Kishoge Site 4, Clonburris

Flood Risk Assessment

Prepared for:

South Dublin County Council

www.jbaconsulting.ie

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Contract

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This report describes work commissioned by South Dublin County Council. Andrei Cozma of JBA Consulting carried out this work.

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Acknowledgements

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Contents

List of Figures

List of Tables

Abbreviations

AEP……..………………….Annual Exceedance Probability

CFRAM…………………Catchment Flood Risk Assessment and Management

DoEHLG………………..Department of the Environment, Heritage and Local Government

FARL …………………..FEH index of flood attenuation due to reservoirs and lakes

FB………………………Freeboard

FFL……………………..Finish Floor Level

FRA……………………..Flood Risk Assessment

FSR……………………..Flood Studies Report

FSU……………………..Flood Studies Update

GL………………………Ground Level

GSI……………………...Geological Survey of Ireland

LHB……………………...Left Hand Bank

OPW……………………Office of Public Works

PFRA……………………Preliminary Flood Risk Assessment

RFI……………………….Request for Further Information

RHB……………………..Right Hand Bank

RR……………………….Rainfall-Runoff

SAAR……………………Standard Average Annual Rainfall (mm)

SFRA…………….…….Strategic Flood Risk Assessment

URBEXT………………..FEH index of fractional urban extent

WL………………………Water Level

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 to ensure sustainability and effective management of flood risk. This FRA is complying and consistent with the Guidelines.

1.1. Terms of Reference and Scope

JBA Consulting was appointed by South Dublin County Council to prepare a Site-Specific Flood Risk Assessment (FRA) for the proposed Site 4 development in Kishoge, Clonburris.

Under the 'Planning System and Flood Risk Management - Guidelines for Planning Authorities' (DEHLG / OPW, 2009), proposed development must undergo a Flood Risk Assessment (FRA) prior to planning to ensure sustainability and effective management of flood risk. The planning authority in this instance is South Dublin Country Council.

1.2. Flood Risk Assessment; Aims and Objectives

This study is being completed to inform the future development of the Site 4 as it relates to flood risk. It aims to identify, quantify and communicate to the client the risk of flooding to land, property and people and the measures that would be recommended to manage the risk in order to facilitate the development of the site.

The objectives of this FRA 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;
- Either;
    - Clarify what further assessment may need to take place to adequately define the risk from the Griffeen River and Kilmahuddrick Stream or;
    - 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 'Planning System and Flood Risk Management - Guidelines for Planning Authorities' by the DEHLG / OPW (2009). A review of the likely effects of climate change, and the long-term impacts this may have on development has also been undertaken.

For general information on flooding, the definition of flood risk, flood zones and other terms, refer to 'Understanding Flood Risk' in Appendix A.

1.3. Development Proposal

Site 4 Kishoge consists of 12 clusters of buildings distributed across the site. The site extends to the northeast to accommodate the Kilmahuddrick Stream crossing and a connection road linking to future developments to the east.

In the western part of the site, a central area is designated for the future development of a school. A road currently under construction traverses the site from west to east.

A full description of the proposed development is available separately from CS Consulting. The proposed site layout is shown in Figure 1-1.

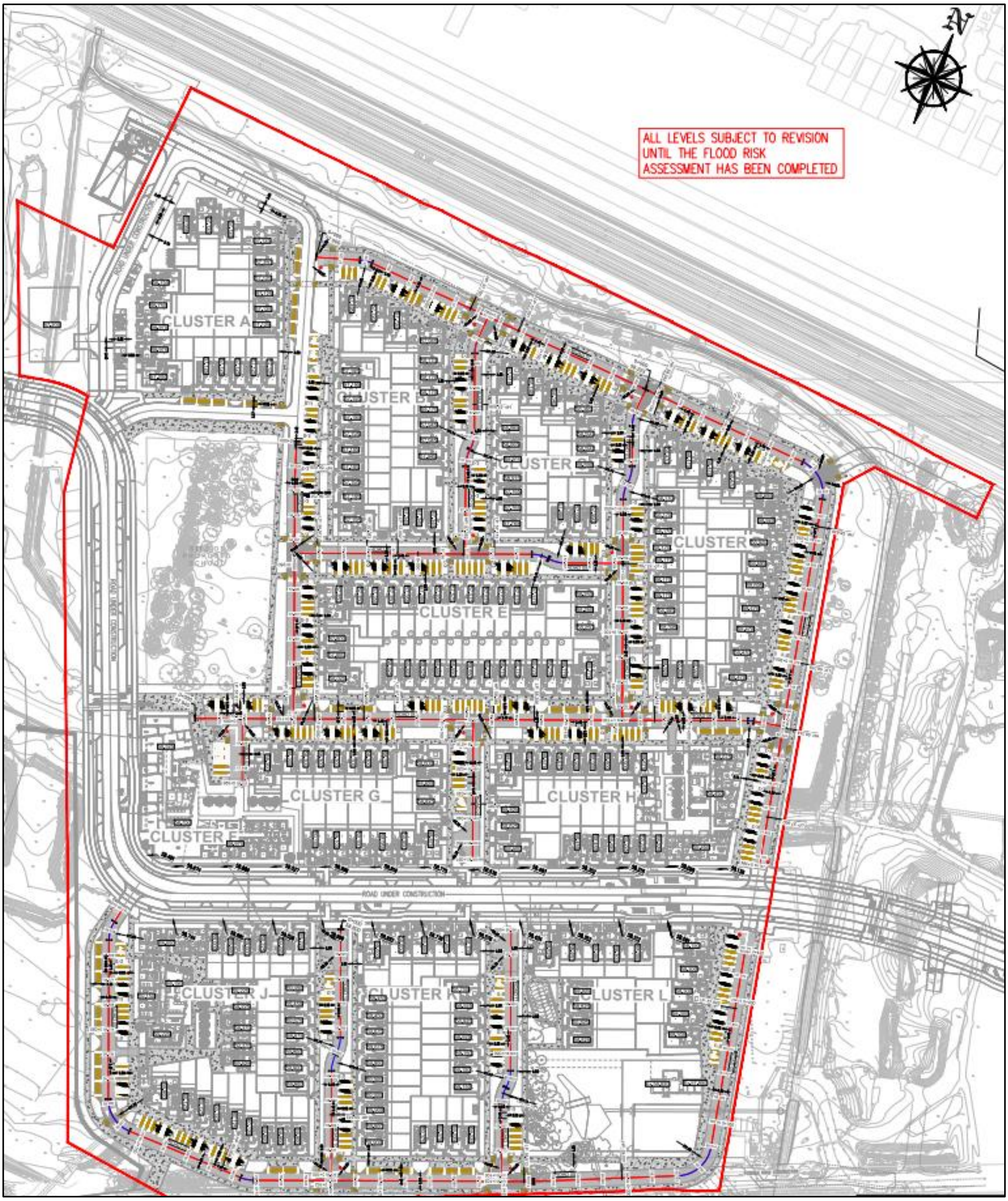


Figure 1-1 Proposed site layout

1.4. Report Structure

Section 2 of this report gives an overview of the study location and associated watercourses. Section 3 contains background information and initial assessment of flood risk. The detailed flood risk assessment, including hydrology and modelling, is outlined in Section 4. Site-specific mitigation measures are provided in Section 5 and the Justification Test is applied in Section 6. Conclusions are provided in Section 7.

2 Site Background

2.1. Location

The site is part of a planned development within Clonburris, a 280-hectare area in west Dublin, Ireland, situated between Lucan, Clondalkin, and Liffey Valley. Positioned in the northwestern part of Clonburris, it lies between the Dublin-Kildare railway line and the Grand Canal, approximately 12 kilometres from Dublin city centre. The site is bordered to the north by the railway line and Kilmahuddrick Stream, to the south by Grand Canal Way, to the west by greenfields until the Griffeen River, and to the east by Kilmahuddrick Stream and the R136.

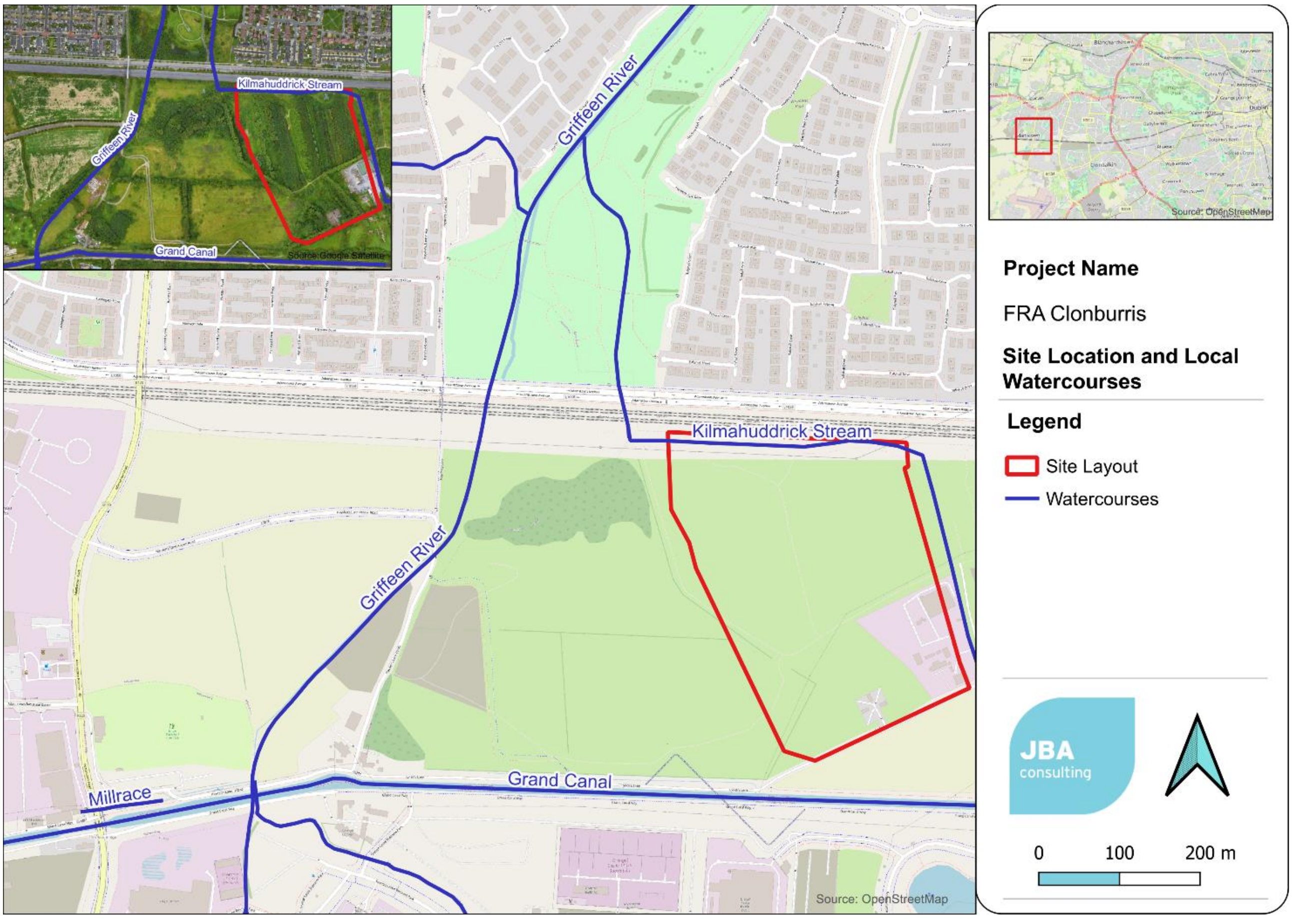


Figure 2-1 Site location and hydrological features

2.2. Hydrological features

Two watercourses and the Grand Canal are located adjacent to or within the development area.

The primary watercourse, the Griffeen River, flows from south to north, passing west of the site. It runs beneath the Grand Canal and the existing railway. North of the railway, the Griffeen River continues its course towards the Liffey River.

The Kilmahuddrick Stream, a local drainage channel, runs adjacent to the eastern boundary of the site but remains outside it. Along the southern boundary, it flows within the site, parallel to the railway. The stream passes through a culvert beneath the railway before continuing northward across a greenfield area, where it eventually joins the Griffeen River. Its flow primarily originates from regulated discharge from a pond located south of the Grand Canal, supplemented by additional stormwater runoff from the broader site.

The Grand Canal is situated on a raised embankment to the south of Site 4. The canal was opened to cargo boat traffic on February 2, 1779 and the first passenger service began in 1780 between Dublin and Sallins. The introduction of the railways brought about a decline in traffic, and the last boats were withdrawn in 1959-60. The canal is now operated as a leisure amenity and is owned and administered by Waterways Ireland. The section of the canal within the SDZ has 2 no. lock gates, a lock gate cottage and a unique form of overflow system which takes water from the west of the 11th lock, runs parallel to the north of the canal and re-enters the main waterbody to the east of the 9th lock. This system ensures that the canal does not overflow (the canal system and the associated Cappagh Overflow is a self-contained waterbody).

2.3. Site Topography

The general topography of the area is illustrated in Figure 2-2.

Within the site, elevations range from approximately 60 m in the southwestern part to 55 m in the northern part. The topography indicates a general slope from the southwestern to the northern part of the site, which may influence local drainage patterns and surface water interactions.

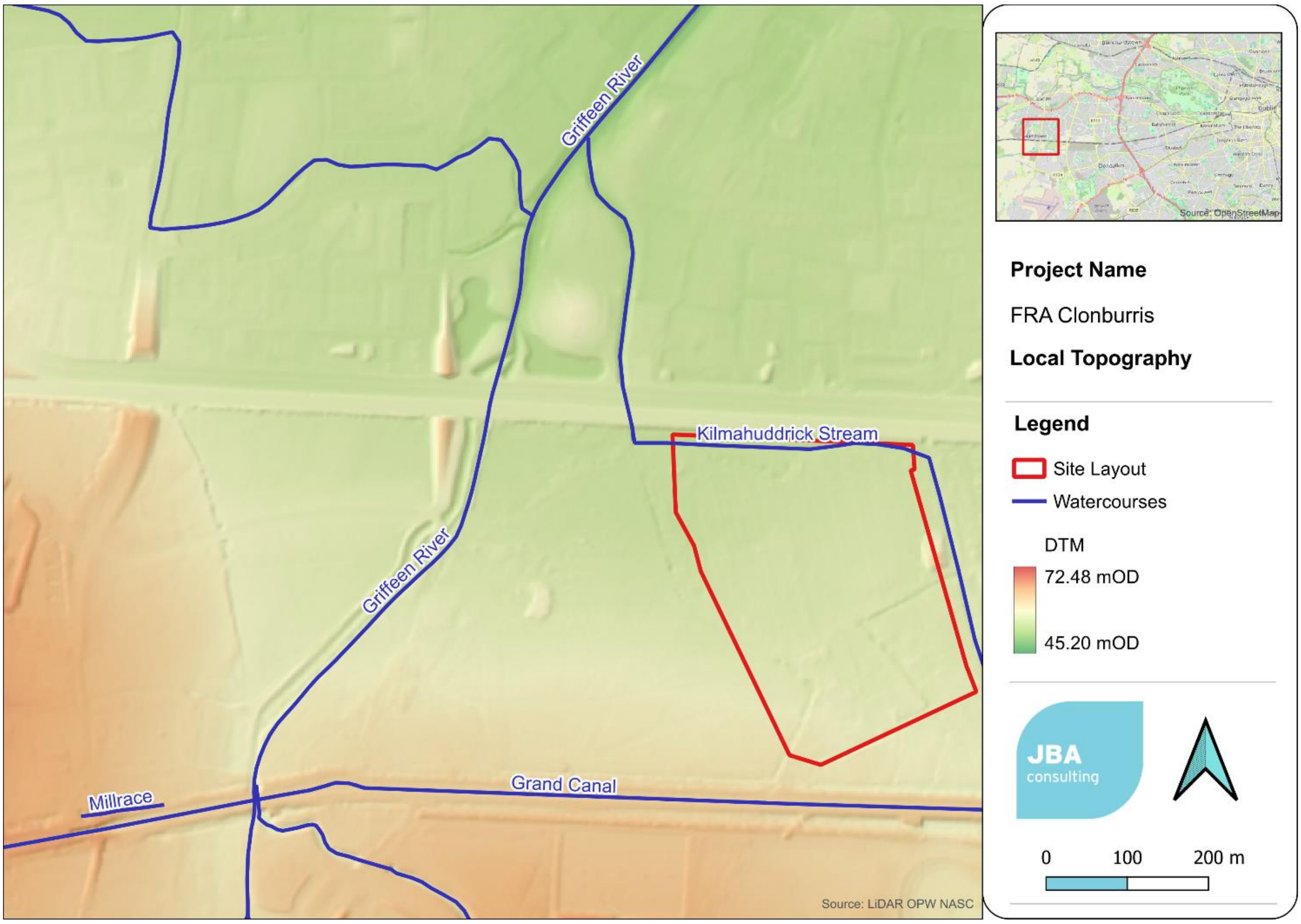


Figure 2-2 Site Topography

2.4. Site Geology

The site consists of a mix of deep well-drained mineral soils, which offer favourable drainage conditions for construction, and poorly drained mineral soils, which may require careful water management to prevent waterlogging. These factors are particularly important near watercourses, where hydrological dynamics influence land usability.

The site is located within a region of high groundwater vulnerability, making it particularly susceptible to contamination due to the presence of shallow soils and potential karstic features. This increases the risk of pollutants from construction activities or surface runoff infiltrating the groundwater system. As a result, any development within the outlined area must incorporate strict protective measures to safeguard the water table.

The combination of poorly drained soils in certain areas and high groundwater vulnerability presents a heightened risk of contamination if not properly managed. Sustainable development in this area requires careful planning to address both drainage challenges and groundwater protection, ensuring long-term environmental integrity and urban resilience.

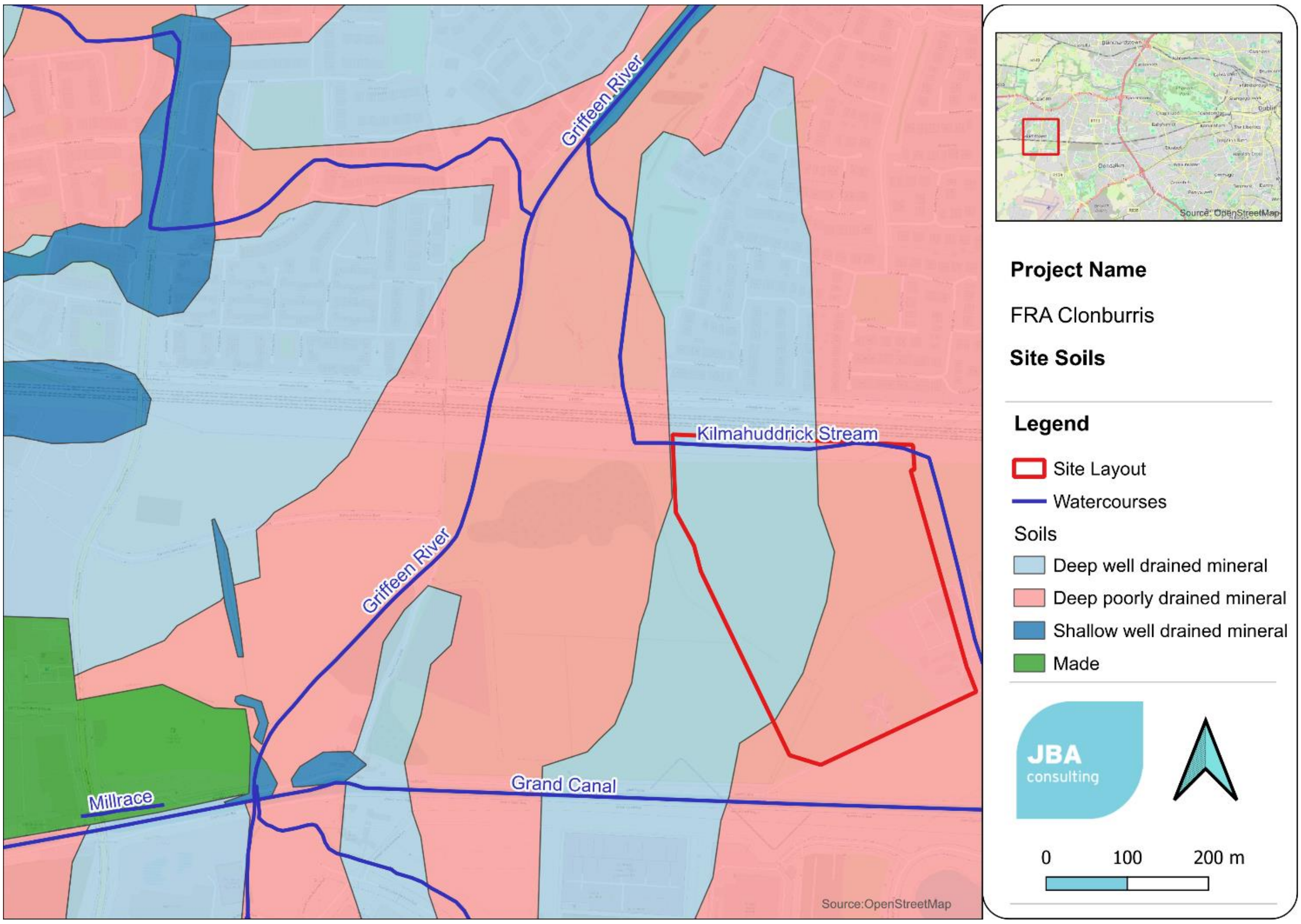


Figure 2-3 Soil maps

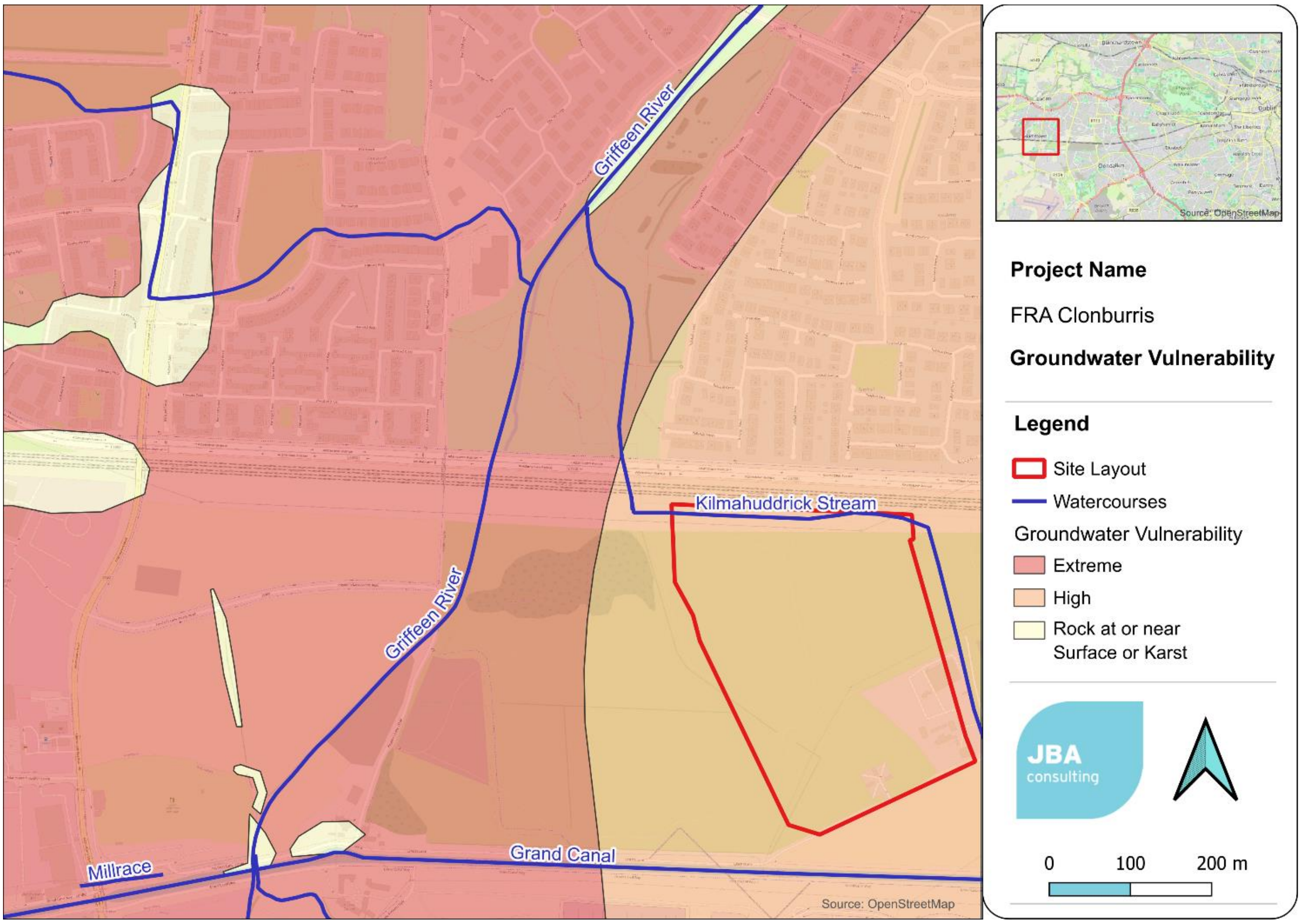


Figure 2-4 Groundwater Vulnerability

3 Flood Risk Identification

An assessment of the potential for, and scale of, flood risk at the site is conducted using historic and predictive information. This identifies any sources of potential flood risk to the site and reviews historic information. The findings from the flood risk identification stage of this FRA are provided in the following sections.

