk management informs place-making by:*

- *Avoiding inappropriate development in areas at risk of flooding that do not pass the Justification Test, in accordance with the Guidelines on the Planning System and Flood Risk Management;*

Taking account of the potential impacts of climate change on flooding and flood risk, in line with national policy regarding climate adaptation. Flood Risk Management Core Objectives:

- Avoiding inappropriate development in areas at risk of flooding;

- Avoiding new developments increasing flood risk elsewhere, including that which may arise from surface run off;
- Ensuring effective management of residual risks for development permitted in floodplains;
- Avoiding unnecessary restriction of national regional or local economic and social growth; and
- Improving the understanding of flood-risk and ensure flood risk management in accordance with best practice

This report is guided by the Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009) which outlines procedures for the incorporation of flood risk identification, assessment and management into the planning process.

1.2.2 Regional

The Eastern and Midland Regional Assembly (EMRA) is one of the three regional assemblies in Ireland, established to coordinate regional development and spatial planning. Edenderry is incorporated into the EMRA Regional and Spatial Economic Strategy (RSES). The EMRA RSES 2019-2031 contains several relevant policy objectives pertaining to this assessment:

- RPO 3.10: Ensure flood risk management informs development by avoiding inappropriate development in areas at risk of flooding and integrate sustainable water management solutions (such as SUDS, non-porous surfacing and green roofs) to create safe places. Development plans should assess flood risk by implementing the recommendations of the Planning System and Flood Risk Assessment Guidelines for Planning Authorities (2009) and Circular PL02/2014 (August 2014).
- RPO 3.11: Local Authorities, DHPLG, OPW, and other relevant Departments and agencies to work together to implement the recommendation of the CFRAM programme to ensure that flood risk management policies and infrastructure are progressively implemented.
- RPO 8.12: To ensure that adequate infrastructure is in place to meet demands from continuing growth and development of the economy and to cater to existing and increased population levels.

1.2.3 Local

The Offaly County and Meath County Development Plan (CDP) informs planning decisions and management on a local basis. Objectives pertaining to the proposed development are outlined fully in Section 3.2.4.

1.3 Aims and Objectives

This study is being completed to inform the installation and maintenance of utility infrastructure at the site as it relates to flood risk (permanent works & construction phase). It aims to identify, quantify and communicate to Planning Authority officials and other stakeholders the risk of flooding to land, property, people and the measures that would be recommended to manage the risk.

The objectives are to:

- Identify potential sources of flood risk.
- Confirm the level of flood risk and identify key hydraulic features.
- Assess the impact the proposed development has on flood risk accounting for climate change scenarios.
- Develop appropriate flood risk mitigation and management measures which will allow for the long-term development of the site.

Recommendations for development have been provided in the context of the OPW / DoEHLG planning guidance, "The Planning System and Flood Risk Management". A review of the likely effects of climate change, and the long-term impacts this may have on any development has also been undertaken.

1.4 Development Proposal

The Proposed Development primarily consists of a c. 23.65 km 300mm NB steel pipeline (referred to as the "GNI143 Ballykilleen Pipeline"), a hot tap tie-in to the existing BGE77, Gas to the West (PTTW) pipeline, an above ground pigging compound at the pipeline offtake location (referred to as the "Kilwarden Offtake Installation") and new Above Ground Installation (AGI) (referred to as the "Ballykilleen AGI").

The Proposed Development site comprises a linear pipeline route (including associated construction works compounds) that traverses counties Meath and Offaly and the following townlands: Aghnagillagh, Ardnamullan, Ballyboggan, Ballynakill, Castlejordan, Clongall, Harristown, Kilwarden, Park and Ticroghan (Co. Meath); and Ballykilleen, Clonmore, Drumcooly, Edenderry, Lenamarran, Monasteroris, Mountwilson, Rathgreedan, Rathmore, Roosk, Shean and Thornwell (Co. Offaly) (hereinafter referred to as the 'Site' or 'Proposed Development Site').

The purpose of the proposed GNI 143 Ballykilleen Pipeline to connect from the existing 750mm NB BGE77 pipeline (also known as Pipeline to the West (PTTW)) to the Edenderry Renewable Energy Complex. The Proposed Development is intended to facilitate the conversion of the existing Cushaling Peaker Plants within the Edenderry Renewable Energy Complex from their current single-fuel operation (liquid fuel, primarily hydrotreated vegetable oil (HVO)) to dual-fuel operation, with natural gas as the primary fuel and HVO retained as backup.

This FRA is prepared in support of 2 no. individual applications being made (1) to Commission for Regulation of Utilities (CRU) under Section 39A[1] of the Gas Act 1976, as amended, and (2) An Coimisiún Pleanála (ACP) as a Strategic Infrastructure Development (SID) application under Section 182C(1) the Planning and Development Act 2000, as amended.

The Flood Risk Assessment adopts a reasonable worst-case approach (based on the 1% AEP and 0.1% AEP flood extents). The route of the GNI-143 Ballykilleen Pipeline is provided in Figure 1-1. This ensures that flood risk has been appropriately identified and assessed, and that the conclusions of the FRA remain robust for all potential final pipeline alignments within the corridor.

The pipeline route includes 2 River Crossings (RVX), the Kilwarden and Yellow River and 30 watercourses (WCX) (including Grand Canal).

The proposed development is provided in Figure 1-1.

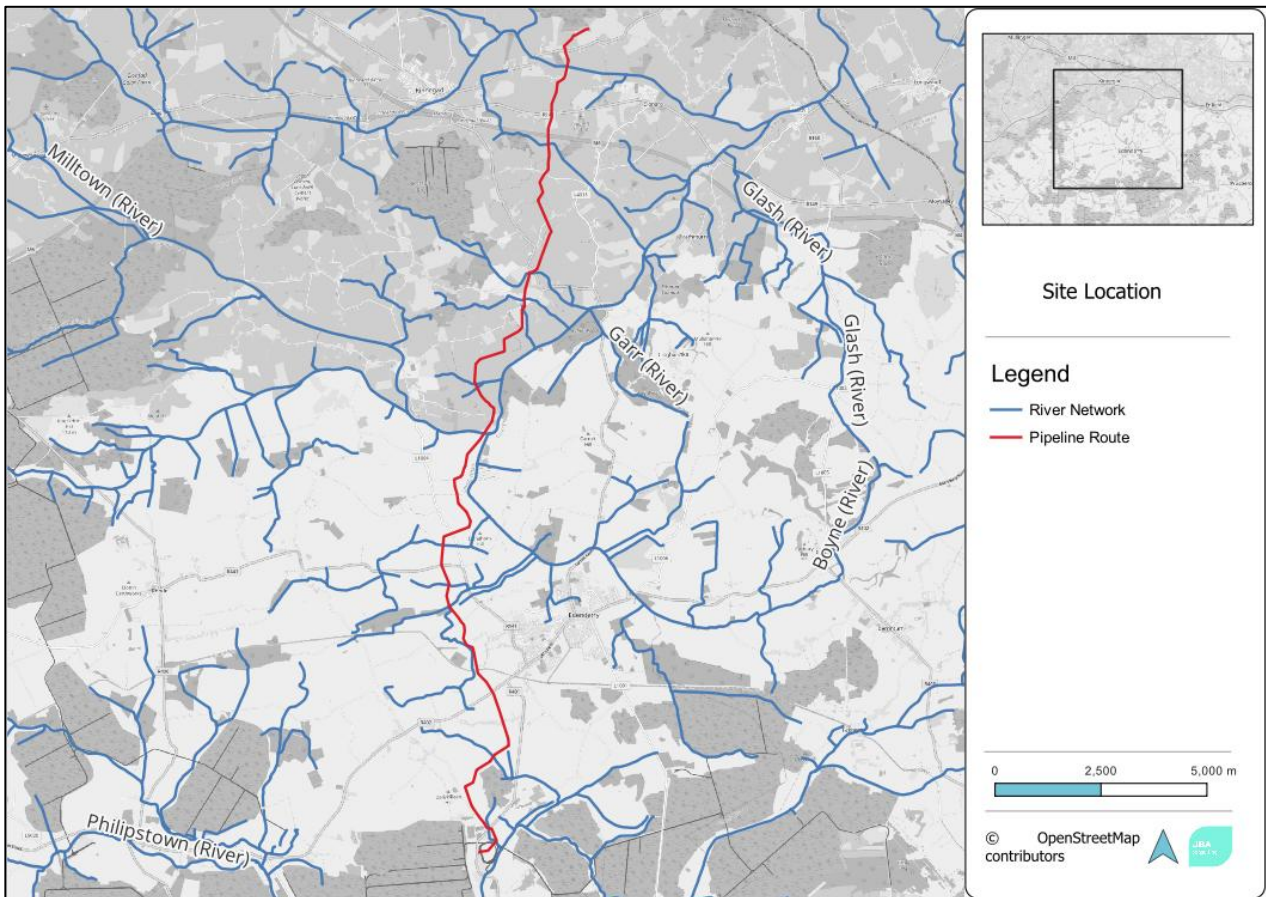


Figure 1-1: Proposed Development

1.5 Report Overview

The report is structured as follows:

- **Section 2** describes the site context, including the location of the Proposed Development, local topography, underlying geology and soils, and the surrounding hydrological environment.
- **Section 3** identifies potential sources of flood risk affecting the Proposed Development, drawing on historical flood records and available predictive flood mapping datasets.
- **Section 4** presents the hydraulic modelling undertaken to define flood extents and flood levels for relevant watercourses and to inform the assessment of flood risk under present-day and future climate scenarios.
- **Section 5** assesses flood risk to the Proposed Development, outlines mitigation measures incorporated into the design and construction methodology, and considers residual flood risk.
- **Section 6** applies the Development Management Justification Test, where relevant, in accordance with the Planning Guidelines.
- **Section 7** provides the overall conclusions of the Flood Risk Assessment.

1.6 Methodology

This assessment is a desktop study undertaken according to the Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009).

A full list of resources or sources of data used to complete this desktop study are listed below:

- OPW Flood Maps - floodmaps.ie
 - Eastern CFRAM Study
- Geological Survey Ireland - gsi.ie
- EPA Maps - epa.ie
- EPA LEAP portal - leap.epa.ie
 - Groundwater/Surface Water Historic Flooding
- Teagasc - gis.teagasc.ie
- Government of Ireland - gov.ie
 - Project Ireland 2040
 - National Planning Framework
 - National Development Plan
 - County Development Plan
- Regional and Spatial Economic Strategy - emra.ie

- [Google Earth - earth.google.com](http://earth.google.com)
- [GSI Open Topographic Data Viewer](#)

2 Site Background

2.1 Location

The proposed linear pipeline development traverses 23.65km, starting near Clonard, Co. Meath and terminating south of Edenderry, Co. Offaly.

Refer to Figure 2-1 for the hydrological environment.

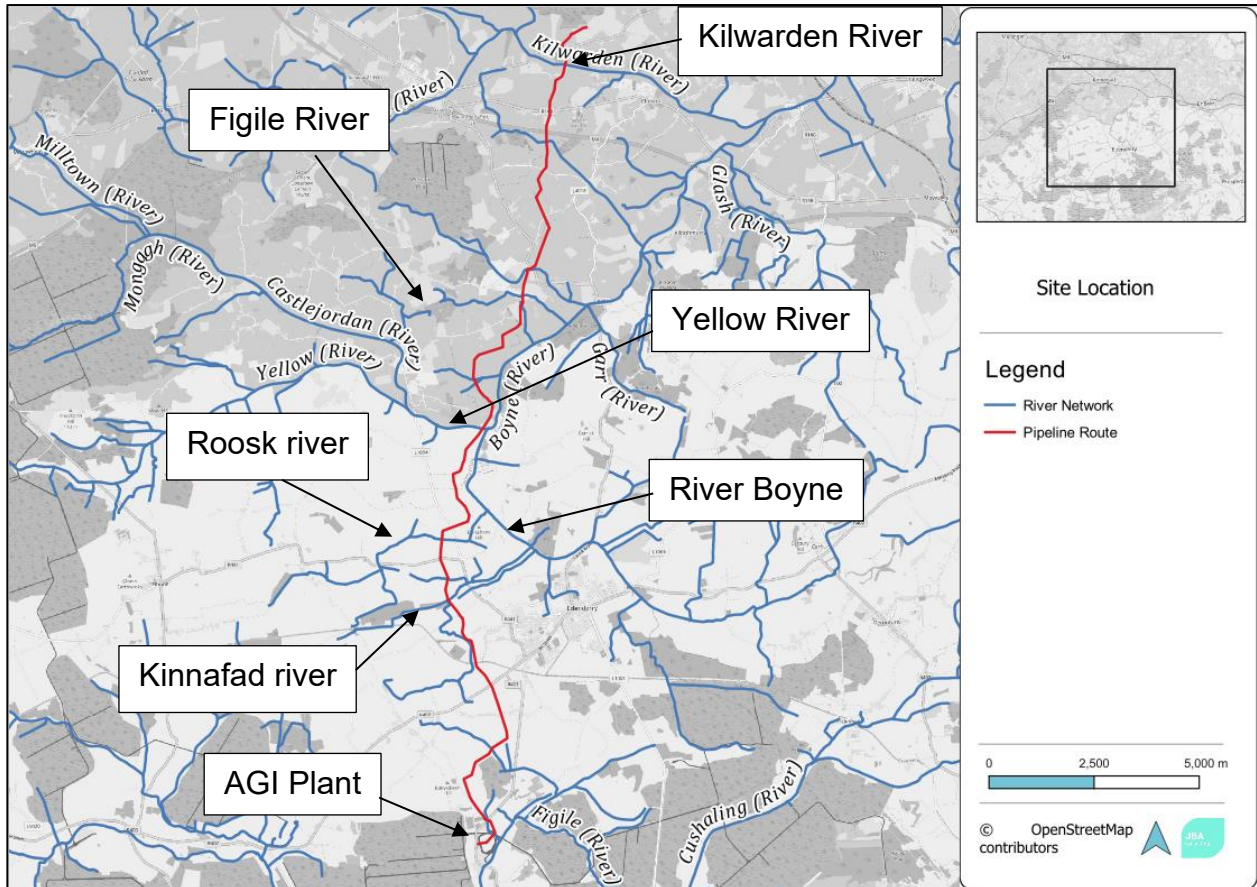


Figure 2-1: Site Location & section of development assessed in this report.

2.2 Watercourses

The main river system in the area has been identified as the Boyne River. A number of tributaries of the Boyne River crosses the gas pipeline throughout its length. Of note is the Figle River, Kilwarden River and Yellow River which as highlighted in Figure 2-1. To small tributaries of the River Boyne, the Roosk and Kinnafad rivers have also been identified.

2.3 Topography

The ground elevation of the area in the vicinity of the River Boyne can be seen in Figure 2-2. Ground elevation across the site ranges from approximately 65-71mOD. The prevailing fall is to the northeast towards the Boyne River. Localised areas fall towards the tributary of the River Boyne.

