Athlone Gas Pipeline Flood Risk Assessment

September 2024

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Contract

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This report describes work commissioned by Fingleton White, by an instruction dated 20th June 2024. Fingleton White representative for the contract was Johnny Fingleton. David Casey of JBA Consulting carried out this work.

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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 gas pipeline south of Athlone West, Co. Roscommon.

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 57: Ensuring flood risk management informs place-making by avoiding inappropriate development in areas at risk of flooding in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities.

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 Northern and Western Regional Assembly (NWRA) is one of the three regional assemblies in Ireland, established to coordinate regional development and spatial planning.

Athlone West is incorporated into the NWRA Regional and Spatial Economic Strategy (RSES). The NWRA RSES 2020-2032 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 3.7.18: Support ongoing implementation of flood risk management and flood protection measures to facilitate the growth of Athlone subject to the outcome of appropriate environmental assessment and taking account of the proximity of sites of international nature conservation interest
- 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 Roscommon County Development Plan (CDP) informs planning decisions and management on a local basis. Objectives pertaining to the proposed development are outlined fully in Section 3.2.3.

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, not 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 is the installation of a 2.5km natural gas pipeline and above ground pressure reduction station which will supply Greener Ideas Ltd power site. The new pipeline shall tie into the existing 750 NB BGE/77 pipeline in an agricultural field on the west side of the R446 road. The total site area is approximately 12.1ha. The pipeline crosses Dublin-Galway railway tracks, the M6 motorway, and the Cross River. Each crossing will involve trenchless installation and either; (a) conventional micro-tunnelling MT, or (b) guided auger-boring / hybrid MT. Conventional open trench installation will be employed for the remainder of the route.

The pipe will have an internal diameter of 200mm and under the river will be installed in a 600mm concrete sleeve set 1900mm below the bottom of the riverbed (for the section that runs under the Cross River. There will be no new hardstanding area or change to the surface environment.

Six temporary working areas are proposed at the following locations:

- 1 no. temporary working area at the proposed hot tap location,
- 1 no. temporary working area located in the agricultural lands to the north of the Drum Community Centre, and
- 4 no. temporary working area at the proposed tie-in with the Monksland AGI.

1.5 Report Overview

Section 2 of this report gives an overview of the study location and associated watercourses. Section 3 contains background information on flood risk. Section 4 provides initial assessment of flood risk and mitigation measures. Section 5 of the report applies the Justification Test as outlined in the Planning System and Flood Risk Management Guidelines for Planning Authorities. Section 6 provides the conclusion of the document.

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
- Geological Survey Ireland - gsi.ie
- EPA Maps - epa.ie
- EPA LEAP portal - leap.epa.ie
- Teagasc - gis.teagasc.ie
- Government of Ireland - gov.ie
    - Project Ireland 2040
    - National Planning Framework
    - National Development Plan
- Regional and Spatial Economic Strategy - nwra.ie
- Google Earth - earth.google.com
- GSI Open Topographic Data Viewer

2 Site Background

2.1 Location

The site is located in a rural area of southern County Roscommon to the south of Athlone West (Co Westmeath). The site boundary extends through the village of Summerhill along the R446. Agricultural lands extend beyond the R446 and the Dublin-Galway rail service and M6 motorway pass through the northern section of the site. Monksland Kilnnamanagh Bog and the Shannon River lie to the east.

Refer to Figure 2-1 for the hydrological environment.