3.1. Flood History

To determine whether there has been any documented flood history at or close to the site, a variety of flood information sources were examined. This covers both standard internet searches and the OPWs national flood information portal, www.floodinfo.ie.

3.1.1. Floodinfo.ie

The OPW host a national flood information portal, www.floodinfo.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. Clonburris has been associated with significant flooding in its recent history, according with the reports and articles studied on www.floodinfo.ie (briefly specified below).

Among the many articles available on floodinfo.ie, the nearest recorded event is a singular occurrence with ID-3320, which has been addressed by various authors:

- Dublin Regional Inspectorate: "Selected Floods in the Griffeen Catchment, January 2005," which states, "The flood on 15th November 2002 was not as significant as those recorded on 6th November 2000 and 12th June 1993;
- J.B. Barry and Partners Ltd.: "Report on Flood Event 5/6th November 2000 in the River Griffeen Catchment," March 2001;
- South Dublin Country Council "Report on Flooding 5th & 6th November, 2000".

It is important to note that these events did not occur near the site. Figure 3-1 shows the location of the closest flood events extracted from floodinfo.ie.

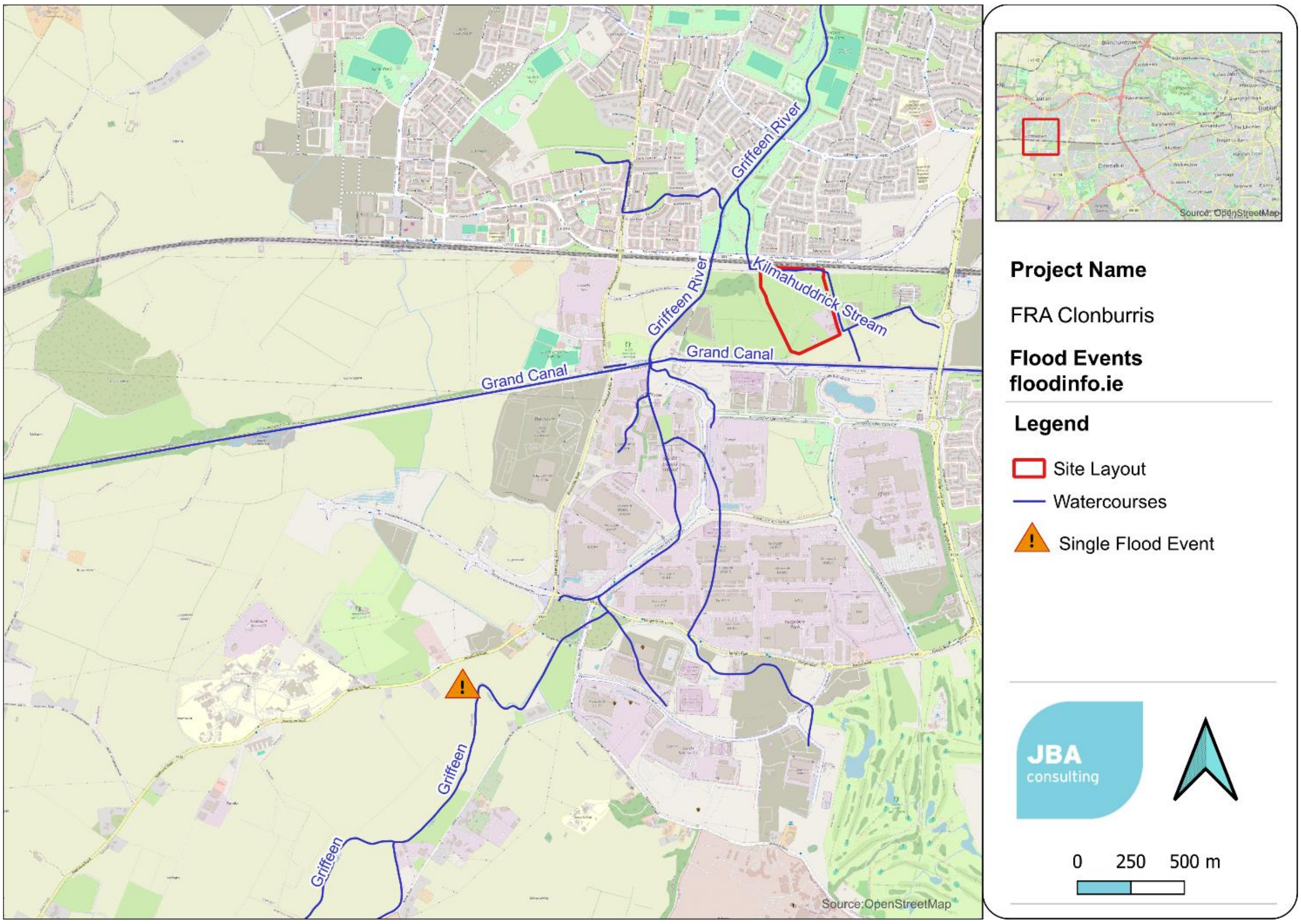


Figure 3-1 Past flood events (source www.floodinfo.ie)

3.1.2. Internet Searches

An internet search was conducted to gather information about whether the existing site was affected by flooding previously.

Flooding of residential and commercial properties occurred in lower catchment at Lucan Village, in the mid-catchment at the Old Forge, Grange Manor and Finnstown housing developments and in the upstream catchment at College Lane/Aylmer Road and at the Newcastle Treatment Works.

Therefore, we can affirm that the area of interest for this project is not among the areas often affected in the past.

3.2. Predictive Flooding

The local area has been subject to the CFRAM study which has been used to generate flood mapping for SDCC plans:

- Catchment Flood Risk Assessment and Management (CFRAM) Study
- South Dublin County Development Plan 2022-2028
- Clonburris SDZ - Strategic Flood Risk Assessment (September 2017)

3.2.1. Catchment Flood Risk Assessment and Management (CFRAM) Study

The nationwide Catchment Flood Risk Assessment and Management (CFRAM) program carried out to assess and map the country's river systems to identify areas at risk of significant flooding. The predictive flood risk mapping under the CFRAM program was developed using hydraulic modelling conducted as part of the study. These hydraulic models provided flood level predictions for various fluvial and tidal events, which were used to map flood extents for the 10% Annual Exceedance Probability (AEP) event, the 1% AEP event, and the 0.1% AEP event. The mapping shown in this section is taken from www.floodinfo.ie.

As shown in Figure 3-2, the site remains unaffected by flooding under all three present day scenarios. Limited flooding is observed to the west of the site during the 0.1% AEP event.

It is noted that the CFRAM does not specifically model or provide flood outlines for the Kilmahuddrick Stream.

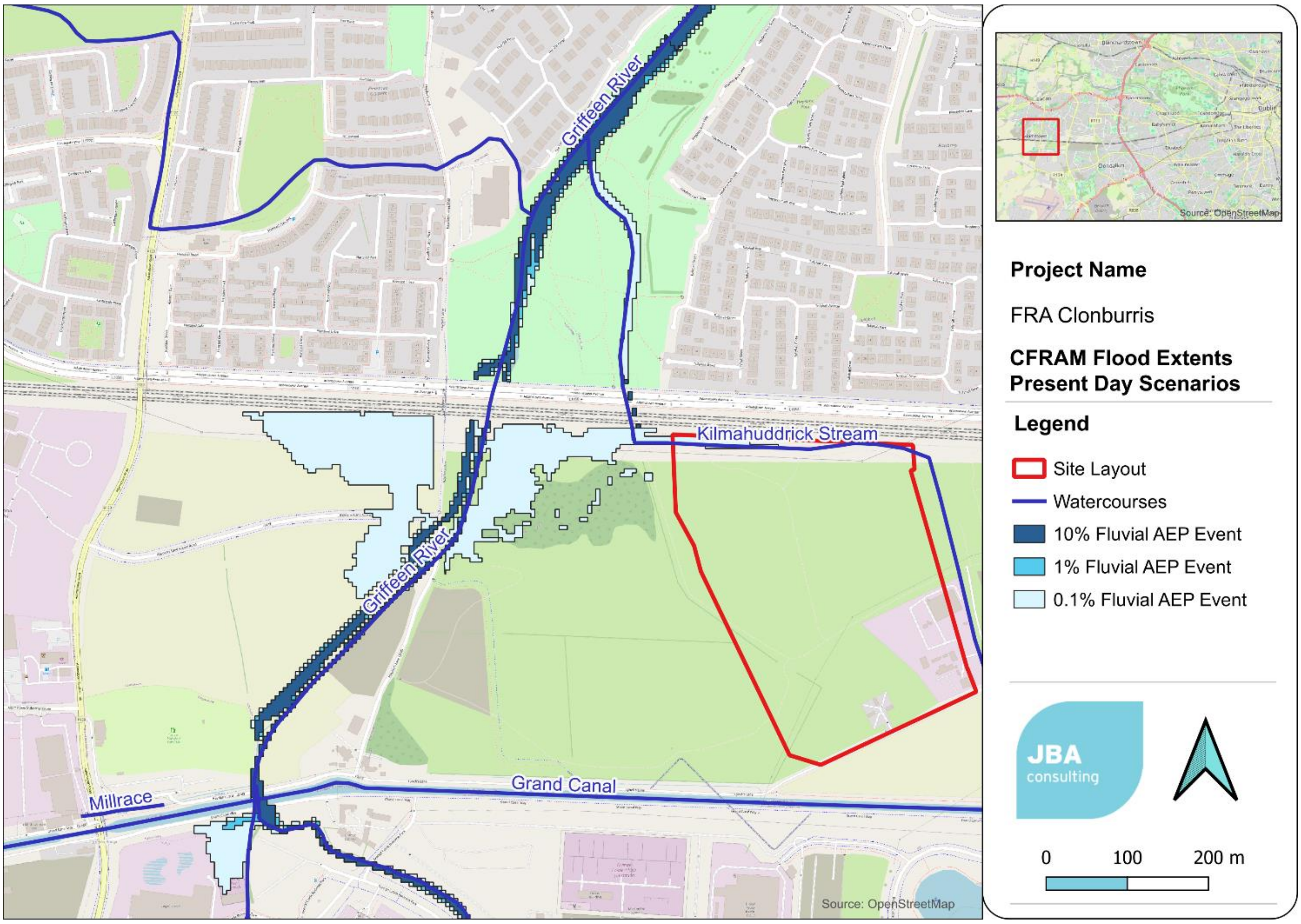


Figure 3-2 CFRAM Fluvial Flood Extents – Present Day

Figure 3-3, illustrates the flood extent under the Mid-Range Future Scenario, accounting for potential flow increases due to climate change. The site is marginally flooded for the 1% AEP event while the northern part of the site gets flooded for 0.1% AEP event.

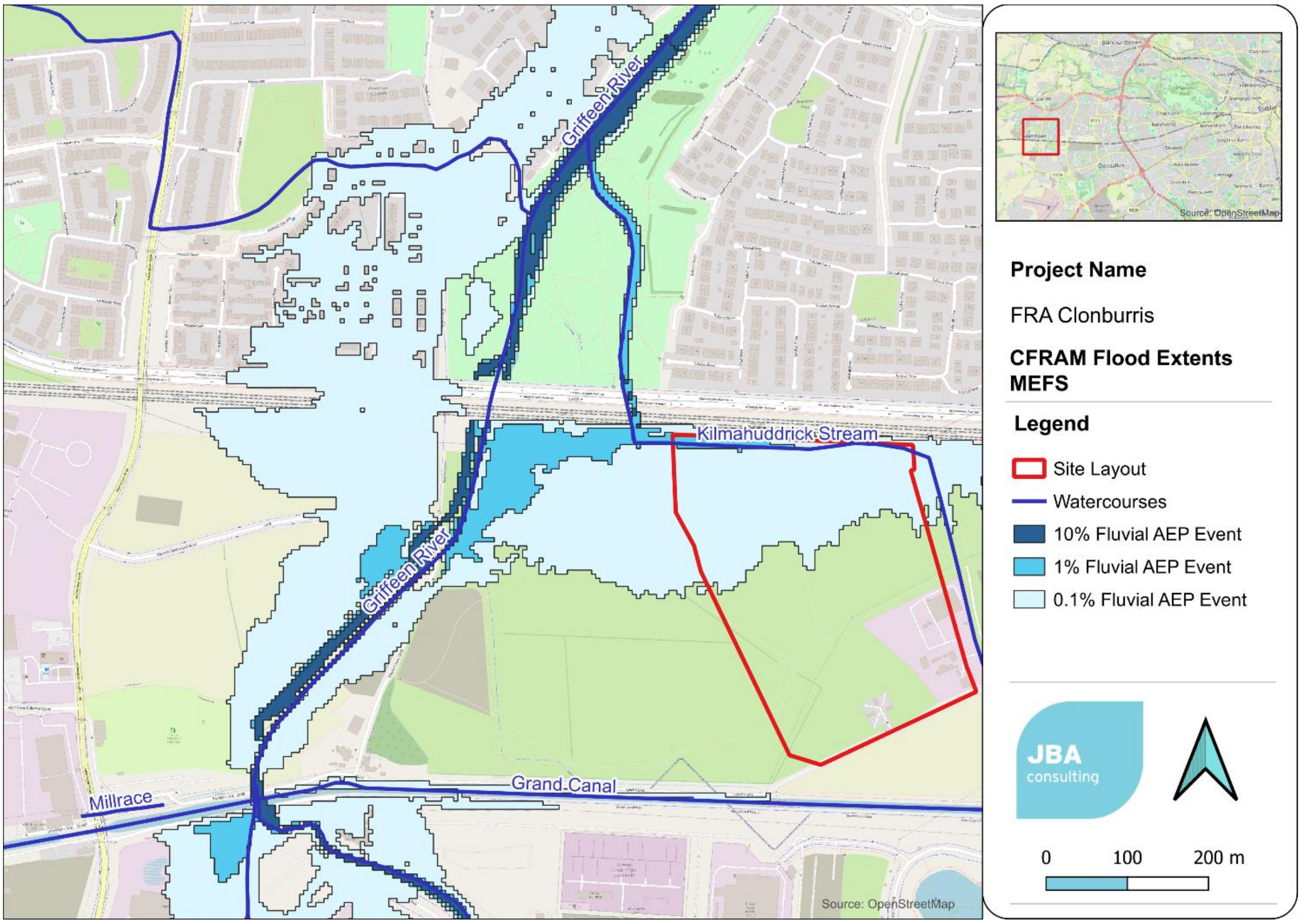


Figure 3-3 CFRAM Flood Extents – MRFS

Figure 3-4 illustrates the flood extent under the High End Future Scenario, accounting for potential flow increases due to climate change. The site is partially flooded to the north for the 1% AEP event while a substantial part of the site is flooded for 0.1% AEP event. Overall more than half the site is impacted.

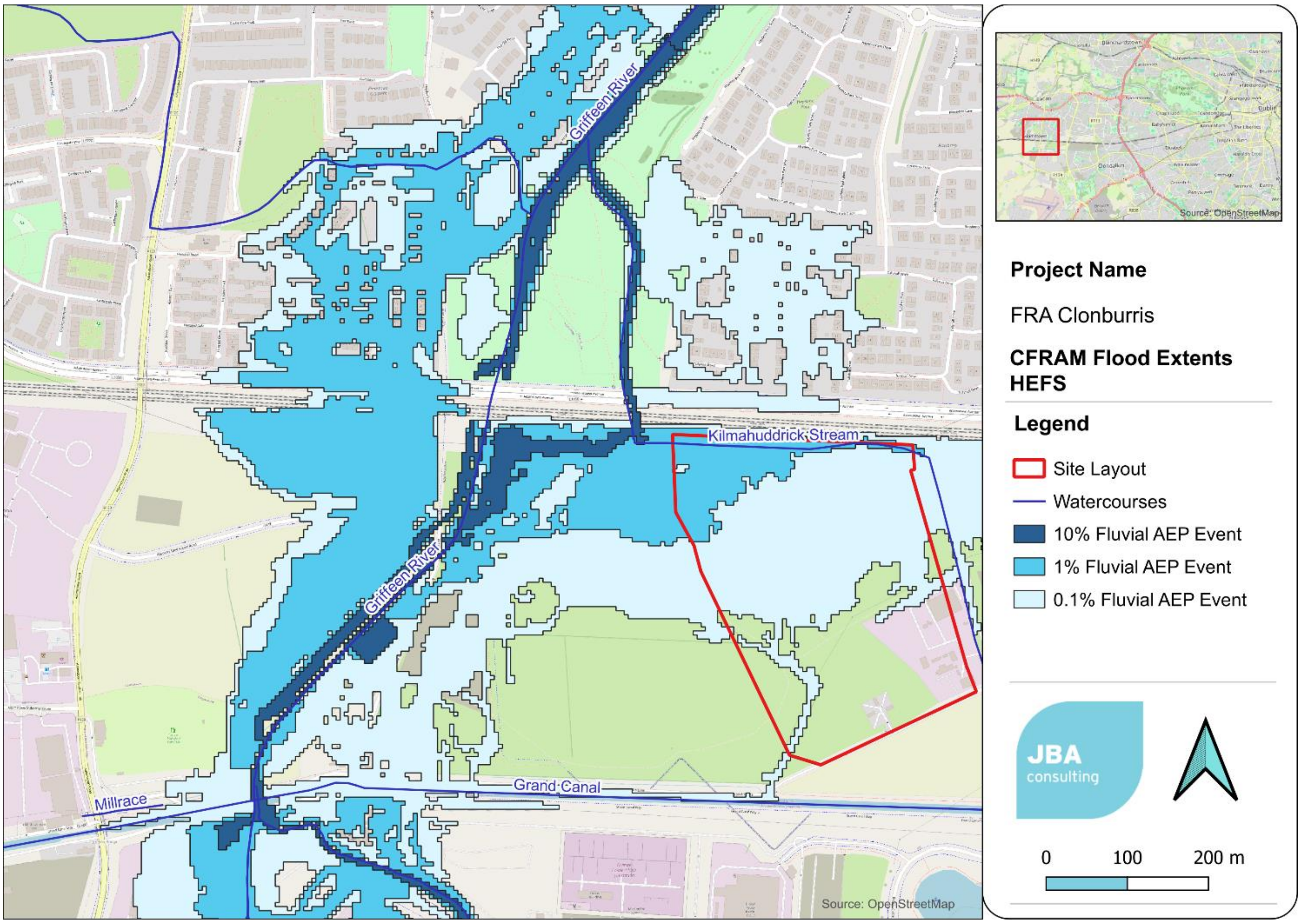


Figure 3-4 CFRAM Flood Extents – HEFS

3.1.1. Clonburris SDZ - Strategic Flood Risk Assessment

The Clonburris Strategic Development Zone (SDZ) Planning Scheme includes a Strategic Flood Risk Assessment (SFRA) that evaluates potential flood risks within the development area. According to the SFRA which used the current scenario 1% and 0.1% AEP CFRAM extents, there is no overlap between zoned undeveloped lands designated for vulnerable uses and areas classified as Flood Zone A or B.

Figure 3-5: Clonburris SDZ Flood Zone Mapping

The Clonburris SDZ SFRA is consistent with the CFRAM and indicates that the proposed development is not situated within areas identified as having a high or moderate probability of flooding. However, it's essential to implement appropriate surface water management strategies to mitigate any potential flood risks, especially considering the site's proximity to watercourses such as the Griffeen River and the Grand Canal.