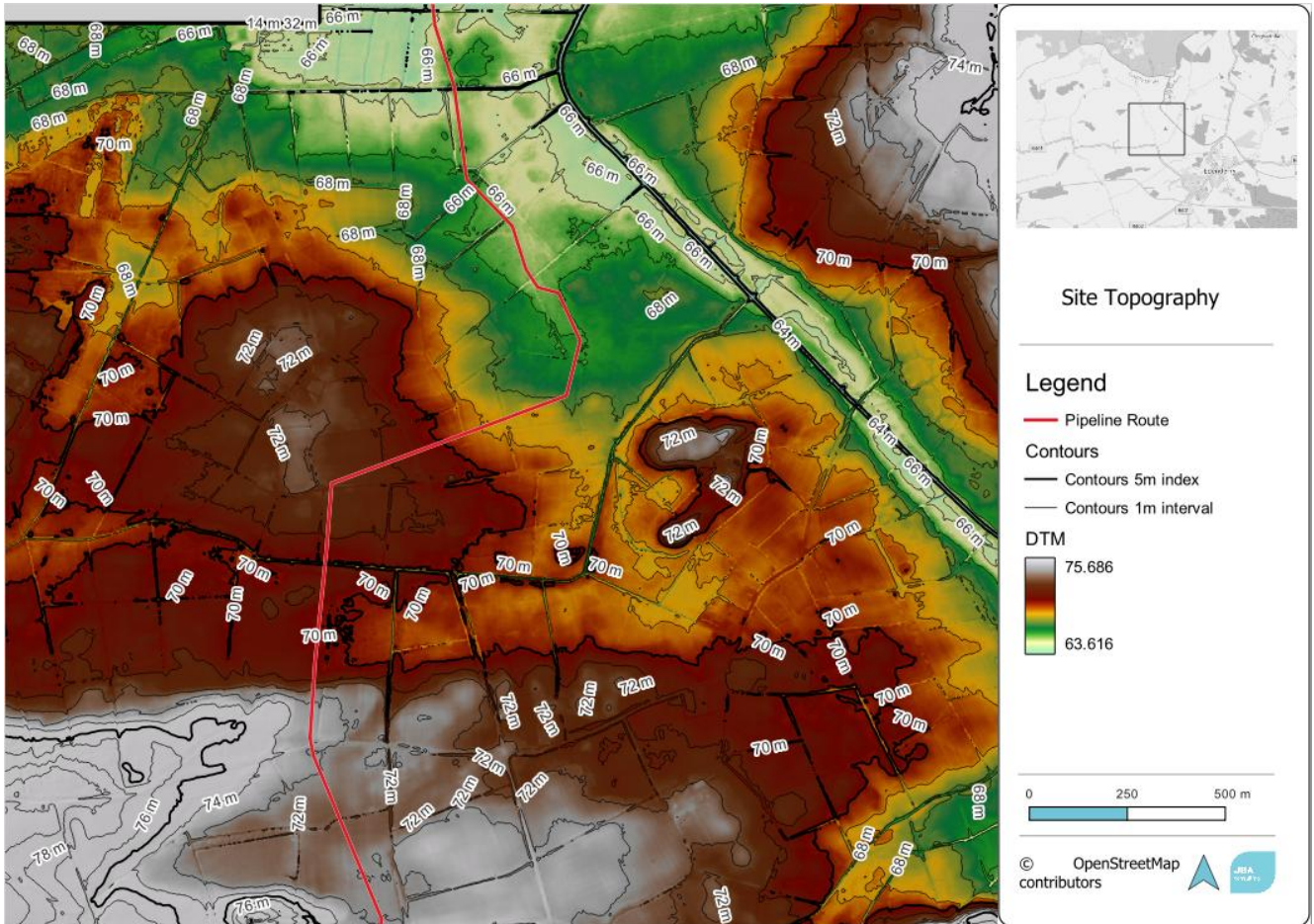


Figure 2-2: Site Topography

2.4 Site soils and geology

The groundwater and geological maps of the site, provided by the Geological Survey of Ireland (GSI), have been studied. The underlying bedrock has been identified as Edenderry Oolite Member and is described as Oolitic Limestone. The subsoil across the site is varied but primarily identified as Till, but the gas pipeline also crosses GLS and Alluvium type subsoils, refer to Figure 2-3.

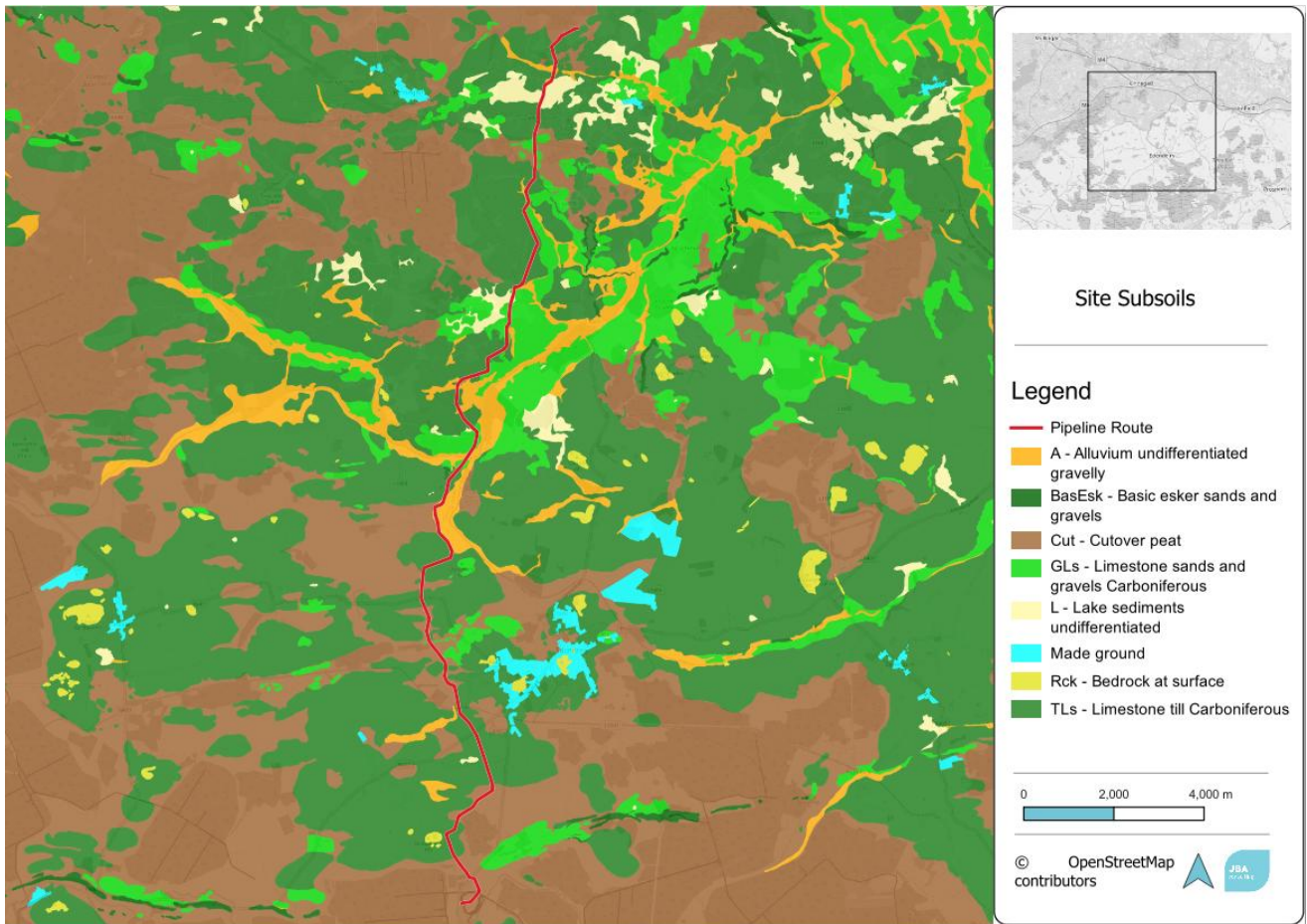


Figure 2-3: Site Subsoils

The site is underlain by the Edenderry Oolite Member which is classified as a locally important aquifer.

3 Flood Risk Identification- Stage 2

An assessment of the potential for and scale of flood risk at the site is conducted using historical and predictive information. This identifies any sources of potential flood risk to the site and reviews historical flood information. The findings from the flood risk identification stage of the assessment are provided in the following sections. Further detail on the Planning Guidelines and technical concepts is provided in Appendix A.

Due to the scale of the development and number of watercourses, a Stage 2 FRA has been conducted within this section or the FRA process.

3.1 Flood History

A number of sources of flood information have been reviewed to establish any recorded flood history at, or near the site. This includes the OPW's national flood information portal, www.floodinfo.ie, and general internet searches.

3.1.1 Floodinfo.ie

The OPW have established a National Flood Risk Hazard Mapping website, www.floodinfo.ie, which highlights areas at flood risk through the collection of recorded data and observed flood events. The website provides significant national data that there are multiple reports of flooding within the area, however, the site is unaffected by these flood events. The flooding that occurred in 2023 is not part of the online dataset at present. The closest event to the site is:

- Flood ID-1296 - Boyne Boyne Bridge, Edenderry Recurring
- Flood ID-13853 - Flooding at Edenderry & Environs

Refer to Figure 3-1 overpage.

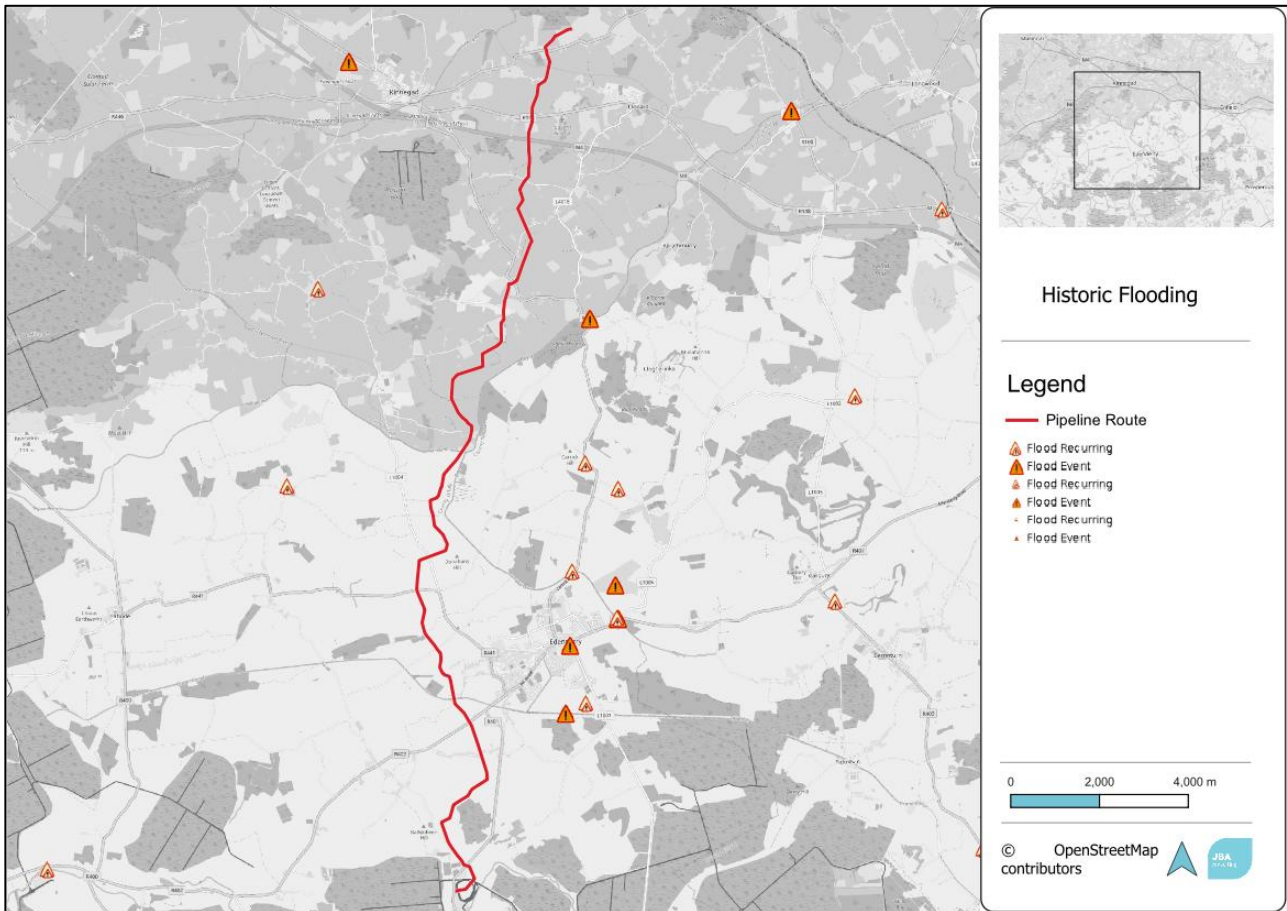


Figure 3-1: Past Flood Events

3.1.2 Internet Searches/ Anecdotal Evidence

An internet search was conducted to gather information about whether the site had previously been affected by flooding, and no reports of flooding were found at the site or in the vicinity.

3.2 Predictive Flood Mapping

The wider area has been subject to predictive flood mapping or modelling studies and other related studies and plans.

- Catchment Flood Risk Assessment and Management (ECFRAM) Study

3.2.1 Eastern CFRAM Study

The primary source of data with which to identify flood risk to the site is the Catchment Flood Risk Assessment and Management Study (CFRAM) for the Shannon River Basin District (RBD). The CFRAM commenced in 2011 and was finalised in 2016. The study involves detailed hydraulic modelling of rivers and their tributaries. It is noted that not all watercourses

have been modelled under the CFRAM study. Modelling has been restricted to larger watercourse such as the River Boyne that flows through an urban centre such as Edenderry. Finalised flood maps for the 10%, 1% and 0.1% AEP flood events for the present day and climate change scenarios are publicly available through the CFRAM Study website and floodinfo.ie. The CFRAM study is the most detailed flood mapping study to be carried out in the area.

Figure 3-2 displays an extract from the CFRAM fluvial flood extents for the River Boyne, while a close up is provided in Figure 3-3 where the proposed development is adjacent to the flood extents. The remaining watercourses such as the Kilwarden River and other tributaries of the River Boyne have not been included in the CFRAM study.

The associated climate change map is provided in Figure 3-4.