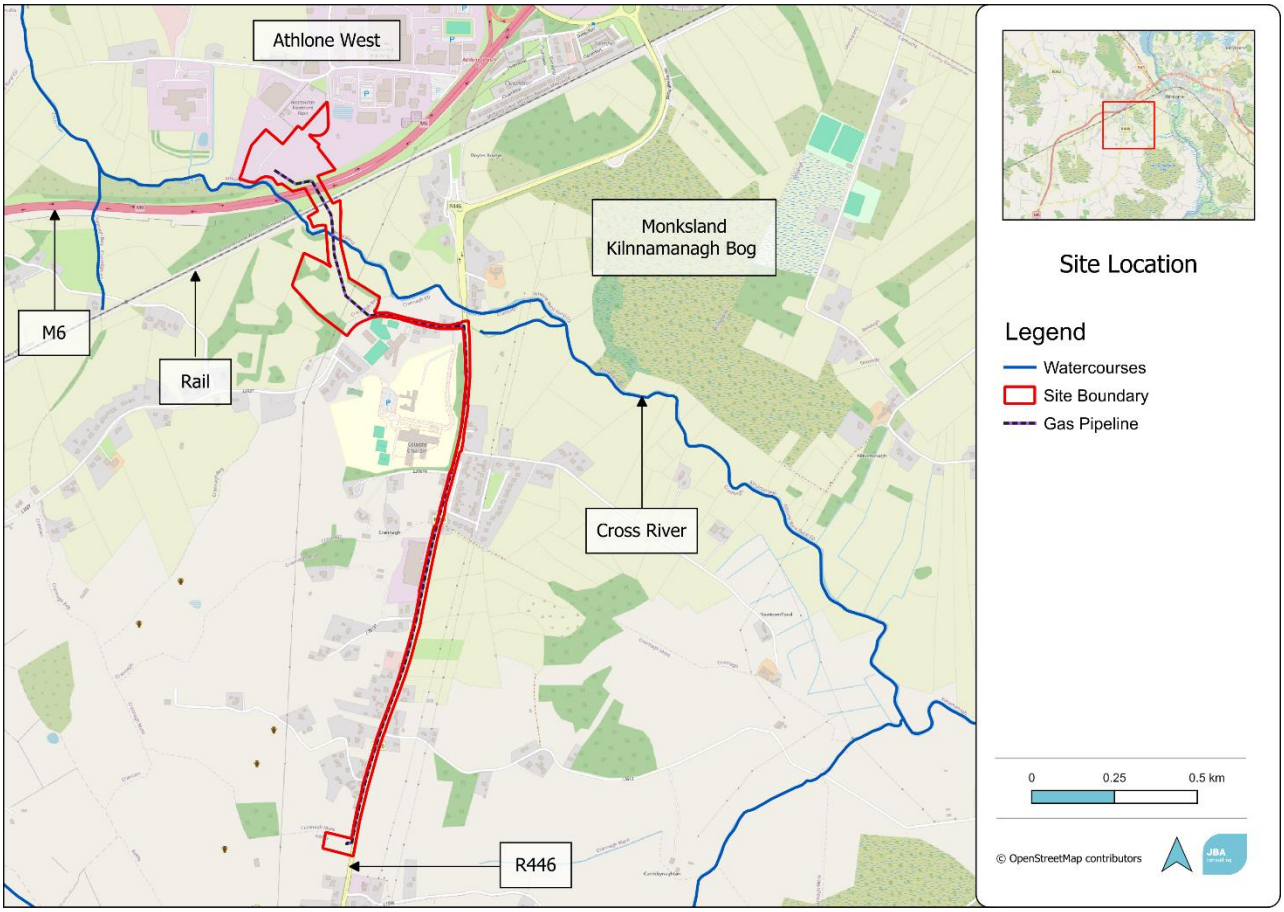

Figure 2-1: Site Location. Inset showing the section of pipeline assessed in this report.

2.2 Watercourses

The Cross River is the closest waterbody which flows across the path of the proposed gas pipeline in a northwest to southeast direction towards the River Shannon. The confluence between the Cross River and the River Shannon is approximate 4.6km downstream of the site. The site falls within the Upper Shannon catchment.

2.3 Topography

The ground elevation of the area can be seen in Figure 2-2. Ground elevation across the site ranges from approximately 33.5 - 49 mOD with higher elevations towards the south. The prevailing fall is towards the Cross River. Land becomes consistently flatter to the east and southeast towards the River Shannon.

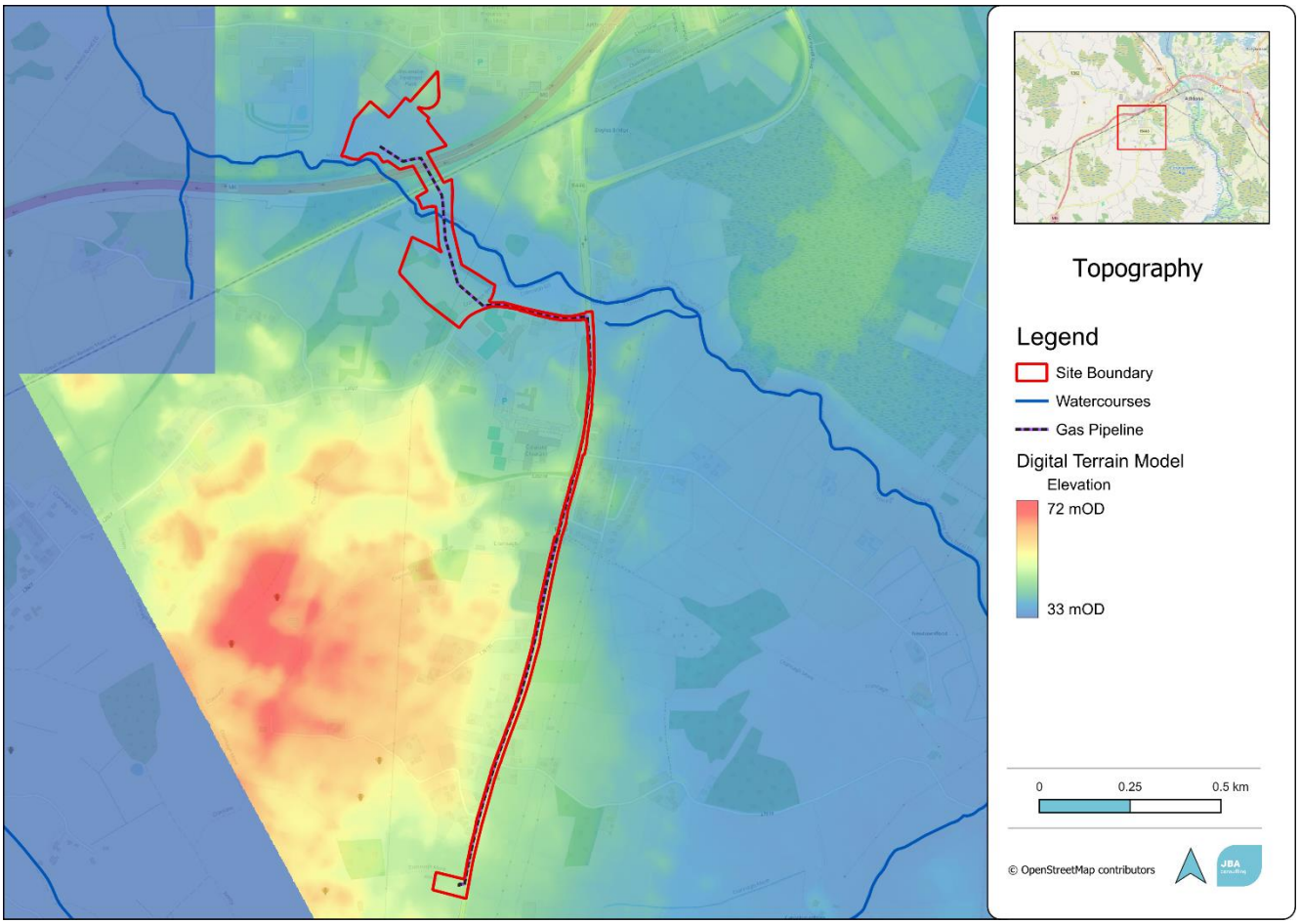

Figure 2-2: Site Topography

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. Waulsortian Limestone comprises the underlying bedrock at the site which is described as massive, unbedded lime-mudstone. The subsoil across the site is varied. Beginning in the northeast trending towards the southwest the subsoil comprises cut peat, limestone sands and gravels, alluvium, limestone till and patches of made ground.

