Finlay Park
Flood Risk Assessment

Technical Report

December 22

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Westar Homes Ltd

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Contract

This report describes work commissioned by William Fadden, on behalf of Westar Homes Ltd, by a letter dated 17th February 2021. David Casey of JBA Consulting carried out this work.

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Purpose

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Abbreviations

1D	One Dimensional (modelling)
2D	Two Dimensional (modelling)
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 Levels
FRA	Flood Risk Assessment
FSR	Flood Studies Report
FSU	Flood Studies Update
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

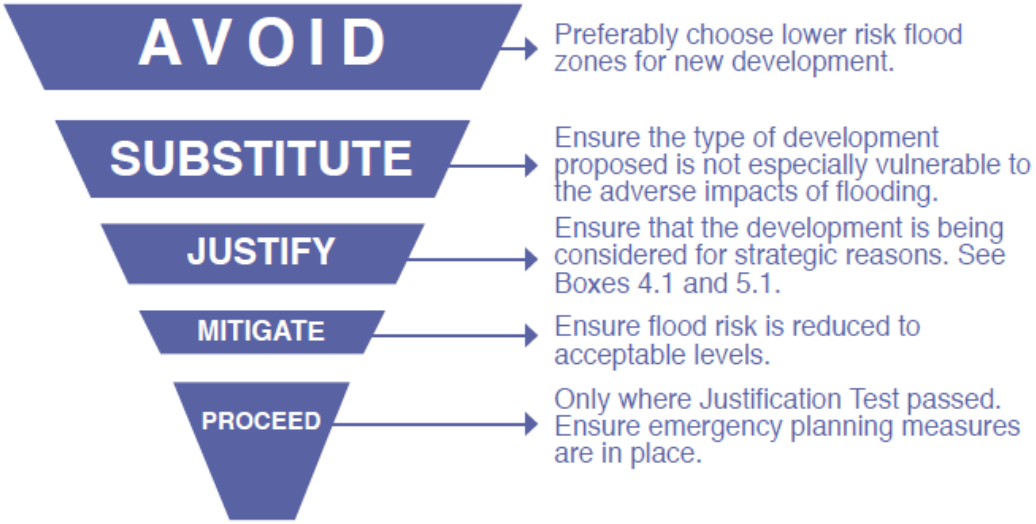
URBEXT ..... FEH index of fractional urban extent

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 (FRA) to ensure sustainability and effective management of flood risk.

The FRA will begin with a review of the flood risks and sources in the study area and will be based on the sequential approach and Justification Test (if applicable) as outlined below in Figure 3.1 & 3.2 of the Planning System and Flood Risk Management Guidelines.



Overall, the assessment of flood risk will be based on the flood zone classification (A,B & C and the associated Vulnerability Classes described in Table 3.1 of the FRA guidelines.

1.1 Terms of Reference

JBA Consulting was appointed by Westar Homes Ltd to prepare a FRA for the proposed development of a site located at Finlay Park, Naas. The report was prepared in response to a request for a Flood Risk Assessment.

1.2 Flood Risk Assessment Aims and Objectives

This study is being completed to inform the future development of the site as it relates to flood risk. It aims to identify, quantify and communicate to Planning Authority officials and other stakeholders the risk of flooding to land, property and people and the measures that would be recommended to manage the risk.

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 that the proposed development has on flood risk;
- 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 / DECLG planning guidance, "The Planning System and Flood Risk Management", and the governing County Development Plan and Local Area Plan.. A review of the likely effects of climate change, and the long-term impacts this may have on any development has also been undertaken.

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

1.3 Development Proposal

The proposed development will consist of the construction of 134 no. apartments (comprising a mixture of 70 no. 2 storey apartments and 64 no. apartments - 22 no. 1 bedroom apartments, 77 no. 2 bedroom apartments, and 35 no. 3 bedroom apartments) with private open space provided in the form of balconies/terraces as follows:

A) Block A (4 storey apartment block) comprising 26 no. apartments (6 no. 1 bed units, 16 no. 2 bed units & 4 no. 3 bed units); Block B (part 4 part 5 storey apartment block) comprising 66 no. apartments (10 no. 1 bed units, 33 no. 2 bed units and 23 no. 3 bed units), with a commercial/ health/medical unit (c. 247.6 sq. m) at ground floor; Block C (part 4 part 5 storey apartment block) comprising 42 no. apartments (6 no. 1 bed, 28 no. 2 bed units and 8 no. 3 bed units);

B) Vehicular/pedestrian and cyclist access from the Old Caragh Road (in new arrangement) along with the provision of 201 no. undercroft and surface car parking spaces as well as 388 no. undercroft and surface cycle parking spaces; internal road and shared surface networks including pedestrian and cycle paths;

C) Public Open space including proposed plaza, as well as central communal (courtyard) open space including outdoor playground area at podium level;

D) 1 no. temporary (for 3 no. years) 3-sided signage structure (c. 4.5m in height) at the entrance to the proposed development.

E) Provision of foul and surface water drainage, including relocation of existing foul main in northern part of site as well as green roofs; linear greenway path, bin stores; plant rooms; public lighting and all associated landscaping and boundary treatment works, site development and infrastructural works, ESB substations, and all ancillary works necessary to facilitate the development.

The proposed Finish Floor Level (FFL) has been set at 87.0mOD.

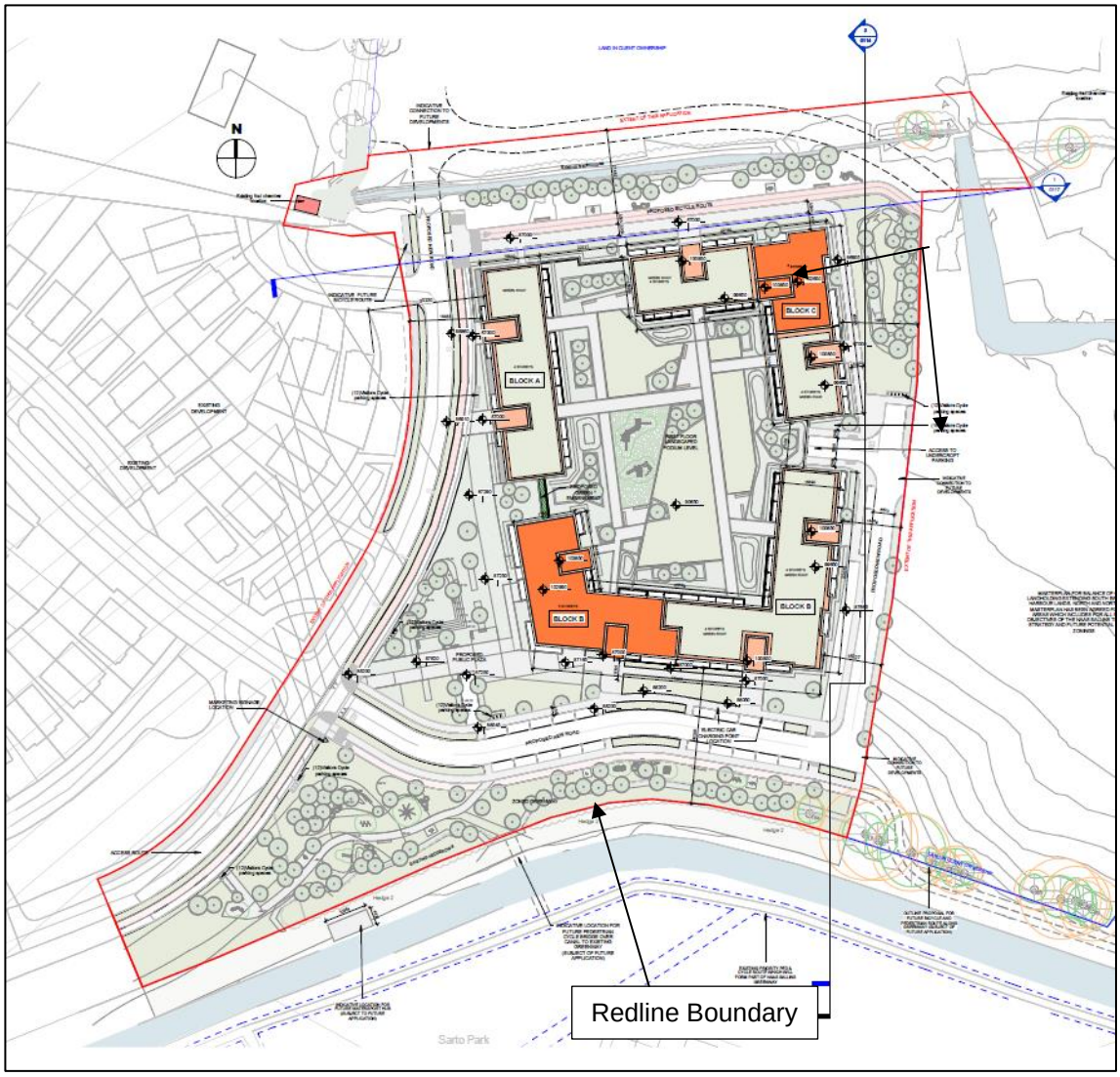


Figure 1-1: Site Layout

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. An overview of the technical approaches to Flood Risk Assessment (FRA) are included in Section 4 while site-specific mitigation measures are explained in Section 5. Conclusions are provided in Section 6.

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

2 Site Background

This section describes the proposed commercial development site in Finlay Park, Naas, including watercourses, geology and wider geographical area.

2.1 Location

The proposed development site is identified as Finlay Park and is located within greenfield lands. It is situated to the north of urban core of Naas town. Existing residential properties are located to east and west of the site, and to the south beyond the Grand Canal. Refer to Figure 2-1 for the site location.

Agricultural lands are located to the north of the site.