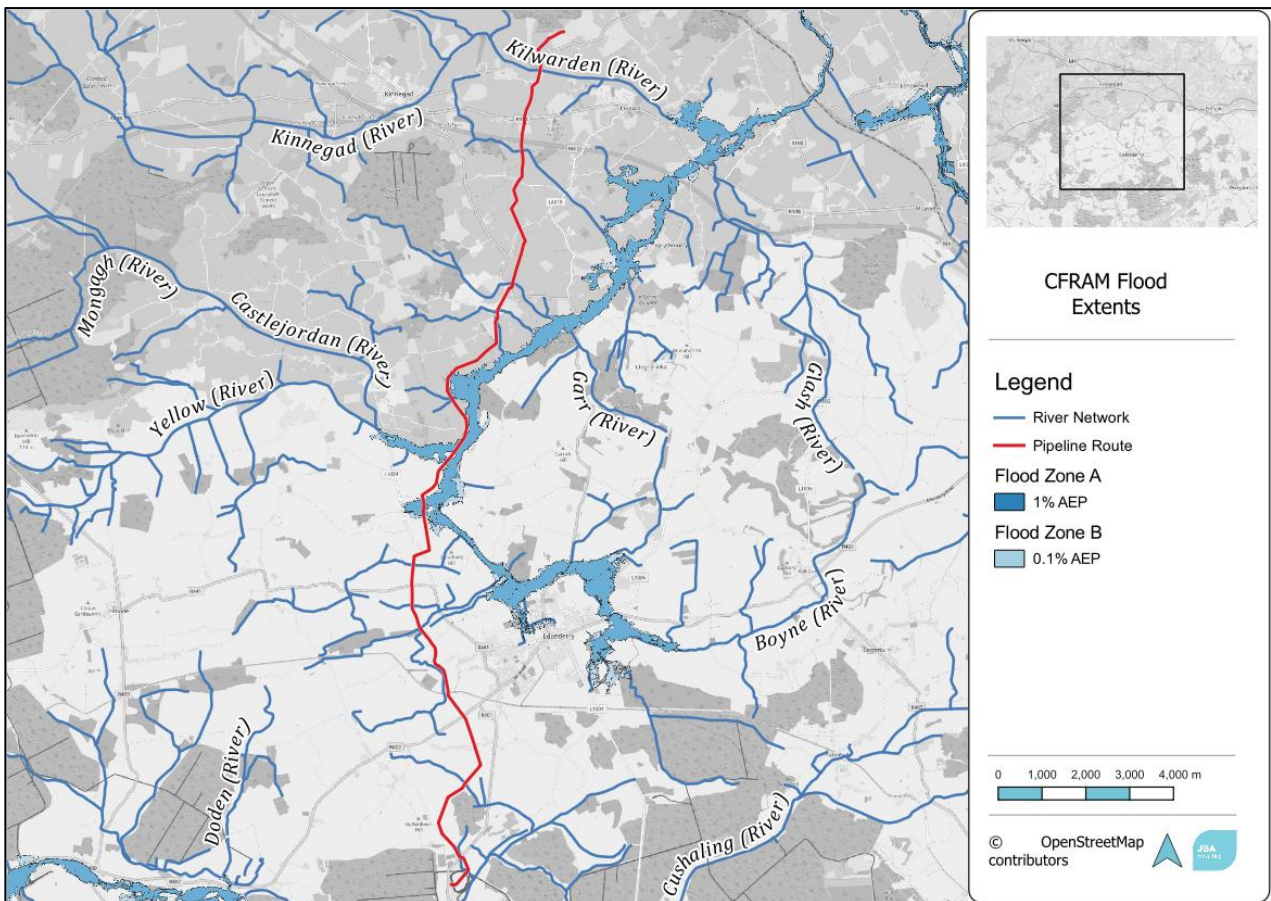


Figure 3-2: CFRAM Fluvial Flood Extent Map

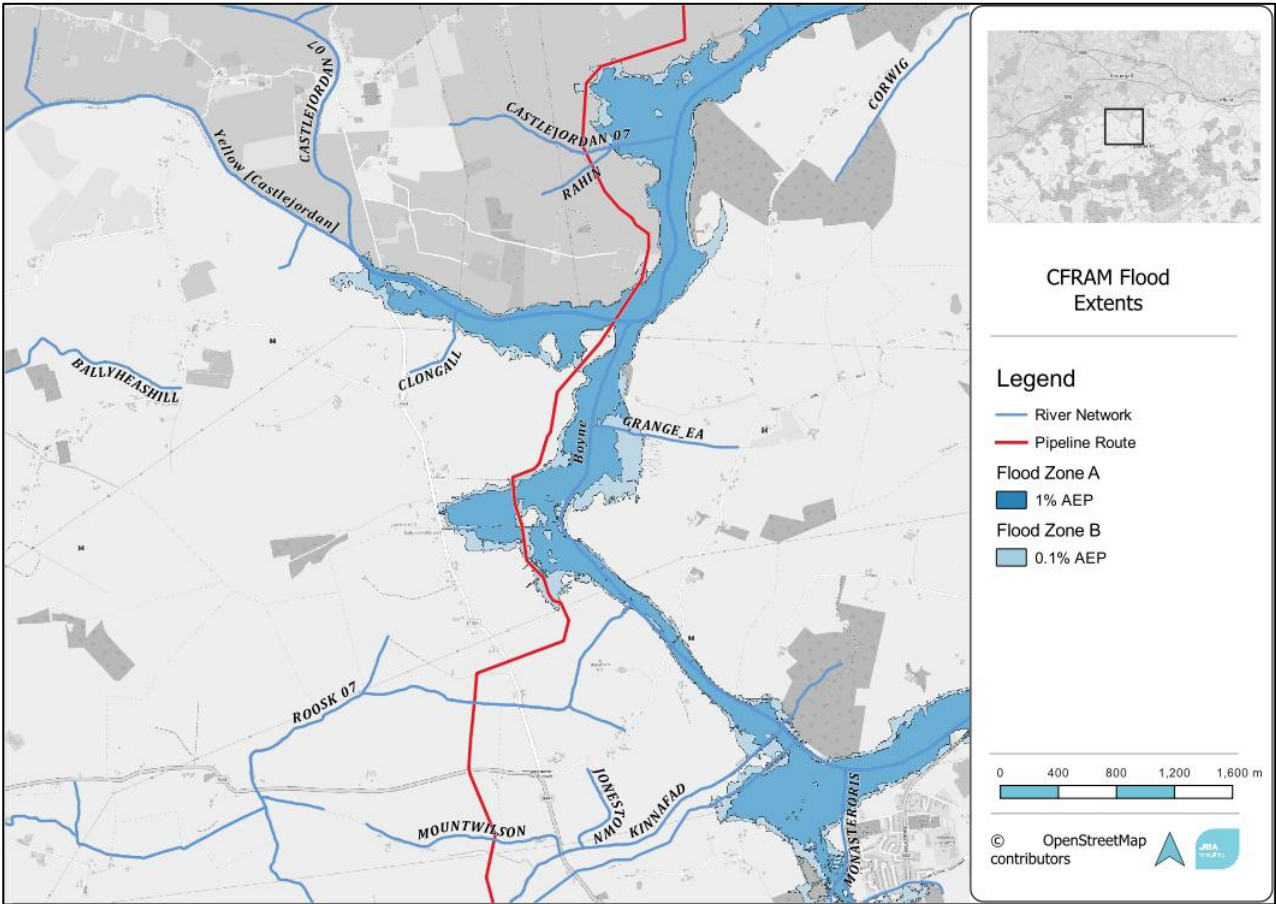


Figure 3-3: CFRAM Fluvial Flood Extent Map 2

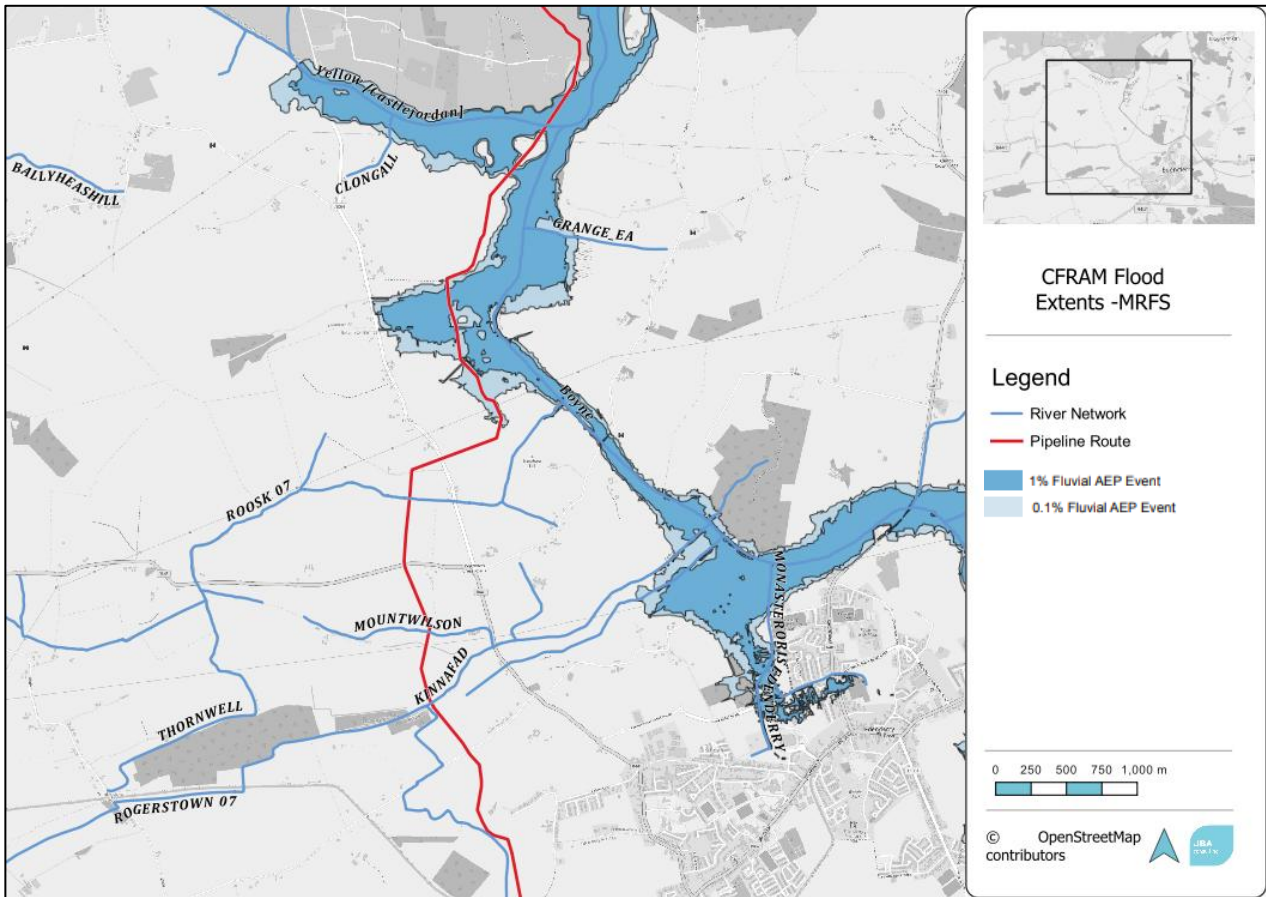


Figure 3-4: CFRAM 1% and 0.1% AEP flood extents for the Medium Range Future Scenario (MRFS)

3.2.2 National Indicative Fluvial Mapping (NIFM) study

The OPW hosts the National Indicative Fluvial Mapping (NIFM) study on the floodinfo.ie portal. This fluvial mapping shows the modelled extent of lands than might be flooded by rivers during a theoretical flood event with an estimated probability of occurrence for watercourses not covered by the CFRAM AFAs.

The NIFM study is based on a 2D only topographic model where the estimated peak flood flows are applied directly to the LIDAR. The study is indicative only and does actively model the river network and associated structures. The study is limited to catchments greater than 5km² and that have not been incorporated into the CFRAM study.

Within the study area the Kilwarden River, River Boyne Tributaries and the Figile River have been covered by the NIFM study.

The 1% and 0.1% AEP fluvial flood extents for the site are presented in Figure 3-5, and specific areas in proximity to the pipeline are presented in Figure 3-7, Figure 3-8 and Figure 3-9. Based on the NIFM Study, overtopping of the tributaries of the River Boyne, Kilwarden River and Figile River occurs along certain areas of the proposed gas pipeline route.