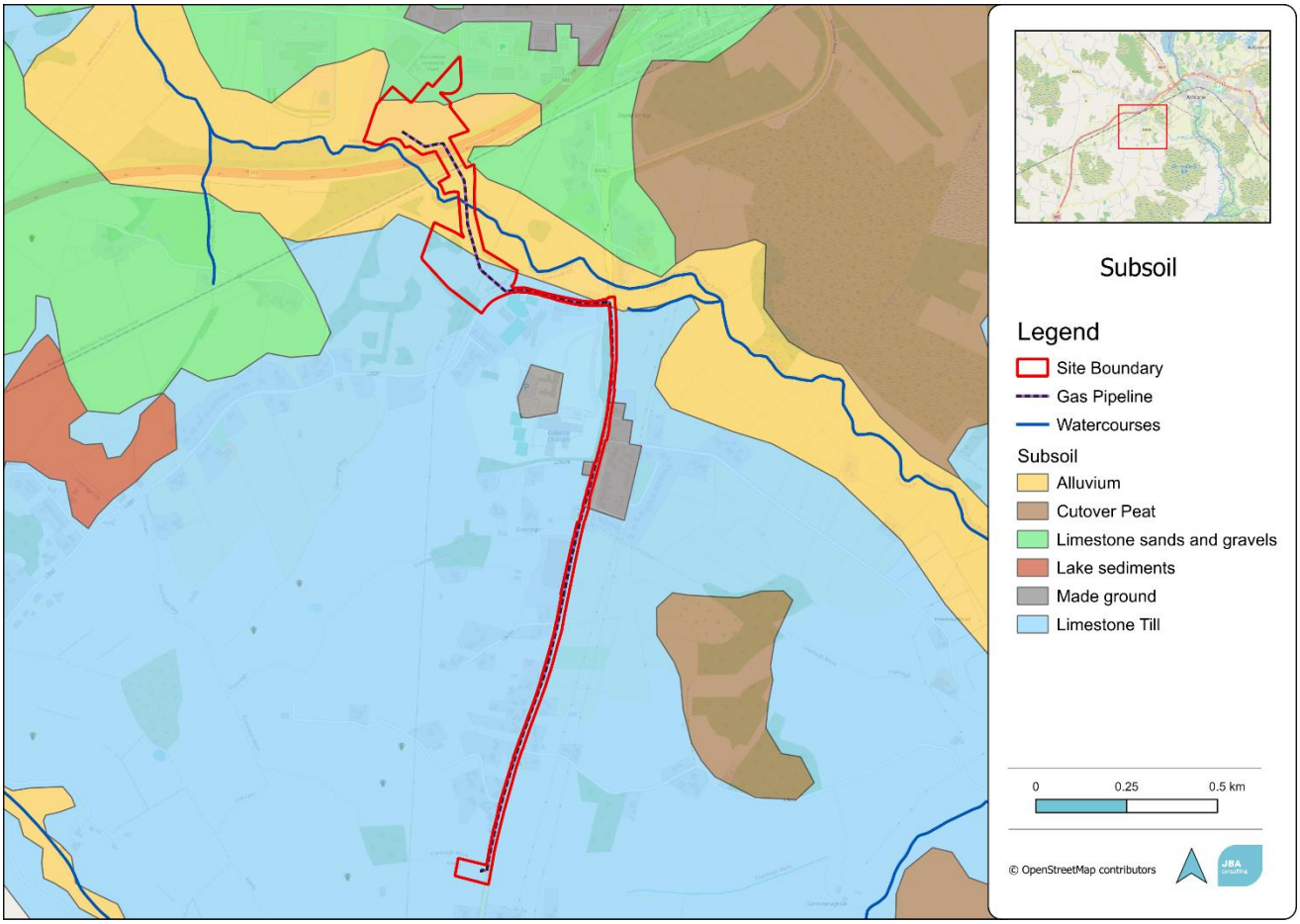

Figure 2-3: Site Subsoils

The site is underlain by two groundwater bodies. The Athlone West (IE_SH_G_014) groundwater body and an Industrial Facility groundwater body (IE_SH_G_018) associated with Arran Chemical Company Limited (Pollution Control Licence P0110-01). The Cross River forms the southwestern boundary of the Industrial Facility groundwater body. The aquifer across both groundwater bodies is described as moderately productive only in local zones.

3 Flood Risk Identification

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 are provided in Appendix A.

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-5268 - An area of low-lying land was identified in the Environmental Impact Assessment for the N6 Ballinasloe to Athlone Road Scheme as an area of likely pluvial flooding as it is set back from any watercourses. No dates were provided for any flood events.
- Flood ID-5241 - Recurring flooding is associated with an enclosed depression karst formation. The OPW sites the source of flooding as 'lake' and it is assumed that the feature is a seasonal lake.

Refer to Figure 3-1 overpage.