The Planning Scheme outlines that prior to the commencement of development, strategic district-level measures and detailed designs should be prepared by the developer(s) and agreed upon with South Dublin County Council through a Surface Water Management Plan to implement the prepared Surface Water Strategy.

3.1.1. South Dublin County Development Plan SFRA

The Strategic Flood Risk Assessment (SFRA) for the South Dublin County Development Plan provides a detailed evaluation of flood risks across the county to support sustainable development and land-use planning. The assessment identifies areas prone to flooding and ensures that flood risk management is a key consideration in the development process.

The SFRA serves as a framework for guiding development decisions, ensuring that new developments are appropriately located and resilient to potential flooding. It incorporates flood zone mapping to help planners and developers assess risk levels for proposed projects.

It categorizes flood-prone areas into Flood Zones A, B, and C. This classification is based on data from the Eastern Catchment Flood Risk Assessment and Management (CFRAM). However, unlike standard practice, which typically relies on present-day scenario flood extents for zoning, this assessment has applied the High-End Future Scenario (HEFS) results. The use of HEFS flood extents for defining Flood Zones A and B is a precautionary approach and usually climate change is considered separately to current scenario risk.

Figure 3-6, extracted from the study, illustrates the flood mapping for the Clonburris Strategic Development Zone.

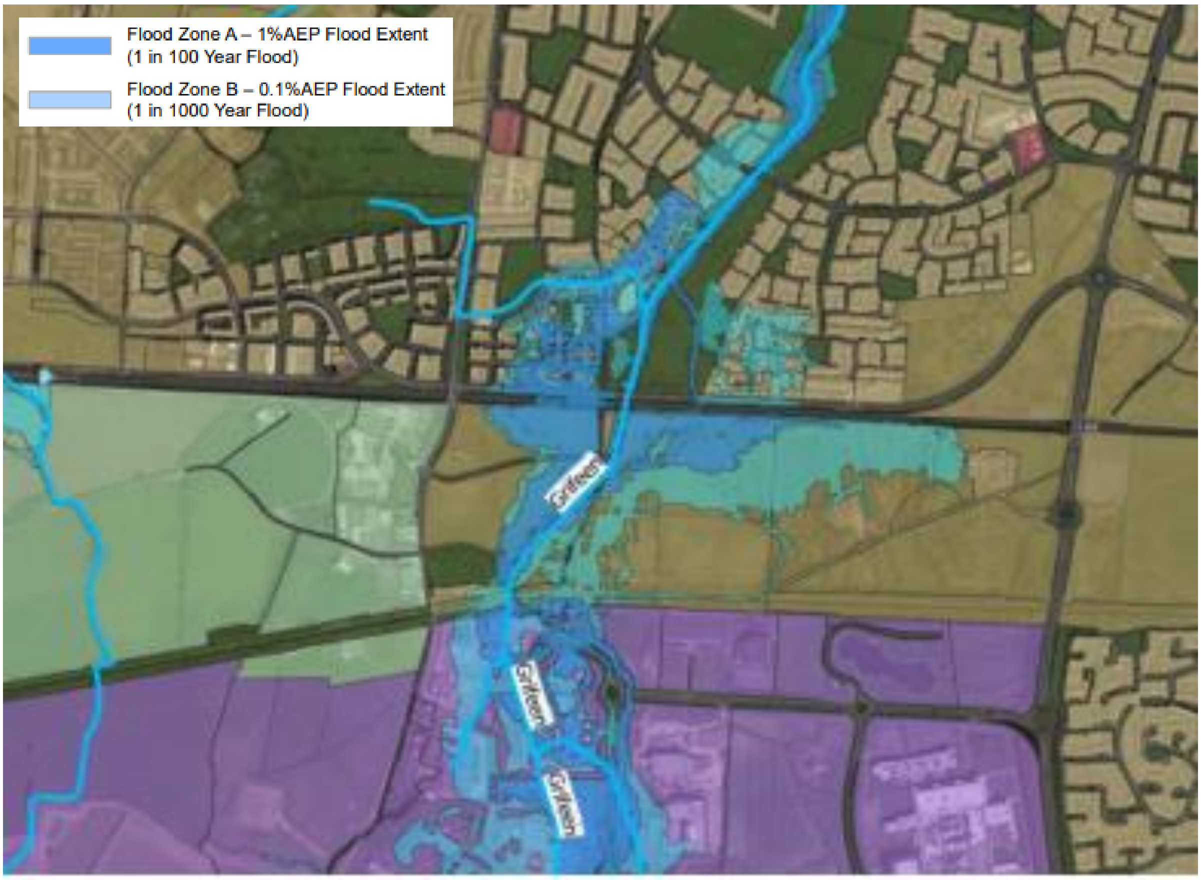


Figure 3-6 South Dublin County Development Plan SFRA Flood Zones (CFRAM HEFS)

3.2. Flood Sources

The initial stage of a Flood Risk Assessment requires the identification and consideration of probable sources of flooding. Following the initial phase of this Flood Risk Assessment, it is possible to summarise the level of potential risk posed by each source of flooding. The flood sources are described below.

3.2.1. Tidal

The site is located at a considerable distance from the coast, rendering it unaffected by tidal fluctuations, and there are no recorded tidal influences in the area.

3.2.2. Fluvial

Fluvial flooding is the dominant risk for the site, as shown in CFRAM mapping. While the site remains unaffected by flooding for the present-day scenarios, the northern part is significantly impacted under the 0.1% AEP event under the Mid-Range Future Scenario and the 1% and 0.1% under the High End Future Scenarios.

To confirm the flood risk presented by Griffeen River and allow a more detailed analysis of the proposed site, a hydraulic model has been developed. The model build is outlined in Section 4.

CFRAM data does not include the Kilmahuddrick Stream. To confirm the flood risk associated with this watercourse and enable a more detailed analysis of the proposed development, the hydraulic model built to evaluate the fluvial risk of the Griffeen also includes a detailed representation of this stream.

3.2.3. Pluvial/ Surface Water

Pluvial or surface water flooding occurs as a result of rainfall-generated flows that arise before run-off can enter a watercourse or sewer. The OPW PFRA pluvial mapping had been used under the Clonburris SDZ SFRA, however the PFRA mapping has now been removed from use and is no longer relevant.

Since Clonburris SDZ will be subject to comprehensive development (from a greenfield state) it was subject to its own Surface Water Strategy which will manage the risk of pluvial/surface water flooding. As such the previous maps, as well as being removed from service are also no longer relevant and stormwater/pluvial flood risk is managed under the overarching SWP which feeds into the site based management methods, as summarised in Section 5.2.3.

3.2.4. Grand Canal Breach

The canal is situated on a raised embankment and therefore has the potential for breach/overtopping which would then result in lands adjacent to the canal being at residual risk of flooding. The likelihood and extent of breach of this raised canal has been considered under the SFRA for the Clonburris SDZ. The embankment appeared to be in good condition during the site visits for the FRA and the likelihood of breach is low, as was also confirmed under the SFRA. Given the unlikely scenario of breach the SFRA confirmed that the area will remain accessible to emergency services given the shallow depths expected to occur and risk to life is low. There is limited potential to inundate properties and much of the flooding expected to be below a standard threshold level. Regular monitoring by Waterways Ireland of the embankment was recommended by the SFRA to ensure that this risk is managed. Risk of canal breach has not been considered further and as any FFLs/development levels will be guided by extreme levels in the Kilmahuddrick Stream this will also act to raise development levels up above potential breach level. Canal breach is therefore not an issue that is explored in more detail under this FRA.

3.2.5. Groundwater

GSI groundwater vulnerability mapping indicated a high risk to the groundwater at the site, there is no record of historic groundwater flooding in the area and the GSI Groundwater flood mapping does not return any predicted groundwater flooding in the area.

The risk of groundwater flooding has been screened out at this stage.

4 Hydrology & Hydraulics

To assist in estimating the potential flood risk to the proposed development this section will provide hydrological estimates and modelled flood extents as part of a detailed assessment. To further investigate flood risk arising from the Griffeen River and Kilmahuddrick Stream an extensive hydrological analysis was carried out and a detailed hydraulic model was built to include all the hydrological features which may have an impact on flood risk for the site. The model enables testing of design scenarios and an evaluation of risk under post development condition.

4.1. Topographical Data

All available data, including cross-sectional surveys, LiDAR, and site survey, were utilised to accurately represent the topography within the model domain and any structural features that could influence flow paths or conveyance, such as embankments, roads, and culverts.

The cross-sectional survey from the CFRAM project was used to define channel capacities and structural elements for the Griffeen River along the modelled sector.

However, the CFRAM survey was complemented with a new survey (December 2024) which captures all new culverts installed on Griffeen River as part of the under-construction road project but also includes updated measurements at the structures conveying flow under the railway. The survey was deemed necessary due to the alterations in hydraulic conditions resulting from the development of the road infrastructure in the area.

This survey also included cross-sections of the Kilmahuddrick Stream and its culvert which conveys flow under the railway. This stream was not covered in the CFRAM survey or hydraulic model.

The 2-metre resolution LiDAR data, sourced from the CFRAM project and downloaded from the GSI Open Topographic Data Viewer, covers the entire model domain. The LiDAR data was processed using GIS tools to stamp the channel capacities and develop a 2D model that incorporates all hydraulic elements, allowing for the simulation of all potential flooding sources.

4.2. Hydrology

Peak flows and hydrographs for the Griffeen River and Kilmahuddrick Stream were determined based on new hydrological estimations performed by JBA to be used as inflow boundary conditions in the model.

The Griffeen River flows in a northerly direction west of the site. The stream is culverted under the Grand Canal. At about 100 m downstream of the Canal, the river channel splits into two parallel branches, before crossing Hayden’s Lane. It continues northward, passing under the railway line through two culverts before the branches rejoin and flow further north through the existing Griffeen Park.

The Kilmahuddrick Stream runs along eastern and northern site boundary. It is culverted underneath the railway line and discharges into the Griffeen River. Its flow is primarily influenced by the surface water attenuation pond located south of the Grand Canal, which is subject to an restricted outflow.

4.2.1. Catchment Characteristics

The catchments size varies from 30.46km^2 at the downstream to 24.80km^2 at the upstream on the Griffeen. Urbanised areas are mostly in the lower reaches. The bedrock for the catchment is predominantly a mix of greywacke & shale and limestone. The soils are extremely mixed. The land cover primarily consists of pastures, non-irrigated arable land, and industrial or commercial units. There is also some sport and leisure facilities, road and rail networks and associated land, green urban areas, discontinuous urban fabric, coniferous forest, complex cultivation patterns, and an airport.

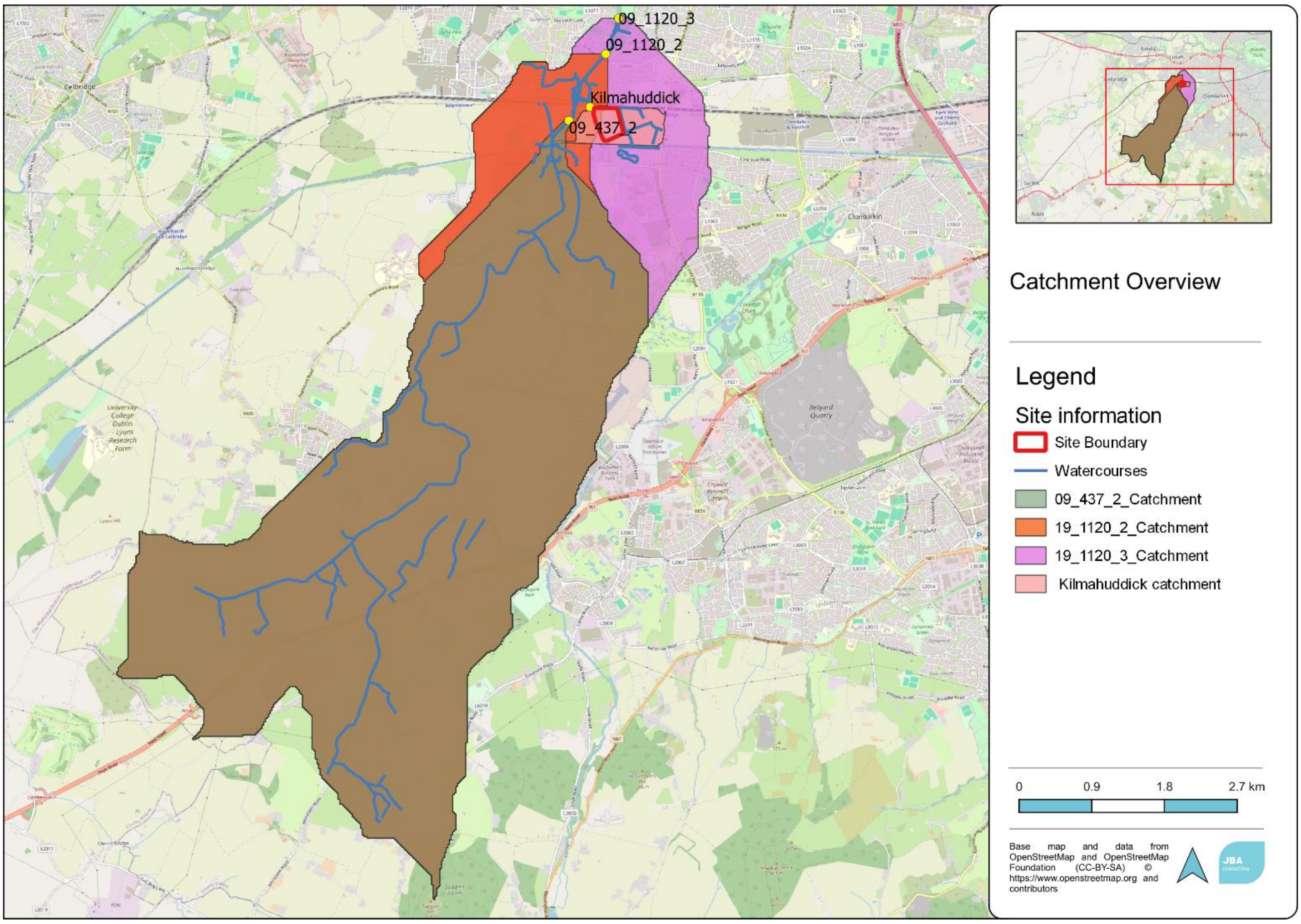


Figure 4-1 Catchment overview

Table 4-1 lists the parameters pertinent to the catchment and used flow estimations.

Table 4-1 Final catchment descriptors at each HEP.

Descriptor	HEP_1	HEP_2	HEP_3	HEP_4
FSU Node	09_437_2	09_1120_2	09_1120_3	Kilmahuddrick
Area	24.80	26.93	30.46	0.49
$SAAR_{1961-90}$	764	761	757	764
$SAAR_{1971-00}$	756	749	749	756
$SAAR_{1981-10}$	771	782	782	771
$SAAR_{1991-20}$	799	795	795	799
FARL	1	1	1	1
BFI Soil	0.63	0.64	0.65	0.63
URBEXT	0.12	0.13	0.16	0.17
MSL	12.19	13.16	13.66	0.87
S1085	10.32	9.61	9.64	4.30
DrainD	0.99	0.99	0.89	3.84
ArtDrain2	0	0	0	0
Soil (number)	2 (100%)	2 (100%)	2 (100%)	2(100%)

4.2.2. Peak flows

To estimate peak flows the FSU method was chosen as it makes direct use of local, up to date peak flow records. Maximum flow values are presented for the present-day, MRFS and HEFS scenarios in Table 4-2, Table 4-3 and Table 4-4.

Table 4-2 Present - day peak flow estimates (m^3/s)

HEP code	50%	20%	10%	5%	2%	1%	0.1%
09_437_2	5.83	7.64	8.92	10.14	12.01	13.53	19.65
09_1120_2	6.10	7.99	9.33	10.61	12.57	14.15	20.56
09_1120_3	6.46	8.46	9.88	11.24	13.31	14.99	21.77
Kilmahuddrick	0.18	0.27	0.33	0.40	0.51	0.61	1.08

Table 4-3 Climate change (MRFS) peak flow estimates (m^3/s)

HEP code	50%	20%	10%	5%	2%	1%	0.1%
09_437_2	7.00	9.16	10.70	12.17	14.41	16.23	23.58
09_1120_2	7.32	9.59	11.20	12.74	15.08	16.98	24.67
09_1120_3	7.75	10.16	11.86	13.49	15.97	17.98	26.12
Kilmahuddrick	0.22	0.32	0.39	0.48	0.61	0.73	1.30

Table 4-4 Climate change (HEFS) peak flow estimates (m^3/s)

HEP code	50%	20%	10%	5%	2%	1%	0.1%
09_437_2	7.58	9.93	11.60	13.19	15.61	17.58	25.54
09_1120_2	7.93	10.39	12.13	13.80	16.34	18.40	26.72
09_1120_3	8.40	11.00	12.85	14.61	17.30	19.48	28.30
Kilmahuddrick	0.24	0.35	0.43	0.52	0.66	0.79	1.41

4.2.3. Hydrograph shape

To generate hydrograph shapes, the FSU method have been used. Figure 4-2 and Figure 4-3 present the inflow hydrographs for the most upstream node of Griffeen River and for the Kilmahuddrick Stream.

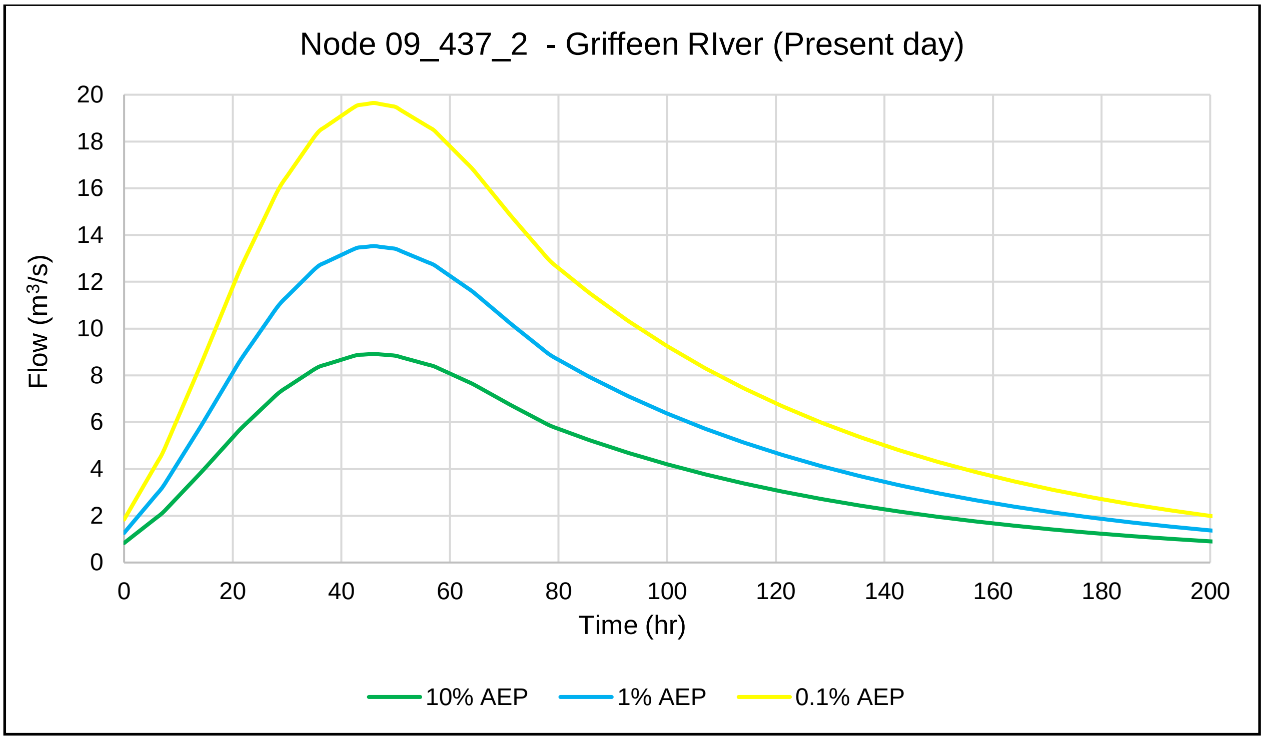


Figure 4-2 Hydrographs for Griffeen River, node 09_437_2

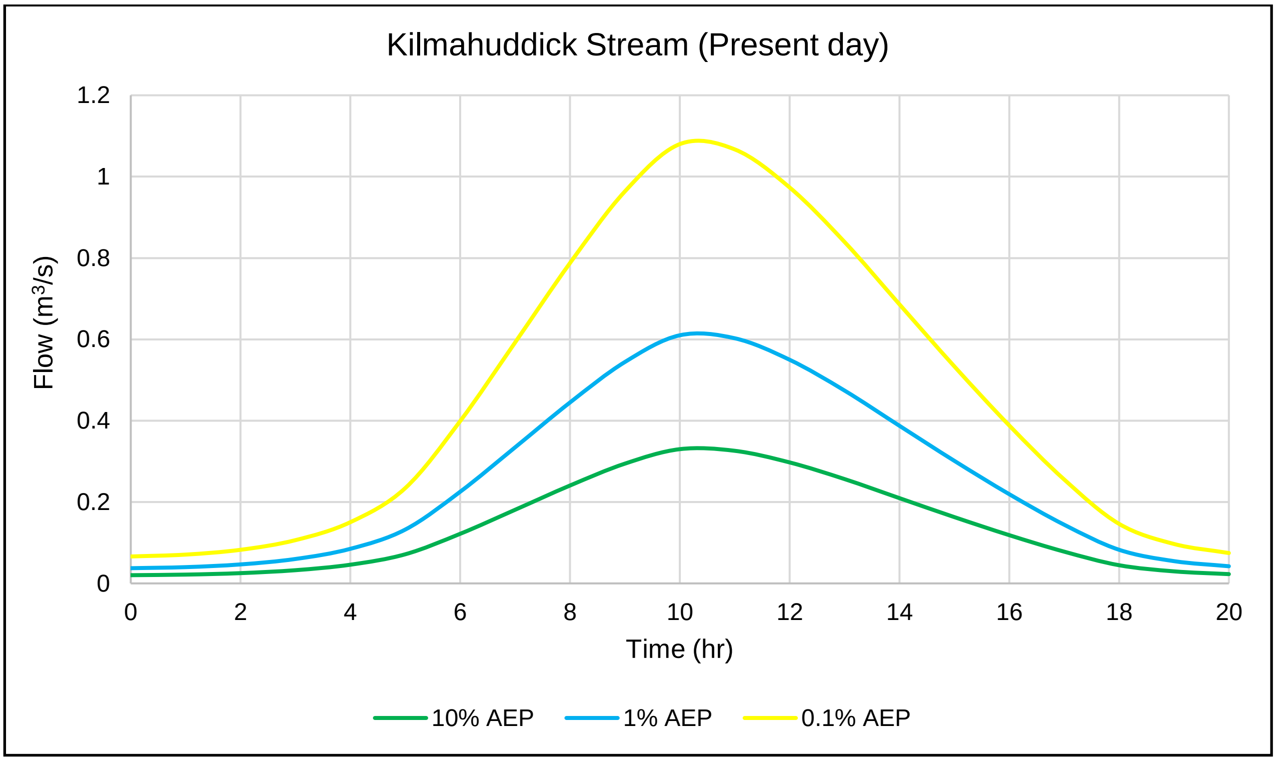


Figure 4-3 Hydrographs for Kilmahuddrick Stream

4.2.4. Comparison with CFRAM

The differences in peak flow values between the Eastern CFRAM Study (HA09 Hydrology Report) and the JBA Hydrological Study result from several key factors related to QMED estimation, flood growth curve selection, and climate change adjustments.