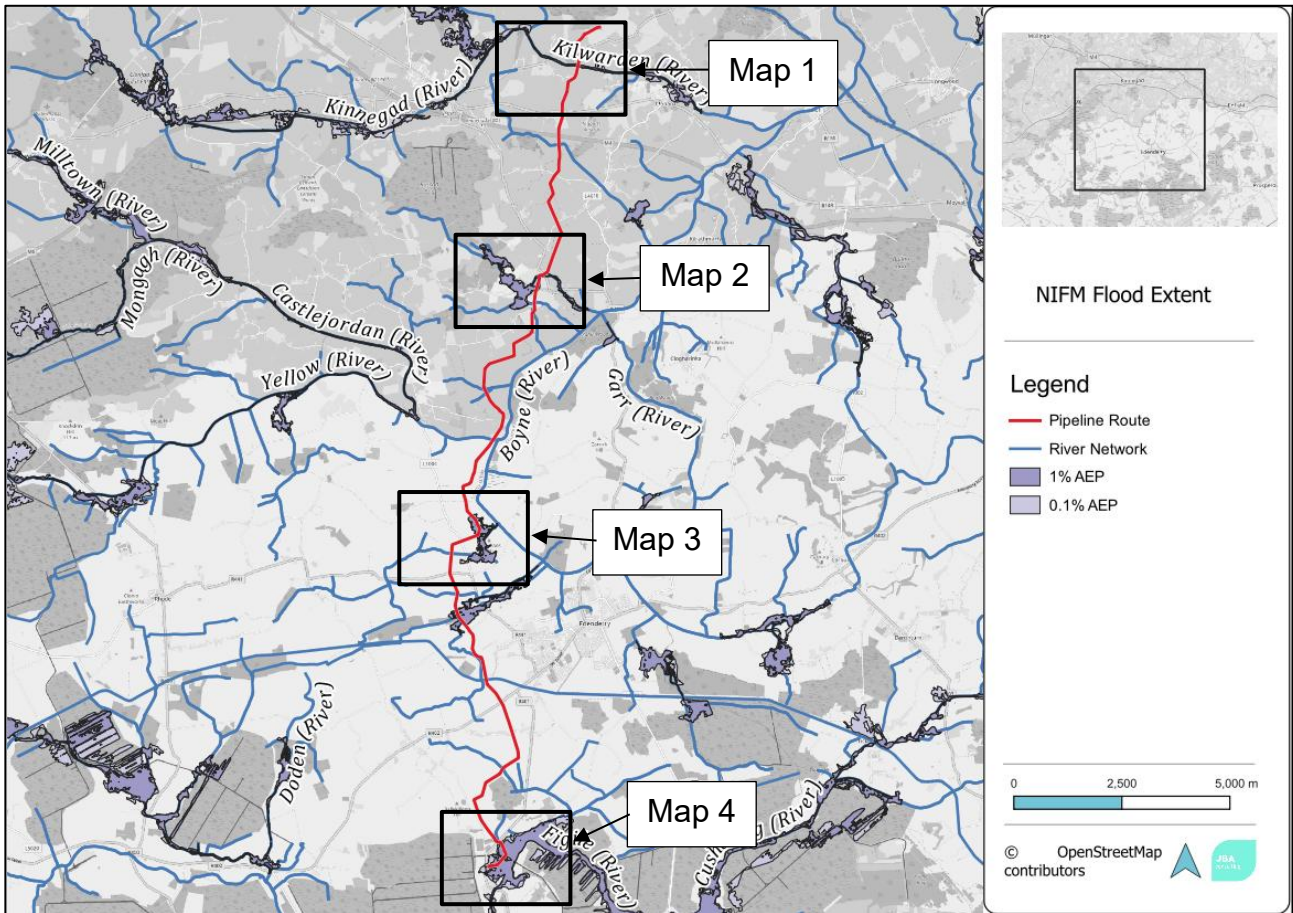


Figure 3-5: NIFM Flood Extent Map



Figure 3-6: NIFM Flood Extent Map 1- Kilwarden River

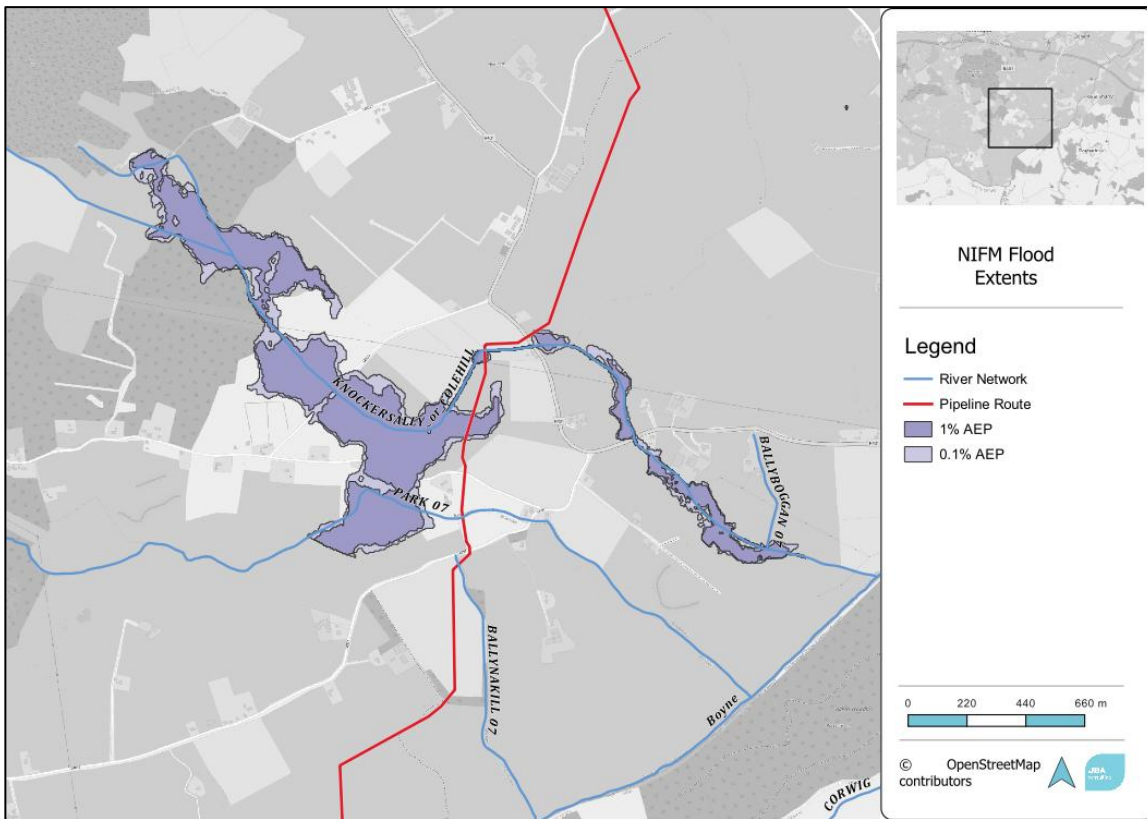


Figure 3-7: NIFM Flood Extent Map 2

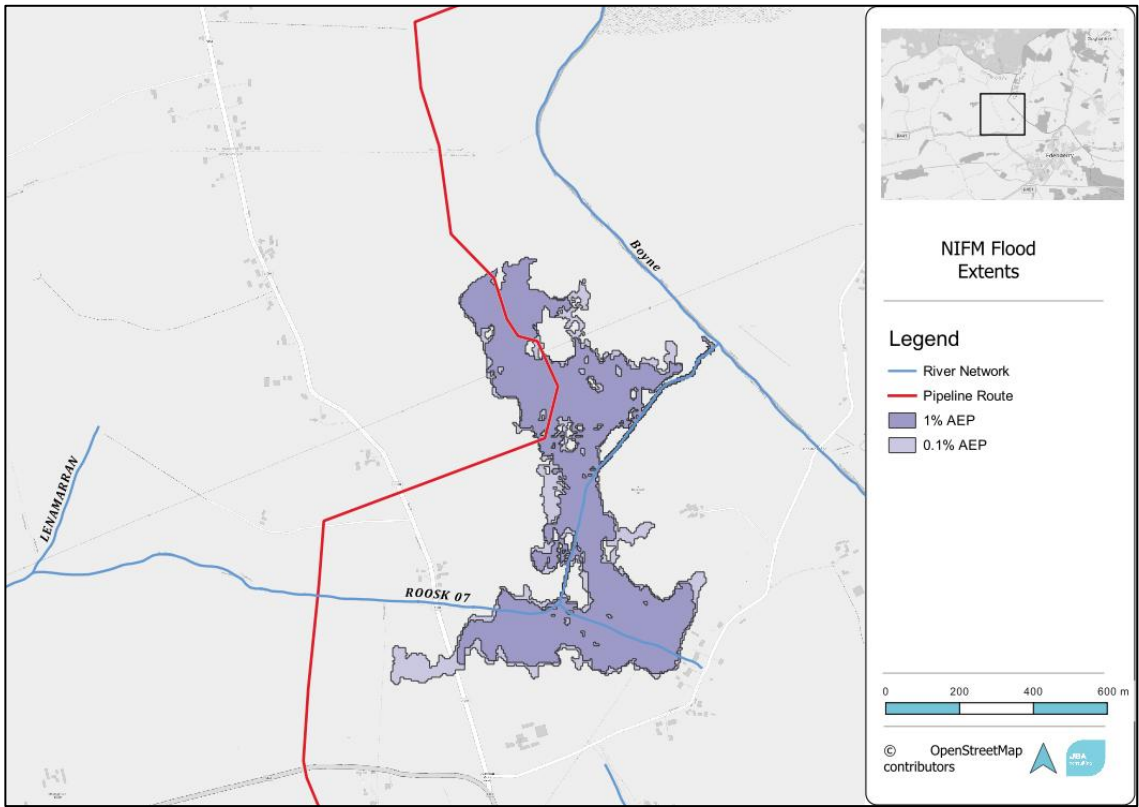


Figure 3-8: NIFM Flood Extent Map 3 – Roosk river

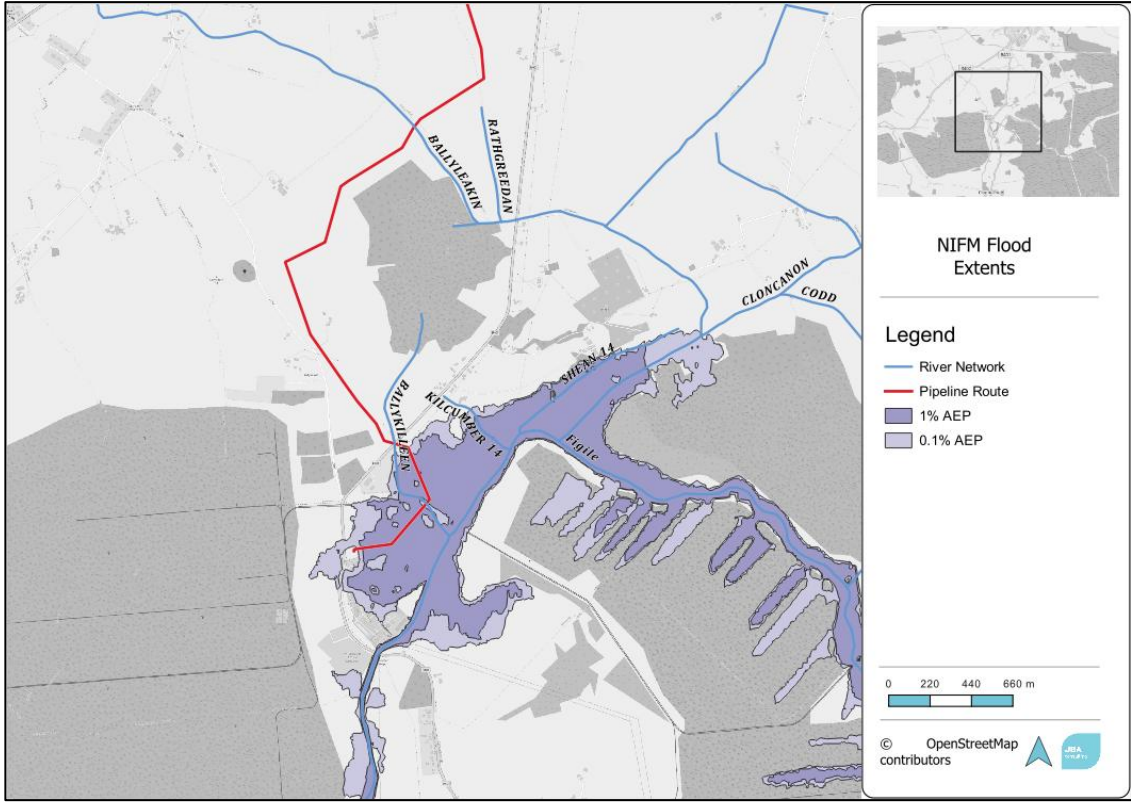


Figure 3-9: NIFM Flood Extent Map 4- Figile River

3.2.3 Historic Groundwater Flooding

The site and surrounding areas were assessed for prior groundwater flooding through the GSI map viewer. From a review of Figure 3-10, it is noted that there is a concentration of historic groundwater flooding located near the centre of the pipeline at the junction between the Yellow River and the River Boyne.

A close up of this area is provided in Figure 3-11. Within Figure 3-11, the areas at risk appear to be low-lying areas located within the River Boyne & Yellow River flood plain.

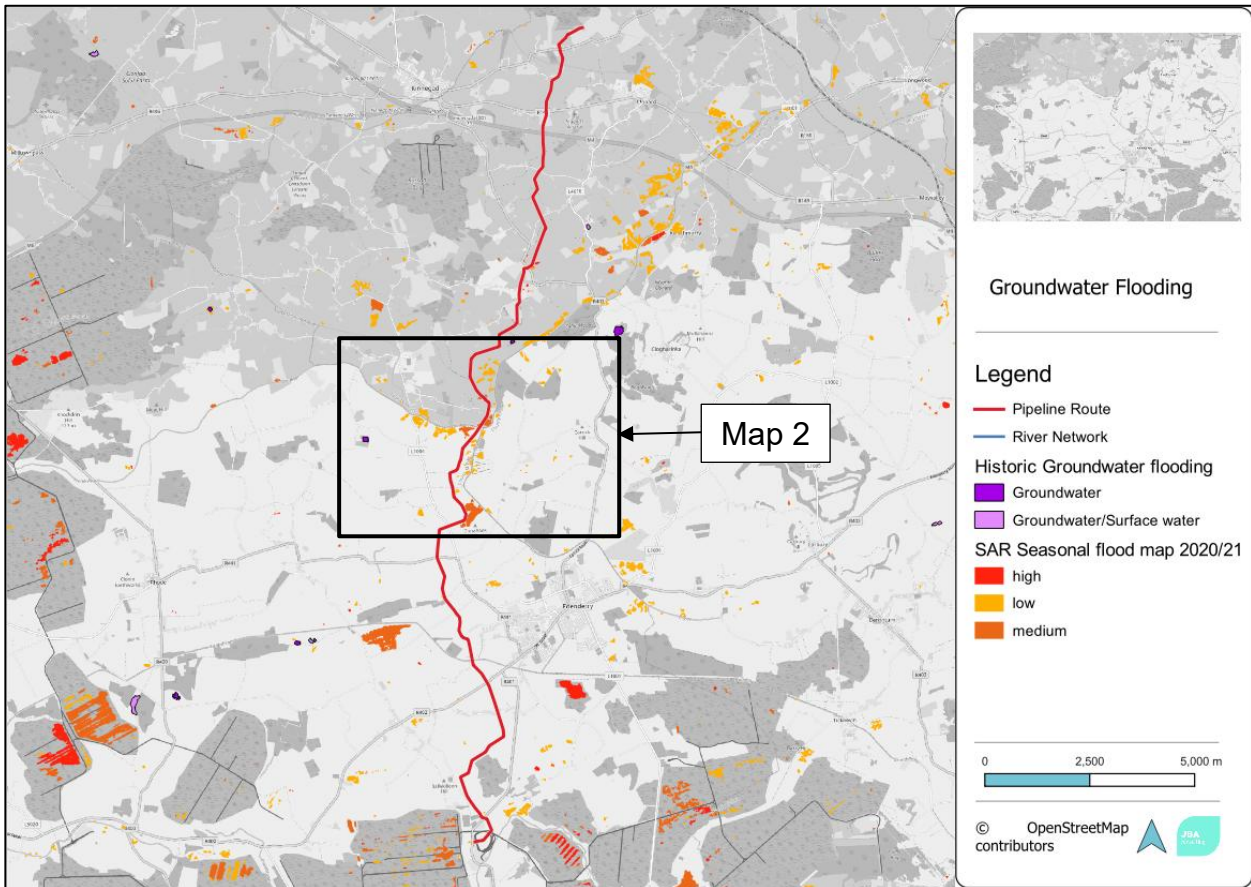


Figure 3-10: Historic Groundwater Flooding - Map 1

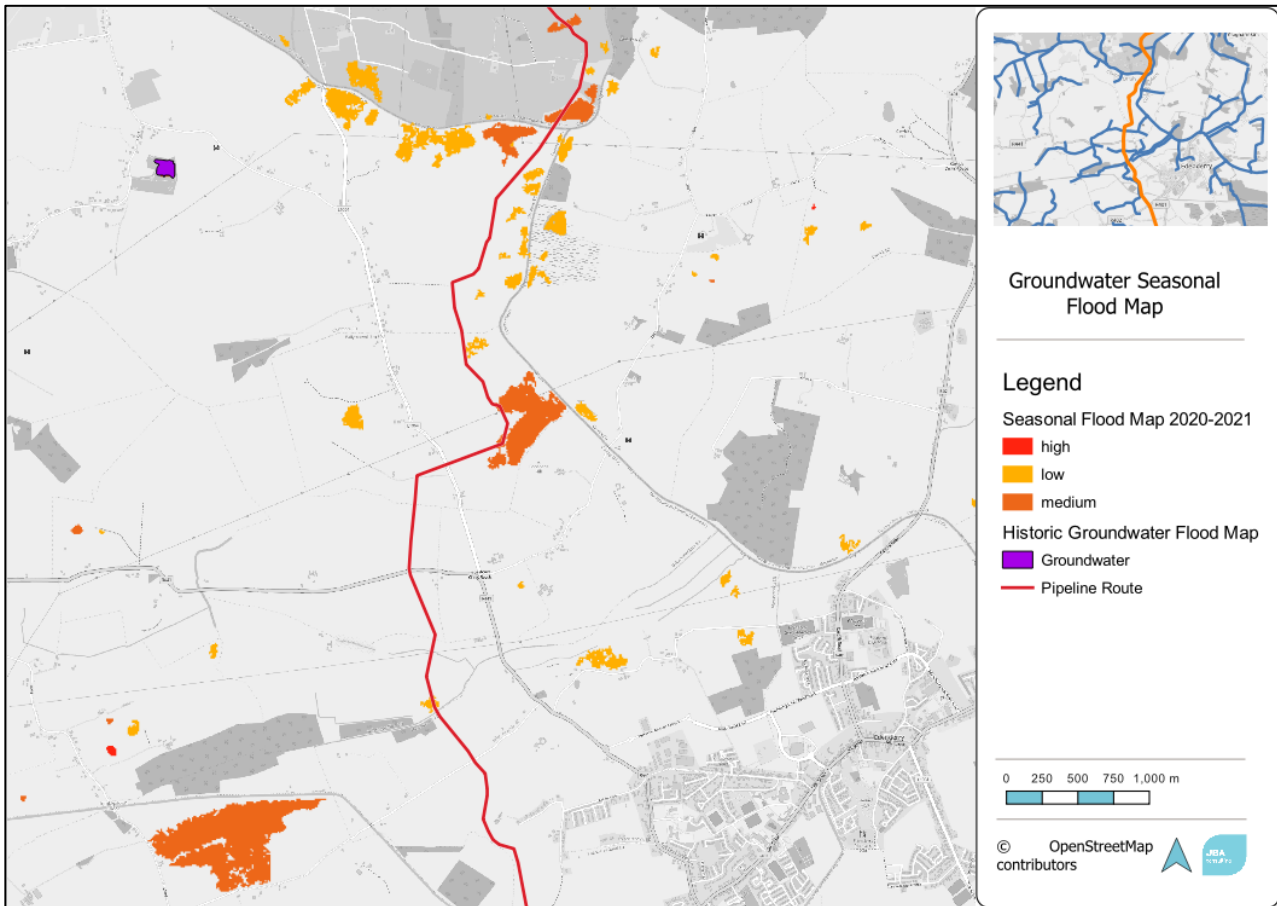


Figure 3-11: Historic Groundwater Flooding - Map 2

3.2.4 Offaly County Development Plan 2021 - 2027

The Offaly CDP outlines several objectives that were considered in this report in relation to the proposed development:

- ITC 7.51: Have regard to the EU Flood Risk Directive, the Flood Risk Regulations (S.I. No. 122 of 2010) and the Guidelines for Planning Authorities on the Planning System and Flood Risk Management and Circular PL2/2014, through the use of the sequential approach and application of the Justification Tests in Development Management.
- ITC 7.52: Ensure that a flood risk assessment is carried out for development proposals impacting on flood risk areas, in accordance with the Guidelines for Planning Authorities on the Planning System and Flood Risk Management. This assessment shall be appropriate to the scale and nature of risk to the potential development.
- ITC 7.54: Ensure that where flood risk management works take place that the natural and cultural heritage, rivers, streams and watercourses are protected and enhanced.
- ITC 7.55: Support the implementation of recommendations in the CFRAM Programme to ensure that flood risk management policies and infrastructure are progressively implemented.

- ITC 7.56: Ensure each flood risk management activity is examined to determine actions required to embed and provide for effective climate change adaptation as set out in the OPW Climate Change Sectoral Adaptation Plan for Flood Risk Management applicable at the time.

It is noted that the site area is not specifically covered within the Offaly County Development Plan SFRA report, but the River Boyne is examined within the county flood maps. The flood maps are based on the CFRAM study and therefore does not provide additional information to that provided in Section 3.2.1.

3.2.5 Edenderry Local Area Plan 2023-2029

This Edenderry Local Area Plan (LAP) 2023-2029 has been prepared as the key strategic planning document, which will guide the overall development of the town in the period to 2029. The LAP sets out an overall strategy for the proper planning and sustainable development of Edenderry in the context of Project Ireland 2040, the National Planning Framework, the Regional Spatial and Economic Strategy for the Eastern and Midland Region and the Offaly County Development Plan (CDP)

The Edenderry LAP 2023-2029 has been prepared in accordance with the requirements and provisions of the Planning and Development Act 2000 (as amended).

A Strategic Flood Risk Assessment (SFRA) has been prepared as part of the Edenderry LAP. The SFRA has been based on publicly available data (CFRAM, historic flooding etc) that have been incorporated into the Offaly County Development Plan.

CAEP-53 It is Council policy to support, in co-operation with the OPW, the implementation of the EU Flood Risk Directive, the Flood Risk Regulations (S.I. No. 122 of 2010) and the 'The Planning System and Flood Risk Management Guidelines for Planning Authorities (2009) and Department Circular PI2/2014 or any updated / superseding version.

CAEP-54 It is Council policy to protect Flood Zone A and Flood Zone B from inappropriate development and direct developments/land uses into the appropriate Flood Zone in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities 2009 (or any superseding document) and the guidance contained in Development Management Standard DMS-106. Where a development/land use is proposed that is inappropriate within the Flood Zone, then the development proposal will need to be accompanied by a Development Management Justification Test and site specific Flood Risk Assessment in accordance with the criteria set out under with The Planning System and Flood Risk Management Guidelines for Planning Authorities 2009 and Circular PL2/2014 (as updated/superseded). In Flood Zone C, (See DMS-106 where the probability of flooding is low (less than 0.1%, Flood Zone C), site-specific Flood Risk Assessment may be required and the developer should satisfy themselves that the probability of flooding is appropriate to the development being proposed.

The County Plan SFRA datasets (including Benefitting Lands mapping), emerging CFRAMS mapping (including National Indicative Fluvial mapping), and the most up to date CFRAM

Programme climate scenario mapping should be consulted by prospective planning applicants and the planning authority in determining planning applications.

It is Council policy to require a Site-specific Flood Risk Assessment (FRA) for all planning applications in areas at risk of flooding (fluvial, pluvial or groundwater), even for developments deemed appropriate in principle to the particular Flood Zone. The detail of these site-specific FRAs will depend on the level of risk and scale of development. A detailed site-specific FRA should quantify the risks, the effects of selected mitigation and the management of any residual risks. The assessments shall consider and provide information on the implications of climate change with regard to flood risk in relevant locations. The 2009 OPW Draft Guidance on Assessment of Potential Future Scenarios for Flood Risk Manage

CAEP-56 It is Council policy to ensure that applications to existing developments in flood vulnerable zones provide details of structural and non-structural risk management measures to include, but not be limited to specifications of the following – floor levels, internal layout, flood resilient construction, flood resistant construction, emergency response planning, access and egress during flood events.

CAEP-57 It is Council policy to work with other bodies and organisations, as appropriate, to help protect critical infrastructure, including water and wastewater, within the county, from risk of flooding. Any potential future variations to the Plan shall consider, as appropriate any new and/or emerging data, including, when available, any relevant information contained in the CFRAMS Flood Risk Management Plans and as recommended in the SFRA for the Plan.

CAEP-58 It is Council policy to have regard to the findings and recommendations of the current Strategic Flood Risk Assessment prepared as part of the County Development Plan.