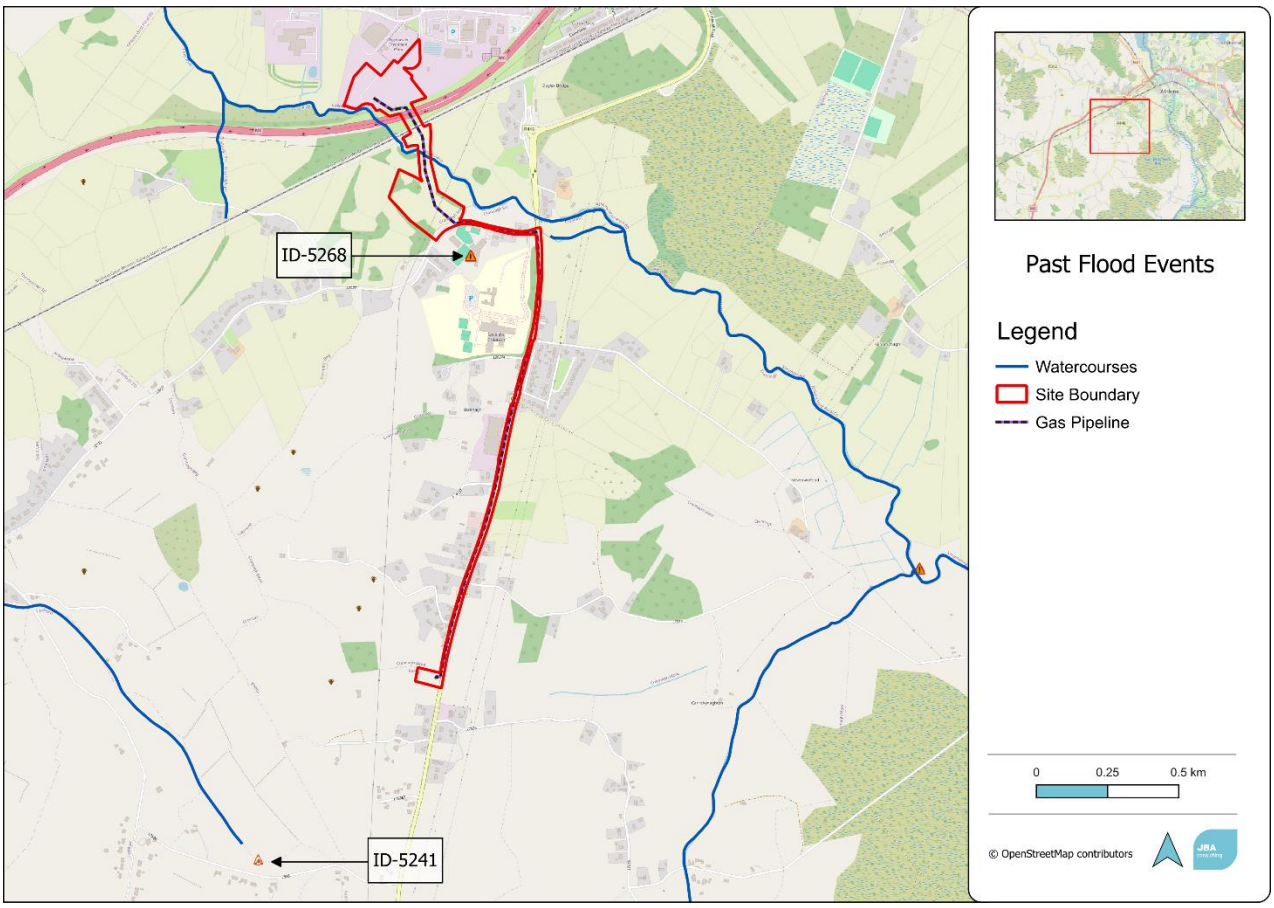

Figure 3-1: Past Flood Events

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. Within the subject area, the CFRAM targeted areas of significant flooding. 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 area.