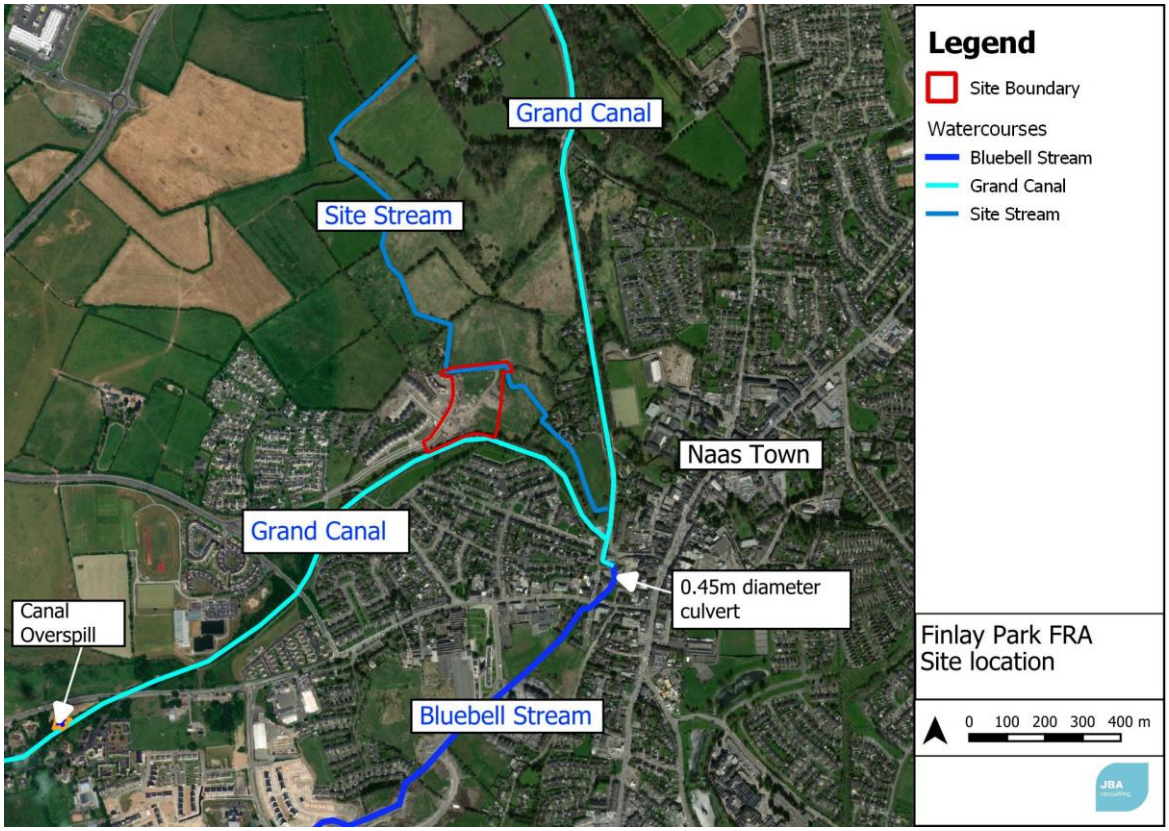


Figure 2-1: Site Location & Hydrological Environment

2.2 Local Watercourses

There are a number of watercourses in the local area which present a potential risk to the site. In the interests of clarity, the watercourses are mapped in Figure 2-1 above described below.

2.2.1 Bluebell Stream.

The Bluebell Stream is located approximately 580m south of the site. It is the main watercourse in the study area and flows through Naas town. It is classified as a feeder system to the Grand Canal. It discharges to the Grand Canal between Lock Gates 2 and 3 at the canal harbour.

2.2.2 Grand Canal

The Grand Canal's Naas section (Corbally Canal) begins in Corbally Harbour approx. 8km southwest of the site. The canal continues to flow towards where it joins with the main canal body approx. 3km north of the town. There are 5 Lock Gates located along the canal between the harbour and the main Canal branch.

The canal is feed by a spring system at the Corbally Harbour and by the Bluebell Stream at the harbour area of the town centre. Following extensive walkovers, no additional feeder systems have been identified in proximity to the site. Further to the west the Castlesize is also a feeder system.

2.2.3 Canal Overspill

The Canal has an overflow channel which diverts surplus flows around Lock Gate 2 and runs parallel to the Canal for approximately 840m north before re-joining the Canal downstream of Lock Gate 1.

2.2.4 Unnamed Stream/Drainage Channel

A stream runs through the site that provides local drainage from lands to the south of the site. This watercourse also receives stormwater flows from the public stormwater system within Naas town Centre. The stormwater is discharged to the stream via a 0.45 dia. culvert located underneath the Grand Canal.

2.3 Local Site and Topography

The site covers an area of c. 0.027km^2. The site is generally level with local falls towards the drainage channel running through the site. Ona regional level, there is a fall towards the north.

2.4 Site Geology

The groundwater and geological maps of the site, provided by the Geological Survey of Ireland (GSI), have been studied and an extract of the geological map is presented in Figure 2-2. The subsoil is till derived chiefly from limestones (TLs), Gravels (GLs) and Alluvium (A).

The underlying bedrock covers both the Ballysteen Formation (Dark muddy limestone, shale) and the Feighcullen Formation (Skeletal, oolitic & micritic limestone) The groundwater vulnerability of the site is 'Moderate' which indicates a groundwater depth of greater than 10m.

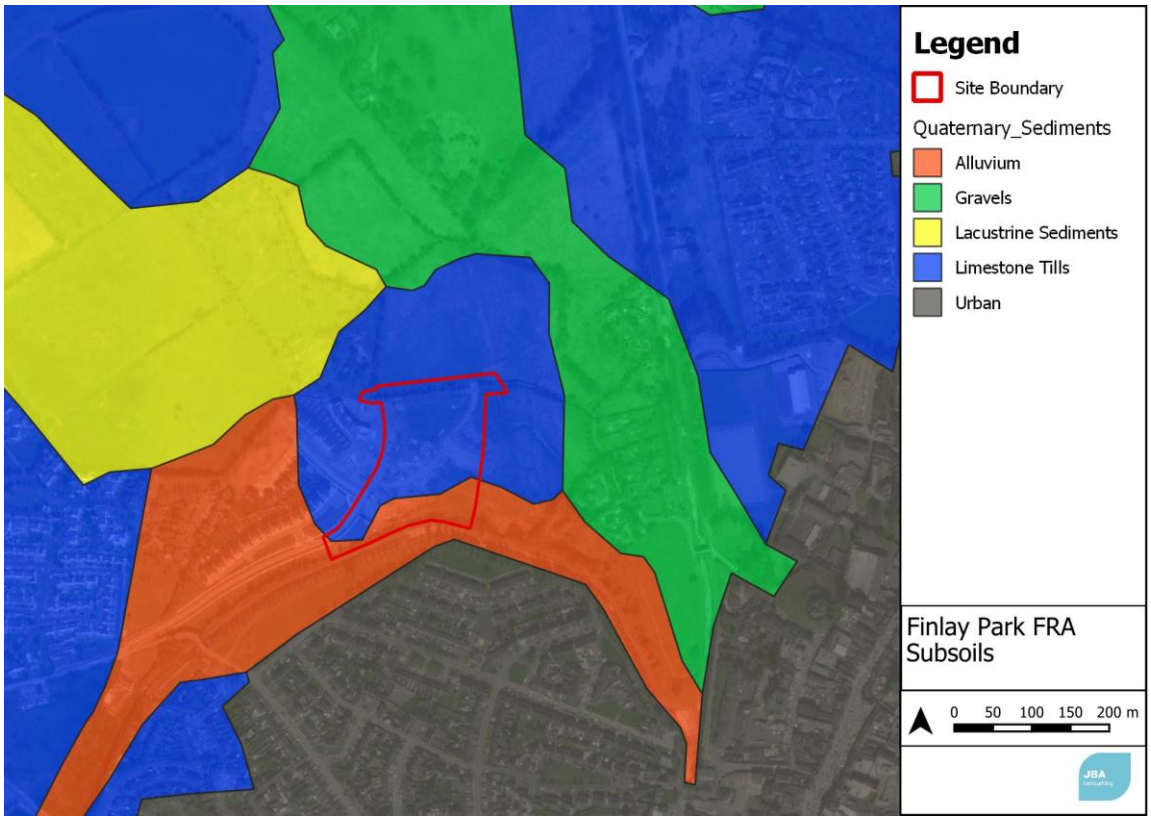


Figure 2-2: EPA Subsoils

2.5 Kildare County Council

2.5.1 Naas Local Area Plan (LAP) (2021-2027)

The existing Naas Town Development Plan shows that the site is in the C (New Residential) zone.

The LAP includes an SFRA which draws on the CFRAM flood mapping, as presented in Section 3.2.2 of this report. The Naas Strategic Flood Risk Assessment recommends that future development proposals on the north-west part of Naas shall be accompanied by a site-specific flood risk assessment, which is appropriate to the type and scale of the development proposed.

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 historic flood information. The findings from the flood risk identification stage of the assessment are provided in the following sections.

3.1 Flood History

A number of sources of flood information were reviewed to establish any recorded flood history at, or near the site. This includes the OPW's website, www.floodmaps.ie and general internet searches. Review of the flood sources outlined in the following section confirm that there is no recorded instance of flooding in the study area.

3.1.1 Floodinfo.ie

The OPW host a National Flood hazard mapping website, www.floodinfo.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. As can be seen in Figure 3-1 below, no historic flood events have been recorded in the area.