CAEP-59 It is Council policy to consult with the Office of Public Works (OPW) in relation to proposed developments in the vicinity of drainage channels and rivers for which the OPW are responsible, and the Council will retain a strip of 10 metres on either side of such channel where required, to facilitate access thereto.

CAEP-60 It is Council policy to consult, where necessary, with Inland Fisheries Ireland, the National Parks and Wildlife Service and other relevant agencies in the construction of flood alleviation measures in Offaly.

CAEP-61 It is Council policy to work with the OPW and other relevant Departments and agencies to implement the recommendations of the CFRAM programme to ensure that flood risk management policies and infrastructure are progressively implemented, and to also work with catchment-based Flood Planning Groups, (including where catchments go beyond the Council's administrative boundary) in the development and implementation of catchment-based strategies for the management of flood risk – including those relating to storage and conveyance.

CAEP-62 It is Council policy that where resources are available and subject to compliance with the Habitats and Birds Directives, the Council will contribute towards the improvement and / or restoration of the natural flood risk management functions of flood plains.

CAEP-63 It is Council policy to take account of and incorporate into local planning policy and decision making, including possible future variations to this plan, the recommendations of the Flood Risk Management Plans (FRMPs), including planned investment measures for managing and reducing flood risk.

3.2.6 Meath County Development Plan 2021 - 2027

The Meath CDP outlines several objectives that were considered in this report in relation to the proposed development:

- INF POL 18: To implement the “Planning System and Flood Risk Management – Guidelines for Planning Authorities” (DoEHLG/OPW, 2009) through the use of the sequential approach and application of Justification Tests for Development Management and Development Plans, during the period of this Plan.
- INF POL 19: To implement the findings and recommendations of the Strategic Flood Risk Assessment prepared in conjunction with the County Development Plan review, ensuring climate change is taken into account.
- NF OBJ 20: To implement the Planning System and Flood Risk Management- Guidelines for Planning Authorities (DoEHLG/OPW 2009) or any updated guidelines. A site-specific Flood Risk Assessment should be submitted where appropriate.
- INF POL 25: To have regard to the recommendations of the Fingal East Meath Flood Risk Assessment and Management Study (FEMFRAMS) and the Eastern Catchment Flood Risk Assessment and Management Study (CFRAMS).

3.3 Sources of Flooding

3.3.1 Fluvial

The principal source of flooding for the site is the River Boyne and a number of tributaries including the Figlie River, Yellow River and Kilwarden River based on the NIFM and CFRAM flood events.

It is note that the NIFRM study is indicative only and therefore to confirm the flood extents along proposed pipeline it is necessary to build a hydraulic model of the river system to inform the appropriate pipeline route. This is provided in Section 4 of the FRA report.

3.3.2 Coastal

As the site is located inland away from any coastline and this source of flooding has therefore been screened out of further assessment.

3.3.3 Pluvial

Pluvial flooding is the result of rainfall-generated overland flows that arise before run-off can enter a watercourse or sewer. Rainwater can pond and accumulate on hard surfaces if not properly managed.

Based on review of the site topography (Figure 2-2) there are no identified depressions within the site boundary that that would be susceptible to pluvial flooding or surface water ponding. There may however be some local areas prone to pluvial ponding in close proximity to the River Boyne that correspond to the groundwater flood risk areas highlighted in Figure 3-11.

3.3.4 Groundwater

Groundwater flooding results from high sub-surface water levels that impact upper levels of the soil strata and overland areas that are usually dry. Review of the gsi.ie web-portal confirms that there are no known karst features in the area. The GSI historic mapping does not identify any historic flooding in proximity to the gas pipeline, however historic groundwater inundation has been noted in the areas adjacent to the proposed pipeline.

Further investigation would be required to close off the flood risk in this area if it is proposed to modify the proposed route.

3.3.5 Summary

The Flood Risk Review undertaken in Section 3 has highlighted a number of areas along the proposed pipeline route that are at risk of fluvial flooding. The CFRAM study incorporates a detailed 1D/2D hydraulic that provides relatively accurate flood extents/mapping. The output from the CFRAM study is largely restricted to the River Boyne.

Further to the CFRAM study, the NIFM study provides indicative flood extents for watercourses in the area such as the Kilwarden River, Figile River etc. As the NIFM is indicative only (based on 2D model only) it is necessary to build a site specific 1D/2D model of the affected watercourses to confirm the flood risk to inform the appropriate mitigation measures. The River Boyne was also modelled to provide additional detail regarding flood extents and depths in the vicinity of the pipeline.

This progresses the report to a Stage 3 FRA to incorporate hydraulic modelling. The development of the hydraulic model is outlined in Section 4, that has been used to inform the appropriate mitigation measures in Section 5.

4 Flood Risk Assessment- Stage 3- Hydraulic Model

4.1 Flood Risk

As outlined in Section 3.2 and Section 3.3.5, the proposed gas pipeline crosses a number of tributaries of the Boyne River. As the NIFM is indicative of flood risk only it is necessary to confirm the flood extents along the River Boyne tributaries, Kilwarden River and Figile River a hydraulic model has been constructed. The hydraulic model will also enable the assessment of climate change. The construction and application of the hydraulic model used is discussed in this chapter.

Table 4-1 below provides an introduction to the main areas and river systems assessed along the gas pipeline route as part of the FRA. These areas included in Table 4-1 have been identified to be at risk of inundation from either the NIFM or CFRAM studies. All remaining watercourses have been considered not to present a significant flood risk to the pipeline due to the small size and relevant catchment areas. The risk can be appropriately managed by the mitigation measures provided in Section 5.2.

The detailed hydraulic model will confirm the flood extents and levels to the areas presented in Table 4-1

Table 4-1: Hydraulic Model Roadmap

Watercourse / Flood Source	Flood Mapping Basis	Flood Events Assessed	Section of Pipeline Affected	Nature of Pipeline Interaction
River Boyne and Yellow River	CFRAM fluvial flood mapping	1% AEP and 0.1% AEP (present day and climate change scenarios)	Chainage 10,000 to Chainage 14,000	Pipeline crosses Flood Zone A/B in proximity to the river channel; interaction assessed through detailed hydraulic modelling
River Boyne Tributaries (Roosk & Kinnafad)	National Indicative Fluvial Mapping (NIFM)	1% AEP and 0.1% AEP (present day and climate change scenarios)	Chainage 14,000 to Chainage 17,000	Pipeline crosses Flood Zone A/B in proximity to the river channel; interaction assessed

				through detailed hydraulic modelling
Kilwarden River	National Indicative Fluvial Mapping (NIFM)	1% AEP and 0.1% AEP (present day and climate change scenarios)	Chainage 1,000 to Chainage 2,000	Pipeline shown to reside in Flood Zone C. Proposed River crossing to be managed by CEMP, buffer to river channel
Figile River	National Indicative Fluvial Mapping (NIFM)	1% AEP and 0.1% AEP (present day and climate change scenarios)	Chainage 14,000 to Chainage 17,000	Pipeline and AGI plant are entirely located in Flood Zone C

4.2 Hydrology

A number of watercourses have been considered for the inflows at this site - the River Boyne, Figile River and three separate tributary watercourses, as either the gas pipeline runs adjacent to or passes through the NIFM and CFRAM flood extents.

Figure 4-1 illustrates the site location and the catchments of these watercourses. The characteristics of each catchment were derived from the FSU (Flood Studies Update) ungauged node database.

The QMED values for tributary Stream were calculated using the FSU Small Catchments, which has been modified for catchments under 25km². The FSU SC method was chosen as it is the most up to date method for hydrology estimation in Ireland. There were no appropriate pivotal sites. The growth curves were estimated from the FSU GLO curves. The hydrograph shapes were derived from the JFES standard FSR RR hydrographs.

For the River Boyne catchment, flows were generated using the FSU equation and one pivotal site (Duleek DS). Growth curves were estimated using the EV1 distribution. The hydrograph shapes were derived from the three most hydrologically similar catchments

The peak flow estimates for the two watercourses are presented in Table 4-3.

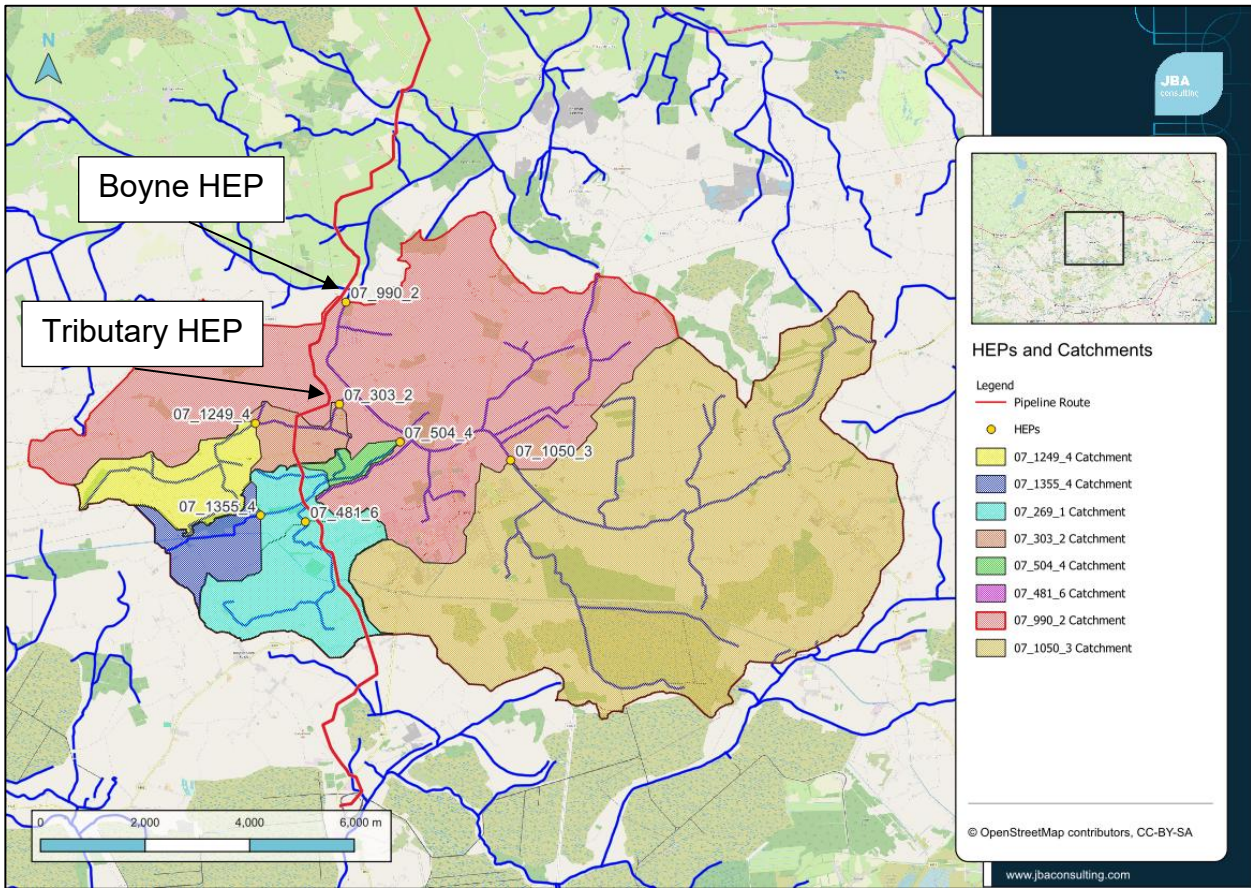


Figure 4-1: Watercourses and catchment areas

Table 4-2: Catchment descriptors

Descriptor	07_990_2 (Boyne)	07_303_2 (Tributary)
AREA	97.03	5.534
SAAR1991-20	836	904
FARL	1	1
BFI Soil	0.64	0.65
URBEXT (CORINE 2018)	0.086	0
MSL	16.247	6.559
S1085	2.28	2.66
DrainD	0.795	1.91
ArtDrain2	0.748	0.804

Table 4-3: FSU Peak flow estimates

Flood probability	07_303_2 (Boyne)	07_990_2 (Tributary)
50% AEP	1.09	12.03
1% AEP	2.27	25.13
0.1% AEP	2.42	35.12

4.3 Hydraulic Modelling

4.3.1 Hydraulic Model Set Up

To assess flood risk at the site, a 1D-2D ESTRY-TUFLOW hydraulic model was developed. This model facilitates the simulation of river channels, streams, floodplains, and hydraulic structures, providing predictions of water levels under various scenarios (see Figure 4-2 for the hydraulic model schematisation). The model was constructed in the following stages:

- **Model Creation:** A 1D-2D ESTRY-TUFLOW model of the River Boyne, Kilwarden River, Figile River, and Boyne tributary system, including the surrounding area and the proposed site, was developed using a Digital Terrain Model (DTM) and channel survey data.
- **River Survey-** Up to date survey works have been undertaken during 2025 to survey the modelled watercourses to ensure that they are accurately captured.
- **Structure Integration:** Existing hydraulic structures were incorporated into the model based on survey data and a baseline condition was established.
- **Baseline Simulations:** Hydraulic simulations were carried out for the baseline condition to determine the existing flood extents and delineate Flood Zones.
- **Residual Risk Assessment:** Additional scenarios were modelled to assess residual risks for the site, including the impacts of climate change and other residual risk scenarios.

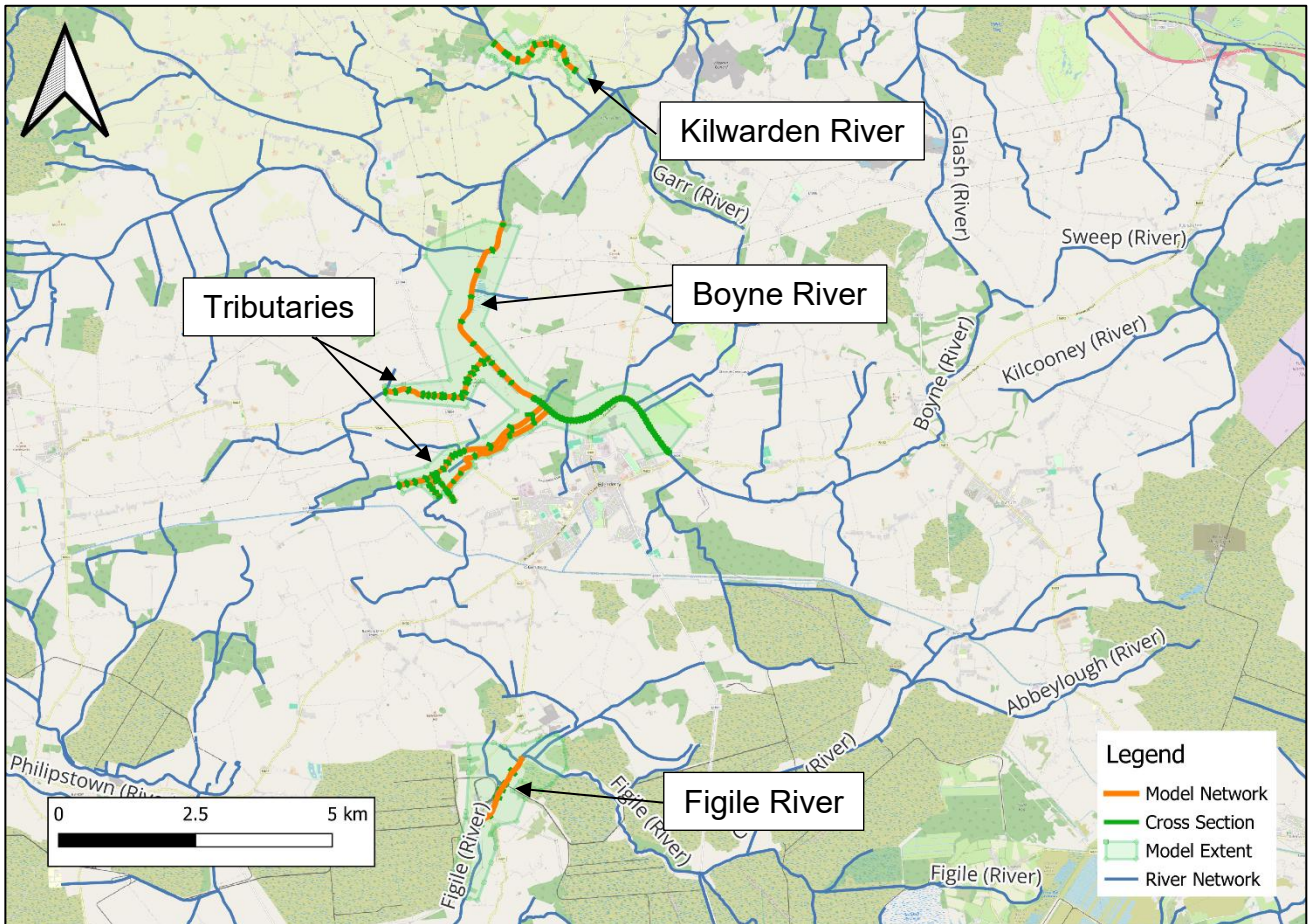


Figure 4-2: Model Schematisation

4.3.2 Model Results

The modelled flood extents are provided in Figure 4-3. The results confirm for the Kilwarden River, Figile River and the Roosk river the flood extents are considerably less than the indicative NIFM flood extents.