QMED Estimation Differences

- The JBA study used the Lucan gauge as a pivotal site, which is closer to the Hydrological Estimation Points (HEPs) and is hydrologically similar to them. This ensures a more reliable QMED estimation compared to the CFRAM study.
- The JBA study estimated QMED at 6.46 m^3/s, while the CFRAM study used a lower value of 6.21 m^3/s.

Choice of Flood Growth Curve

- JBA applied the FSU method, which includes the most up-to-date gauging stations, resulting in a more representative and accurate growth curve.
- The CFRAM study relied on older AMAX data and used a pooling group that only included ECFRAM catchments, leading to potential overestimations in peak flows.

Climate Change Flow Calculation Differences

- CFRAM applied significantly higher climate change uplifts (88% for MRFS and 166% for HEFS) based on an increase of the URBEXT by a factor of 2.7 and 11.8 respectively
- Considering the URBEXT impacts on a base by case basis, adjusting a climate change scenario by 88% and 166% at this location was not considered to be an appropriate or representative increase given that SDCC SuDS policy will help to ensure that future increases in development will limit runoff to greenfield rates and also incorporate nature based solutions, making them far more resilient to impacts of climate change. URBEXT itself is not a climate parameter it is related to impermeable land cover and increases in runoff.
- JBA did investigate sensitivity to future development and ran the 0.1% AEP with a 40% climate change flow increase. This would align more closely with an assessment of a further +10% increase in flow as a result of the footprint of planned development in the CDP increasing the URBEXT parameter. The adjustment does not present any significant issue to the proposed design of the park, housing or other infrastructure. The investigation of sensitivity did not conclude that any further adjustment of MRFS and HEFS climate change scenarios due to URBEXT was necessary.
- As such, JBA followed OPW's Sectoral Adaptation Plan that is also stated in the SDCC Development Plan SFRA, applying a 20% increase for MRFS and 30% for HEFS and making no adjustments to URBEXT.

Table 4-5 shows a comparison between the peak flow values estimated within JBA Hydrological Study and the Eastern CFRAM Study for Node 09_1120_3 which is representative for the proposed site.

Table 4-5 Comparison of peak flows, JBA estimates versus CFRAM

Scenario	Present day		MRFS		HEFS	
	1%AEP	0.10%AEP	1%AEP	0.10%AEP	1%AEP	0.10%AEP
JBA Peak Flow (m3/s)	14.99	21.77	17.98	26.12	19.48	28.30
CFRAM Peak Flow (m3/s)	18.09	29.68	33.98	55.76	48.30	79.25

4.3. Hydraulics

4.3.1. Software and modelling domain

The hydraulic model has been run for multiple baseline scenarios to identify and analyse the changes in flood risk caused by the alterations due to the under construction road project which is crossing the main channel and floodplain of Griffeen River. More details on modelled scenarios are detailed in the following section. Where appropriate, the need for further post-development modelling was identified, and thereafter the necessary design approach.

A 2D HEC-RAS hydrodynamic model was developed to evaluate the flood risk to the site due to the Griffeen River and the Kilmahuddrick Stream, enabling a detailed representation of flood extents and water depths within and adjacent to the site boundary. The model encompasses an appropriate calculation domain to account for both hydrological features that may contribute to flood risk for the site.

HEC-RAS is software designed to perform one-dimensional steady flow as well as one- and two-dimensional unsteady flow simulations for complex river networks, including natural and constructed channels, floodplains, levee-protected areas, dam operations, and breach scenarios. The software facilitates efficient setup and analysis of multiple scenarios and outputs. It features a user-friendly interface, GIS compatibility, extensive data entry options, advanced hydraulic analysis tools, and robust data storage and management capabilities.

4.3.2. Modelled scenarios

The approach proposed by JBA involves a comprehensive assessment that accounts for various baseline conditions, which evolved during the development of this flood risk assessment due to ongoing road construction. The road is being constructed over the Griffeen River, which also runs through the floodplain and the site. Consequently, a new baseline scenario accounts for these changes, incorporating newly in-channel surveyed data, which was modelled in comparison with the previous baseline, which relies on the CFRAM survey data available in the OPW Cross-Sectional Survey Data Finder repository.

Furthermore, a post-development scenario has been developed to analyse the additional flood risk introduced by the residential development and to assess the effectiveness of the proposed compensation measures. To achieve the design levels for the site, the post-development scenario has also been tested with multiple blockage scenarios to iteratively identify the worst-case conditions and make necessary design level adjustments.

Since the proposed development includes a road crossing over the Kilmahuddrick Stream, the post-development model was run for increased flows in compliance with Section 50 requirements. Through an iterative process, the optimal culvert size was determined and integrated into the post-development model.

Table 5-1 lists all scenarios considered as part of the detailed hydraulic modelling. These scenarios are largely described in the following subchapters and aim to provide a comprehensive understanding of flood risk and to inform appropriate recommendations for mitigation measures and design works for the proposed development.

Table 4-6 Modelled Scenarios

Modelled scenario	Scenario description and modelled events
Old baseline (Before the road construction)	This scenario is built upon the available LiDAR and in-channel survey data from CFRAM and new survey data on Kilmahuddrick Stream. The purpose of this scenario is to redefine the predicted CFRAM flood risk with up-to-date hydrology flow estimations. Modelled events: • 1%AEP • 1%AEP (MRFS) • 1%AEP (HEFS) • 0.1% AEP • 0.1% AEP (MRFS) • 0.1% AEP (HEFS)
Current baseline (After the road construction)	Accommodates all the changes given by the ongoing road works such as: new culverts scheme, channel alterations and ground raising for road embankment across the floodplain. Modelled events: • 1%AEP • 1%AEP (MRFS) • 1%AEP (HEFS) • 0.1% AEP • 0.1% AEP (MRFS) • 0.1% AEP (HEFS)
Post-development (no compensatory storage mitigation)	This scenario uses the current baseline conditions and introduces the terrain modifications due to the proposed development (such as access and internal roads, buildings etc). Analyses the flood risk impacts caused by the development and identifies the appropriate mitigation measures. Modelled events: • 1%AEP • 0.1% AEP
Post-development and S50 compliance	Determines the Section 50 compliant design for the proposed culvert which conveys the Kilmahuddrick Stream flows under the site access road (part of the prosed development). Modelled event: • 1%AEP Climate Change + FSE (Section S50 flows)
Residual risks (Post-development conditions)	Accommodates multiple blockage scenarios to identify appropriate design levels for the site. Modelled events:

Modelled scenario	Scenario description and modelled events
	• 1%AEP • 1%AEP (HEFS)
Post-development FINAL (with compensatory storage mitigation)	Includes all elements and modifications introduced by the proposed development, including the Section 50 compliant structure and evaluates the effectiveness of the mitigation measures proposed to alleviate the impacts that might have resulted from the post-development runs. Modelled events: • 0.1% AEP

4.3.3. Old baseline scenario

The objective of this scenario was to redefine the CFRAM hazard maps using the same in-channel arrangement, similar to CFRAM but with updated flow estimates performed by JBA within this study for the Griffeen River. Also, this scenario was used to determine the flood risk for the site due to the Kilmahuddrick Stream which was unknown as it was not part of the CFRAM programme.

A comparison between the CFRAM flows and the updated flows used for modelling was provided in Section 4.2.

Figure 4-4, Figure 4-5 and Figure 4-6 illustrate the updated flood extents for 1%AEP event and 0.1%AEP event in baseline conditions, medium future range scenario and high-end future scenario.

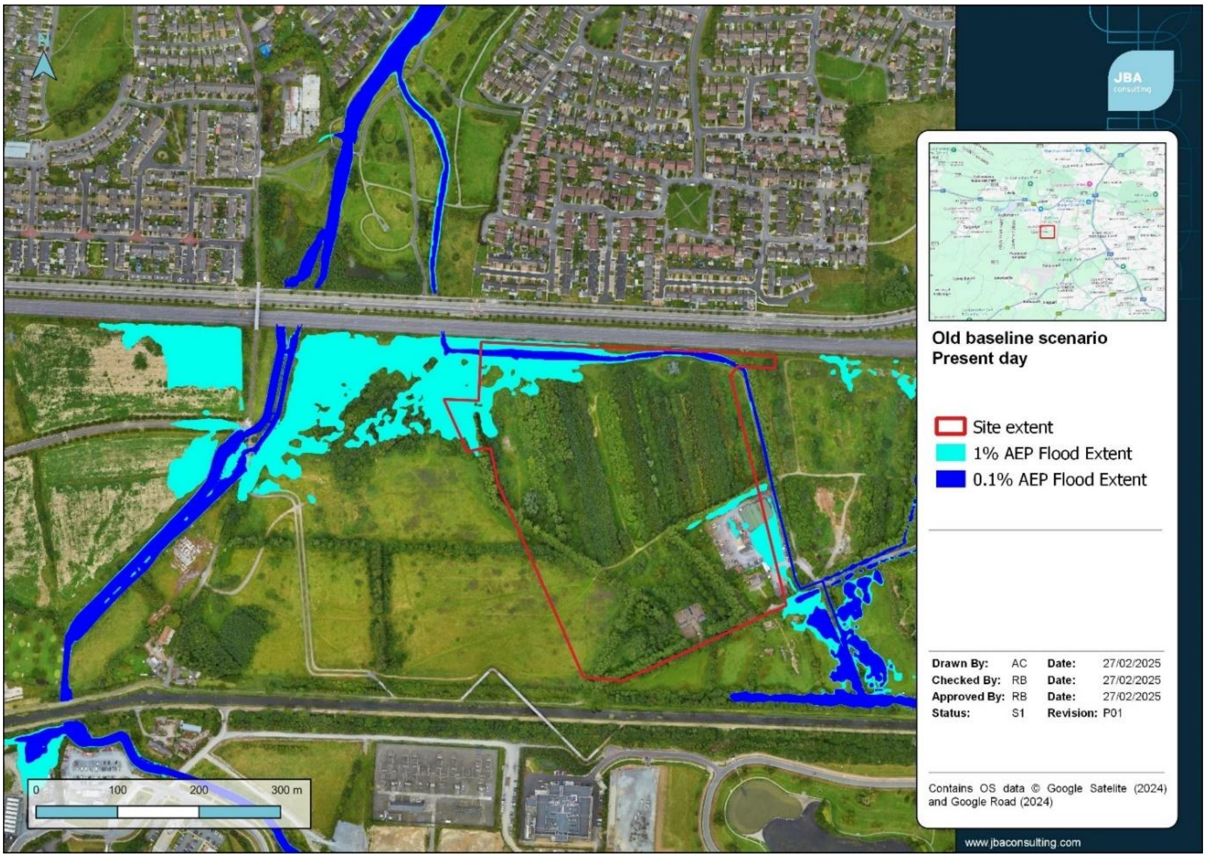


Figure 4-4 Flood extents for 1% AEP and 0.1% AEP (Present-day) - Old baseline scenario

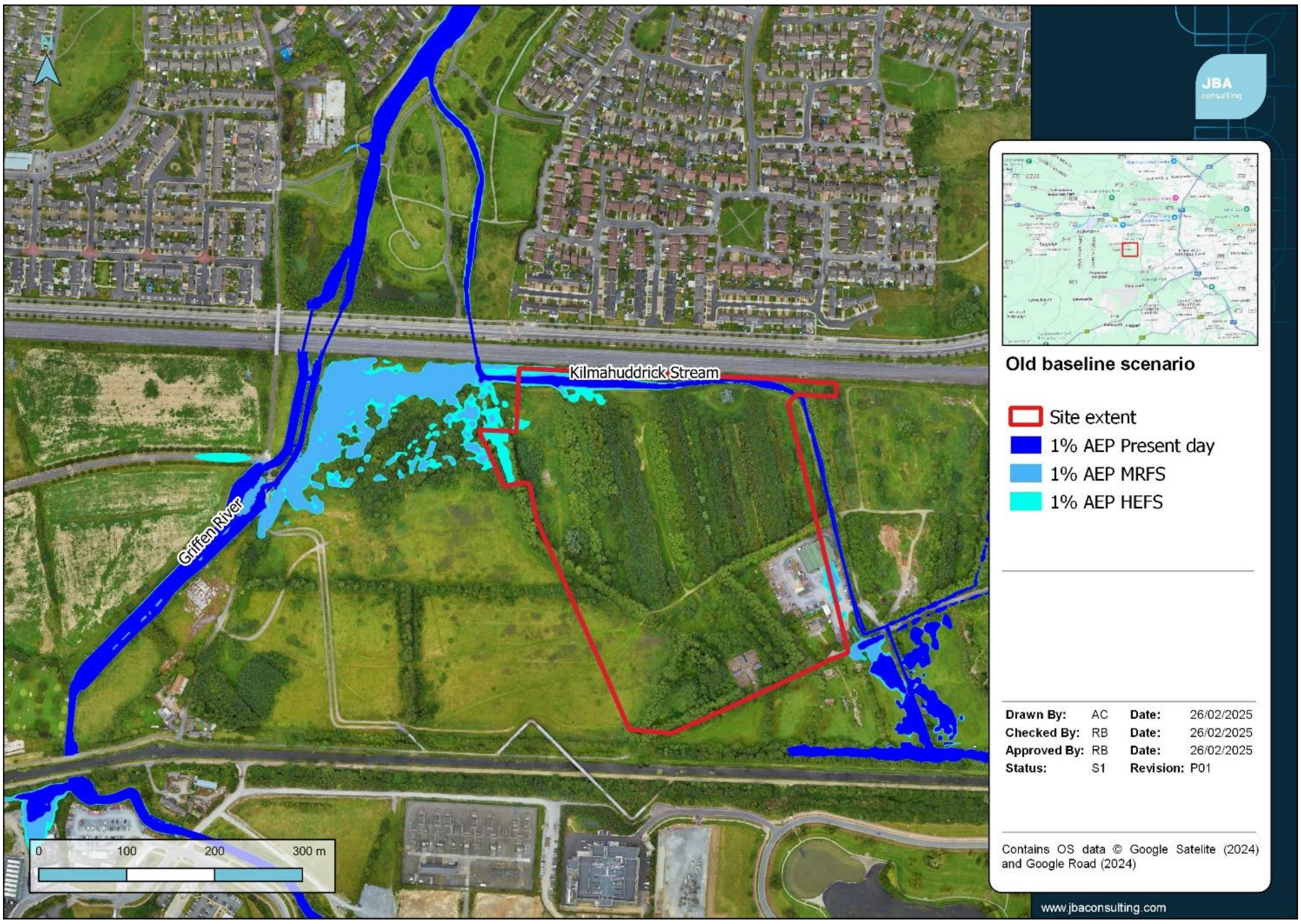


Figure 4-5 Flood extents for 1% AEP Present - day, MRFS and HEFS - Old baseline scenario

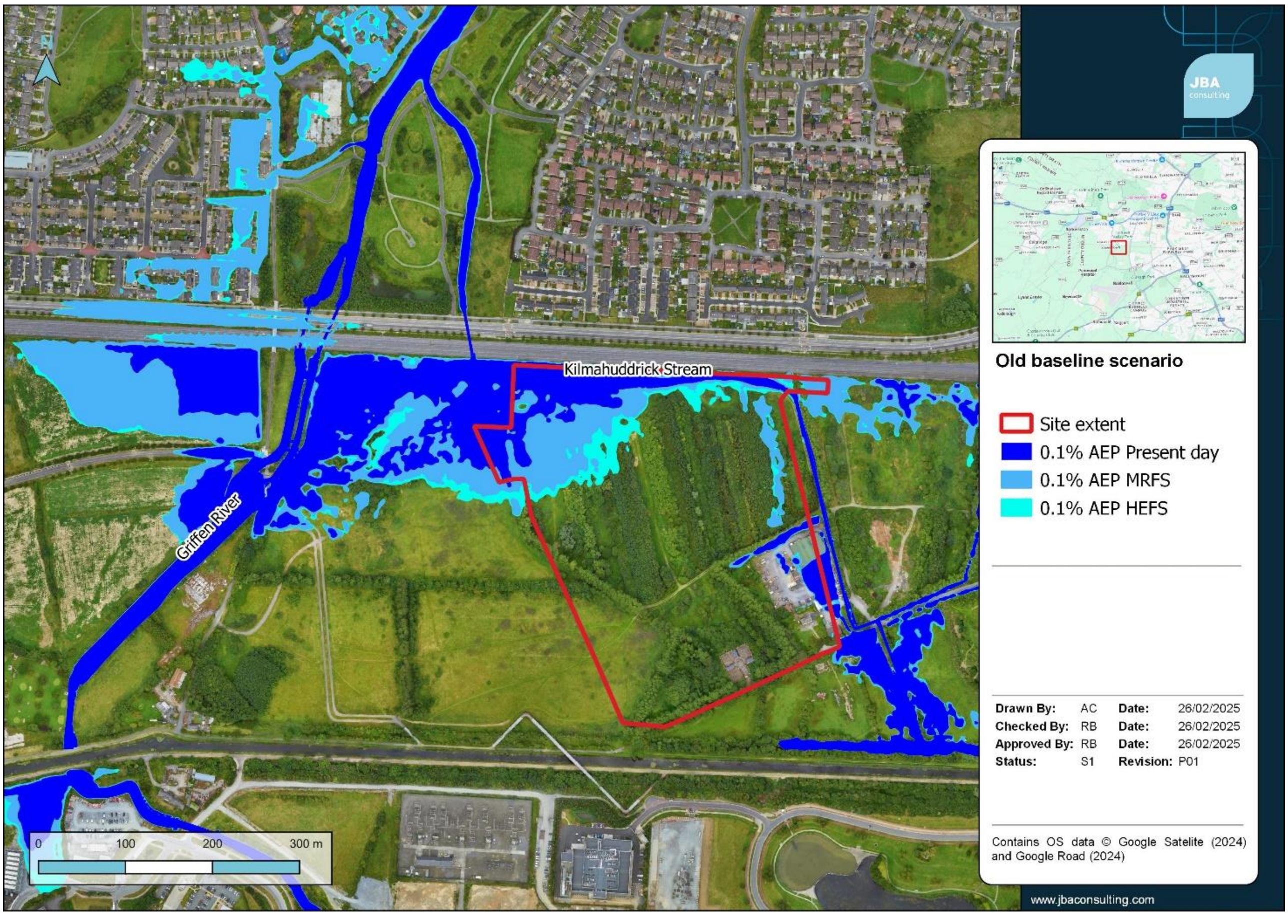


Figure 4-6 Flood extents for 0.1% AEP Present day, MRFS and HEFS - Old baseline scenario

Figure 4-7 presents a comparison between the modelled flood maps and the CFRAM maps. The results show similar outcomes for current day scenarios but diverge for the climate change conditions. This divergence occurs due to differences peak flows, resulting from the updated flow calculations and climate change adjustments, which differ from the approach used in CFRAM, as detailed in Section 4.2.4.

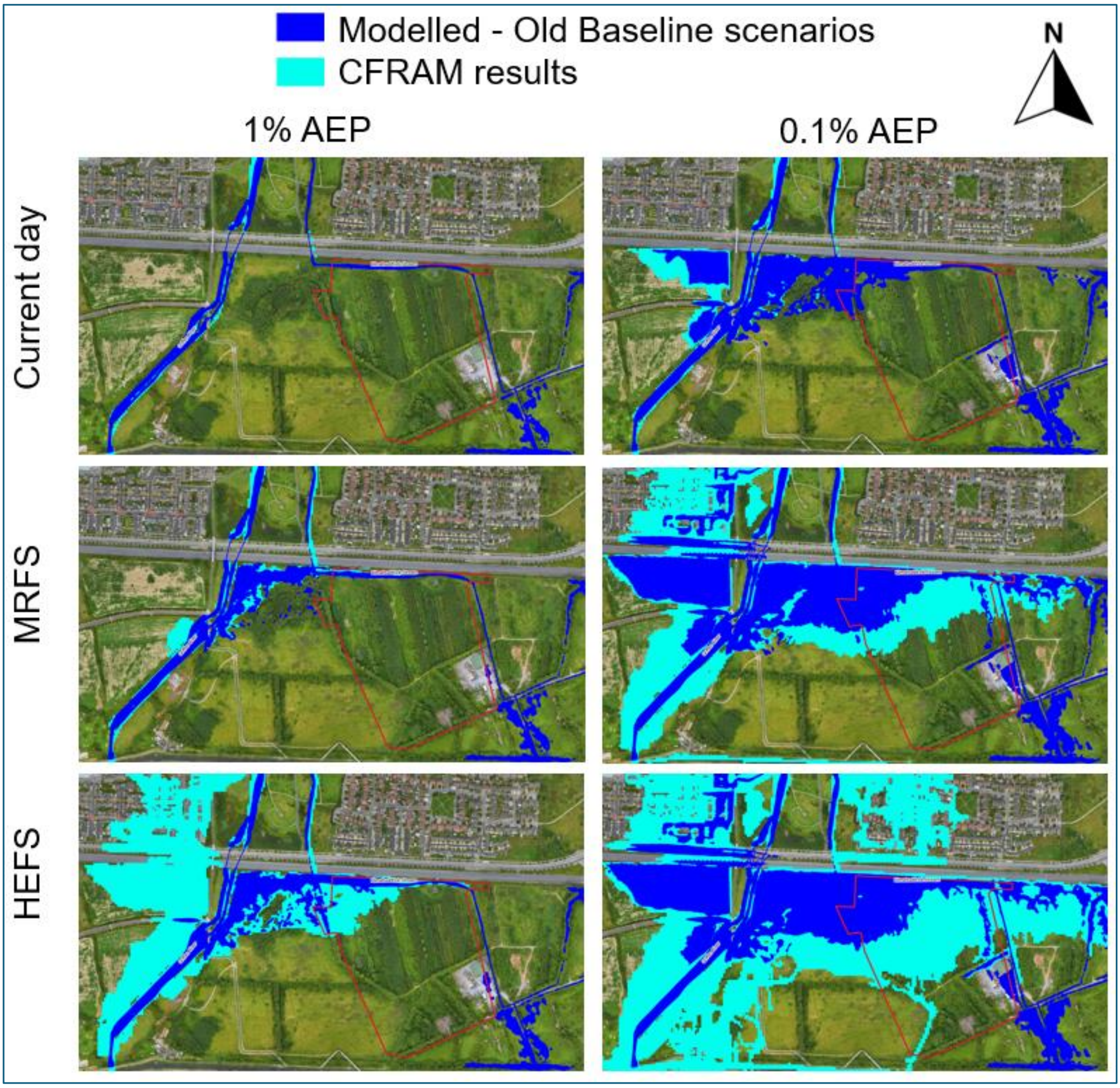


Figure 4-7 Comparison between modelled flood extents and CFRAM flood extents

4.3.4. Current baseline scenario

The current baseline scenario was simulated to evaluate potential flood risks to the site from the Griffeen River and Kilmahuddrick Stream, considering the updated configuration of the Griffeen River's main channel. This configuration has changed from the CFRAM dataset due to an ongoing road construction project. The project incorporates a new culvert system at Hayden's Lane and raised (road) embankments within the floodplain, which have been included in the model based on the latest survey data and road design drawings. The new culvert system includes the installation of two high-capacity culverts in the Griffeen channel, reducing any flow obstruction caused by the previous culvert arrangement, as shown in Figure 4-8.