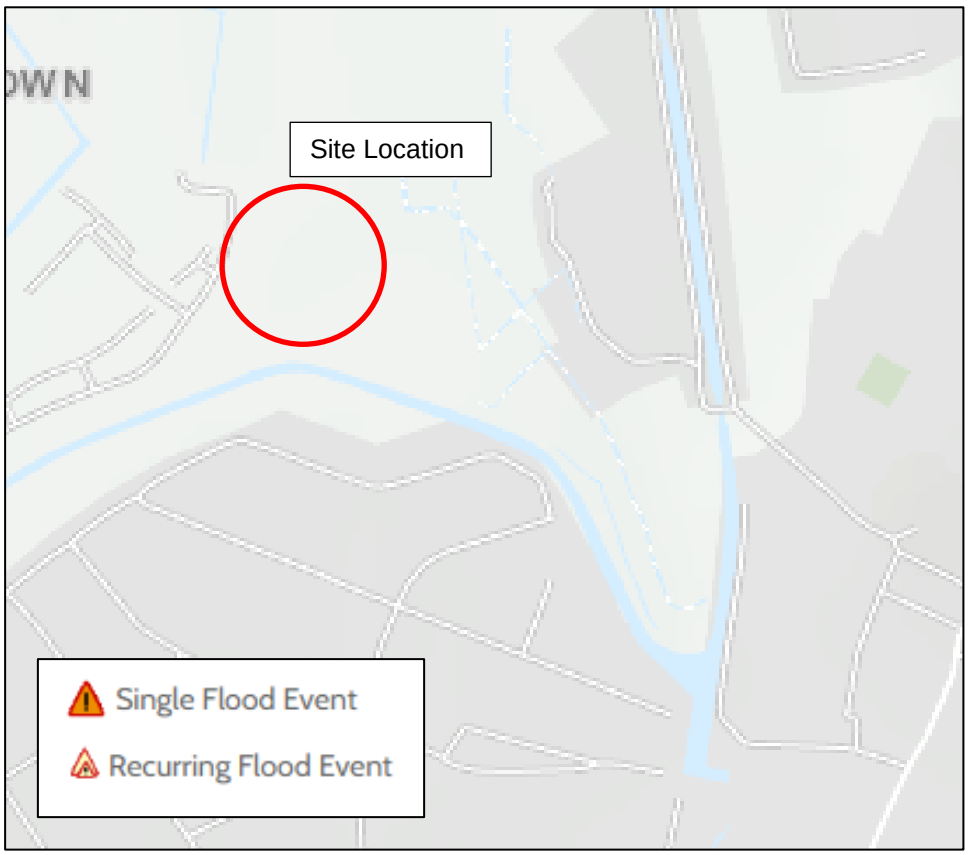


Figure 3-1: Floodmaps.ie

3.1.2 Eastern CFRAM

Information on flooding on the wider area is available and the Eastern CFRAM Hydraulics Report[1] provides a useful summary of key events in Naas, these events have been described and expanded upon by JBA, below in Table 3-1. The proposed site or surrounding area are not reference as having flooded.

Table 3-1 Key Historic Floods in Local Area

Date	Comment
Oct 2011	Flooding to M7 at Citywest and M7 Castlewarden. Fluvial event in region 2% AEP event - as described in OPW overarching report on Oct 2011 event (Report ref: IBE0600Rp0014)
Aug 2008	Flooding due to heavy and prolonged rainfall. No further information available for Naas. Gauging station downstream of Morell Bridge (09024) indicated 50% AEP event.
Nov 2000	Flooding from Morell River as it backed up at Johnstown Manor Bridge. Event likely to be between 1% - 2% AEP event on the Morell catchment.
Jun 1993	Flooding to Roselawn Estate, Millbrook and Mountain View Estate from the Naas Stream and Broadfield River. Morrell River also caused flooding upstream of Old Johnstown Bridge. 2% AEP event estimated for the Naas Stream and Broadfield River.
Dec 1954	Event estimated to be around 1% AEP event for Naas Stream and Broadfield River. Flooding to Popular Square and Millbrook from Naas Stream/Broadfield River. The Harbour (of the Canal) was also reported to have overflowed causing adjacent houses to flood, this was presumably caused or linked to the 'Callan's River' near New Row. Callan's River is also known as the Canal Feeder channel or Bluebell Stream which feeds the canal at the harbour (flowing in from lands to the south-west of Naas) and then passes under the canal in a siphon[2].

3.1.3 Internet Search

An internet search was conducted to gather information about whether the site was affected by flooding previously. The Millennium Park Link Road was reported as closed due to flooding on the 22 November 2017[3]. No other information about this event was provided.

3.2 Predictive Flood Mapping

The subject area has been a subject of number of predicative flood mapping or modelling studies and other related studies and plans:

- Naas Flood Relief Scheme (2022).
- Eastern Catchment Flood Risk Assessment and Management Study;
- National Indicative Fluvial Mapping (NIFM);
- County Development Plan 2017-2013,
- Draft County Development Plan 2023-2029,
- Naas Local Area Plan SFRA 2021-2027 (RPS, 2021);
- Preliminary Flood Risk Analysis Report- Waterways Ireland

The level of detail presented by each method varies according to the quality of the information used and the approaches involved. The Naas FRS is the most detailed assessment of flood extent and supersedes the fluvial flood outlines presented by the OPW CFRAM study.

1 Eastern CFRAM Study, HA09 Hydraulics Report - Naas Model (IBE0600Rp0027, version F03) Draft Final, OPW.

2 Communication from OPW, Jan 2017. Siphon is indicated in a map within the Kildare County Council Naas Surface Water Drainage Assessment Strategic Review 2011. However, no mention of the siphon is made in CFRAM hydraulics report, only the feeder outlet is mentioned.

3 https://www.kildarenow.com/news/roads-kildare-affected-flooding-ahead-evening-commute/195648

3.2.1 Naas Flood Relief Scheme (Naas FRS)

Following the completion of the CFRAM Study which highlighted the potential risk of flooding throughout Naas, the Naas FRS was progressed. The aim of the Naas FRS is to advance and implement a flood relief scheme for Naas.

Works began during 2020 and the Stage 1 Hydrological & Hydraulic analysis are scheduled for completion by Q4 2022. This will lead onto Stage 2, Planning which is scheduled for completion by Q2 2025.

As part of Public Engagement Day (No.1), the 1% AEP flood extent map has been provided and an extract is provided in Figure 3-3. Review of Figure 3-3, confirms that the site is not at risk of inundation from the modelled 1% AEP event.

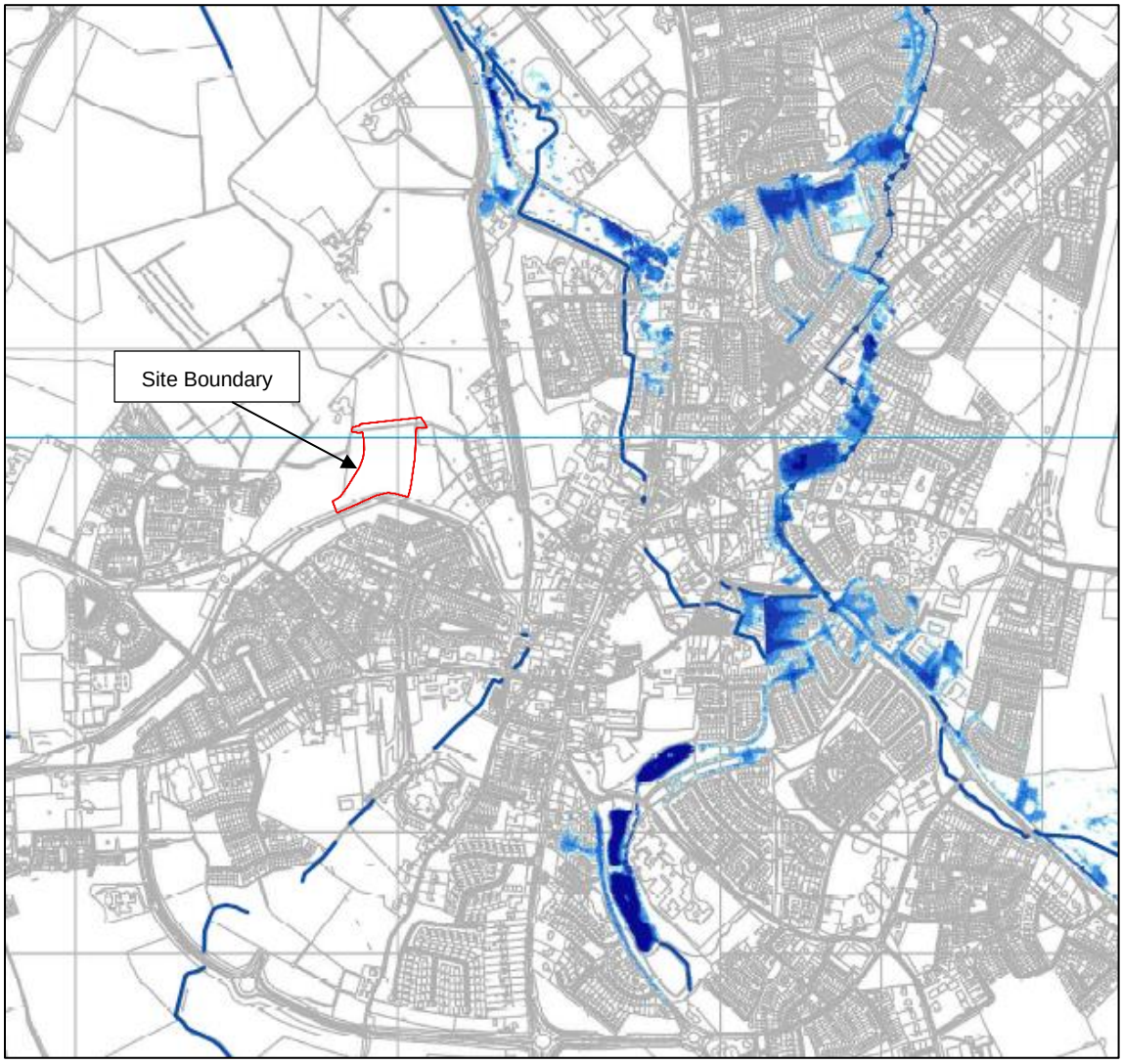


Figure 3-2: Naas FRS -1% AEP Flood Extent

3.2.2 Eastern Catchment Flood Risk Assessment and Management Study (Eastern CFRAM)

The primary source of data with which to identify flood risk to the site is the Eastern CFRAM. The Eastern CFRAM covers approximately 6,300km² and involves detailed hydraulic modelling of rivers and their tributaries along with coastal flooding.