Regarding the River Boyne, the flood extents broadly similar to the predicative CFRAM flood extents.

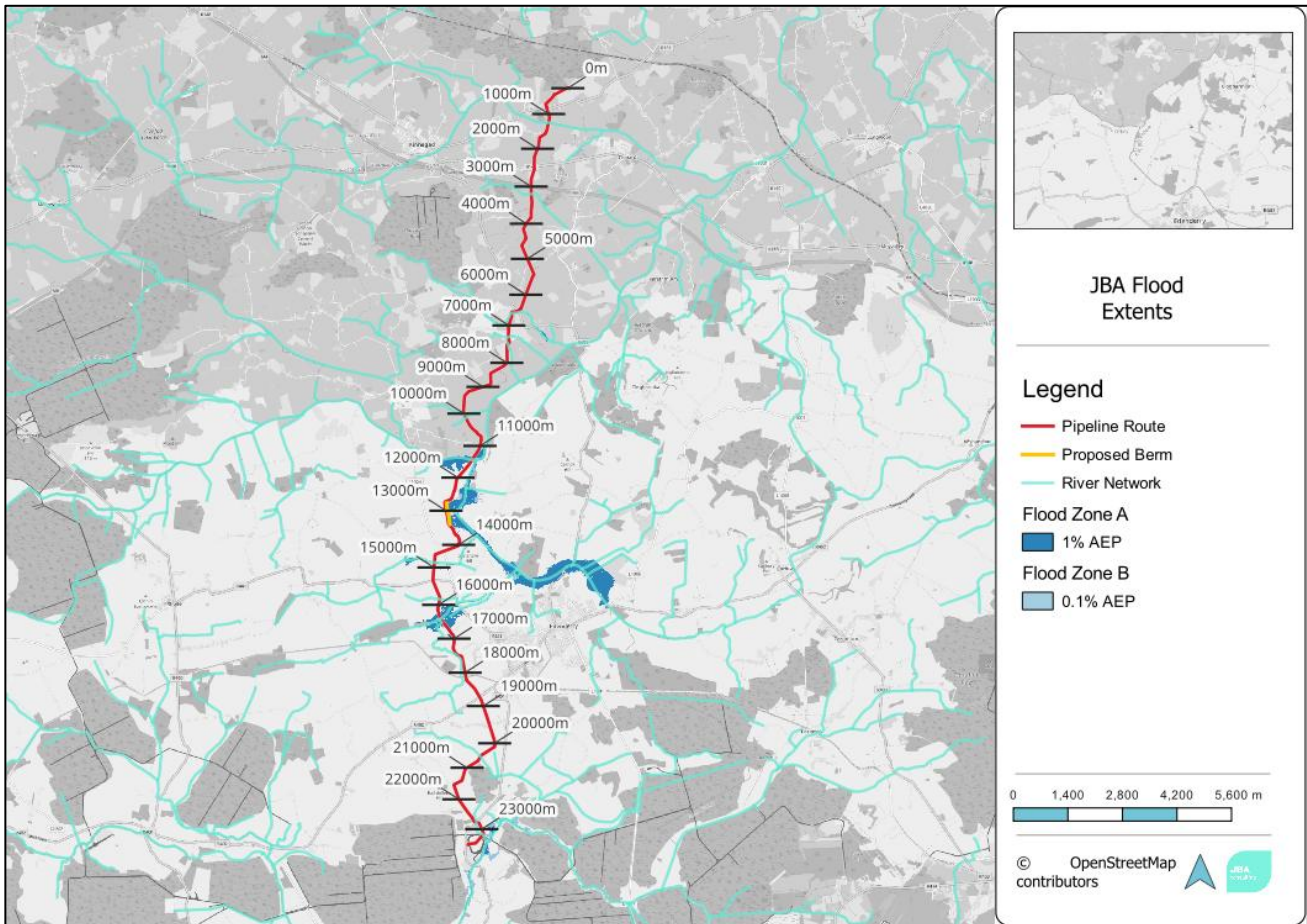


Figure 4-3: Flood Extents - GNI 143 Ballykilleen Pipeline

The flood extents for each individual area are covered in the following sections.

4.3.2.1 River Boyne Flood Extents

Figure 4-4 presents the modelled flood extents for the River Boyne and its associated tributaries for 1% AEP and 0.1% AEP events, corresponding to Flood Zones A and B, respectively. The results confirm inundation in the vicinity of the Yellow River and along the Boyne River between chainage 13,000m -14,000m

In this area (chainage 13,000-14,000m) the pipeline does cross Flood Zone A/B. During the construction phase, excavated topsoil will be temporarily stored in a linear mound along the works corridor. While its primary function is material storage, this mound will also serve as a berm, providing secondary protection by helping to limit the ingress of floodwaters into the excavated trench and construction area.

The resulting flood map with the berm in place is presented in Figure 5-1. The results confirm that there is no resulting increase in flood risk downstream of the site. It is noted that the berm will only be in place for the duration of the construction and all grounds will be returned to the existing profile.

Further to the south, the pipeline crosses the Roosk River (chainage 15,000m) however the hydraulic model confirms that the flood waters remain in bank up to the 0.1% AEP Flood event.

With reference to Figure 4-5, it is noted that the gas pipeline does cross Flood Zone A & B in localised areas between chainage 16,000m - 17,000m in close proximity to the stream identified as the Kinnafad River. Mitigation measures for the gas pipeline in this area are provided in 5.2.

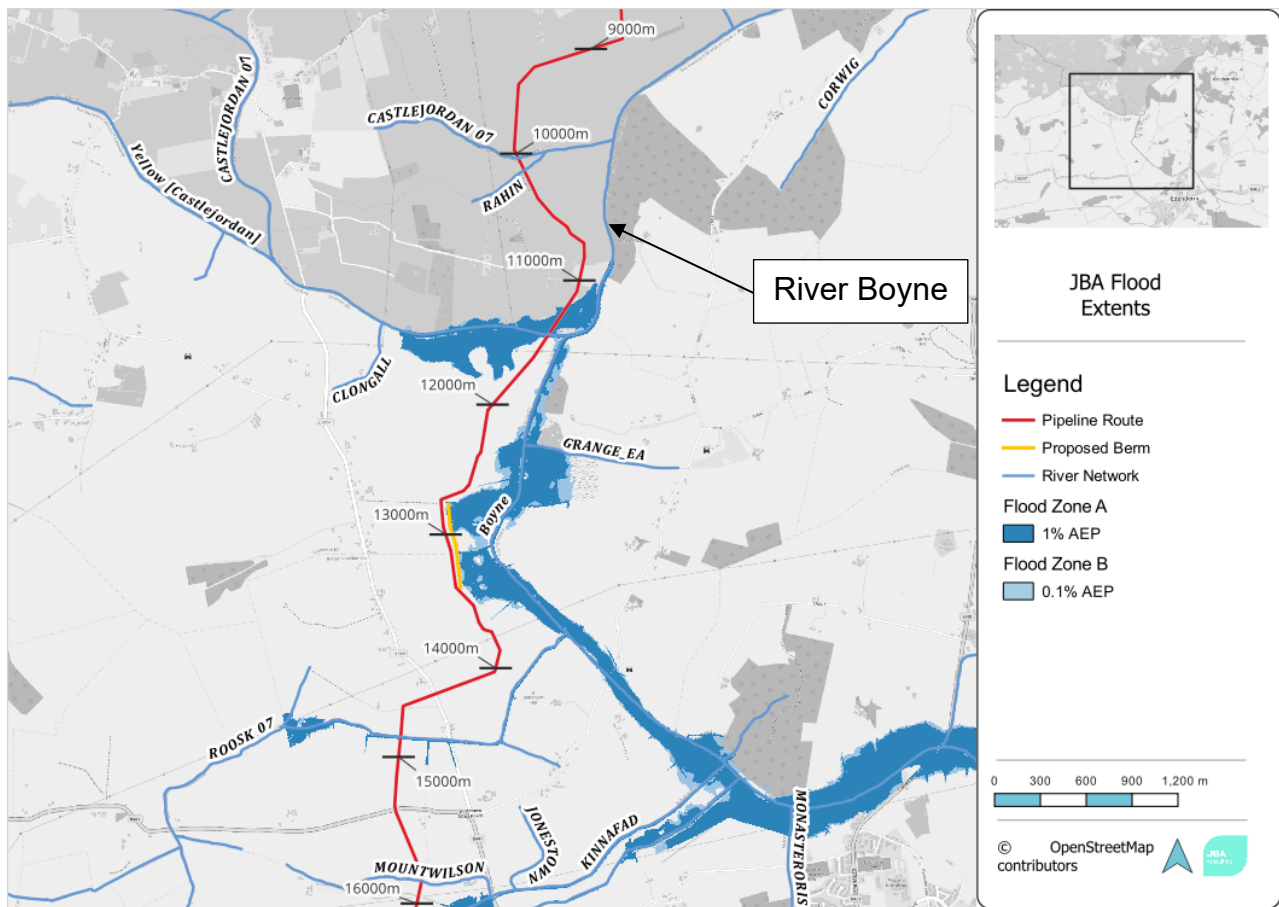


Figure 4-4: River Boyne Flood Zones - GNI 143 Ballykillen Pipeline

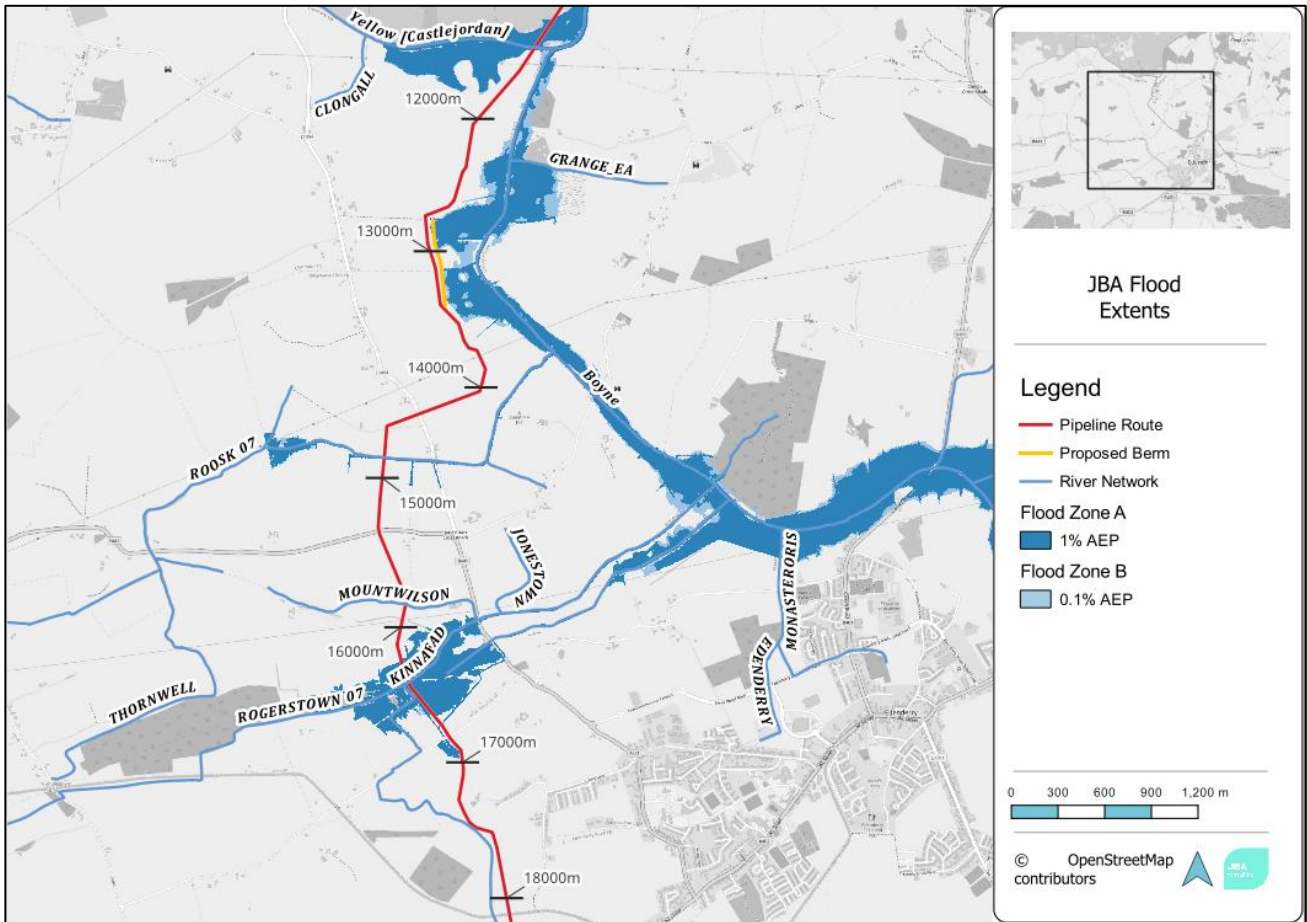


Figure 4-5: River Boyne Tributaries Flood Zones - GNI 143 Ballykilleen Pipeline

4.3.2.2 Model Results - GNI 143 Ballykilleen AGI Pipeline

Figure 4-6 presents the modelled flood extents for the 1% AEP and 0.1% AEP events, corresponding to Flood Zones A and B, respectively. The results indicate that there is limited overtopping of the Figile River in the vicinity of the proposed AGI plant.

The corresponding flood levels are provided in Table 4-4 overpage. The corresponding flood levels are presented in Table 4-4.

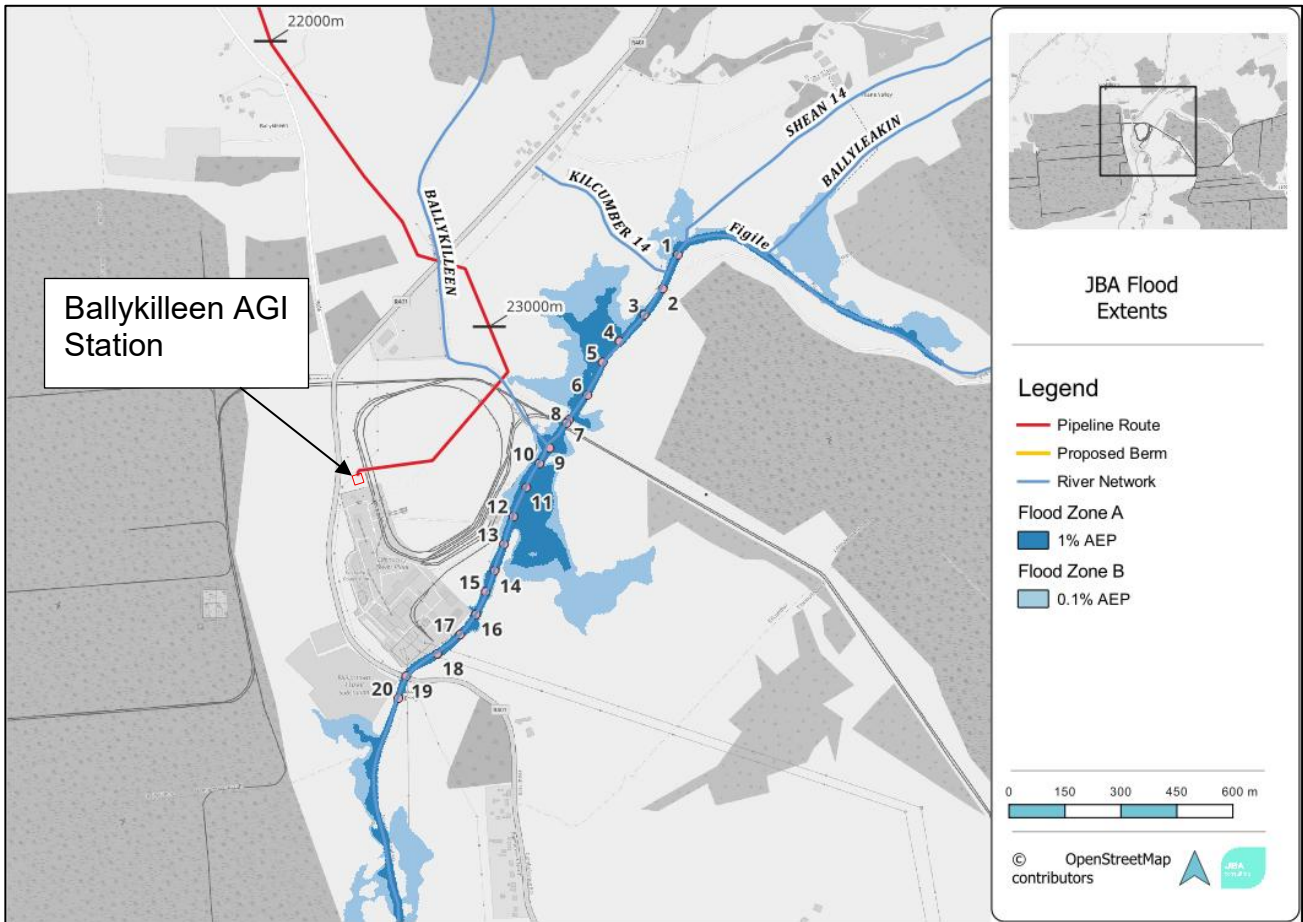


Figure 4-6: Flood Zones - Ballykilleen AGI

Table 4-4: Flood Levels

Reporting Point	Q100 (mOD)	Q1000 (mOD)
1	66.67	66.9
2	66.67	66.9
3	66.66	66.9
4	66.66	66.89
5	66.65	66.89
6	66.65	66.88
7	66.64	66.88
8	66.63	66.86
9	66.63	66.86
10	66.63	66.86
11	66.63	66.86
12	66.63	66.86
13	66.63	66.86
14	66.63	66.86
15	66.63	66.85
16	66.63	66.85
17	66.63	66.85
18	66.62	66.84
19	66.61	66.83
20	66.61	66.83

4.3.3 Model Results - Kilwarden River

The flood model results for the section of the gas pipeline in proximity to the Kilwarden River are presented in Figure 4-7. A review of the flood extents confirms that the flood waters for the 1% AEP and 0.1% AEP flood events remain in bank and do not present a food risk to the pipeline.