Figure 4-8 depicts the fluvial flood extents for the 1% and 0.1% AEP events, representing Flood Zone A and Flood Zone B, when both the Griffeen River and Kilmahuddrick Stream are taken into account. The map reveals that due to the new arrangements of the Griffeen River culverts preventing surcharging and overtopping (at Hayden's Lane), the 1% and 0.1% AEP flows remain contained within the channel, posing no flood risk to the site. However, the south-eastern corner of the site is partially within Flood Zona B due to the Kilmahuddrick Stream.

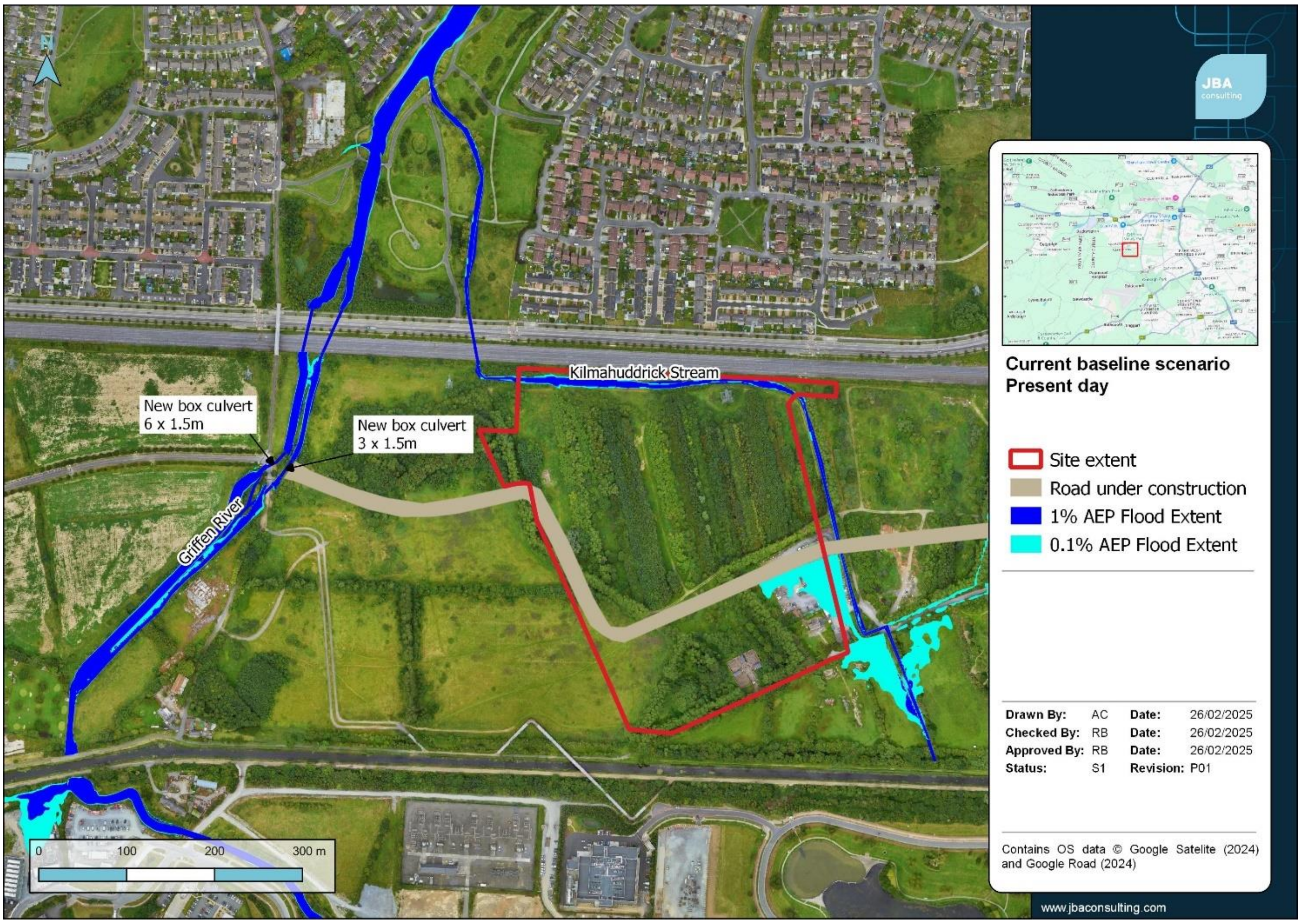


Figure 4-8 Flood extents for 1% AEP and 0.1% Present day - Current baseline scenario

The current baseline scenario was also simulated using climate change-adjusted flows to assess potential future conditions. Figure 4-9 and Figure 4-10 show the resulting flood extents for the 1% and 0.1% AEP events under the Mid-Range Future Scenario (MRFS) and High-End Future Scenario (HEFS), respectively. The climate change maps indicate that the south-eastern part of the site remains at flood risk due to the Kilmahuddrick Stream, though the increase in flood risk is not significant.

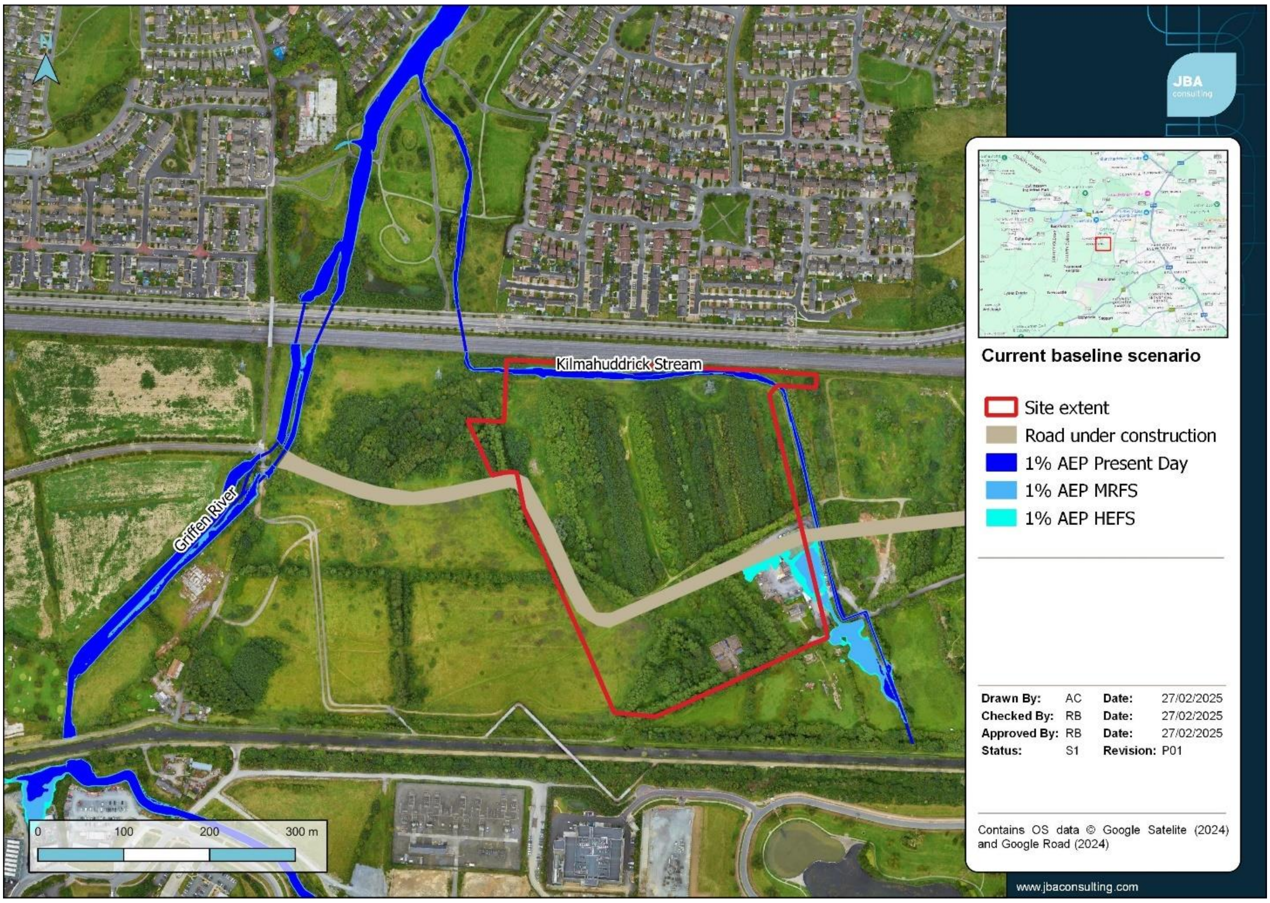


Figure 4-9 Flood extents for 1% AEP Present - day, MRFS and HEFS - Current baseline scenario

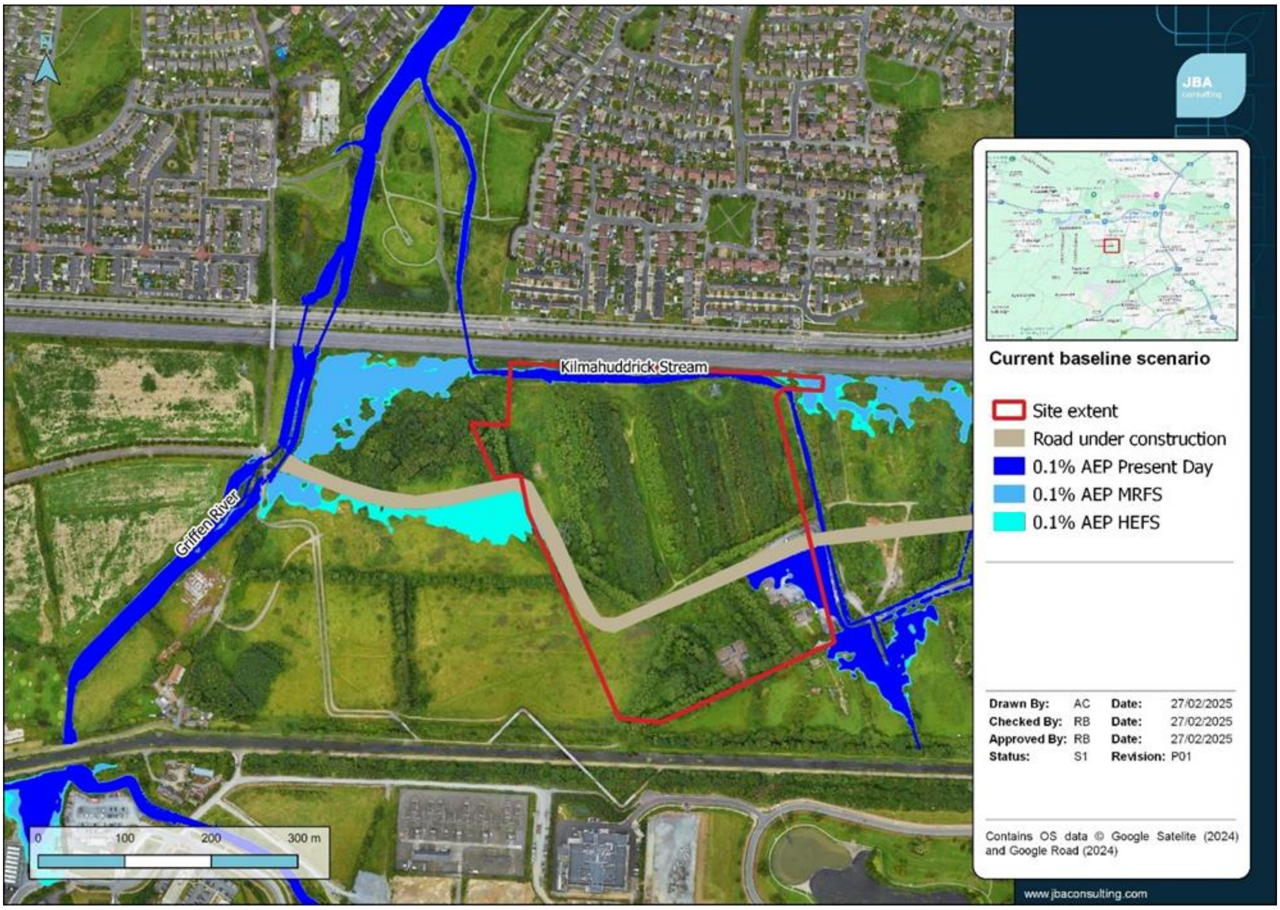


Figure 4-10 Flood extents for 0.1% AEP Present day, MRFS and HEFS - Current baseline scenario

The climate change maps for the current in-channel conditions show notable differences compared to the CFRAM maps. However, these differences are mainly due to hydrological considerations (as explained in the previous chapter) and the enhanced conveyance of the Griffeen River culverts and road embankment that are now constructed.

4.3.5. Post development scenario

The post-development scenario was simulated to assess the impact of the proposed development on flood risk, with the development layout incorporated into the model to represent the proposed roads and buildings accurately.

4.3.5.1 Proposed works

The proposed development consists of 12 clusters of buildings, distributed on both the north and south sides of the newly constructed roadway. Clusters A to I are situated north of the road, while Clusters J to L are positioned to the south.

In the northwestern section of the site, a designated plot has been reserved for a future school development. The planned building clusters is surrounded by roadways. At the northeastern corner, the proposed roadway crosses the Kilmahuddrick Stream, requiring the design and sizing of a culvert in accordance with Section 50 of the Arterial Drainage Scheme requirements.

Site access is provided via a west-to-east roadway running through the development. Future expansions to the east will be connected through this roadway, as well as via the extension of the surrounding roadway in the northwestern section of the site.

All these elements were incorporated into the model to assess their impact on flood risk and to determine whether mitigation measures are required to compensate for the volume loss within the floodplain caused by the proposed development.

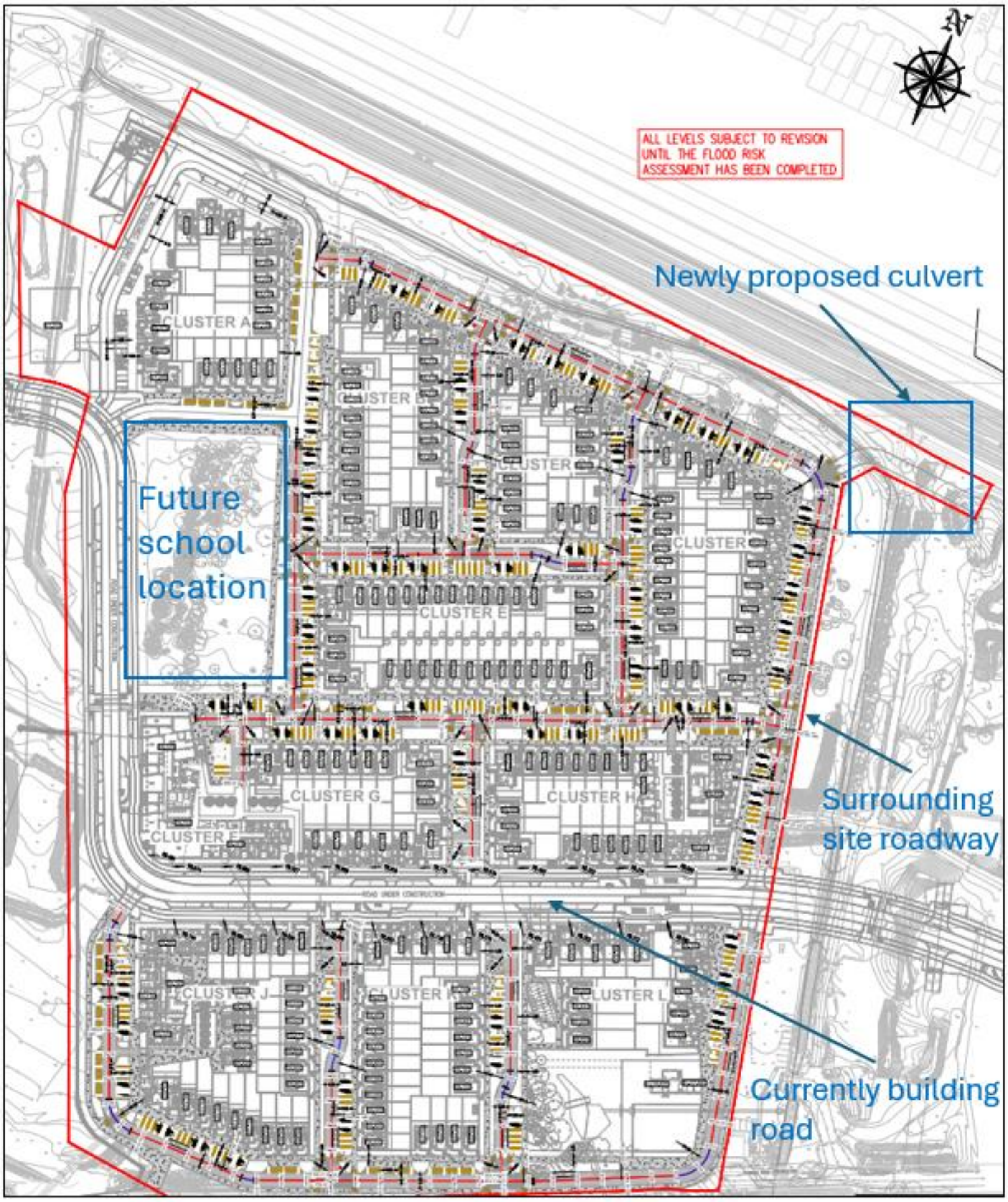


Figure 4-11 Site layout with localisation of important features

4.3.5.2 Post-development impacts

The site is located outside the Flood zone A, and as such, there is no impact on the flood risk for the 1% AEP event. The results for the post- development scenario in the 0.1% AEP event indicate a loss of floodplain along the Kilmahuddrick Stream in the southeastern part of the site, where the floodplain is obstructed by the road surrounding Cluster L.

Due to this obstruction, a greater flow returns to the main channel of the Kilmahuddrick Stream being directed downstream in the direction of the existing culvert beneath the railway, with an estimated increase in flow of approximately 0.005 m³/s (5 l/s) compared to the baseline scenario.

The flood extents for 1% and 0.1% AEP, corresponding to post-development scenario are shown in Figure 4-12.

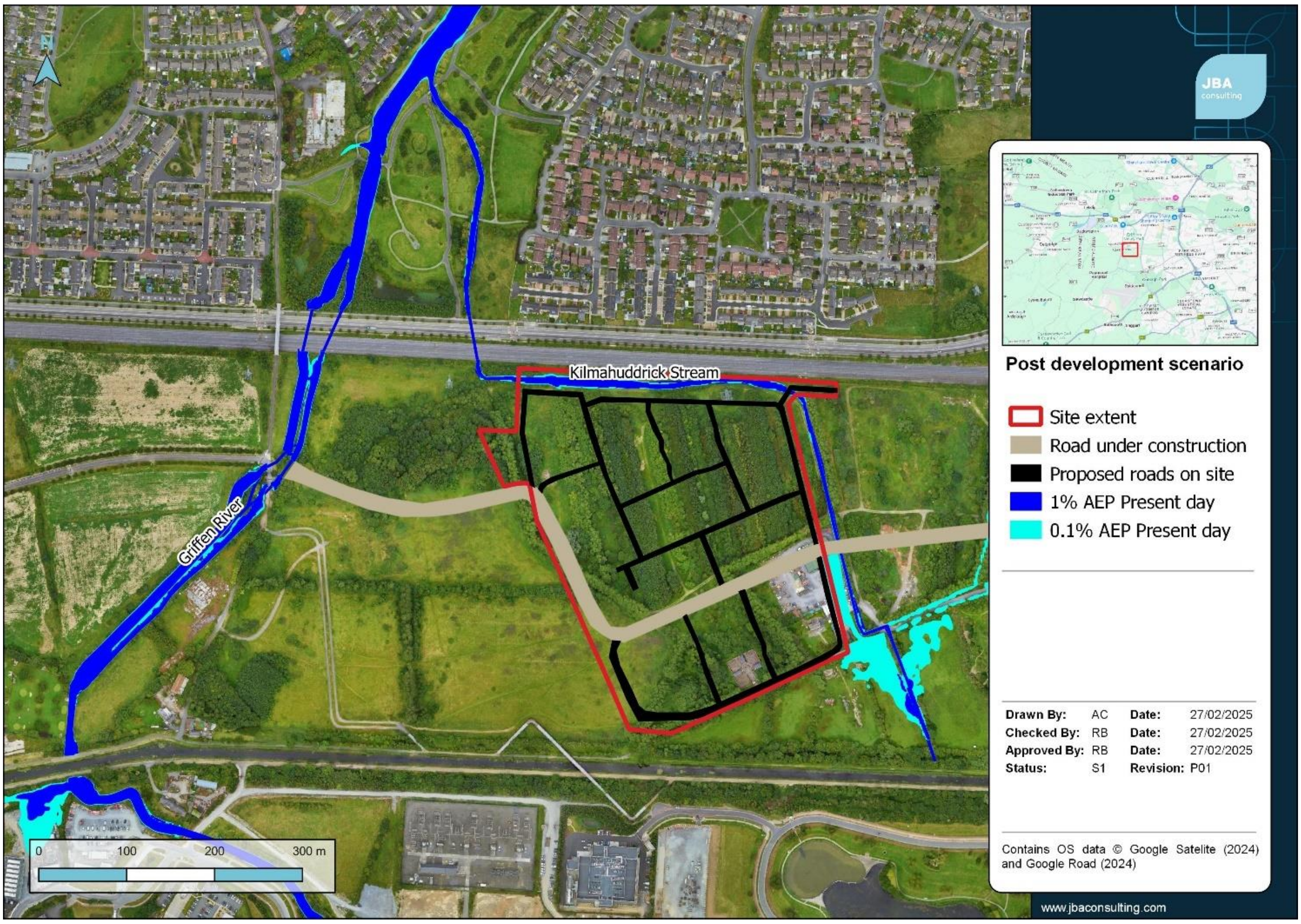


Figure 4-12 Flood extents for 1% AEP and 0.1% AEP flows - Post-development scenario

4.3.5.5 Compensation measures and efficiency

To compensate for the floodplain loss identified in the post development scenario for the 0.1% AEP event and to alleviate the slight increase in flow some flood storage solutions were analysed.