Flood maps are publicly available for 10%, 1% and 0.1% AEP and covers (amongst others) the Bluebell River. Flood maps have been finalised for Naas Town and an extract of the flood map covering the site is presented in Figure 3-3. The CFRAM map suggests that the site is located in Flood Zone C and at low risk of flooding. The source of flooding appears to be the Bluebell Stream which surcharges into the Grand Canal and subsequently into the site.

Following review of the CFRAM Hydraulics report, it appears that the Grand Canal has only been modelled in the 2d domain only and with limited extents. This results in an inaccurate representation of the Grand Canal in the model especially when modelling the hydraulics of the system. The intention of the CFRAM is to highlight areas at risk of inundation and trigger further assessment.

As highlighted in Figure 3-3, the flow path close to the site is an overland flow path and does not represent a watercourse. The stream runs in a westerly direction along the northern site boundary and has not been specifically modelled in the CFRAM study. The flood mapping in this area has only been represented by 5m resolution LIDAR data hence the need to undertake a detailed site specific flood model to improve confidence in the assessment of flood risk to the site.

It is noted that the CFRAM study has been superseded by the Naas Flood Relief Scheme (Section 3.2.1).

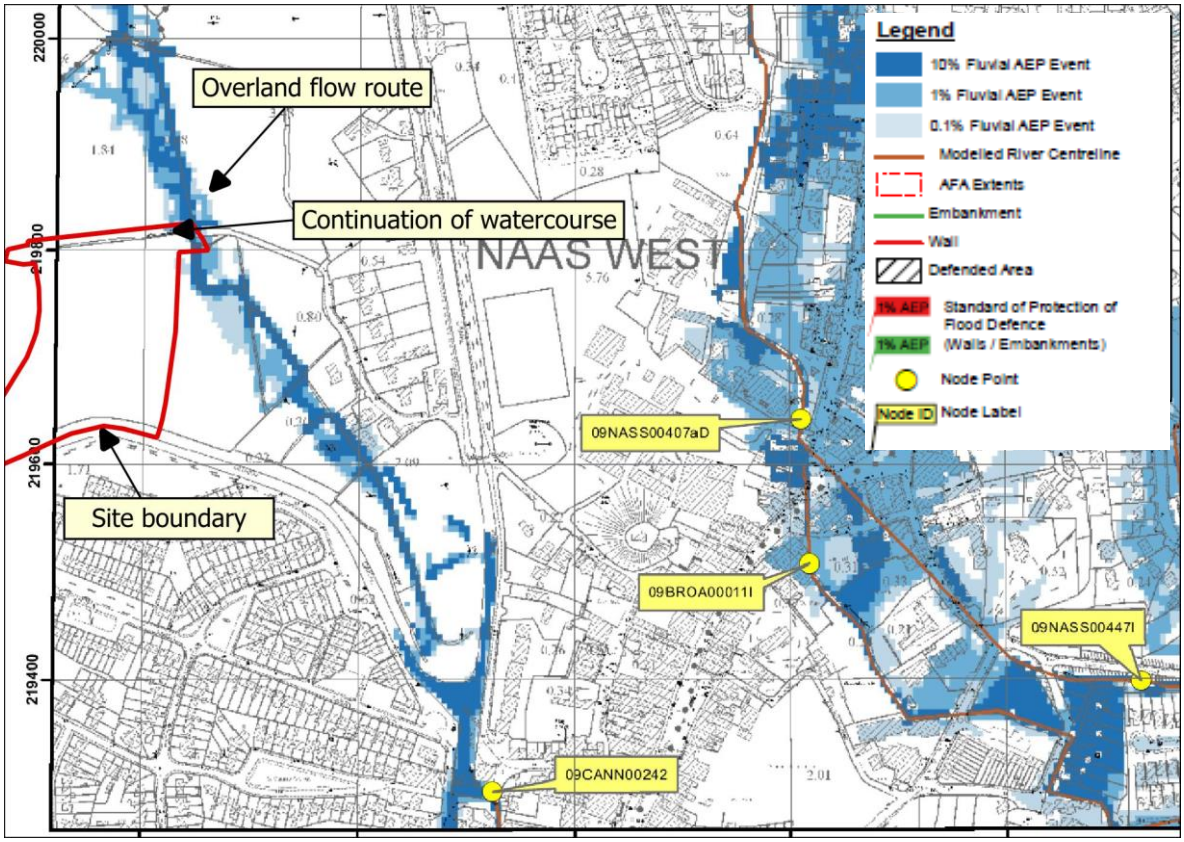


Figure 3-3: CFRAM Flood Map

3.2.3 National Indicative Fluvial Mapping (NIFM)

The Office of Public Works recently published the NIFM data which included all watercourses on the EPA watercourse layer excluding:

- any section of watercourse with an upstream catchment area of less than 5km^2,
- any section of watercourse for which flood spatial data has been produced under the National CFRAM Programme bar a 500m overlap at the upstream boundary of the National CFRAM Programme spatial data

National Indicative Flood Maps (NIFM) only provide an indication of areas that may be prone to flooding. Flood maps have been developed for the current scenario, and for two potential future scenarios; the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS), taking into account the potential impacts of climate change. The National Indicative Fluvial Maps are not the best achievable representation of flood extents, and they are not as accurate as the Flood Maps produced under the National Catchment Flood Risk Assessment and Management (CFRAM) Programme.

As Naas has been incorporated within the CFRAM study it has not been included within the NIFM scope of works and therefore no additional mapping has been provided.

3.2.4 Naas Local Area Plan SFRA 2021-2027 (RPS, 2021);

The Naas Local Area Plan (LAP) has been prepared for Naas to set out the overall strategy for proper planning and sustainable development within the town. Under the Naas LAP 2021-2027 the site is located in lands zoned as C: New Residential (R1.6).

A Strategic Flood Risk Assessment (SFRA) has been prepared as part of the LAP. It is noted that the SFRA flood maps have been based on the CFRAM flood mapping (refer to Section 3.2.2), which has been superseded by the Naas FRS outputs. Therefore, the Naas LAP/SFRA does not provide any additional information regarding fluvial flooding.

The SFRA does not highlight groundwater or pluvial flooding within the site or surrounding area.

3.2.5 Kildare County Development Plan 2017-2023

The Kildare County Development Plan 2017 - 2023 is the governing document for development in the area. It aims to set out the priorities and goals of the council over the lifetime of the plan for spatial and sectoral development. It will be superseded by CDP 2023-2029. The policies have been reviewed and incorporated in Appendix C.

3.2.6 Draft Kildare County Development Plan 2023-2029

The Kildare County Development Plan 2023 - 2029 is currently in draft stage and will replace the current CDP in 2023.

As part of the Drat Development Plan, a Strategic Flood Risk Assessment (SFRA) was commissioned to inform development based on flood risk. The SFRA informs the strategic land use planning decisions by providing an assessment of flood risk within the region. However, the SFRA flood maps have been based on the CFRAM flood extents, which was supplanted by the Naas FRS mapping.

The CDP policies have been reviewed and incorporated in Appendix D.

3.2.7 Preliminary Flood Risk Analysis Report- Waterways Ireland

As part of the CFRAM preliminary works programme the Preliminary Flood Risk Report has been prepared by Waterways Ireland. The findings of the report confirm that overtopping of the Grand Canal is rare and only three instances have been recorded.

- Vandalism of the lockgate resulting in overtopping of the canal banks
- Failure of stormwater system resulted in surface water discharging into the canal.
- Localised flooding in Celbridge, Co Kildare resulting on overtopping of the canal, but no houses were impacted.

No indication of potential flood risk has been highlighted in the Naas area.

3.3 Sources of Flooding

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.

3.3.1 Fluvial

Review of the Naas FRS flood map confirms that the site is not at risk of inundation during the 1% AEP flood event.

Under the CFRAM flood mapping the proposed development is located in Flood Zone C with an overland flow route travelling just with the site's north-eastern boundary.

Although the site is confirmed to be located in Flood Zone C. it is clear that the extent of flooding shown to the east is not an accurate representation.

It is clear that this overland flow path is a result of two main factors, which are described below;

1. **The canal was represented in 2D only**. LiDAR data (degraded to 5m grid resolution) was used to define the available volume in the Canal instead of representing the Canal in the 1D domain. It is unrealistic to assume that only including the Canal in the 2D domain is fully representative because the Canal would in practise convey far more volume to its formal overflows than is represented by a limited 2D model approach.
2. **Structures on the Canal were not represented.** The Canal was represented by LiDAR which did not include openings for the structures to allow flow to be conveyed through them. This causes a large and unrealistic bottleneck upstream of these structures which in turn causes a large amount of overland flow from the Canal.

It is clear from the analysis of the CFRAM mapping that the flood extents in the vicinity of the proposed site are not an accurate representation. Although this has been confirmed by the Naas FRS, a specific flood model has been developed to clarify the baseline flood extents and aid in the development of mitigation measures to support the proposed design of the site. This is covered under Sections 4 & 5 of this report.

3.3.2 Tidal

The development site is located inland so tidal flood risk has therefore been screened out at this stage.

3.3.3 Pluvial

Pluvial, or surface water, flooding is the result of rainfall-generated flows that arise before run-off can enter a watercourse or sewer. It is usually associated with high intensity rainfall. Although flood risk from pluvial sources is not identified in the OPW PFRA maps, it exists in all areas. Adequate storm water drainage systems will minimise the pluvial flood risk.

It is also important that increases in surface water runoff as a result of the development, including changes from greenfield to paved area, are managed. Pluvial mitigation is discussed further in Section 5.1.4.

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.

Groundwater flood risk is confirmed to be low by the OPW PFRA and the GSI mapping thus it has been screened out at this stage.

3.3.5 Grand Canal

The Grand Canal is located near the site's south-western boundary. Although there has been no recorded inundation in proximity to the site or within the Naas area, specific measures have been outlined in Section 5.1.3 to manage the flood risk from the Grand Canal.