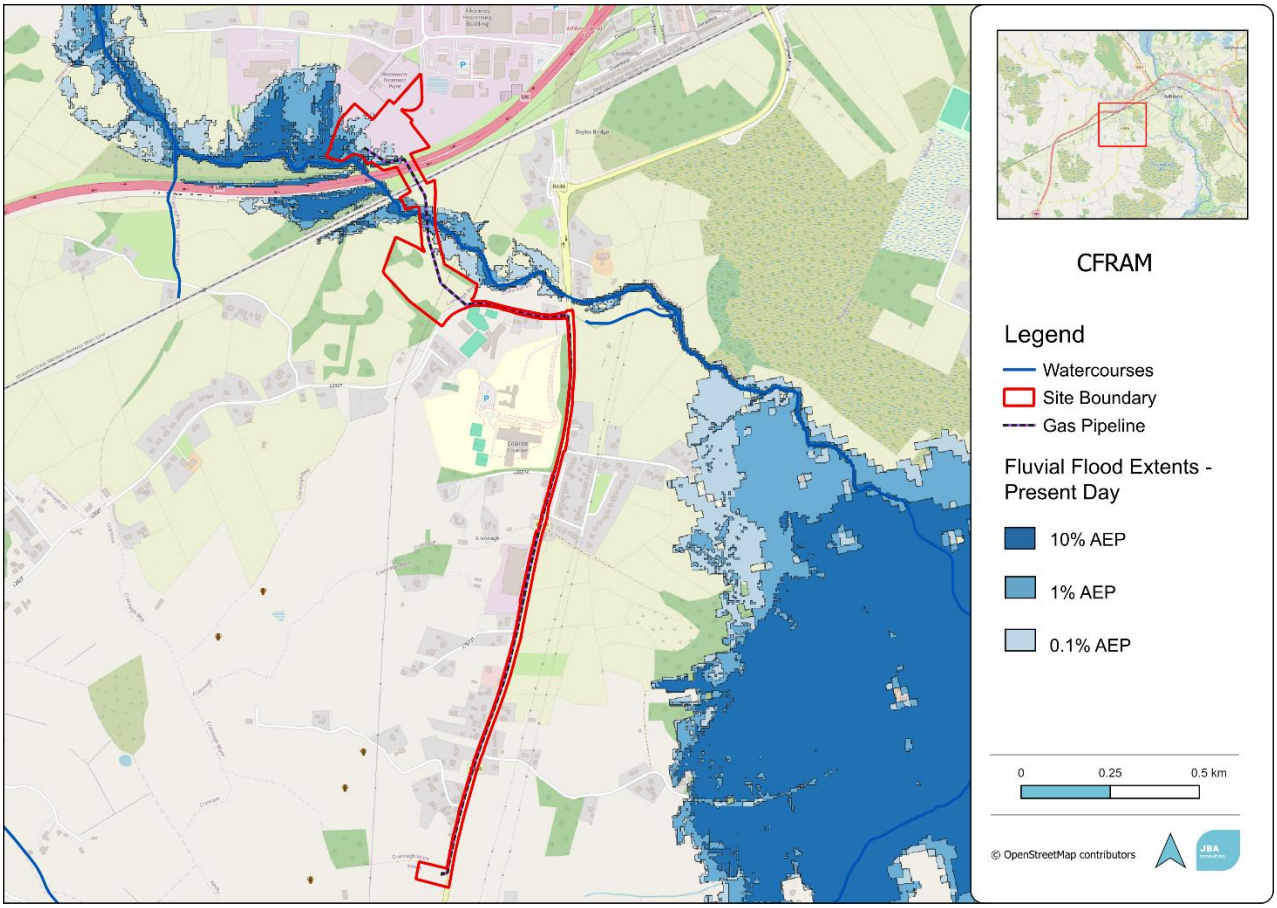

Figure 3-2: CFRAM Fluvial Flood Extent Map

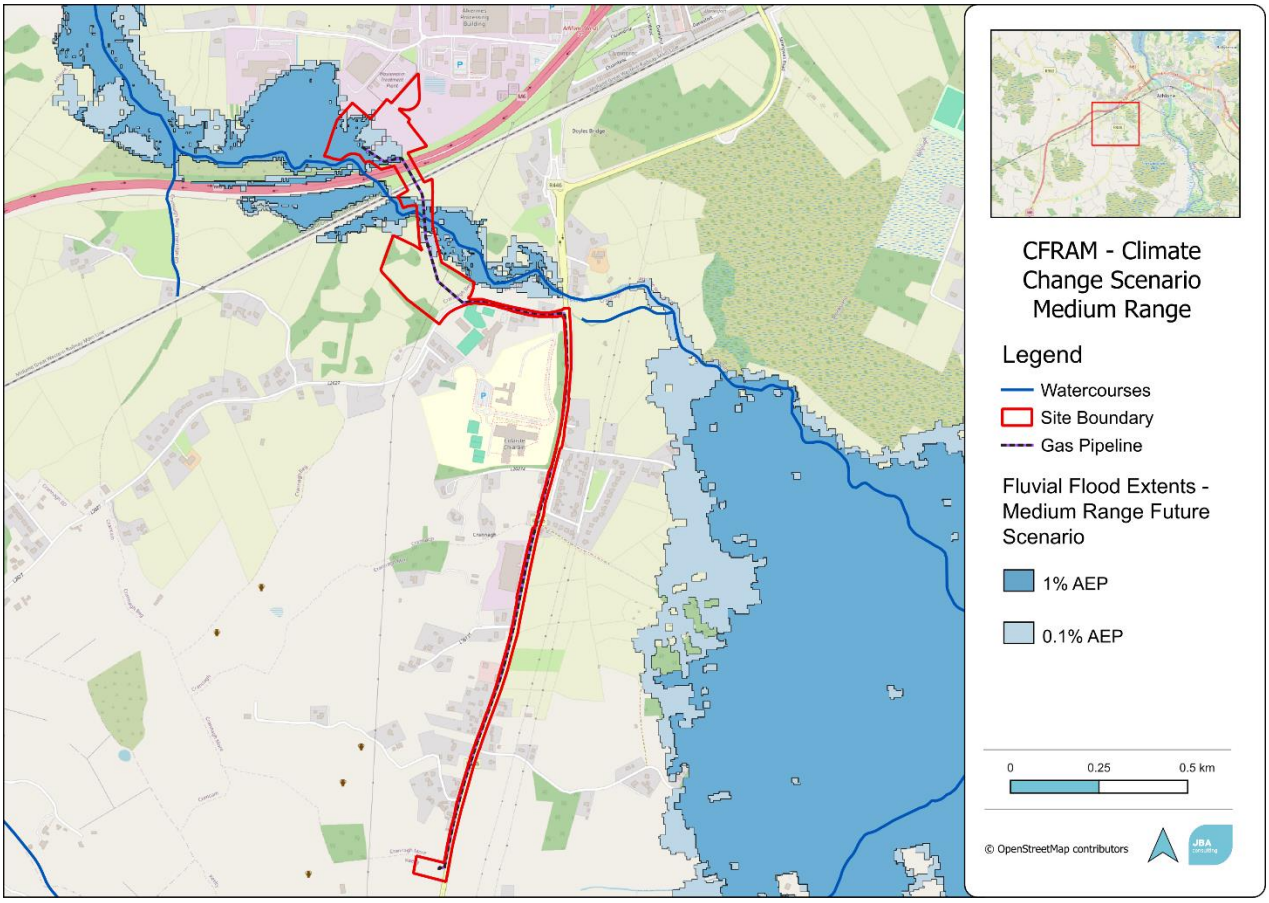

Figure 3-3 CFRAM 1% and 0.1% AEP flood extents for the Medium Range Future Scenario (MRFS)