The most hydraulically effective solution involves a lateral storage area proposed in the northern part of the site, on the northern boundary of Clusters C and D. The excavated volume consists of approximately 170m³, with an internal slope grading from east to west to ensure a gravitational drainage. The admission section of the storage is set at 55.5mOD level, which is 50mm below the 1% AEP flood level, ensuring the storage is activated only during extreme flood events. Therefore, the storage is designed to operate during extreme events at or exceeding the 1% AEP event.

This proposed mitigation measure reduces the flow in the Kilmahuddrick Stream at the railway section, restoring it to baseline levels and therefore offsetting any increase as a result of the loss of Flood Zone B.

Figure 4-13 presents the location of the proposed lateral storage area, along with a schematic of its representation within the 2D model. Figure 4-14 represents modelled flow for the Kilmahuddrick Stream that is leaving the lands under the railway line – this clearly shows that there is no increase in flow under the 1% or 0.1% AEP events and risk downstream is therefore not increased. Risk upstream is also not increased in this scenario.

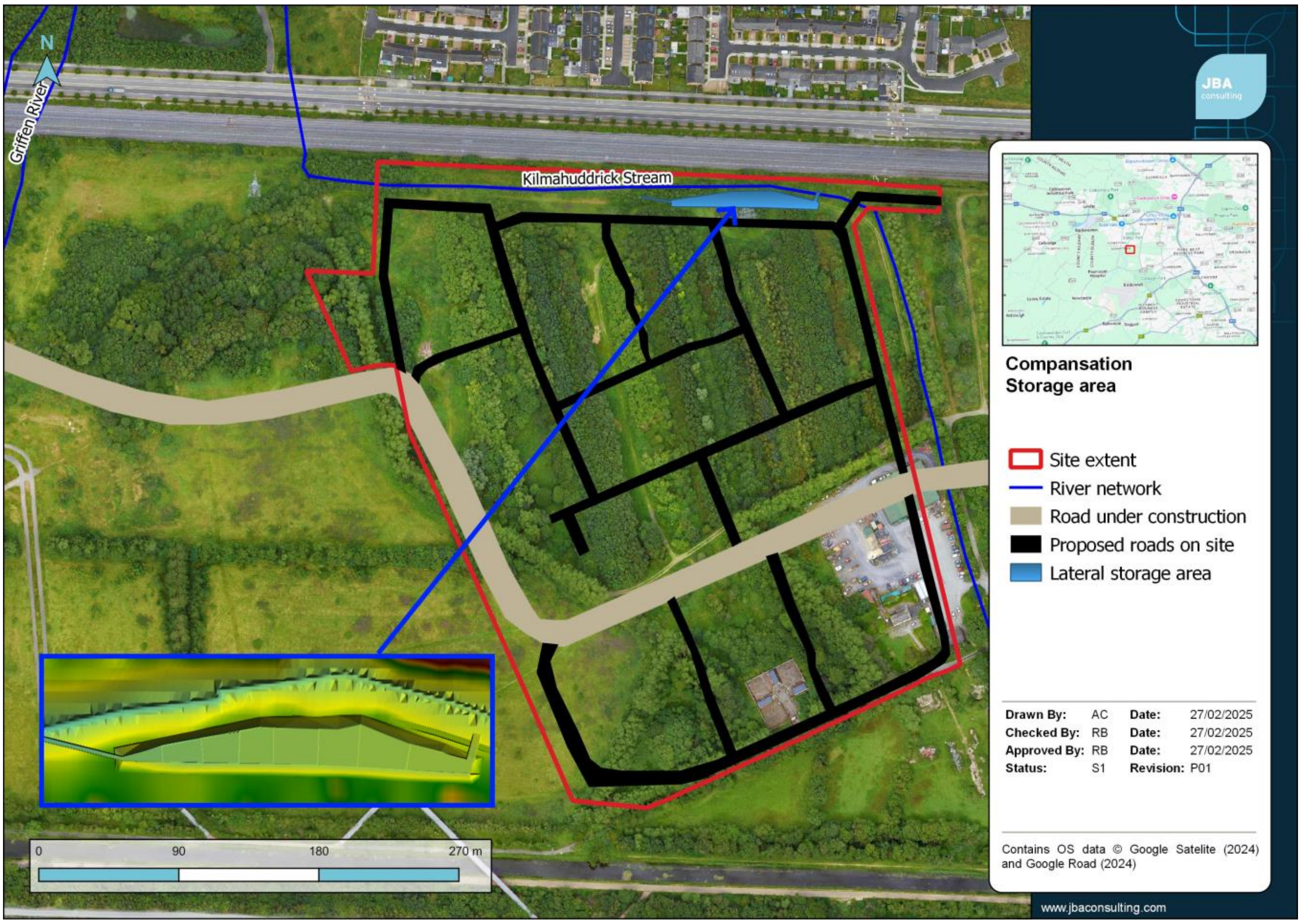


Figure 4-13 Flood compensation storage area location and representation

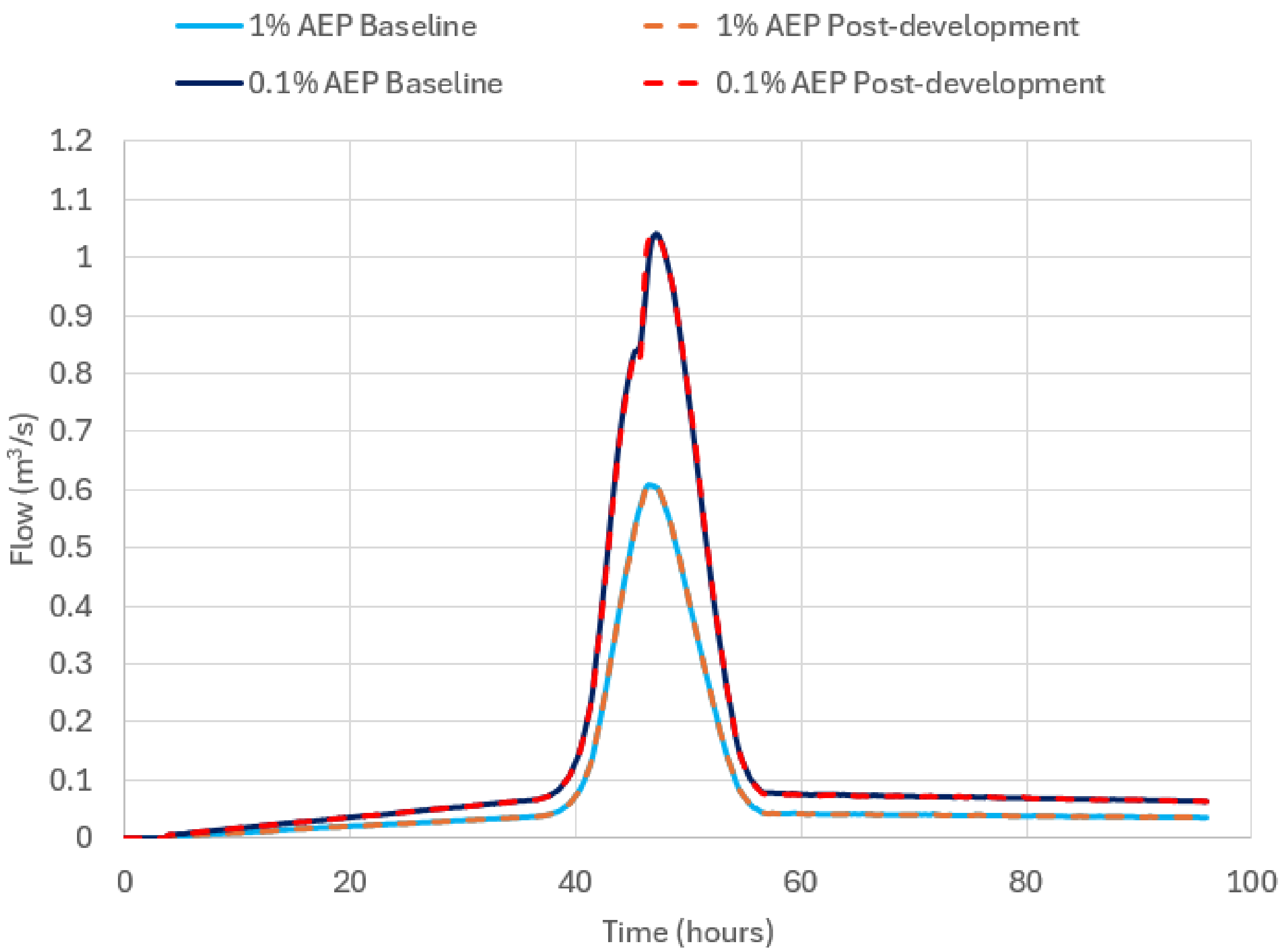


Figure 4-14 Model Flow v Time for the current baseline vs post development

4.3.5.3 Section 50

This section of the report supports the design for the culvert crossing the Kilmahuddrick Stream, in accordance with the Arterial Drainage Act (1945) and OPW Section 50 requirements. The objective is to ensure that the culvert has adequate hydraulic capacity, does not increase flood risk, and complies with the Section 50 requirements. The culvert is located at the northeastern corner of the site, where roadway adjacent to Cluster D crosses the Kilmahuddrick Stream.

The hydraulic design standards for a culvert or bridge that should be met under Section 50 according to the OPW Guide to Applying for Consent under Section 50 of the EU (Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945 are as follows:

- A bridge or culvert must be capable of passing a fluvial flood flow with a 1% annual exceedance probability (AEP) or 1 in 100-year flow without significantly changing the hydraulic characteristics of the watercourse.
- A culvert must be capable of operating under the above design conditions while causing a hydraulic loss of no more than 300 mm (excluding the culvert gradient).

- If the land potentially affected includes dwellings and infrastructure, it must be demonstrated that those dwellings and/or infrastructure are not adversely affected by constructing the bridge or culvert.
- A culvert diameter, height and width must not be less than 900 mm to facilitate maintenance access and reduce the likelihood of debris blockage.

To be compliant with the Section 50 requirements, it is necessary to include provision for climate change (20%) and an appropriate Factorial Standard Error (FSE). A 95% Factorial Standard Error (FSE) was considered for the modelled culvert.

Various culvert sizes were tested to identify a design that complies with Section 50 requirements. The final proposed solution is a box culvert measuring 2.1m wide by 2.1m high, installed 0.5m below bed level, with a minimum soffit level of 56.65mOD.

Figure 4-15 presents the longitudinal profile of the Kilmahuddrick Stream near the proposed Section 50 culvert. The maximum afflux at the culvert is 200mm, which remains below the acceptable tolerance mentioned above. Additionally, the culvert provides a freeboard of 500mm within the structure between the water level and soffit level, exceeding the minimum freeboard required and ensuring sufficient capacity for extreme flow conditions.

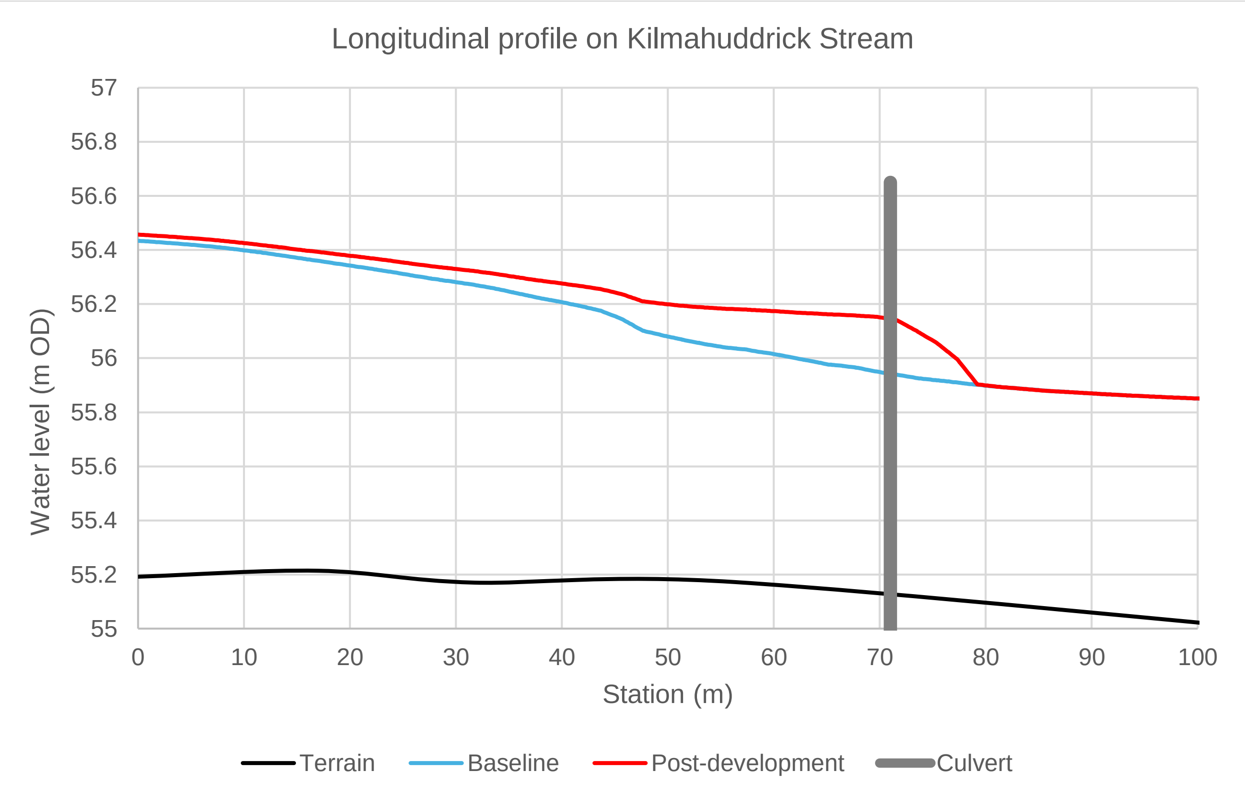


Figure 4-15 Longitudinal profile on the Kilmahuddrick Stream –sector adjacent to the culvert

4.3.5.4 Design scenarios

The design levels for the development are established in accordance with the SDCC Development Plan Strategic Flood Risk Assessment requirements, ensuring resilience against extreme flood conditions. As a result, the design levels are based on the worst-case scenario, determined from:

- 1% AEP event in High-End Future Scenario (HEFS) climate change allowances, incorporating a 30% increase in flow and a 300mm freeboard margin.
- 1% AEP event with a 67% blockage at the existing culverts, ensuring flood resilience while maintaining a 300mm freeboard conditions.

Both conditions were simulated within the designed scenario. It is important to note that seven existing culverts are present in the area of interest, potentially influencing flood risk, and all were incorporated into the blockage scenario within the model.

As the water level profiles of the Kilmahuddrick Stream and Griffeen River gradually decrease in south to north direction, the design levels for the proposed development are determined based on water levels in seven representative points, strategically selected to account for local variations in flood levels and ensure accurate recommendations for design levels.

Figure 4-16 illustrates the distribution of these seven points across the site and the locations of the culverts which are considered for the blockage scenarios.

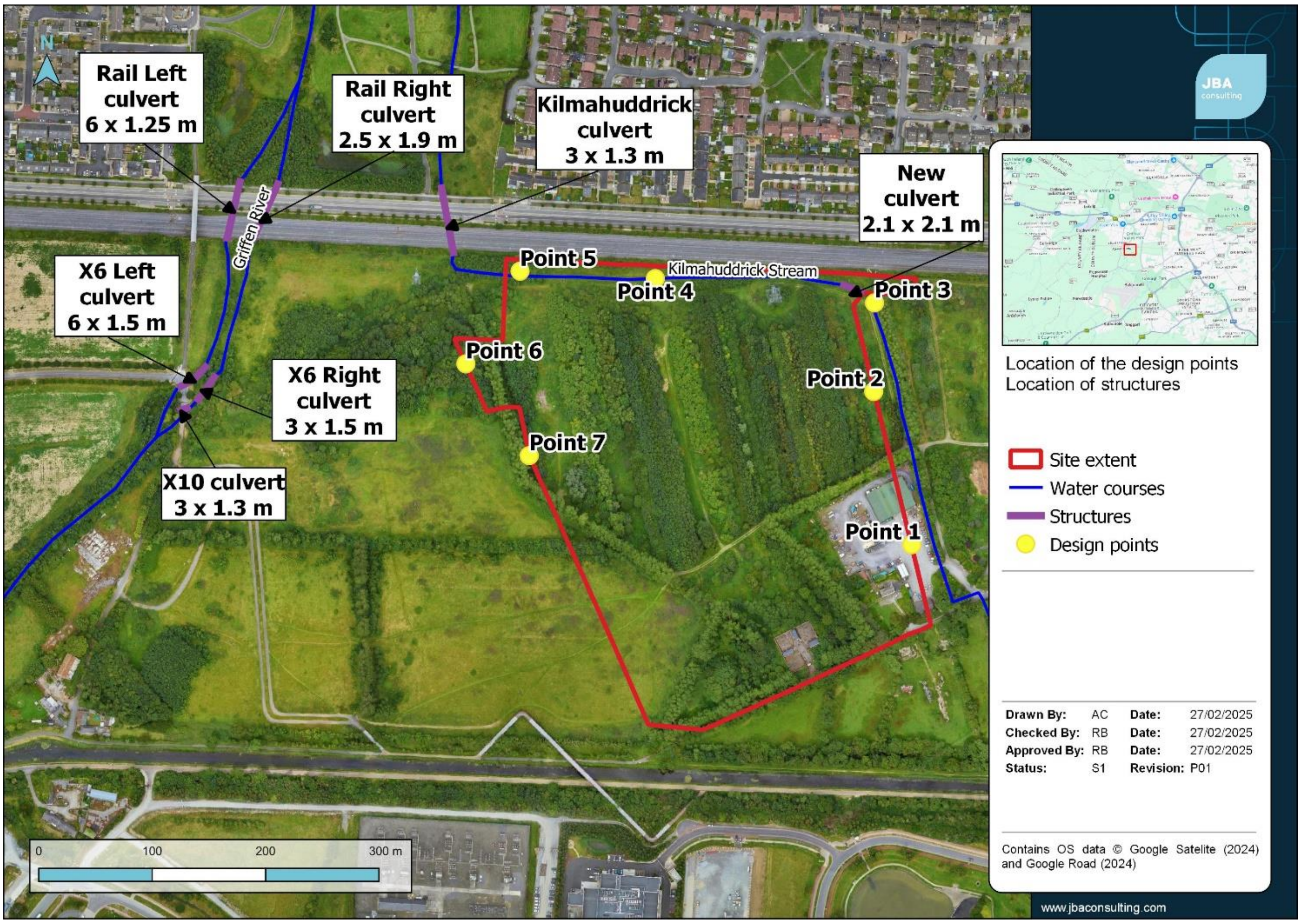


Figure 4-16 Location of blocked culverts and strategic design points

Table 4-7 presents the flood levels for each modelled scenario and for each design point. The highest flood level among all simulated scenarios is marked in red and selected as the final design level for that particular location, to ensure the development remains resilient under the most extreme conditions.

The main source of flooding for the proposed site is the Kilmahuddrick Stream and the blockage of its existing culverts determines the design levels for the site (Point 1 to Point 5).

The results of the design scenarios confirm that the site is not at risk of flooding from the Griffeen River, not even under residual risk conditions with a 67% culvert blockage applied to the existing culverts. Point 6 and Point 7, located in the western boundary of the site, are not at risk of flooding for any scenario. As a results, their levels are determined to ensure proper alignment with the overall site design, maintaining consistency with the surrounding infrastructure and development layout.

Table 4-7 Design levels across the site

Scenario	Levels at design points (mOD)						
	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7
1% HEFS + freeboard	**57.57**	56.1	55.7	55.08	54.95	N/A	N/A
67% Blockage at new culvert + freeboard	57.10	**56.82**	**56.81**	55.32	55.11	N/A	N/A
67% Blockage at Kilmahuddrick culvert + freeboard	57.07	56.33	55.99	**55.54**	**55.53**	N/A	N/A
67% Blockage at X10 + freeboard	57.07	56.33	55.98	55.33	55.12	N/A	N/A
67% Blockage at X6 Left + freeboard	57.07	56.33	55.98	55.33	55.14	N/A	N/A
67% Blockage at X6 Right + freeboard	57.07	56.33	55.98	55.33	55.12	N/A	N/A
67% Blockage at Rail Left + freeboard	57.07	56.33	55.98	55.33	55.12	N/A	N/A
67% Blockage at Rail Right + freeboard	57.07	56.33	55.98	55.33	55.12	N/A	N/A

Figure 4-17 to Figure 4-24 illustrate the flood extents for each design modelled scenario, mapped in relation with the design points and the site boundary.

