

**Pa Healy Road
Flood Risk Assessment**

Technical Report
November 21

Revington Developments Ltd

JBA Project Manager

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Contract

This report describes work commissioned by a signed acceptance form dated 17th December 2018, by Lawlor Burns on behalf of Revington Developments. Ross Bryant and Kevin Buckley of JBA Consulting carried out this work.

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Purpose

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Contents

1	Overview	1
1.1	Term of Reference and Scope	1
1.2	Flood Risk Assessment; Aims and Objectives	1
1.3	Development Proposal	1
1.4	Report Structure	2
2	Site Background	4
2.1	Location	4
2.2	Watercourses	4
2.3	Topography	4
2.4	Site Geology.....	5
3	Flood Risk Identification.....	6
3.1	Flood History	6
3.2	Internet Searches.....	7
3.3	Predictive Flood Mapping.....	7
3.4	Sources of Flooding	11
4	Mitigation & Management of Flood Risk.....	13
4.1	Overview	13
4.2	Residual Risk	13
4.3	Mitigation.....	14
5	The Justification Test for Development Management	16
5.1	Strategy.....	16
5.2	Justification Test: Part 1	16
5.3	Justification Test: Part 2.....	17
6	Conclusion	18
A	Appendix - Understanding Flood Risk Flood	19

Abbreviations

AEP	Annual Exceedance Probability
CFRAM	Catchment Flood Risk Assessment and Management
DoEHLG	Department of the Environment, Heritage and Local Government
FRA	Flood Risk Assessment
GSI	Geological Survey of Ireland
LAP	Local Area Plan
LDP	Local Development Plan
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment

1 Overview

Under the Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009) proposed development must undergo a Flood Risk Assessment to ensure sustainability and effective management of flood risk. This requires a review of all available flood information and assessment of Flood Zones for the development site.

1.1 Term of Reference and Scope

JBA Consulting was appointed to prepare a Flood Risk Assessment (FRA) for the proposed development on the Pa Healy Road Limerick.

1.2 Flood Risk Assessment; Aims and Objectives

This study is being completed to assess the level of flood risk to the proposed site. It aims to identify, quantify and communicate to applicant, Planning Authority officials and other stakeholders the risk of flooding to land, property and people and the measures required to manage the risk. The objectives are to:

- Identify potential sources of flood risk,
- Confirm the level of flood risk and identify key hydraulic features,
- Assess the impact that the proposed development has on flood risk in adjacent areas,
- Develop appropriate flood risk mitigation and management measures which will allow for development of the site.

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

1.3 Development Proposal

A ten year permission for a strategic housing development consisting of a mixed-use development of build-to-rent apartments, student apartments incorporating common areas, café and 3no retail units, creche and management facilities building, and dwelling houses at Canal Bank, Pa Healy Road, Limerick.

The development will consist of a 4ha area bounded by City Canal to the north, Pa Healy Road to the south and Park Road to the east, Canal Bank, Limerick;

A. Demolition of existing 530m² warehouse building on site.

B. Block 1 – Student accommodation building of 8,238m² stepped from three to six storeys, with ground floor café of 144.60m² and 3 no. retail units facing onto Pa Healy road of 86.59m² each, with 9 no. two bedroom, 37 no. three bedroom, and 15 no. four bedroom student apartments, totalling 189 bed spaces, ancillary laundry, refuse and enclosed communal courtyard with landscaping and bicycle storage;

C. Block 2 - A residential apartment building of 6,013.25m² with eight storeys and two penthouse storeys, total ten storeys containing 10 no. studio, 1 no. one bedroom and 52 no. two-bedroom apartments;

D. Block 3 – A residential apartment building of 8,107.10m² with six storeys and two penthouse storeys, total eight storeys containing 16 no. studio, 9 no. one bedroom, and 63 no. two-bedroom apartments;

E. Block 4 – A residential apartment building of 3,869.18m² with six storeys and one penthouse storey, total seven storeys containing 7 no. studio, 13 no. one bedroom and 25 no. two-bedroom apartments;

F. Block 5 – A residential apartment building of 5,849.40m² with six storey and one penthouse storey total seven storeys containing 14 no. studio, 15 no. one bedroom and 37 no. two-bedroom apartments;

G. Block 6 a residential apartment building of 3,869.18m² with six storeys and one penthouse storey, total seven storeys containing 7 no. studio, 13 no. one bedroom and 25 no. two-bedroom apartments;

H. Block 7 a residential apartment building of 4,962m² with five storeys and one penthouse storey, total six storeys containing 12 no. studio, 13 no. one bedroom and 31 no. two-bedroom apartments;