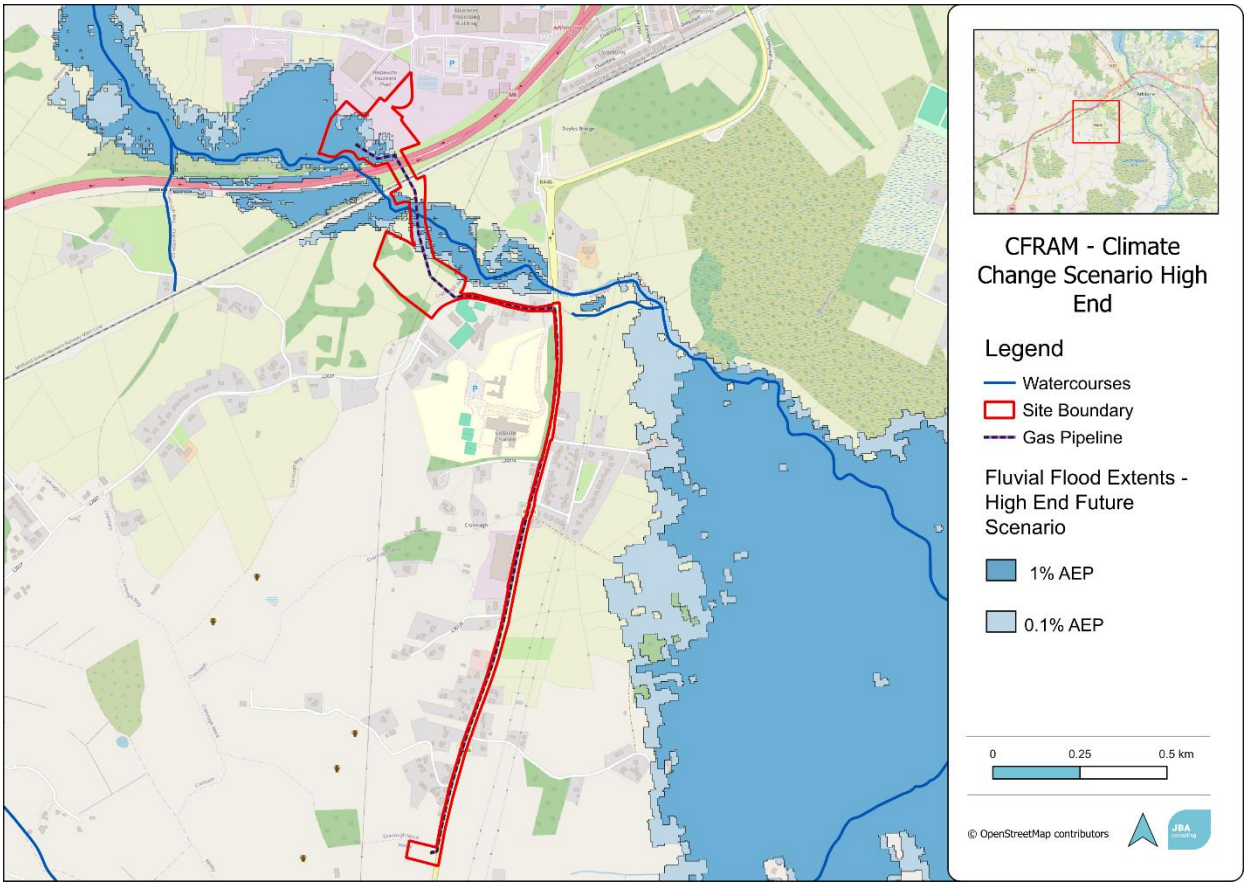

Figure 3-4 CFRAM 1% and 0.1% AEP flood extents for the High End Future Scenario (HEFS)

3.2.2 Historic Groundwater Flooding

The site and surrounding areas were assessed for prior groundwater flooding through the GSI map viewer. There is no indication that groundwater flooding occurs within or near the site. The nearest occurrence is approximate 2.3 km to the northwest on the outskirts of Athlone West, see Figure 3-5.