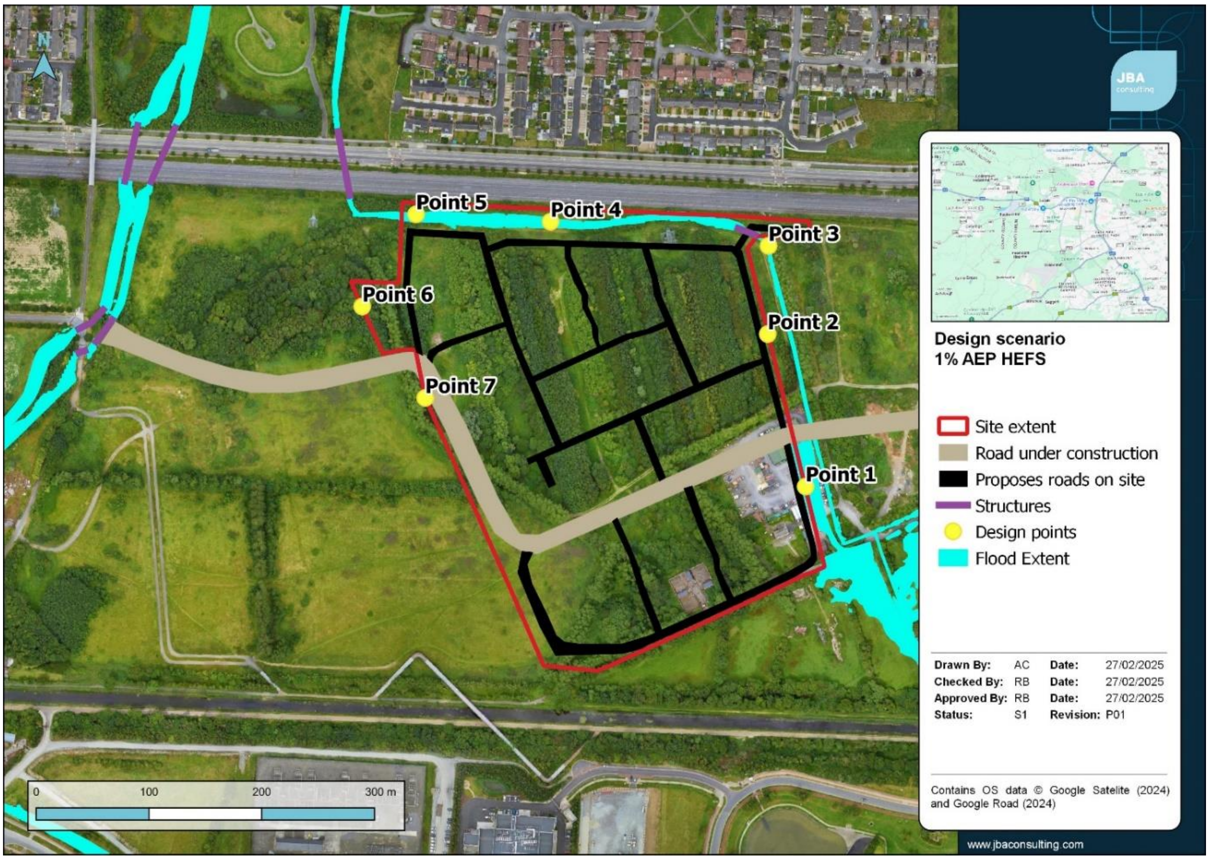


Figure 4-17 Flood map for the 1% AEP HEFS design scenario

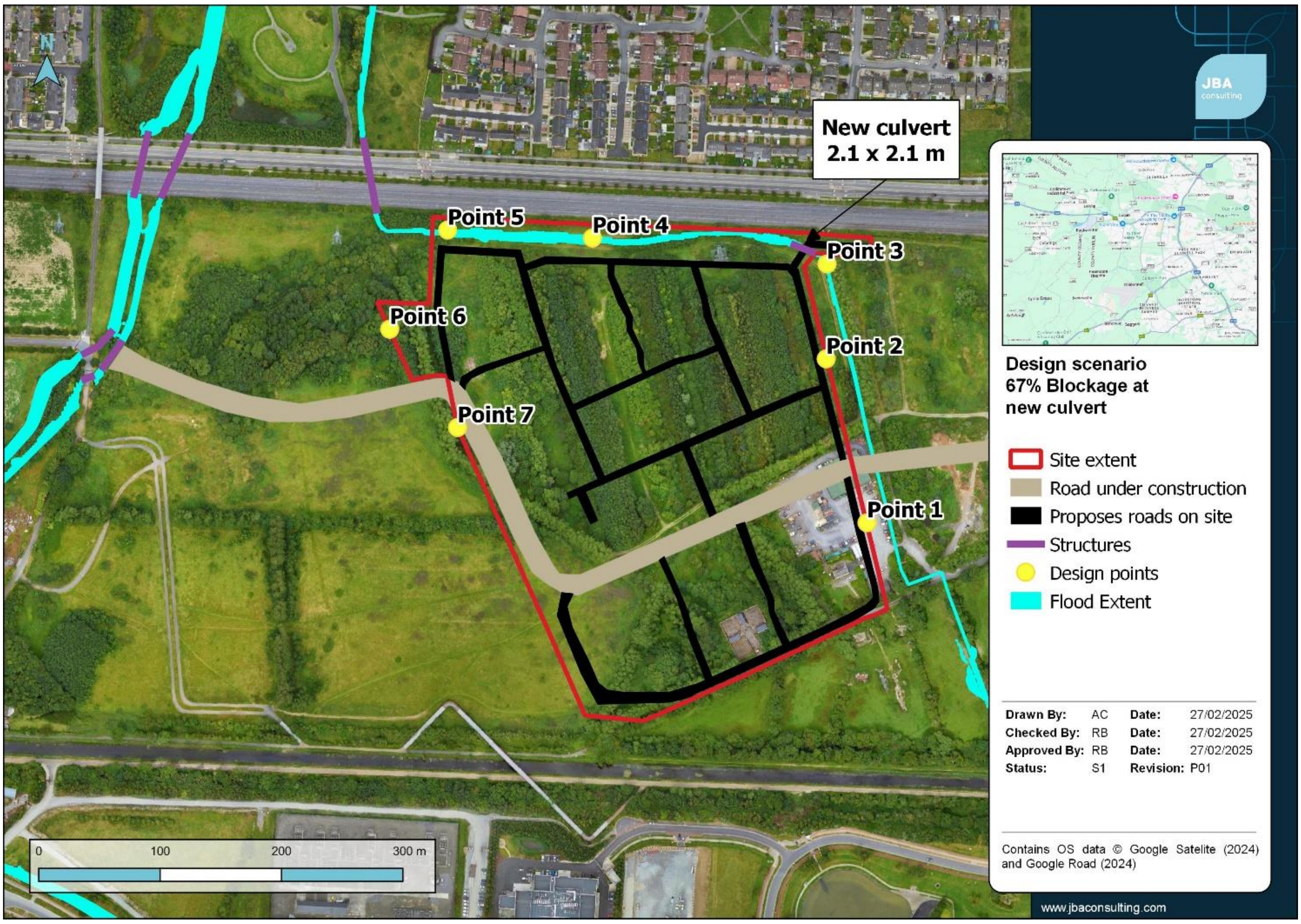


Figure 4-18 Flood map for the 1% AEP + 67% blockage at new culvert

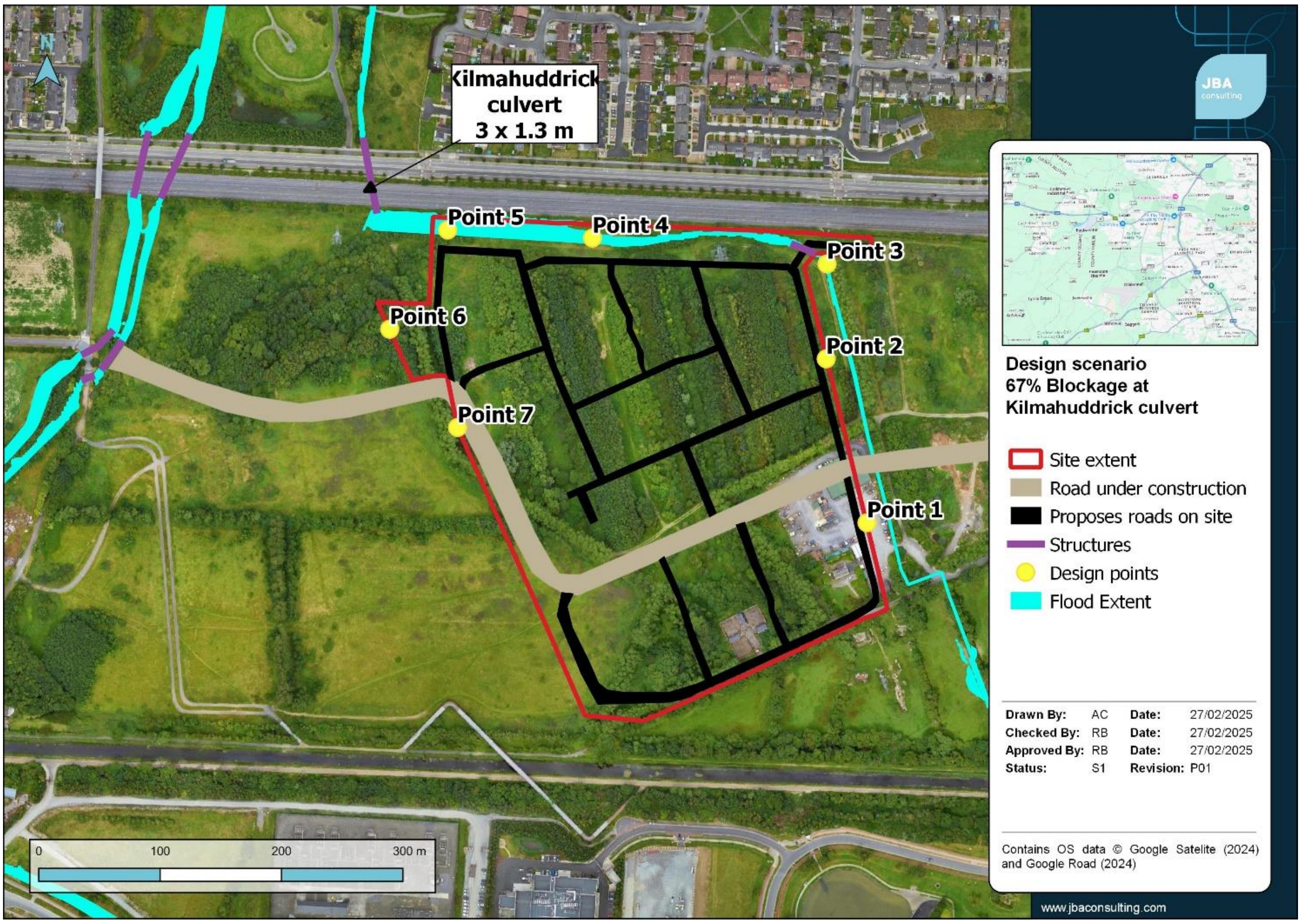


Figure 4-19 Flood map for the 1% AEP + 67% blockage at Kilmahuddrick culvert

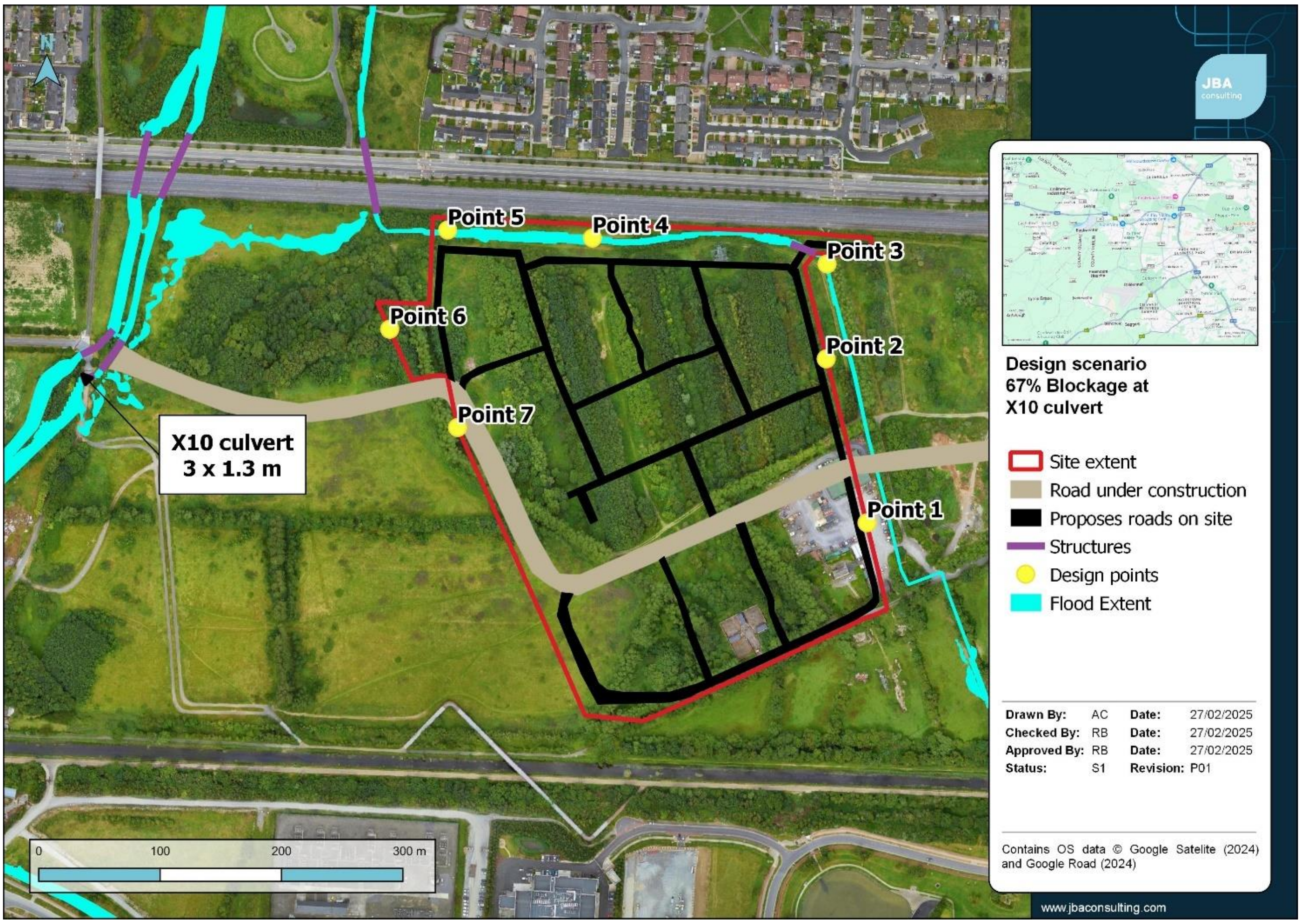


Figure 4-20 Flood map for the 1% AEP 67% + blockage at X10 culvert

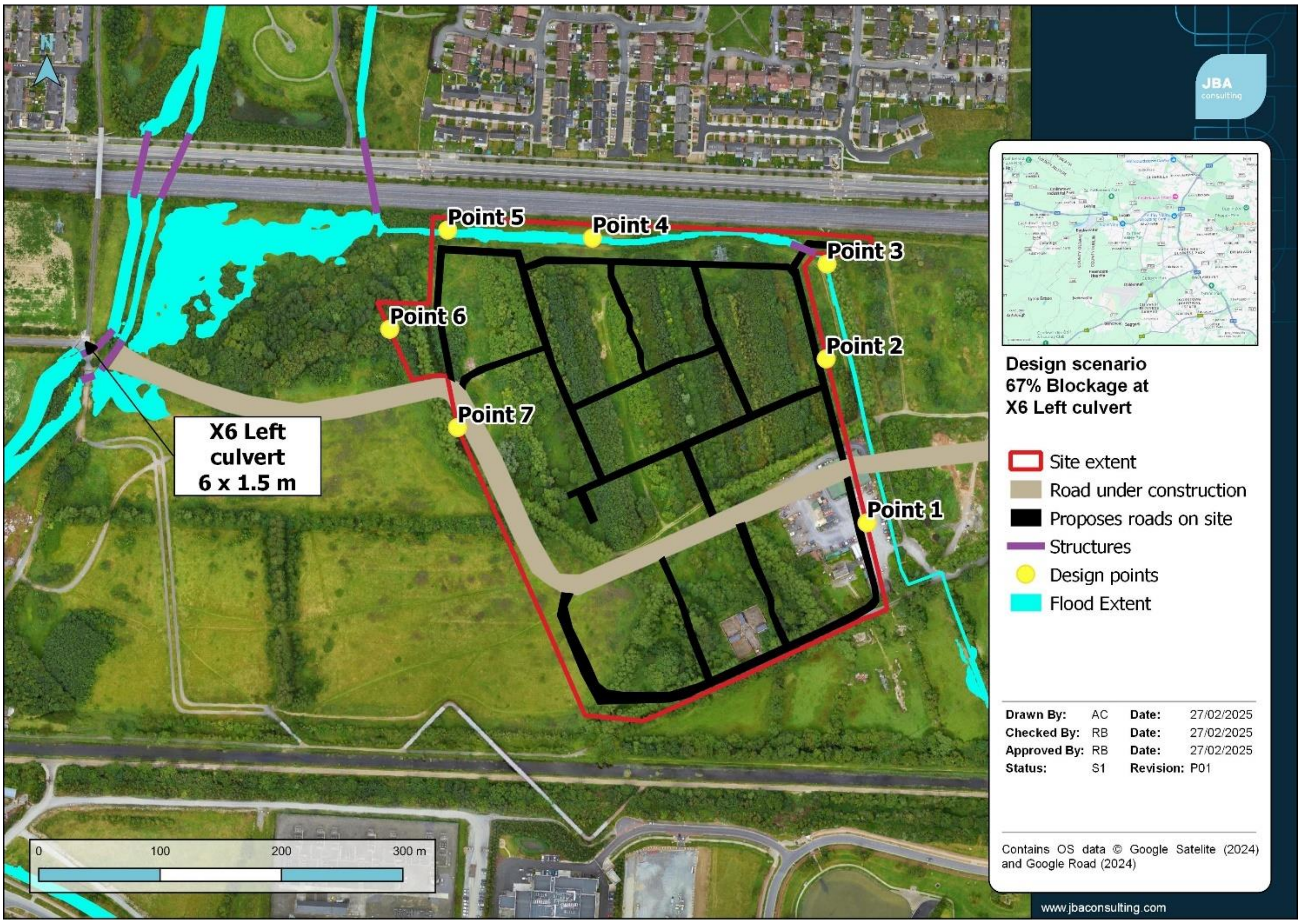


Figure 4-21 Flood map for the 1% AEP + 67% blockage at X6 Left culvert

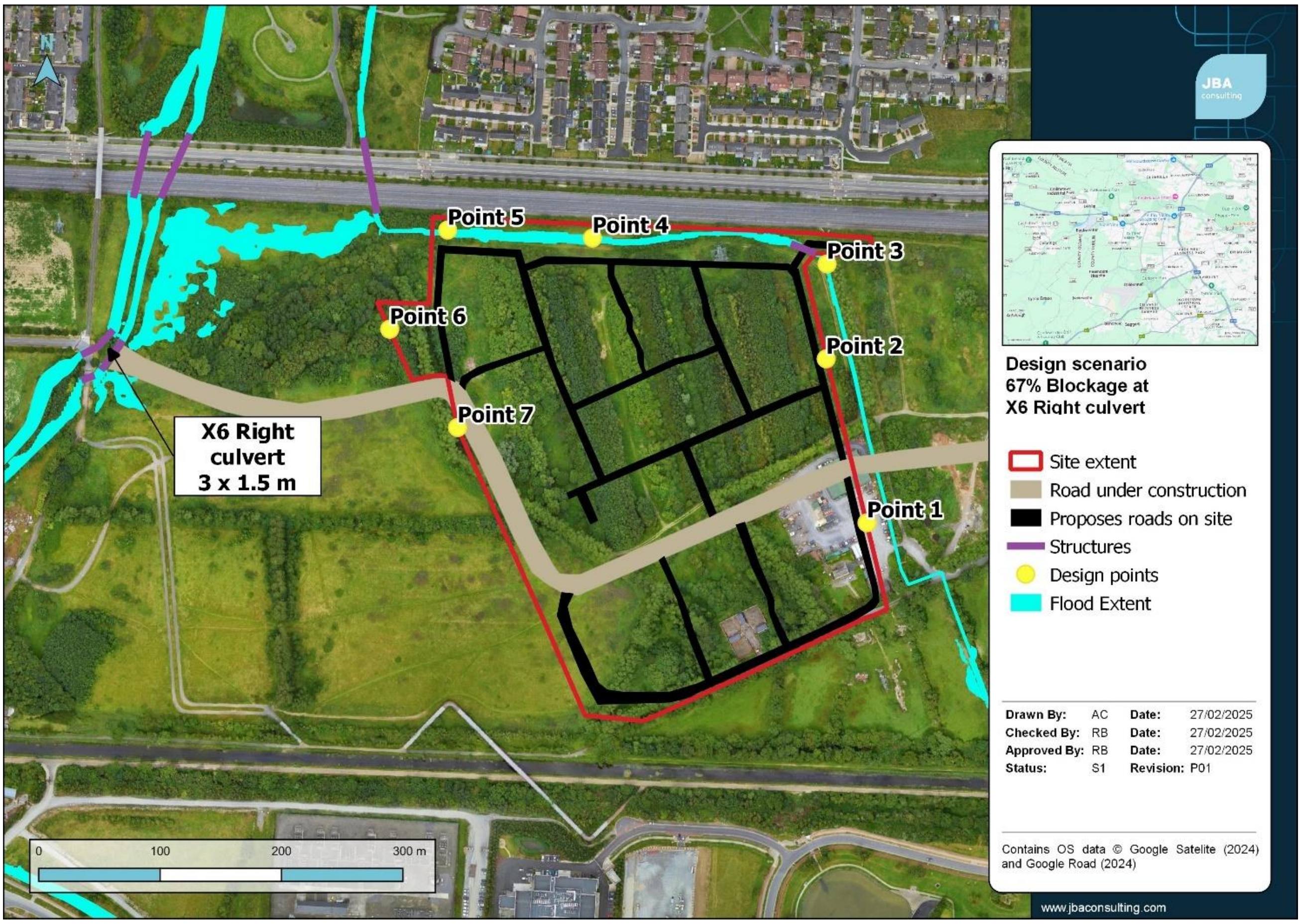


Figure 4-22 Flood map for the 1% AEP + 67% blockage at X6 Right culvert

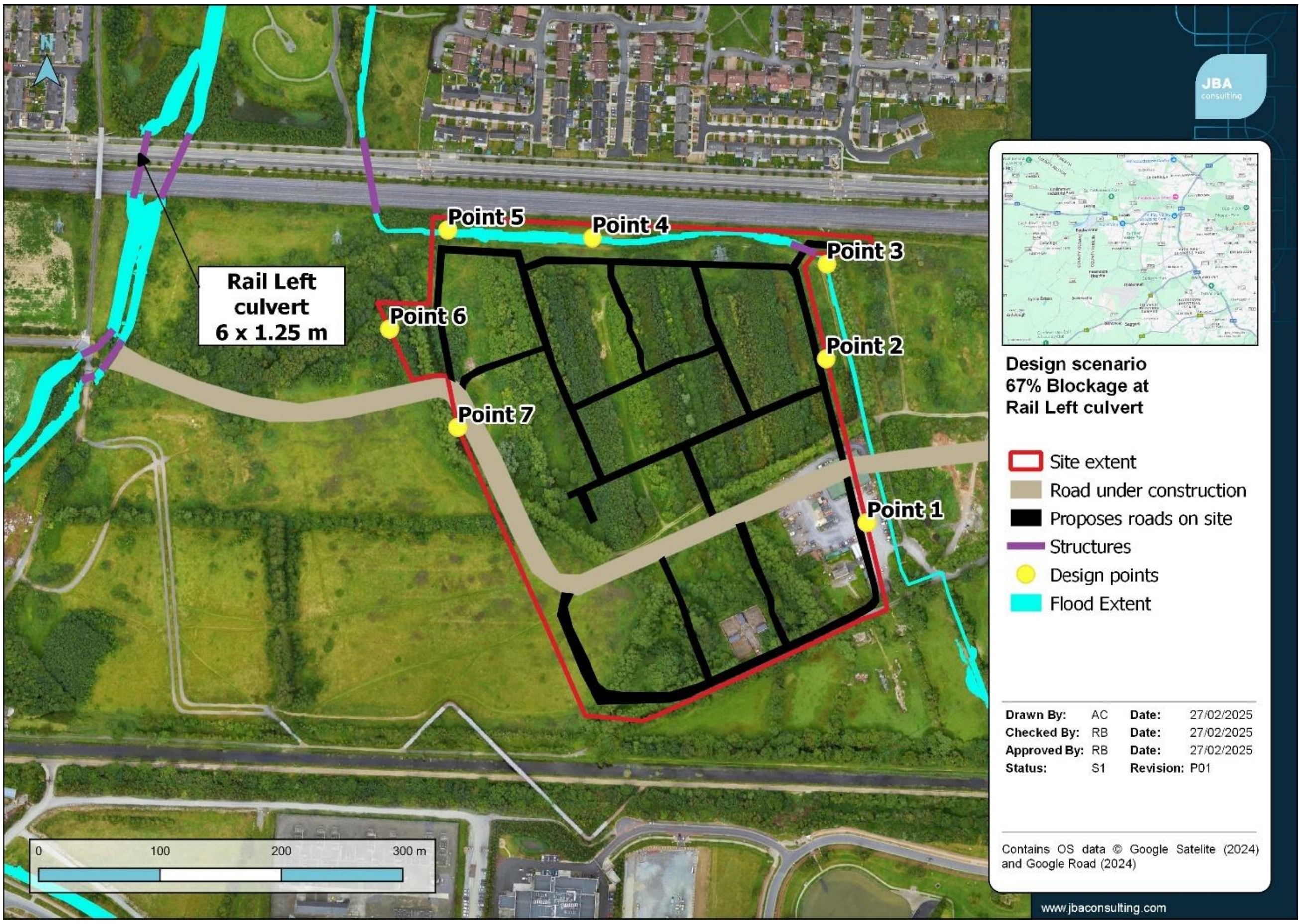


Figure 4-23 Flood map for the 1% AEP + 67% blockage at Rail Left culvert

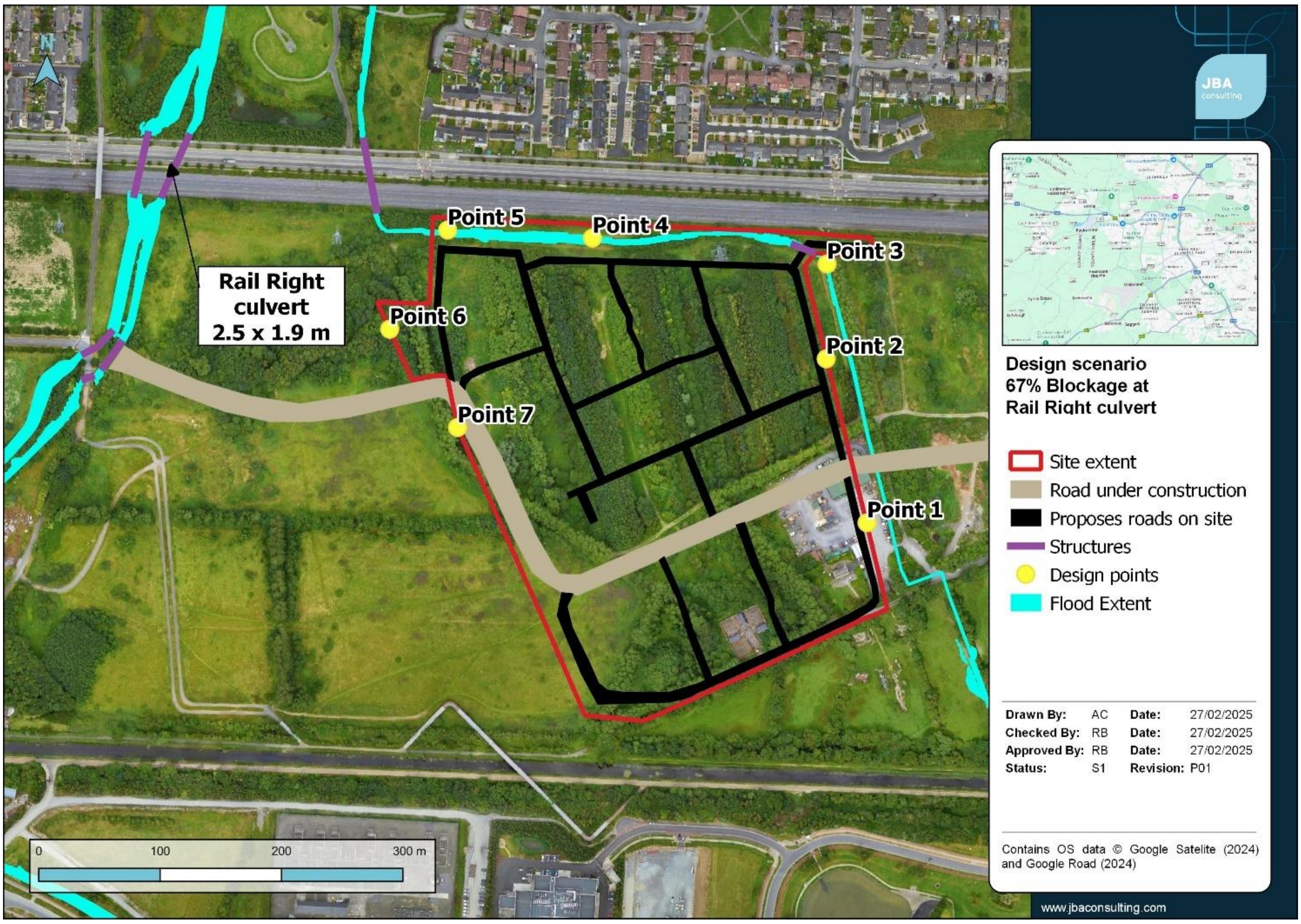


Figure 4-24 Flood map for the 1% AEP + 67% blockage at Rail Right culvert

5 Food Risk Assessment and Mitigation

5.1. Flood Risk

The site is partially exposed to fluvial flood risk, primarily associated with the Kilmahuddrick Stream. The detailed hydraulic and hydrological modelling conducted by JBA has identified localised flood risks in the southeastern part of the site, where a small part falls within Flood Zone B. Fluvial flooding is driven by extreme flow conditions in the Kilmahuddrick Stream, particularly during the 0.1% AEP event, where water levels exceed channel capacity and result in some floodplain inundation.

The Griffeen River, flowing at about 230m west of the site, doesn`t pose any flood risk to the proposed development as the 1% and 0.1% AEP flows are contained within the main channel. The channel has recently been enhanced with a high-capacity culvert system at Hayden’s Lane within the new road project.

5.2. Mitigation Strategy

The South Dublin County Council (SDCC) Development Plan SFRA provides guidance on managing flood risk for new developments within Flood Zones A and B. The flood risk assessment for this site has followed the principles set out in the SFRA to ensure that flood risk is appropriately managed.

A detailed hydraulic model has been developed, providing a higher level of detail than the OPW CFRAM study, allowing for a comprehensive assessment of post-development impacts and residual risks. The model incorporates updated hydrological and in-channel survey data, enabling an accurate representation of existing conditions and potential flood impacts.

The flood risk analysis has considered the current baseline conditions, reflecting current channel and floodplain characteristics, as well as post-development conditions, where terrain modifications and proposed structures have been included. The impact of blockage scenarios at key culverts has been analysed to assess the worst-case conditions, ensuring that the design levels provide an adequate level of protection.

Given the proximity to the Kilmahuddrick Stream and the influence of climate change, the design approach has adopted a precautionary methodology. The finished floor levels (FFL) have been set in accordance with SDCC SFRA requirements, incorporating freeboard allowances to mitigate against extreme events. The proposed flood mitigation measures, including a lateral storage area, have been designed to compensate for the loss of floodplain storage and prevent an increase in downstream flood risk on the Kilmahuddrick Stream.

The following sections set out the approach.

5.2.1. Site layout, access and compensatory storage

The site consists of 12 clusters of buildings, distributed north and south of the under-construction road project. Clusters A to I are positioned north of the road, while Clusters J to L are located to the south. In the northwestern section, a designated plot is reserved for a future school development, with its perimeter enclosed by a road network that act as a barrier against fluvial flooding.

The main access to the site is provided via the under-construction road running west-to-east through the site, with other adjacent future developments being connected through the same road.

To compensate for the floodplain volume loss identified in the 0.1% AEP event, a lateral storage area has been accommodated north of the Clusters C and D. The excavated volume of approximately 170m³, being designed to operate during extreme events at or exceeding the 1% AEP event. This proposed storage reduces the flow in the Kilmahuddrick Stream at the railway section, restoring it to baseline levels and reducing any impacts due to the site development.

At the northeastern corner of the site, adjacent to the Cluster D, one of the roads proposed as part of the development crosses the Kilmahuddrick Stream, requiring for a culvert designed in accordance with Section 50 of the Arterial Drainage Scheme requirements which was also assessed within this FRA. The final culvert design solution consists of a 2.1m x 2.1m box culvert, installed 0.5m below bed level, with a soffit level not lower than 56.65mOD. Hydraulic modelling confirms that the maximum afflux is 200mm, which remains below the 300mm acceptable tolerance, while the provided freeboard of 500mm (open air gap) largely exceeding minimum requirement.

Therefore, the proposed development accommodates culverts design and flood mitigation measures for compensatory storage, ensuring that flood risk is appropriately managed while maintaining compliance with South Dublin County Council flood risk management guidelines.

5.2.2. Finished Floor Levels

The minimum finished floor levels (FFL) for the development have been determined in accordance with the South Dublin County Council (SDCC) Development Plan SFRA.

The design levels are set to ensure that buildings remain above the extreme flood levels, incorporating freeboard allowances to account for uncertainties and future climate change impacts. Multiple design scenarios were modelled for two extreme conditions such as:

- 1% AEP + Climate Change in High-End Future Scenario + 300mm freeboard
- 1% AEP + 67% culvert blockage + 300mm freeboard. The blockage scenarios were modelled for all seven culverts which may have an impact on the site.

A total of eight design scenarios were modelled, and the highest flood level from these simulations was used to determine the final FFL at each design point around the site. These points were strategically chosen to account for local variations in flood risk around the site. Figure 4-16 shown previously in Section 4.3 presents the position of the design points in relation to the site. Table 5-1 provides the designed FFL levels resulted from the modelling.

Table 5-1 Guideline FFLs

Recommended design levels across the site (mOD)							
Design Points	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7
FFL (including freeboard)	57.57	56.82	56.81	55.54	54.95	Based on surrounding ground and rounds	Based on surrounding ground and works

5.2.3. Surface Water

A surface water system will be incorporated within the development design. The proposed surface water system will manage surface water run-off from the site and should be in accordance with SDCC policy and guidelines. Details of the proposed system are provided under separate cover by CS Consulting.

6 The Justification Test for Development Management

6.1. Strategy

The relevant planning guidance for this development is "The Planning System and Flood Risk Management" (DoEHLG & OPW, 2009), which outlines a framework for assessing new developments in areas of flood risk. This framework includes the Justification Test for Development Management, which must be applied to ensure the development is appropriate within the context of flood risk mitigation and planning policy.

As the proposed development includes areas within Flood Zone B and is classified as highly vulnerable, it must undergo and pass the Justification Test (JT) to comply with flood risk management guidelines.