4 Flood Risk Assessment

The initial flood risk assessment has found the site to be in Flood Zone C however there is uncertainty within the previous modelling studies regarding the representation of an overland flow path and its potential risk to the site. This section will assess the likelihood of flooding to the site in more detail using a site-specific hydraulic model of the Bluebell Stream and the Grand Canal and wider flood plain. This will provide clarification of the anticipated flood zone extents, updating the information provided by the Eastern CFRAM study and Naas FRS. The purpose of the hydraulic model is to confirm the Flood Zone A and B extents in the study area while also assessing for climate change and residual risks.

The process involves two main areas, the estimation of the peak flows (hydrology) and the physical model build. The development of the hydrology is provided in Section 4.1, while the model build and the model results are outlined in Section 4.2.

4.1 Hydrology

To assist in the estimation of potential flood risk to the proposed development, this section provides flow estimates for the 1% and 0.1% AEP flood event flows expected along the local watercourses. A summary of the hydrology estimation process is provided in this section.

4.1.1 Catchment Characteristics

The physical characteristics of the catchment influence the hydrology, this includes catchment size, soil type, steepness and the average annual rainfall. Table 4-1 outlines the parameters calculated for the river catchments and Figure 4-1 presents the catchment delineation.

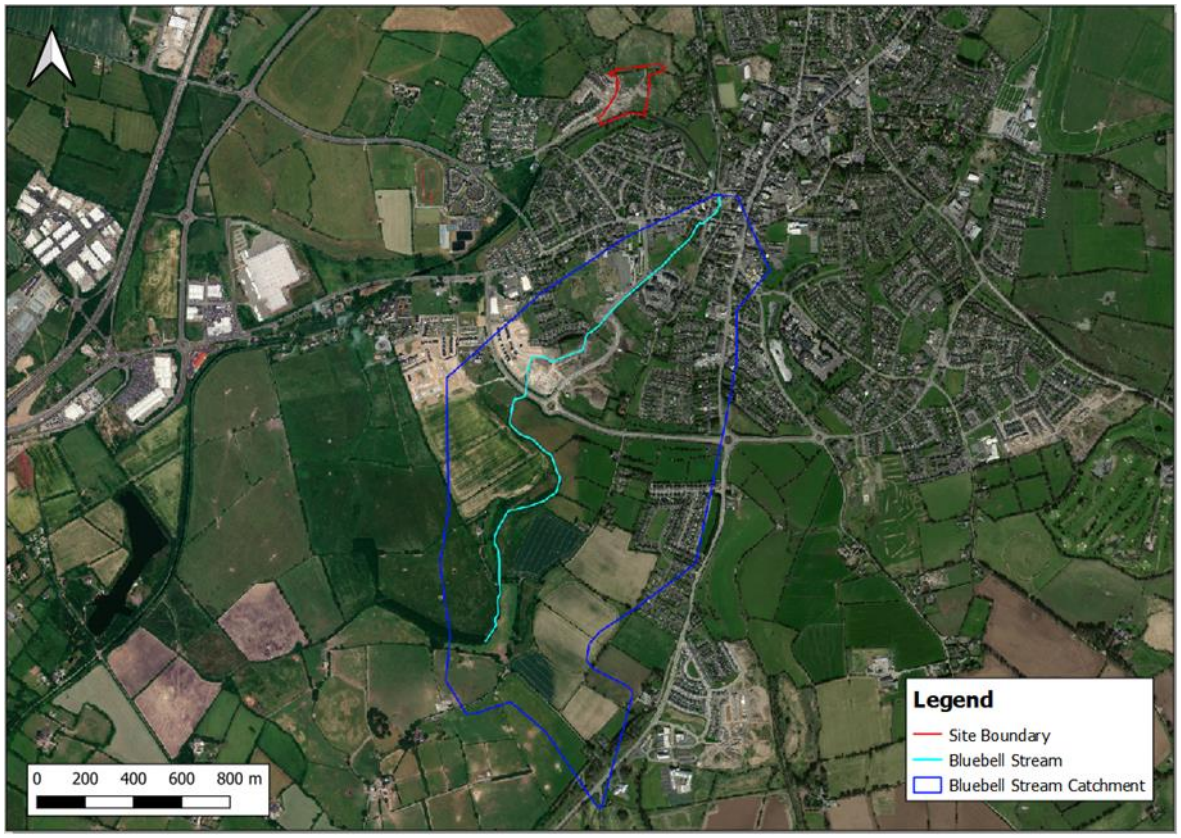


Figure 4-1: Catchment Delineation

Table 4-1: Catchment Characteristics

Descriptor	Site A
Centroid X	688557
Centroid Y	718127
Area	1.96
SAAR	800
FARL	1
BFI Soil	0.67
URBEXT	0.29
MSL	2.57
S1085	5
Stream Frequency	1
DrainD	1.25
ArtDrain2	0
Soil (number)	2
M5-2day	59.8
M5-1day	53.4
r	0.3

4.1.2 Flow Estimation

The FSR RR method was selected for the flow estimation as it produced the more conservative flows and is considered the most applicable method for the catchment size and characteristics. Table 4-2 presents the peak flows incorporated into the hydraulic model for the Bluebell Stream.

Table 4-2: Final Design Flows (m^3/s)

Flood peak (m^3/s) for the following return periods (% AEP)						
50%	20%	10%	4%	2%	1%	0.1%
0.90	1.23	1.48	1.79	2.34	2.85	4.87

4.2 Hydraulic Modelling

4.2.1 Model Set-up

To assess flood risk at the site, a 2D TUFLOW hydraulic model was constructed, allowing for the modelling of river channels, streams, floodplains and hydraulic structures to predict water levels for a range of scenarios (see Figure 4-2 for hydraulic model structure). The hydraulic model was developed in the following stages:

- A 1D/2D TUFLOW model of the Bluebell Stream, Grand Canal and local drainage was created based on a detailed survey data which has been supplemented by DTM data,
- Hydraulic simulations were run to derive the existing flood extent to determine Flood Zones A and B (the 1% and 0.1% AEP flood events),
- The model was then updated to account for the finished levels of the proposed development and the mitigation measures were assessed,
- The scenario examining the effect of climate change (+20% flow under the MRFS scenario) was also assessed.

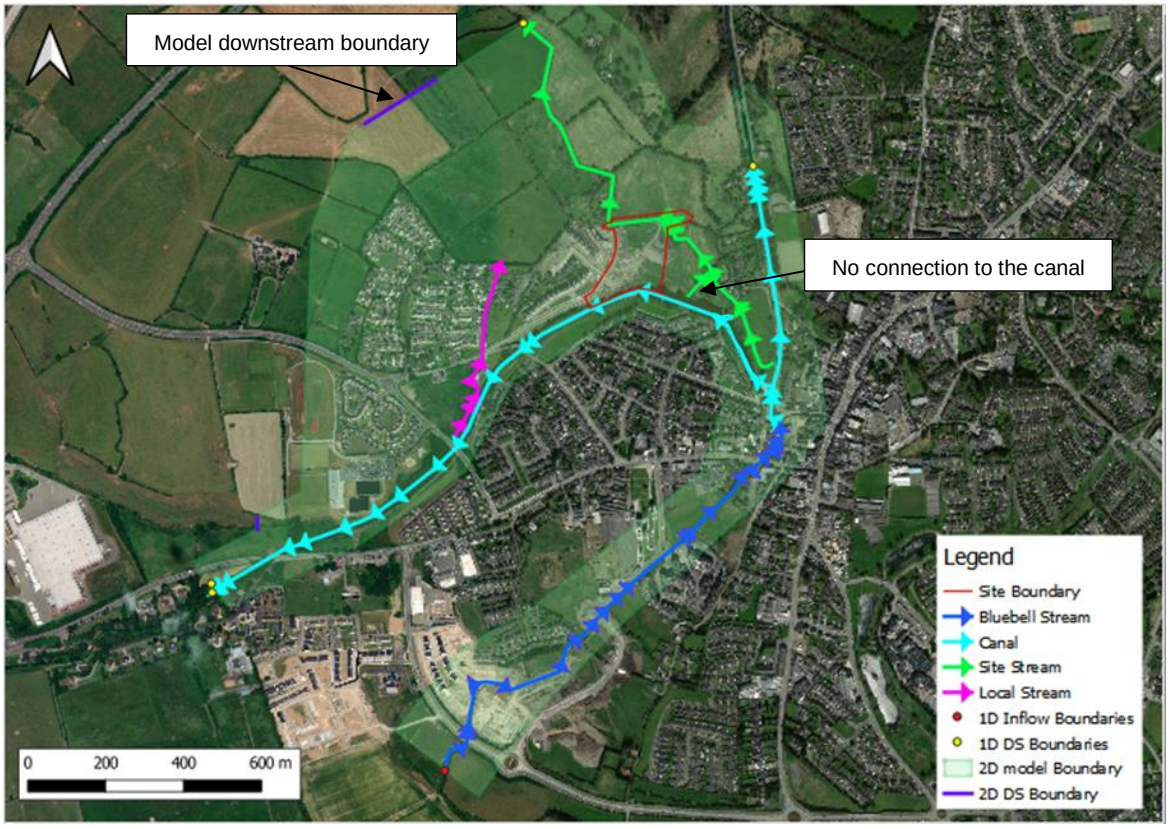


Figure 4-2: Model Setup

The hydraulic model results are presented in Section 4.2.2.

The model has been extended sufficiently upstream of the site towards Corbally Harbour to capture the main flow control devices (gates, overspill) and to ensure that the downstream boundaries will not impact on flood levels adjacent to the site. The model is extended downstream (towards the main canal body) to the lock gate.

The Corbally spring system has not been specifically modelled due to the distance from the site and the minor inflows compared to a 1% AEP flood event from the Bluebell Stream. Within the hydraulic model, a consistent water level based on recorded levels was obtained prior to the main flood event. This ensures that the interaction between the canal and overland flows are accurately modelled.