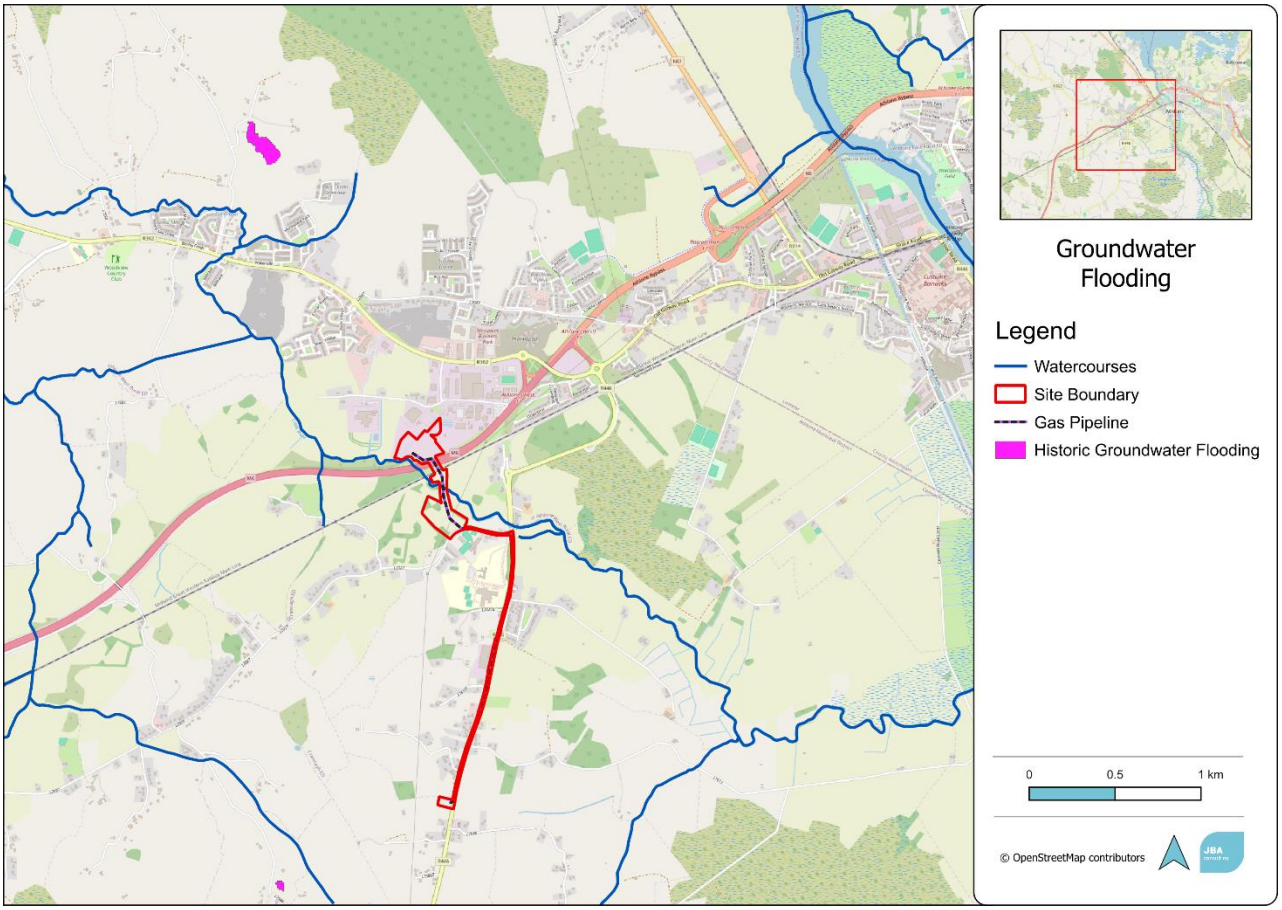

Figure 3-5: Historic Groundwater Flooding

3.2.3 Roscommon County Development Plan 2022 - 2028

The Roscommon 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.

The Monksland / Bellanamullia Local Area Plan 2016-2022 defines the zoning as Industrial and Greenbelt, the settlement boundary is the railway line and there is no formal zoning south of the railway. The area is being included within the Athlone Joint Urban Area Plan, which is yet to be drafted.

It is noted that the site area is not specifically covered within the Roscommon County Development Plan SFRA report due to the new Joint Plan, but the Cross River 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.

3.3 Sources of Flooding

3.3.1 Fluvial

The principal source of flooding for the site is the Cross River. Evidence of potential flooding upstream is evident in CFRAM flood extents to which the M6 and railway form partial barriers further downstream. The study also shows that the site is at risk from 10%, 1% and 0.1% AEP flood events as a result of overtopping of the river banks. The northern part of the site therefore falls into Flood Zones A and B. As the site extends to the south there is no risk of fluvial flooding apparent from the CFRAM study.

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. The lowest point along the route is the Cross River. As the route moves south terrain becomes slightly elevated and gently undulating. Rainfall will flow eastwards along the natural gradient towards the Cross River.

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 the area.

4 Flood Risk Assessment

4.1 Flood Risk

The CFRAM study indicates that majority of the proposed development is within Flood Zone C with only small portions within Flood Zone A and B. A Justification Test has been undertaken in Section 5.