The following section provides a detailed response to each of the Justification Test criteria, demonstrating how the proposed development meets the requirements. Where relevant, technical justifications are referenced within later sections of this report.

6.2. Justification Test: Part 1

The subject site is zoned for development under the South Dublin County Council Development Plan, which was adopted in accordance with The Planning System and Flood Risk Management Guidelines (DoEHLG & OPW, 2009).

The Strategic Flood Risk Assessment (SFRA) for the Development Plan has been considered, and its guidance has been followed in defining appropriate flood mitigation measures for the site. This Flood Risk Assessment (FRA) incorporates detailed hydraulic modeling, including climate change scenarios, culvert blockage analysis, and compensatory storage evaluation, ensuring a level of detail exceeding that of the OPW CFRAM study.

The Development Plan zoning aligns with the proposed residential and infrastructure development, which is categorized as highly vulnerable. The flood mitigation measures ensure compliance with planning requirements, supporting the safe and sustainable development of the site.

6.3. Justification Test: Part 2

The proposed development has been subject to a comprehensive Flood Risk Assessment (FRA), which demonstrates compliance with The Planning System and Flood Risk Management Guidelines (DoEHLG & OPW, 2009). The assessment confirms that the development meets the necessary flood risk management criteria, as outlined below:

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

The proposed development incorporates compensatory flood storage, ensuring that the loss of floodplain volume is offset for Flood Zone B, which is above and beyond what is required under the Planning System and Flood Risk Management Guidelines (OPW DoEHLG 2009). The lateral storage area downstream of the newly built culvert on the Kilmahuddrick Stream culvert provides an additional 170m³ of storage that gets active only on case of extreme events, helping to maintain baseline conditions and prevent increased downstream flood risk.

The proposed mitigation measures ensure that the floodplain functionality is preserved, and the development does not negatively impact flood risk in surrounding areas. The hydraulic model confirms that the localised flood levels remain stable, and the OPW drainage channels continue to function effectively.

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

The flood mitigation strategy follows the guidance of the South Dublin County Council Development Plan SFRA, ensuring that the site is designed to withstand extreme flood events. The Finished Floor Levels (FFL) have been set above the critical flood levels, incorporating a 300mm freeboard allowance, ensuring adequate protection against extreme flooding and appropriately considers residual risk.

Additionally, the culvert crossing at the Kilmahuddrick Stream has been designed following Section 50 requirements, ensuring sufficient conveyance capacity while minimizing backwater effects.

(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 residual flood risk assessment that included a detailed analysis of culvert blockage and exceedance events confirms that the site FFLs/road levels are set appropriately and there is no impact. Canal breach has also been considered under the Clonburris SDZ SFRA and risk is managed to the site.

(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 proposed development has been designed to provide a well-integrated urban environment, ensuring aesthetic and functional compatibility with surrounding existing and future developing infrastructure. The site layout ensures efficient land use, balancing flood mitigation measures with sustainable urban development principles.

This assessment confirms that the Justification Test is passed, demonstrating that the development is suitable for its location, complies with planning guidelines, and does not exacerbate flood risk to the site or surrounding areas

7 Conclusion

This Flood Risk Assessment (FRA) evaluates the potential flood risks associated with the proposed development at Site 4 Kishoge in Clonburris, outlining appropriate mitigation measures to ensure compliance with The Planning System and Flood Risk Management Guidelines (DoEHLG & OPW, 2009).

The key findings from the detailed hydraulic and hydrological assessment conducted by JBA are as follows:

- The site is predominantly located in Flood Zone C, but a small area of the south east corner is located within Flood Zone B, with fluvial flooding from the Kilmahuddrick Stream being the primary flood risk source. The Griffeen River does not pose any flood risk to the site.
- The extreme 0.1% AEP flood event on the Kilmahuddrick Stream leads to localised flooding in the southeastern corner of the site.
- A range of scenarios were modelled and assessed, consisting of post-development scenarios for climate change and culvert blockage conditions to ensure that residual risks were identified and mitigated.
- The modelled scenarios confirm that the proposed development is appropriately mitigated, ensuring no increase for third-party lands downstream of the railway line.
- A compensatory storage of approximately 170m³ has been proposed north of Cluster C and D to balance the floodplain volume loss, restoring the baseline conditions along the Kilmahuddrick Stream in the 0.1% AEP event.
- Mitigation measures have been designed to ensure sustainability and resilience of the development, including appropriate site layout planning, FFLs, compensatory storage, and flood-resilient infrastructure.
- The proposed culvert crossing the Kilmahuddrick Stream adjacent to Cluster D has been designed ensuring compliance with Section 50 requirements while maintaining flow continuity and minimizing backwater effects.
- Finished Floor Levels (FFL) have been set above critical flood levels, incorporating a 300mm freeboard allowance, ensuring adequate protection for the development under extreme flood conditions.

This Flood Risk Assessment (FRA) demonstrates that, with the proposed mitigation measures in place, the development can proceed without increasing flood risk to the site or surrounding areas and the Justification Test has been applied and passed. Furthermore, the design approach ensures compliance with the South Dublin County Council Development Plan and SFRA, providing a resilient and sustainable solution for the Clonburris development.

In conclusion, this FRA confirms that the proposed development is suitable for its location, aligns with the best flood risk management practices, and supports the sustainable development goals of the planning framework. The proposed measures ensure that the site remains resilient to current and future flood risks, while maintaining compliance with local and national planning policies.

A Appendices

A.1. Appendix - 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.1.1. 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 years, a 1% AEP flood 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 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.

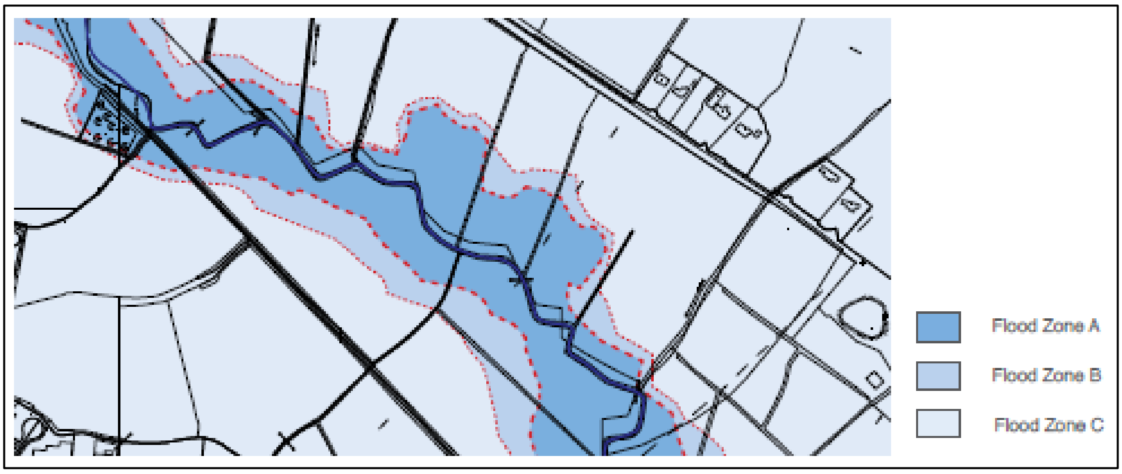
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.1.2. Flood Zones

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

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 will be maintained in perpetuity.



A.1.3. Consequences 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 type of development, nature, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

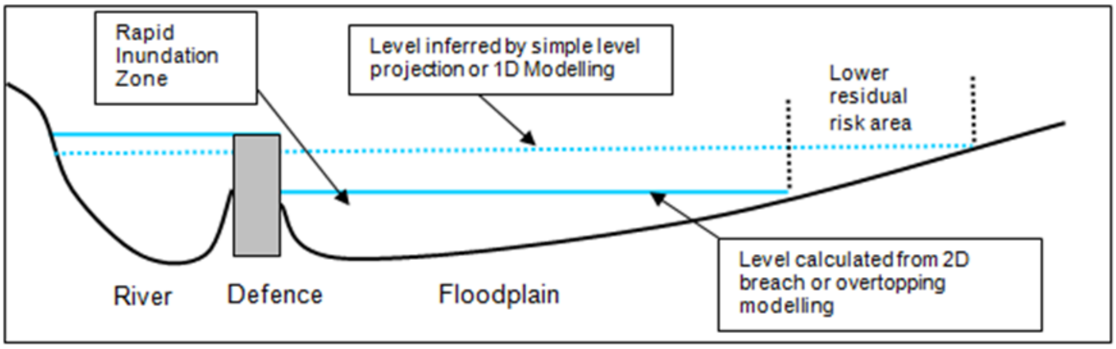
Highly vulnerable, including residential properties, essential infrastructure, and emergency service facilities

Less vulnerable, such as retail and commercial and local transport infrastructure, such as changing rooms.

Water compatible, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

A.1.4. 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 known as residual risk:



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