4.2.2 Model Results and Flood Mechanism

The modelled flood extents for the 1% and 0.1% AEP flood events are presented in Figure 4-3 below. Review of Figure 4-3 confirms that there is no overtopping of floodwaters onto the site during this scenario. The flood extents within the unnamed stream onsite are contained within the stream banks but are technically classified as Flood Zone A. As the flood extents do not overtop the stream banks, there is no impacted on the areas proposed for residential development, therefore there is no requirement to undertake the Justification Test.

Floodwaters overtop the canal banks and subsequently flows to the north away from the site. The floodwaters that flow into the Grand Canal from the Bluebell River primarily remain within the canal system, with flow continuing to flow over lockgate east of the site and the spillways to the west.

The results confirm that canal system has sufficient capacity to contain the floodwaters and convey these flows along the canal system to the north and west without overtopping onto the site. The results from the JBA model confirm the inaccuracies of the CFRAM mapping in this area. This is further confirmed following review of the Naas FRS outputs (Section 3.2.1). No overtopping of the Grand Canal occurs in the vicinity of the site.

The flood levels near the site are presented in Table 4-3.

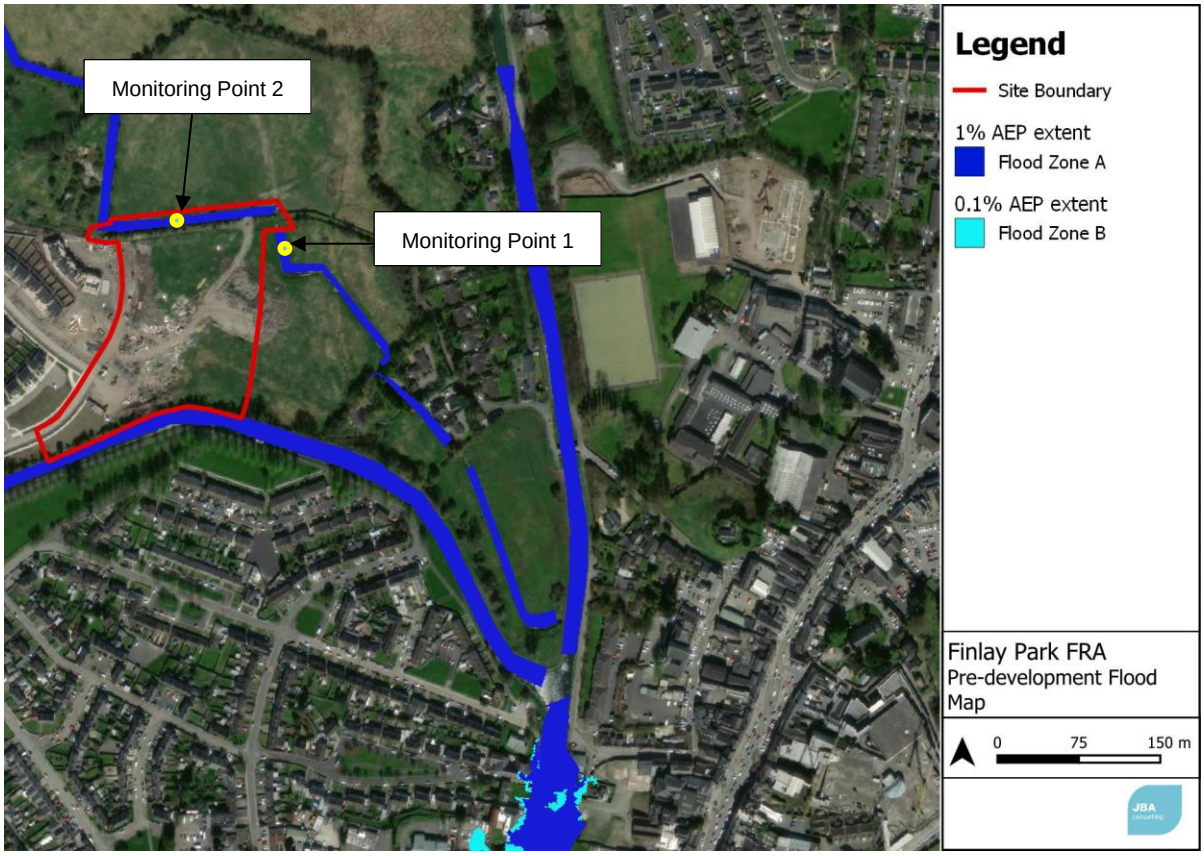


Figure 4-3: Pre-Development Flood Extents

Table 4-3: Flood Levels (mOD)

Monitoring Point	1% AEP (mOD)	0.1% AEP (mOD)
1	85.44	85.44
2	84.93	84.93

5 Flood Risk Assessment and Mitigation

5.1 Flood Risk/Mitigation Measures

A site-specific hydraulic model has been developed comprising the main hydraulic features in the area to confirm the flood risk to the site. Once the canal system is incorporated into the model there is no inundation within the site. The canal system will capture and intercept any potential flood waters and convey these away from the site along the canal system.

Based on review of the Naas FRS and JBA model, all residential development is confirmed to be fully located in Flood Zone C, and at a low risk of inundation. All floodwaters within the site, review to Figure 4-3 are contained within the stream banks and there is no overtopping within the site boundary. The following mitigation measures are based on the JBA flood model.

5.1.1 Building Finished Floor Level

All of the residential properties are located in Flood Zone C. The Finish Floor Level (FFL) has been based on the highest flood levels predicted from the various flood scenarios (0.1% AEP). A minimum floor level of 87.00mOD has been provided within the proposed development.

Based on a minimum FFL of 87.00mOD, a 1.56m freeboard has been provided on the site stream (85.44mOD) at Monitoring Point 4 (Refer to Table 5-1) to minimise the flood risk to the residential properties.

Table 5-1: 0.1% AEP Level and Freeboard

Minimum FFL (mOD)	0.1% AEP (mOD)	Freeboard (m)
87.00	85.44*	1.56

*Monitoring Point 1

5.1.2 Access/Egress

The main access road to the site will be provided via the Old Caragh Road which provides access to the wider Naas area via the R409. The site access is confirmed to be not at risk of inundation during a 1% AEP flood event, based on both the Naas FRS and JBA flood model. Therefore, access to the site can be maintained during the 1% AEP and 0.1% AEP flood event.

5.1.3 Grand Canal

Review of the JBA flood maps and Naas FRS confirm that overtopping of the Grand Canal does not occur in the vicinity of the site that will result in inundation of the proposed development.

Additional assessment is undertaken in Section 5.3 regarding residual risks from the canal.

5.1.4 Stormwater design/Pluvial Flood Risk

Review of the PFRA flood maps indicates that sections of the site are at risk of pluvial inundation, which are identified as low-lying areas within the site. Flood risk within the site will be managed by the provision of a stormwater system which will capture runoff from hardstanding areas. The site profile will be modified as part of the proposed development.

The increase in the hardstanding area onsite could potentially increase the surface water runoff from the site, if not mitigated. A stormwater water system is included within the proposed development which will capture and manage surface water flow from hardstanding areas. The stormwater water system to complies with the overarching Kildare County Development Plan policy and the GDSDS guidance document - the Kildare Policy includes a strong emphasis on SuDS measures and care should be taken in the design to ensure that the system matches the policy requirements as far as possible and justification provided where SuDS measures are not feasible.

Green roofs and stormwater attenuation has been provide and discharge from the site has been limited to 10.7l/s (greenfield equivalent). The proposed stormwater design is provided in Appendix B. For the detailed design please refer to the Surface Water Design Report undertaken by Donnachadh O'Brien which has been submitted as part of the wider planning application.

To minimise the risk of pluvial flooding, a threshold of 150mm is required from the FFL to the external ground levels. This should also apply to the basement entrance ramps. No further mitigation measures are required to manage the pluvial flood risks.

5.1.5 Irish Water Foul Line

An existing foul line crosses the stream just upstream of the site boundary. A culvert is in place to enable flows underneath the pipe. The system currently has the capacity to convey the estimated flows. It does present a risk of blockage however, plans are in place to move this pipeline which will remove blockage risk at this location.

5.2 Climate Change

As per the OPW guidelines, it is necessary to assess the potential impact of climate change on flood risk. The climate change assessment has been based on the Mid Range Future Scenario (MRFS). A scenario was run to estimate an increase of 20% (MRFS) on the peak flood flows. Review of the results confirms that there is some overtopping of the canal during the 1% AEP MRFS flood event with no impact upon the site.

Further to the JBA flood model, within the Naas FRS the 0.1% AEP flood event can be substituted to represent the 1% AEP MRFS event. This confirms that the development is also not at risk from climate change as per the Naas FRS model.

It should be noted that the stream though the site only received stormwater flow via the culvert located under the canal and local site drainage, which is already at full capacity during the 1% AEP event therefore there will be no increased flows within this stream following the impact from climate change.

5.3 Residual Risk/Additional Assessment

Residual risks are defined as risks that remain after all risk avoidance, substitution and mitigation measures have been taken. The flood risk assessment identifies the following as the main sources of residual risk to the proposed development:

- Blockage of the Culvert
- Blockage of Canal Lock Gates
- Canal Breach

5.3.1 Blockage of Culverts/Canal Lock Gates

The model was run with a 66% blockage applied to the following structures during the 1% AEP event (refer to Figure 5-1): two culverts on the site stream, canal lock gates and a culvert along the Bluebell Stream.

The results (Table 5-2) show that none of the structures pose a flood risk to the site in the eventuality of a blockage during the 1% AEP flood event, the maximum water level at site being 85.66mOD, well below the minimum FFL of 87.00mOD, as presented in the table below.