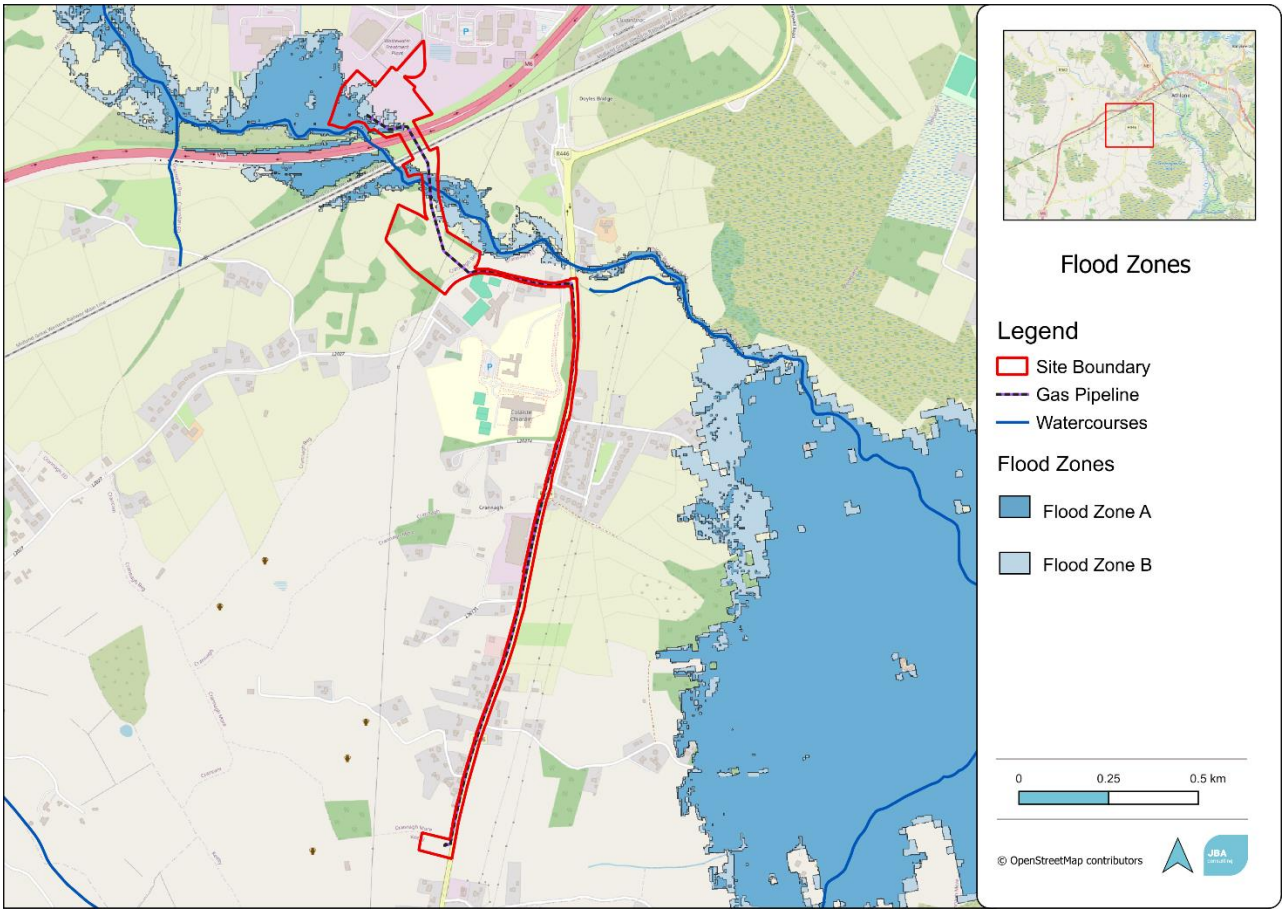

Figure 4-1 Flood Zones

Northern sections of the site area are partially within Flood Zones A and B. These areas will be the location of temporary site compounds. Management of flooding is addressed in a separate FRA report for the temporary work and also under the Construction Environment Management Plan (CEMP).

The proposed development will be located underground and under the Cross River and will therefore not be impacted by any future fluvial flood events. Upon completion of the construction phase, all works will be made good and the existing ground levels will be restored like for like. Therefore, 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. This depth is based on the industry standard safe installation depth of 1.5x the sleeve diameter below the riverbed. 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.

Data for a nearby borehole was sourced from the EPA's LEAP. The borehole is approximately 350m from the proposed river crossing. Subsoils were reported wet at 5m, and water was encountered at 7.2m. Groundwater levels near the river are expected to be higher than this. The assessment was conducted in 2011.

The pipeline will have an internal diameter of 200mm and under the river crossing this will be installed with a 600mm concrete sleeve which is an impermeable layer. Elsewhere the pipeline will be laid in a trench. Best practise should be ensured so that the sleeve joints are sealed and that any gaps between the sleeve and surrounding ground material are plugged with appropriate impermeable material. Similarly, any trench would need to be sealed at appropriate intervals. Adopting these best practise measures will prevent groundwater or permeating surface water from transmitting along the length of the pipeline and instead flow paths will travel around the structure and continue as before. This will result in no change to the groundwater flow regime. The sleeve is also a protective feature that will prevent impacts from hydrostatic pressure from flood water.

4.2 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 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 600mm concrete sleeve used under the river crossing will protect the infrastructure from hydrostatic pressure of flood waters and mitigate the risk of interrupting or changing groundwater flow.
- 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 (exact method TBC) under the river this is a 'trenchless' installation method that requires minimal excavation and reduces ground disturbance.
- There will be no new hardstanding area that could result in an increased rate of surface water runoff.
- Mitigation measures to reduce soil compaction from heavy machinery which could increase the risk of surface water runoff have been outlined in the CEMP.

- Mitigation for temporary works is not covered under this FRA (which is for the permanent works), it discussed further in the stand alone temporary works FRA and also CEMP. Such temporary works would include construction works adjacent to and including the bridge crossing and temporary compounds north of the M4.

4.2.1 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.

4.2.2 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.

4.3 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.

5 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.

Table 5-1 Vulnerability Matrix showing development vulnerability vs Flood Zone to illustrate combinations where the Justification Test must be applied.

	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

5.1 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 is therefore not applicable.

5.2 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 Cross River and within its general floodplain is technically located within Flood Zone A/B and is at risk of inundation (see Figure 4-1). 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 flood extents. 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 main residual risk is the possibility of localised changes to the ground profile where excavation works have been undertaken. Open trench excavation will be employed for majority of the pipeline along R446 where no flood risk is identified. Trenchless methods, which require less excavation and reduce ground disturbance, will be used at the river, road and rail crossings where flood risk from the Cross River is higher. Risk fro failure of the ground water mitigation methods is unlikely given the construction method statements and practises.

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.

6 Conclusion

JBA Consulting has undertaken a Flood Risk Assessment for the proposed gas pipeline in the environs of Athlone.

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. Coastal flooding was determined to be negligible, due to the location of the site and no significant groundwater risks noted from historical data.

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 in some areas of the development within Flood Zones A and B which will reduce ground disturbance and change to ground levels. There will be no new hardstanding area as each end of the pipeline will tie into existing built locations. 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.

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