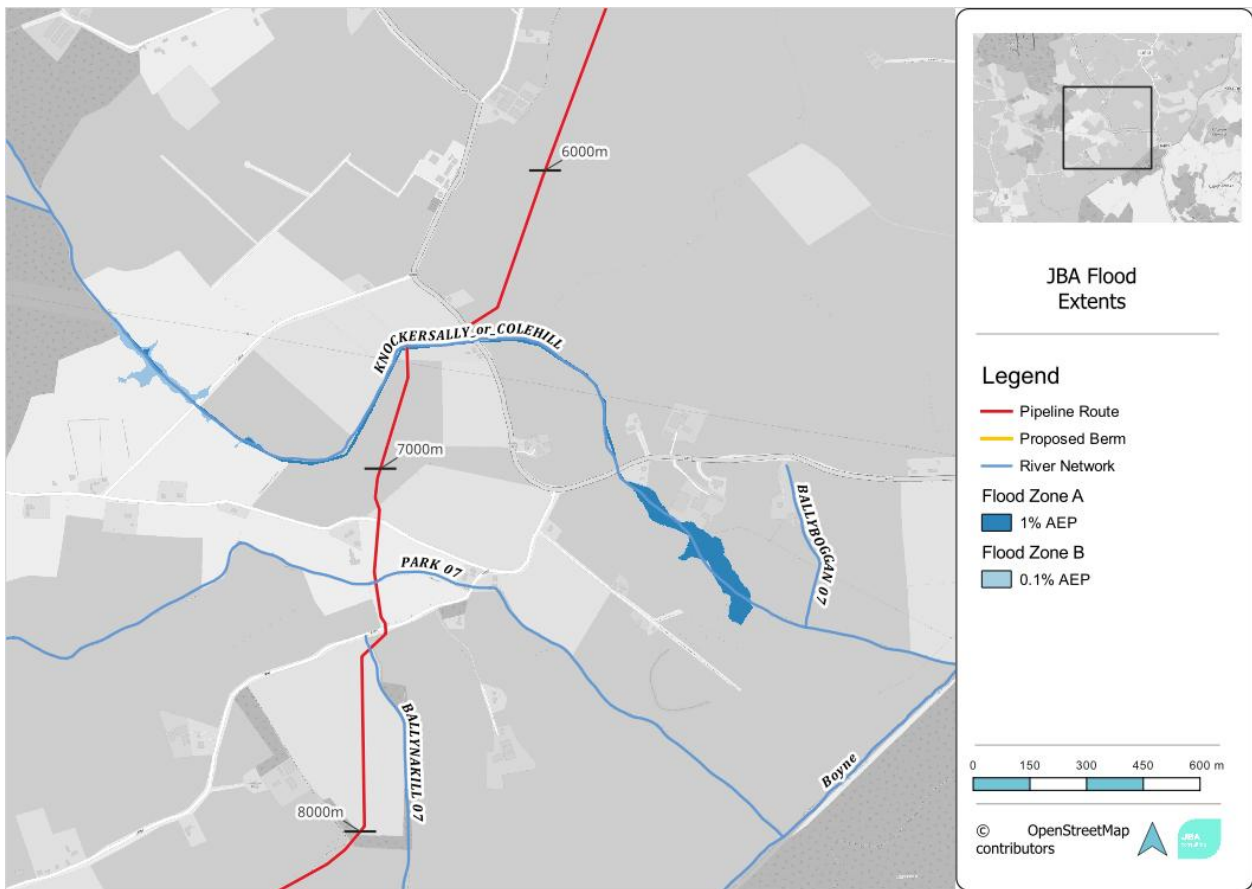


Figure 4-7: Flood Zones Kilwarden Offtake Installation

4.4 Flood Risk Summary

Having reviewed the available predicative flood maps (CFRAM, NIFM and JBA models) the flood risk from the Kilwarden River, Kilgile River, River Boyne and a number of tributaries have been screened out.

Two watercourses remain that present a flood risk to the development. These are the Yellow River (chainage 11,000m-12,000m), refer to Figure 4-4 and the Kinnafad river (chainage 16,000m and 17,000m), the route is located in Flood Zone A/B, refer to Figure 4-5.

Regarding the Yellow River a 20m exclusion zone is provided during the construction phase. A trenchless crossing technique will be utilised to cross the river and no topsoil etc. will be stripped within this flood zone.

For both the Yellow River and the Kinnafad river, the flood risk during the construction will be managed by the mitigation measures outlined in Section 5.2.

In relation to pluvial flooding (refer to Figure 3-11), a small area at risk of pluvial flooding has been identified to the south of the Yellow River. This is not considered to present a flood risk to the development and is secondary to the identified fluvial flooding. The mitigation measures outlined in Section 5.2 will also minimise the pluvial flood risk in this area.

5 Flood Risk Assessment – Stage 3 Appraisal

5.1 Flood Risk

The JBA flood extents confirm that the majority of the proposed development is within Flood Zone C with the only section within Flood Zone A/B is the section that will traverse the Yellow River (chainage 11,000m - 12,000m) and the Kinnafad river (chainage 16,000m - 17,000m).

The flood risk has been screened out from the Kilwarden River and Figile River. The AGI plant is located in proximity to the Figile River and therefore it has been confirmed that the site is located in Flood Zone C.

All construction compounds will be located in within Flood Zone C during the construction phase of the development.

There will be no impact or change to the existing above ground environment that could result in a change to fluvial or surface water flood extents upon installation of the gas pipeline.

The pipeline will be installed 1600mm below the riverbed level. It is currently an indicative depth pending further ground investigation and more detailed analysis of groundwater flow and the water table. A final depth will be confirmed at the detailed design stage. Note, trenchless crossing techniques shall be used for the Yellow and Kilwarden River crossings. At these crossing locations, the pipeline depth under the riverbed will be greater than the minimum 1.6m.

Mitigation measures have been proposed in Section 5.2 to manage the flood risk to the areas of the site located in Flood Zone A & B.

As the pipeline crosses or is in close proximity to Flood Zone A/B, a Justification Test has been undertaken to ensure that the development complies with the FRA guidelines. The Justification Test is undertaken in Section 6.

5.2 Mitigation

Several mitigation strategies have been incorporated into the design of the pipeline or the installation method.

- The route has been designed to avoid Flood Zones A and B insofar as possible.
- The pipeline itself is considered to be narrow and installation of a minimum 1600mm below the riverbed level will ensure there is no disruption in the hyporheic zone. Groundwater will have space for lateral and vertical movement. The pipeline does not present a barrier.
- The trench will be subject to impermeable treatment at intervals to ensure a similar standard of protection.
- The surrounding ground surface will be fully restored to its original state and there will be no change to permeability.

- For the tunnelling/boring under watercourses this is a 'trenchless' installation method that requires minimal excavation and reduces ground disturbance.
- There will be limited hardstanding within the Ballykillen AGI and Kilwarden Offtake Installations. As part of their design a stormwater systems has been included therefore, there will be no increase in surface water runoff due to the development.
- Mitigation measures to reduce soil compaction from heavy machinery which could increase the risk of surface water runoff have been outlined in the CEMP.
- The AGI ground level has been raised above the nearest 0.1% AEP flood level with appropriate freeboard.
- For the construction near the Yellow River (Figure 4-4), a 20m exclusion zone is provided during the construction phase. A trenchless crossing technique will be utilised to cross the river and no topsoil etc. will be stripped within this flood zone.
- In areas of the site confirmed to be located within Flood Zone A, the flood risk will be managed via the monitoring of river levels and weather forecasts. Works in proximity to the river bodies are restricted during red warning rainfall flood events.
- With reference to Figure 5-1, it is proposed to construct an approximate 2m berm using the site topsoil along the eastern side of the pipeline where it intersects the Flood Zone A outlines. This will protect this area of the pipeline from the predicted 1% AEP flood event. The berm does not have an impact on flood levels downstream of the development.

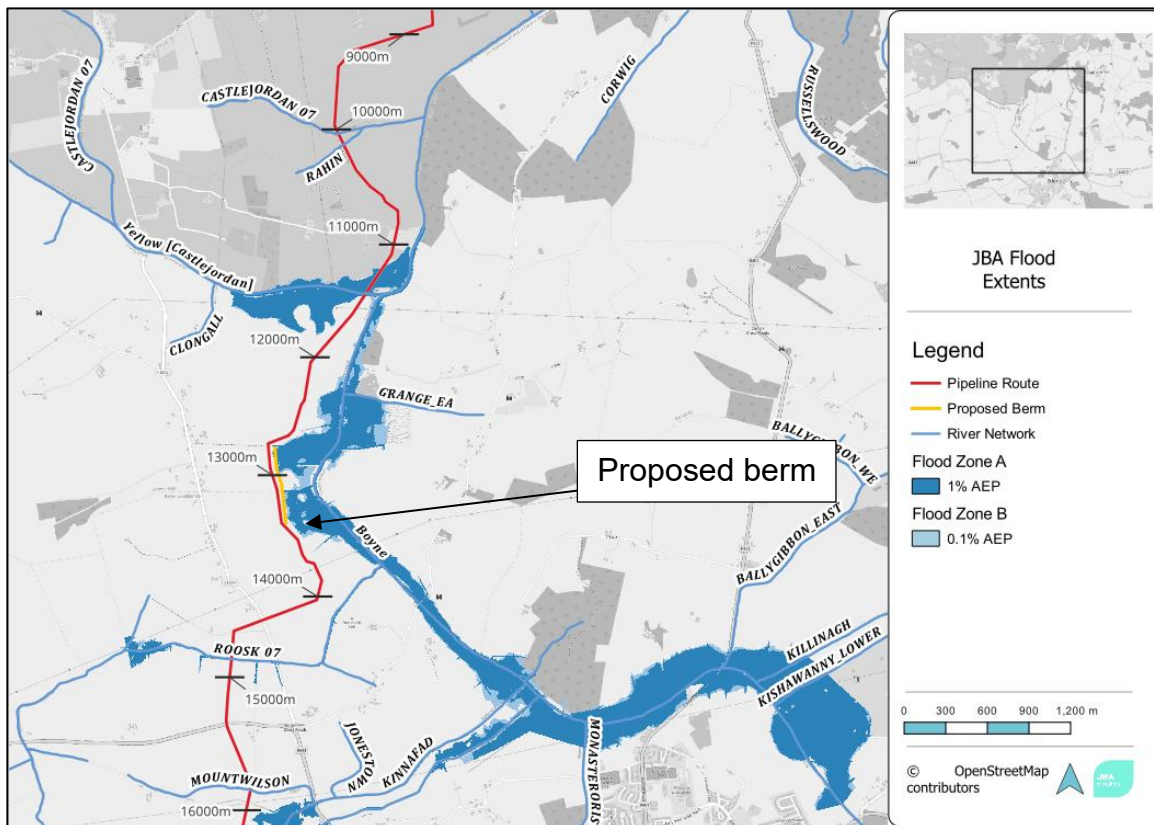


Figure 5-1: River Boyne - Proposed Berm

5.2.1 Surface Water Flood Risk

The risk from fluvial flooding on the site is negligible. Following construction ground levels and conditions will be returned to their condition prior to construction. This will result in no change to flood extents and therefore flood risk will remain negligible.

5.2.2 Climate change

Climate change scenarios included in the CFRAM study indicate that there are some increases in flood extent due to climate change. As the pipeline is located underground, it specifically will not be impacted during a flood event once construction is complete.

5.3 Residual Risk

Residual risks are defined as risks that remain after all risk avoidance, substitution and mitigation measures have been taken. Residual risk is principally limited to failure of the groundwater mitigation methods or changes to ground level at the surface when reinstating levels. The groundwater risk is managed by thorough construction method statements and any nominal changes to ground levels is unlikely to present any significant change in flood risk elsewhere, but would be managed in the same manner.

The main residual risk is the potential failure of the flood defence berm as presented in Figure 5-1. Partially failure of this berm will not impact upon the pipeline or staff as no works will be undertaken during a flood event.

As the proposed development works will not be located directly within the river system and the works will not impact on the flood flows there are no further residual risk that would impact on the development.

Any specific failure of the proposed mitigation measures outlined in Section 5.2 will only lead to localised environmental impacts.

6 Flood Risk Assessment Stage 3- Justification Test

The Justification Test is a key element of the Planning System and Flood Risk Management Guidelines for Planning Authorities. It is applied to developments that are at risk of flooding and considers the need for the development under wider planning objectives against the risk of flooding. The Vulnerability Matrix is used to determine when the Justification Test should be applied.

Gas pipelines have not been specifically identified within the FRA guidelines as in the post - construction the pipeline will be located underground and will not be impacted by flood events. The supporting infrastructure such as the AGI plant would be considered as Highly Vulnerable therefore this classification has been applied to the whole development.

Table 6-1: Vulnerability Matrix

	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

6.1 Justification Test Part 1

The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of the planning guidelines.

Critical linear infrastructure such as roads, railways, powerlines and buried services are not typically defined by land use zoning objectives outside of settlement boundaries and Part 1 of the Justification Test are therefore not applicable.

It is noted that the vast majority of the development is located in Flood Zone C including the AGI plant. For works located in Flood Zone A & B appropriate mitigation measures have been incorporated to minimise flood risk.

6.2 Justification Test Part 2

The proposal has been subject to an appropriate flood risk assessment that demonstrates:

(i) the development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;

The section of the pipeline located under the Boyne Tributary and within its general floodplain is located within Flood Zone C based on the JBA flood maps. i.e. there is a low risk of inundation (refer to Section 4.3). As the pipeline will be installed underground there will be no new hardstanding areas or change to the existing ground levels. Excavated areas will be reinstated with subsoils and topsoil that will result in no change to the existing permeability. Existing environmental conditions will be maintained following construction such that there will be no impact on the pluvial flow paths. There will be no impact to groundwater due to the best practise installation methods employed on both the trench and drilled sections to ensure no transmissivity of groundwater along a preferential pathway.

Conclusion: As the pipeline will be installed underground (with appropriate groundwater mitigation) it will not interfere with the predicted flood extents/ levels and therefore will not increase flood risk elsewhere in the catchment.

(ii) the development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;

The main measure applied to minimise flood risk elsewhere is retaining the existing ground level post installation. This will ensure that there will be no increase flood risk under present conditions and climate change scenarios elsewhere in the catchment.

Conclusion: The existing ground levels will be maintained as part of the works, thereby minimising flood risk to people, property, the economy and the environment as far as reasonably possible.

(iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access.

The majority of the pipeline and all plant/ associated sensitive equipment are located in Flood Zone C. Minor sections of the pipeline is located in Flood Zone A/B and flood risk including residual risk will be managed by the observation of river levels and weather warnings. Climate change has not been included due to the relative short duration of construction.

All construction compounds will be located in Flood Zone C.

Conclusion: Due to the small scale even if the ground was raised nominally above the existing level, it will not have an impact on flood extents in the local area.

(iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The pipeline will be constructed underground with no change to the permeable surface area at ground level from the proposed development. There will be no impact on the wider urban design of the area.

7 Conclusion

JBA Consulting has undertaken a Flood Risk Assessment for the proposed gas pipeline across the proposed 23.65km route, from Co Meath to Co Offaly. The Proposed Development primarily consists of a c. 23.65 km 300mm NB steel pipeline (referred to as the “GNI143 Ballykilleen Pipeline”), a hot tap tie-in to the existing BGE77, Gas to the West (PTTW) pipeline, an above ground pigging compound at the pipeline offtake location (referred to as the “Kilwarden Offtake Installation”) and new Above Ground Installation (AGI) (referred to as the “Ballykilleen AGI”).