Table 5-2: 1% AEP blockage

Minimum FFL (mOD)	1% AEP Blockage (mOD)	Freeboard (m)
87.00	85.66	1.34

*Monitoring Point 1

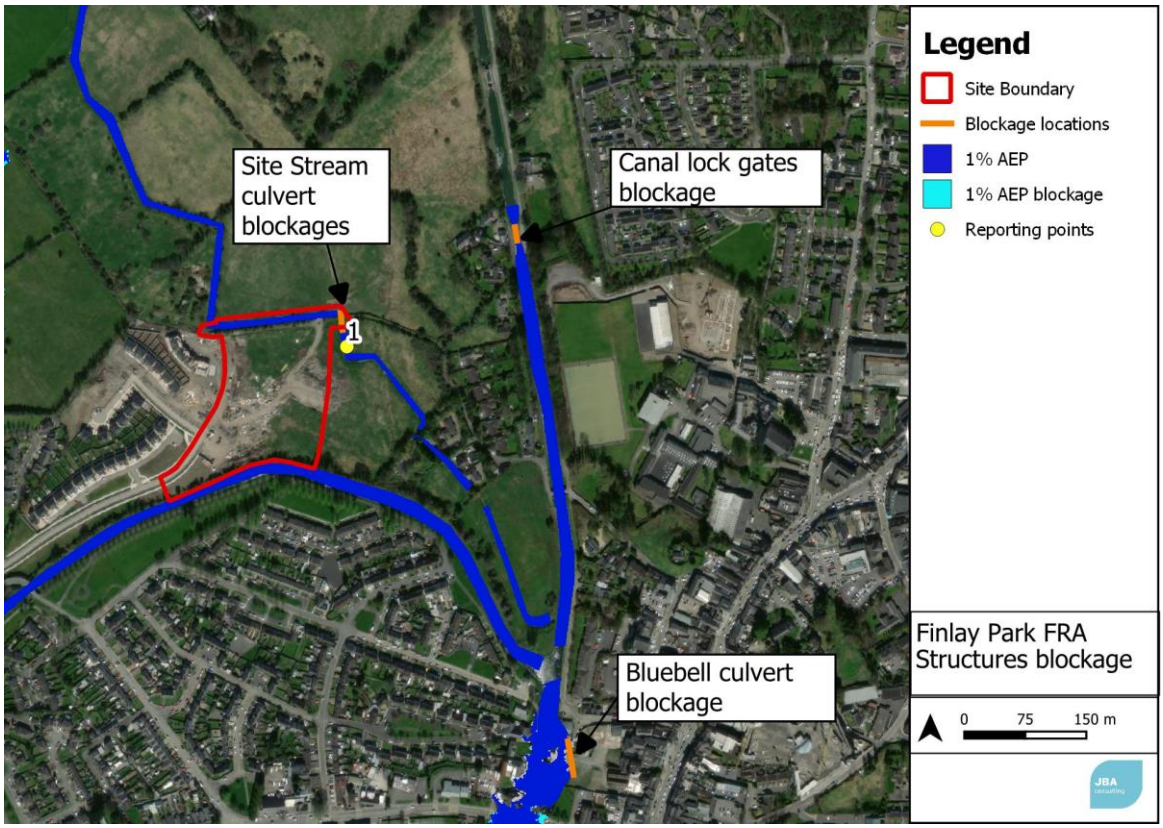


Figure 5-1: Structure Blockage

5.3.2 Partial Breach of the Grand Canal

It is considered that partial breach of the canal bank could present a flood risk to the development, as the site level is lower than the water level within the canal. It is important to note that there is no history of canal breach in the area. If necessary following a review of the structural integrity and width of the canal banks along the stie boundary, that sheet piling will be installed along narrow sections of the canal that would at a higher risk of breach. This will ensure that structural integrity of the canal banks during a flood event. It is noted that in certain areas that land elevations are below the water level within the canal.

The above works will be undertaken to minimise flood risk to the surrounding area.

6 Conclusion

JBA Consulting has undertaken a detailed Flood Risk Assessment (FRA) of the proposed site at Finlay Park, Co Kildare. The assessment was carried out in order to verify and compare with the flood extents undertaken previously by the Eastern CFRAM deliverables. This FRA demonstrated that the proposed design can manage flood risk appropriately.

Review of the CFRAM, Naas FRS and JBA flood maps confirm that the proposed residential development is located in Flood Zone C. The Naas FRS have superseded the CFRAM mapping in the study area.

To aid in the development of mitigation measures, a site-specific hydraulic model has been developed for the Bluebell Stream and Grand Canal system. The model incorporates the main hydrological features in the area and associated flow mechanisms.

Both the JBA hydraulic model and Naas FRS differs significantly from the CFRAM mapping in how the Grand Canal system is represented, and results in significant difference in the final flood maps. Based on this, all mitigation measures are based on the Naas FRS and JBA model. Is should be noted that all the residential areas are located in Flood Zone C within the CFRAM flood maps.

The JBA flood maps confirm that the proposed development is not impacted by the 1% AEP or 0.1% AEP flood events. The hydraulic model confirms that the floodwaters that overflow into the Grand Canal predominantly remains within the system with no inundation within the site predicted.

Based on the JBA and Naas FRS flood maps, access can also be maintained to the development up to the 1% AEP flood event.

The proposed FFL of 87.0mOD provides a freeboard of 1.56m above the 0.1% AEP flood level. Climate change and residual risks have been assessed for the development and the results confirm the development will not be impacted during the modelled scenarios.

The Flood Risk Assessment was undertaken in accordance with 'The Planning System and Flood Risk Management' guidelines and confirms that the proposed development is appropriate from a flood risk perspective and is in agreement with the core principles of the planning guidelines.

Appendices

A 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 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.

Table: Conversion between return periods and annual exceedance probabilities

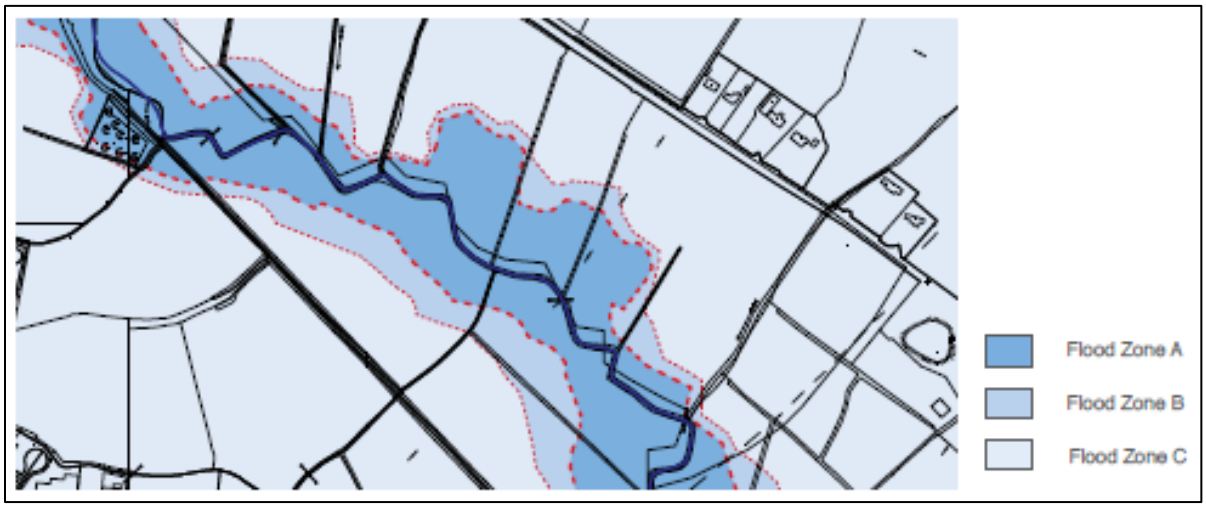
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.2 Flood Zones

Flood Zones are geographical areas illustrating the probability of flooding. For the 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.3 Consequences of Flooding

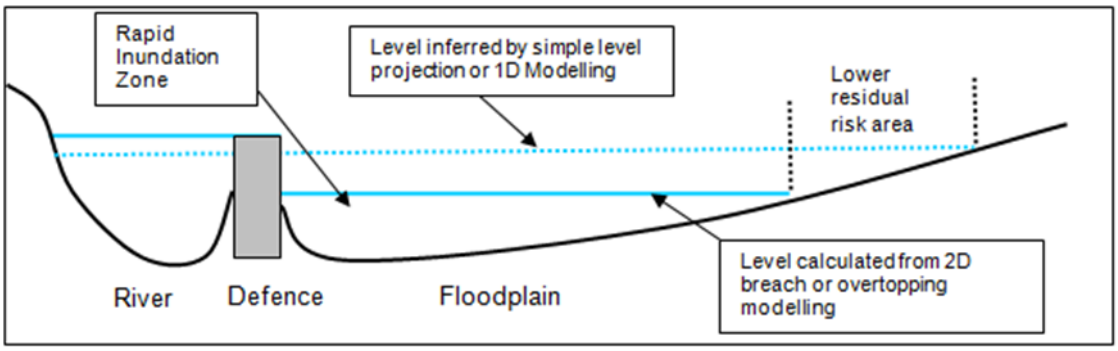
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation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

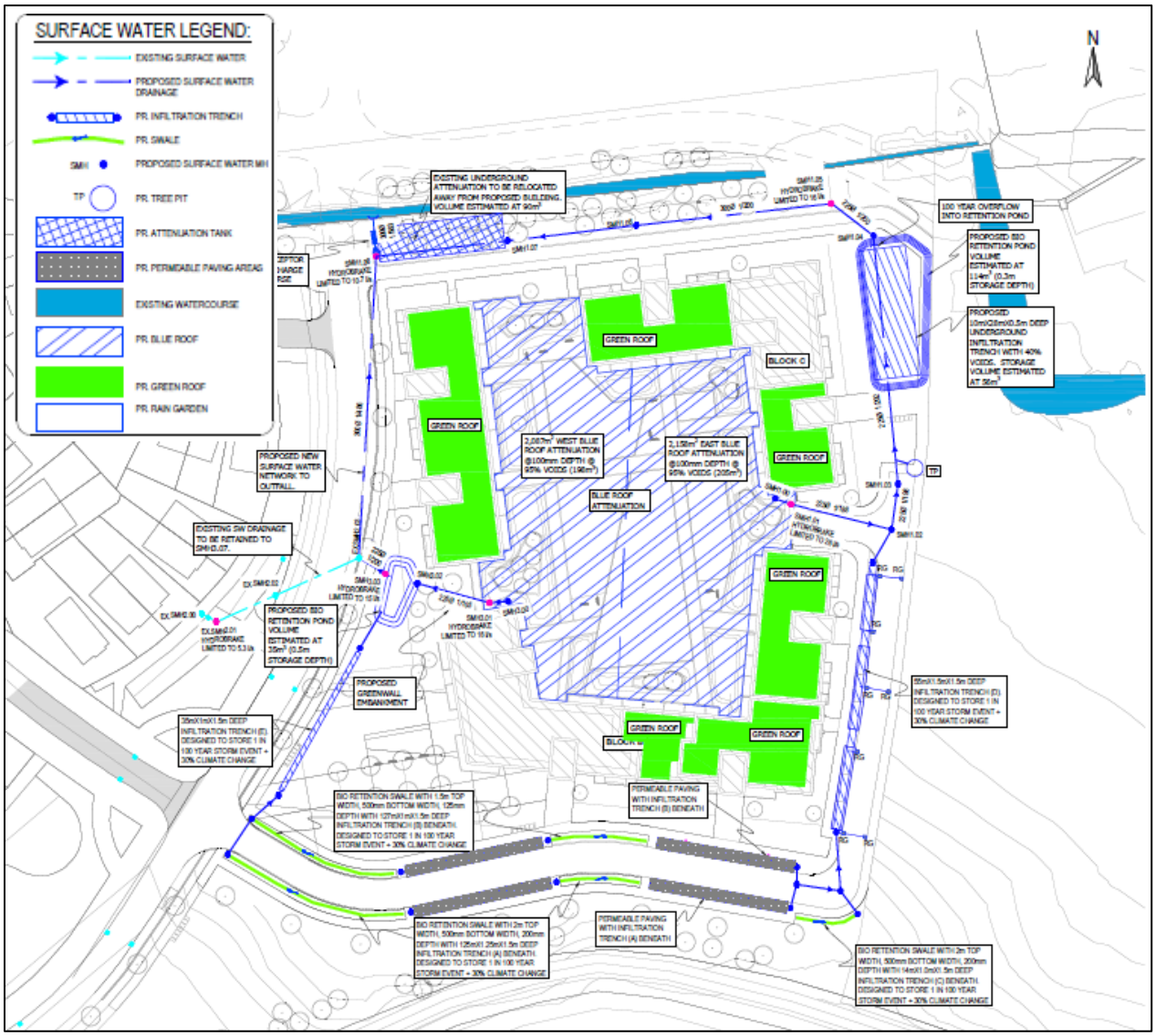
- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities
- **Less vulnerable**, such as retail and commercial and local transport infrastructure, such as changing rooms.
- **Water compatible**, including open space, outdoor recreation and associated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

A.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:



B Appendix - Stormwater Design



C Kildare County Development Plan Policies 2017-2022

It is the policy of the Councils

SW 1 To manage protect and enhance surface water quality to meet the requirements of the EU Water Framework Directive.

SW 2 To incorporate Flood Risk Management into the spatial planning of the county, to meet the requirements of the EU Floods Directive and the EU Water Framework Directive.

SW 3 To support and co-operate with the Office of Public Works (OPW) in delivering the Catchment Based Flood Risk Assessment and Management Programme in particular the Eastern and South Eastern CFRAM studies and associated Flood Management Plans (FRMP). The recommendations and outputs arising from these studies shall be incorporated in preparing plans and assessing development proposals.

SW 4 To support the implementation of the EU Flood Risk Directive (2007/60/EC) on the assessment and management of flood risks and the Flood Risk Regulations (SI No 122 of 2010). SW 5 To manage flood risk in the county in accordance with the requirements of the Planning System and Flood Risk Management Guidelines for Planning Authorities, DECLG and OPW (2009) and circular PL02/2014 (August 2014), in particular when preparing plans and programmes and assessing development proposals. For lands identified in the Strategic Flood Risk Assessment (SFRA) a site-specific Flood Risk Assessment to an appropriate level of detail, addressing all potential sources of flood risk, is required, demonstrating compliance with the aforementioned Guidelines or any updated version of these guidelines, paying particular attention to residual flood risks and any proposed site specific flood management measures

SW 6 To ensure effective management of residual risks for development permitted on floodplains. SW 7 To maintain and enhance the existing surface water drainage systems in the county and promote and facilitate the development of Sustainable Urban Drainage Systems (SuDS) including integrated constructed wetlands and to promote and support the retrofitting of SUDS in established urban areas.

SW 8 To incorporate Sustainable Urban Drainage Systems (SuDS) as part of all plans to address the potential for sustainable urban drainage at district or site level.

SW 9 To limit the surface water run off from new developments through the use of Sustainable Urban Drainage Systems (SUDS). These systems should not adversely impact on open space provision in residential areas.

SW 10 To liaise with the Office of Public Works (OPW) in delivering on flood management works and schemes, as may arise, through the OPW Non-coastal Minor Works Programme and through the OPW's Capital Programme.

SW 11: To ensure that all towns, villages and settlements are provided with adequate flood alleviation measures within the limits of cost effectiveness and the availability of finance.

SW 12 To ensure that flood risk management is incorporated into the preparation of Local Area Plans in accordance with 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities (2009)'.

SW 13 To ensure that the Justification Test for Development Management is applied to proposals for development in areas at a high or moderate risk of flooding where the development proposed is vulnerable to flooding and would generally be inappropriate as set out in Table 3.2 of the 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities (2009)'.

SW14 To seek to ensure that development will not interfere with or interrupt existing surface water drainage systems.

SW 15 To ensure that the reasonable requirements of Inland Fisheries Ireland are adhered to in the construction of flood alleviation measures in the county.

SW 16 To recognise the important role of bogland and other wetland areas in flooding patterns. Development in these areas shall therefore be subject of a Flood Risk Assessment in accordance with the relevant guidance.

SW 17 To require development proposals which may affect canals and their associated infrastructure to prepare a Flood Risk Assessment in accordance with the relevant guidance.

SW 18 To ensure development proposals in rural areas (excluding one-off rural housing) demonstrate compliance with the following:

- the ability of a site in an unserviced area to accommodate an on-site waste water disposal system in accordance with the County Kildare Groundwater Protection Scheme, and any other relevant documents and legislation as may be introduced during the Plan period.
- the ability of a site in an unserviced area to accommodate an appropriate on-site surface water management system in accordance with the policies of the Greater Dublin Strategic Drainage Study (2005), in particular those of Sustainable Urban Drainage Systems (SuDS).
- the need to comply with the requirements of 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' published by the Minister for the Environment, Heritage and Local Government in November 2009.

SW 19 To liaise with the Office of Public Works (OPW) in delivering flood management and alleviation programmes to include, but not limited to, the following:

- South Eastern CRFRAMS and the recommendations therein.
- Eastern CFRAMS and the recommendations therein.
- Newbridge Surface Water Improvement Schemes.
- Morrell River Flood Management Scheme.
- Hazelhatch Flood Management Scheme.

SW 20 To develop and resource a multi-annual programme for the maintenance of river channels under the responsibility of Kildare County Council, to include but not limited to:

- Barrow Drainage District.
- Greese Drainage District.
- Lerr Drainage district.

SW 21 To ensure that rural one off residential developments maintain existing drainage systems, particularly at access points to the property

D Draft Kildare County Development Plan Policies and Objectives 2023-2029

It is a policy of the Council to:

- IN P5: Ensure the continued incorporation of Flood Risk Management and National Flood Risk Policy (2018) into the spatial planning of Kildare, to meet the requirements of the EU Floods Directive and the EU Water Framework Directive and to promote a climate resilient County.

It is an objective of the Council to:

- IN O29: Support and co-operate with the Office of Public Works (OPW) in delivering the Flood Relief/Alleviation schemes and measures contained in the Flood Risk Management Plans adopted by the Council in July 2018, and in other flood management works and schemes, as may arise, through the OPW Non-Coastal Minor Works Programme.
- IN O30: Support the implementation of the EU Flood Risk Directive (2007/60/EC) on the assessment and management of flood risks and the Flood Risk Regulations (SI No 122 of 2010).
- IN O31: Manage flood risk in the county in accordance with the sequential approach and requirements of the Planning System and Flood Risk Management Guidelines for Planning Authorities, DECLG and OPW (2009) and circular PL02/2014 (August 2014), when preparing plans, programmes, and assessing development proposals. To require, for lands identified in the Strategic Flood Risk Assessment, a site-specific Flood Risk Assessment to an appropriate level of detail, addressing all potential sources of flood risk, demonstrating compliance with the Guidelines or any updated version of these guidelines, paying particular attention to avoidance of known flood risk, residual flood risks and any proposed site-specific flood management measures.
- IN O32: Recognise the important role of natural boglands and other wetland areas in flooding patterns. Development in these areas shall therefore be subject to a Flood Risk Assessment in accordance with the relevant guidelines.
- IN O33: Require development proposals which may affect canals and their associated infrastructure to prepare a Flood Risk Assessment in accordance with the relevant guidance.
- IN O34: Require that development along urban watercourses comply with the Inland Fisheries Ireland Guidance: Planning for Watercourses in the Urban Environment (2020), including the maintenance of a minimum riparian zone of 35 metres for river channels greater than 10 meters inwidth, and 20 meters for river channels less than 10 metres in width. Development within this zone will only be considered for water compatible developments as defined in the OPW Planning System and Flood Risk Management Guidelines for Planning Authorities (2009).
- IN O35: Protect any implemented/constructed flood relief schemes from inappropriate development or otherwise.

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