The site is located within Flood Zone A, B and C, signifying varying risk from fluvial flooding. Pluvial flood potential may arise from localised depressions in the ground at the site but is not considered a significant risk.

Predicative model has been undertaken for the Kilwarden River, Figile River and a number of tributaries of the River Boyne. The purpose of the modelling exercise is to confirm the flood extents and levels in the vicinity of the pipeline in proximity to the modelled watercourses.

The Justification Test has been applied and passed as part of the FRA process.

The proposed pipeline will be located underground and following construction, ground levels will be returned to their original state. A trenchless installation method will be used to install the gas pipeline under the two main river crossings; River Boyne Tributary and Yellow River, which will reduce ground disturbance in proximity to the riverbeds. There are a number of minor watercourses along the route which the gas pipeline will be installed across using open cut methods.

The associated AGI plant is located in Flood Zone C and has a greater than 1m freeboard over the predicted 0.1% AEP flood event.

All construction compounds will be located in Flood Zone C and therefore will not be impacted by the predicted 1% AEP and 0.1% AEP flood events.

For sections of the pipeline constructed in Flood Zone A/B (Yellow & Kinnafad rivers), observations of river flood levels and weather warnings will ensure that the flood risk has been minimised. This also applies to areas identified at risk of fluvial flooding.

A section of the pipeline in along the River Boyne (chainage 13,000m-14,000m) is located in Flood Zone A/B will rely on a construction berm to prevent inundation during a 1% AEP flood event. It is noted that the during of the construction will be short and the berm will have no impact on flood extents elsewhere.

Due to the location of the pipeline and the mitigation methods employed, the potential impacts from flooding to the pipeline are considered negligible. There will be no impact to groundwater flow as a result of the mitigation methods related to the pipe drilling and trench construction methods.

The Flood Risk Assessment was undertaken in accordance with The Planning System and Flood Risk Management Guidelines.

A Understanding Flood Risk

Flood risk is generally accepted to be a combination of the likelihood (or probability) of flooding and the potential consequences arising. Flood risk can be expressed in terms of the following relationship: Flood Risk = Probability of Flooding x Consequences of Flooding

A.1 Probability of Flooding

The likelihood or probability of a flood event (whether tidal or fluvial) is classified by its Annual Exceedance Probability (AEP) or return period (in years). A 1% AEP flood has a 1 in 100 chance of occurring in any given year.

In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval and is the terminology which will be used throughout this report.

Table A-1: Conversion between return periods and annual exceedance probabilities

Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.2 Flood Zones

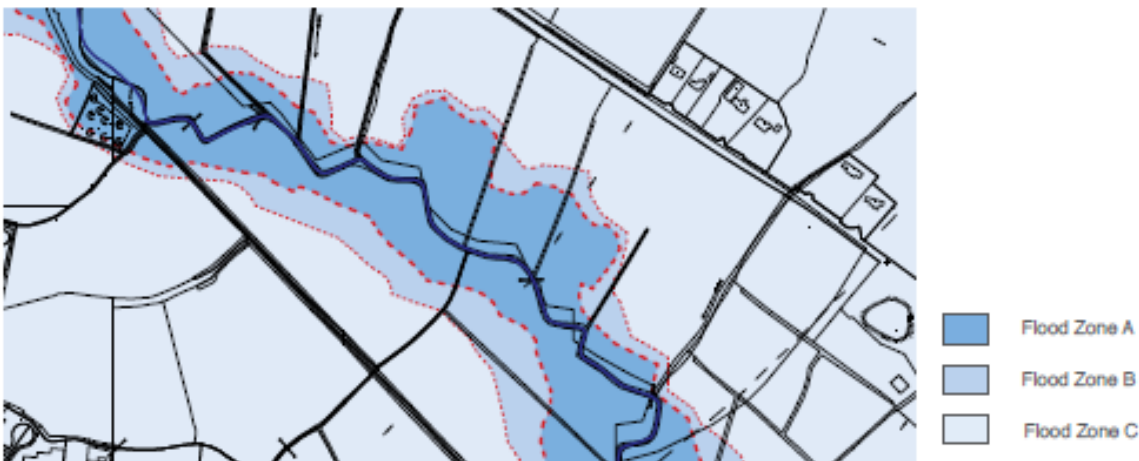
Flood Zones are geographical areas illustrating the probability of flooding. For the purposes of the Planning Guidelines, there are 3 types or levels of flood zones, A, B and C.

Table A-2: Flood Zones

Zone	Description
Flood Zone A	Where the probability of flooding is highest; greater than 1% (1 in 100) from river flooding or 0.5% (1 in 200) for coastal/tidal flooding.
Flood Zone B	Moderate probability of flooding; between 1% and 0.1% from rivers

	and between 0.5% and 0.1% from coastal/tidal.
Flood Zone C	Lowest probability of flooding; less than 0.1% from both rivers and coastal/tidal.

It is important to note that the definition of the flood zones is based on an undefended scenario and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.



A.3 Consequence of Flooding

Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc.).

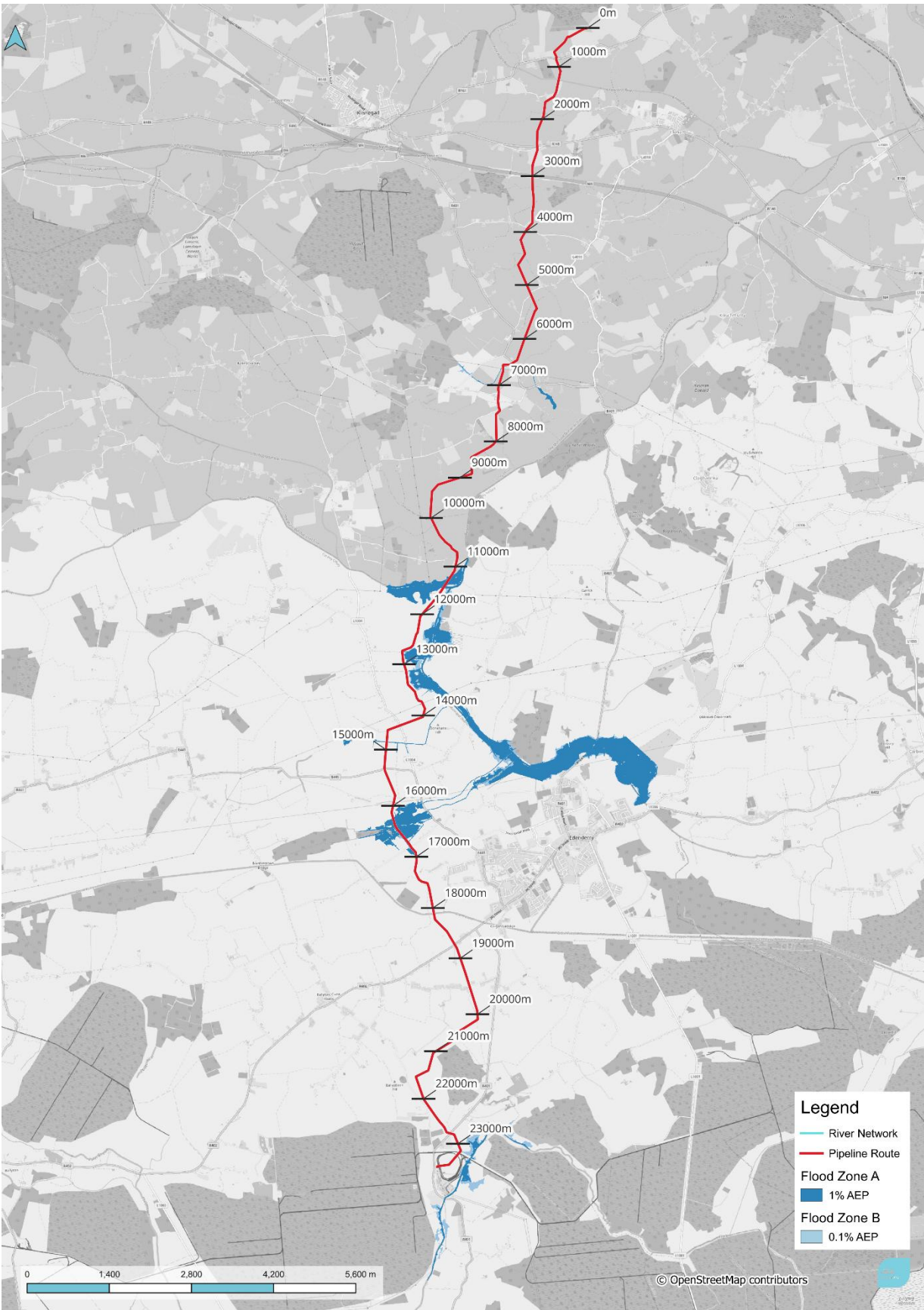
The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on the type of development, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

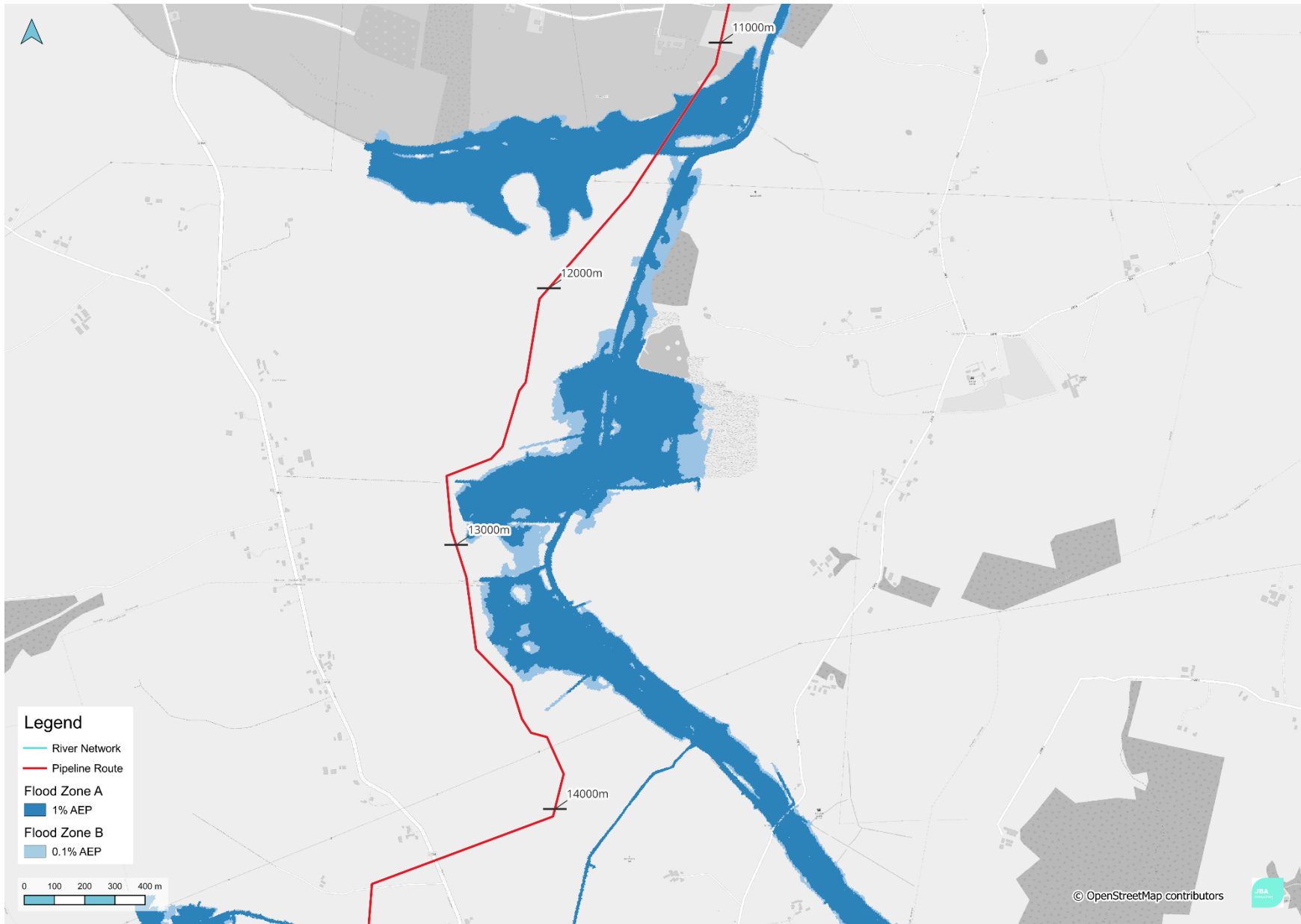
- Highly vulnerable, including residential properties, essential infrastructure and emergency service facilities;
- Less vulnerable, such as retail and commercial and local transport infrastructure;
- Water compatible, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

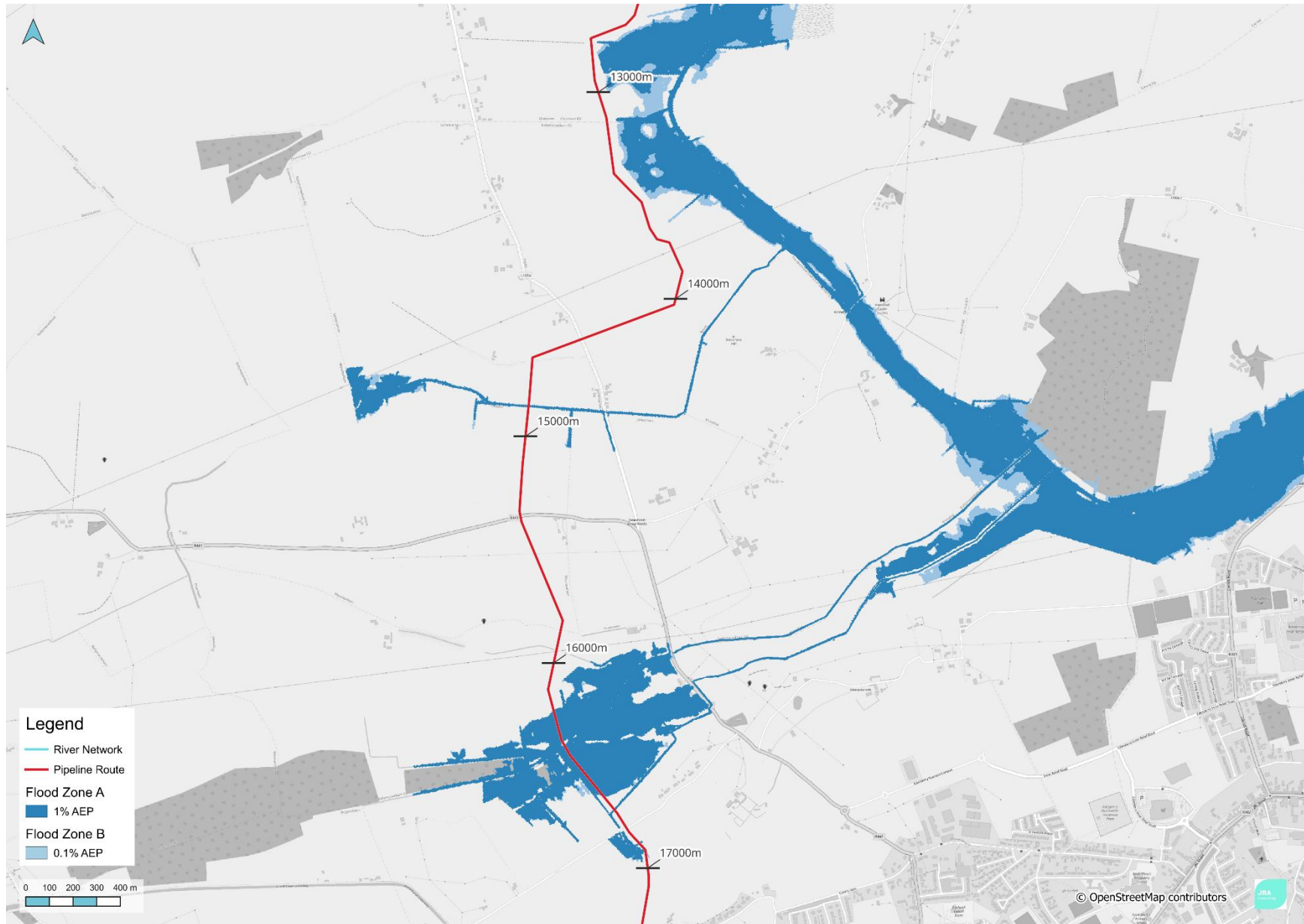
A.4 Residual Risk

The presence of flood defences, by their very nature, hinder the movement of flood water across the floodplain and prevent flooding unless river levels rise above the defence crest level, or a breach occurs. This is known as residual risk.

Flood maps











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