I. Community facilities building of 1,336.90m² and three storeys with creche, café, management offices and common accommodation for use by apartment dwellers;

J. 18 no. Executive Houses – Consisting of 2 no. detached four-bedroom houses of 194.62m² each and 16 no. terraced four-bedroom houses of 177.82m² each, with off street parking to front separate from communal parking;

K. 148 Car parking spaces throughout the development and 420 secured bicycle parking spaces throughout the development;

L. Ancillary works comprising; new vehicular entrances onto Pa Healy Road, pedestrian and cycle links to Pa Healy road, Park road and City Canal, bin storage for all developments adjacent to all entrances, New public park of 0.5ha along city canal, communal open space and communal roof gardens for all apartments, all ancillary drainage, civil and landscape works, public lighting within estate and Electricity Sub-station to rear of Block 1.

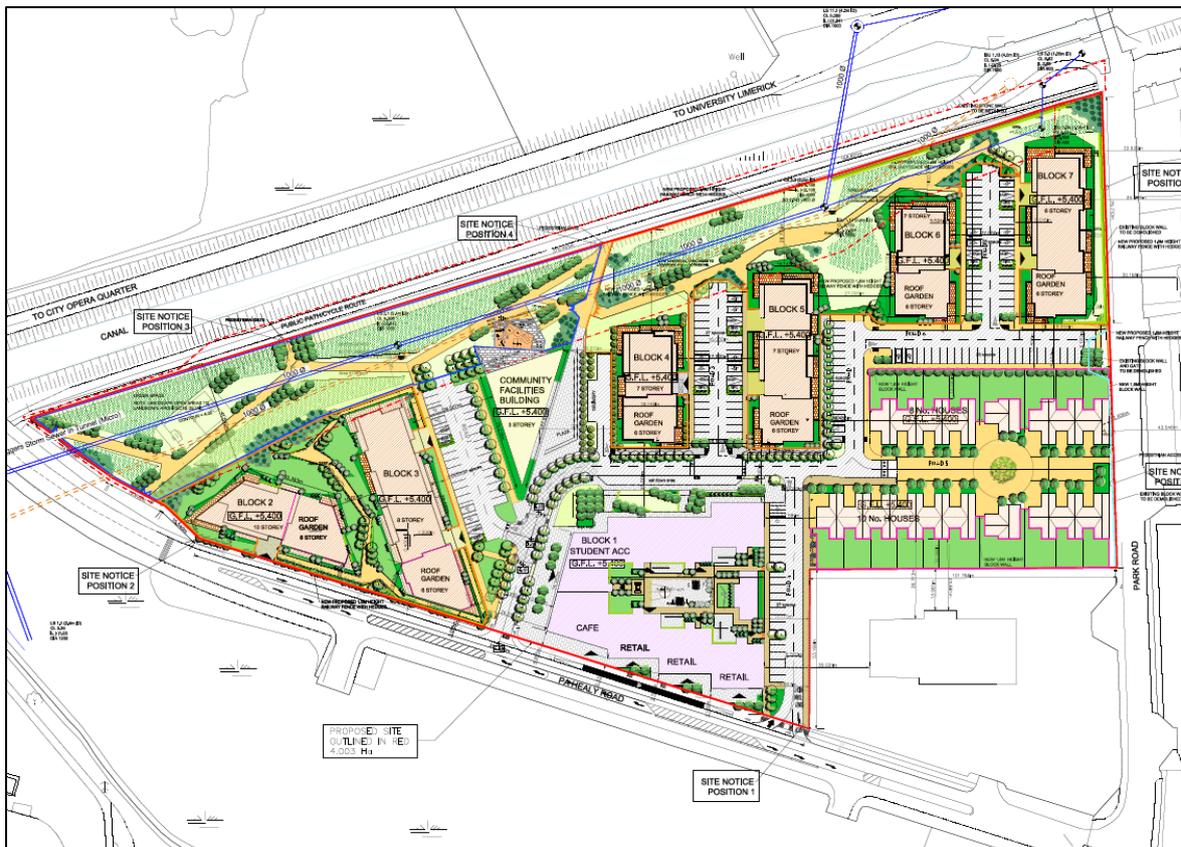
The total number of units is as follows;

Build to rent apartments - 363 (66x studio, 64 x one bedroom, 233 x two bedroom); Student apartments - 61 (9 x two-bedroom, 37 x three bedroom and 15 x four bedroom, totalling 189 student bed spaces); 18 Dwelling houses.

Overall total of residential units is 442. Overall Gross floor area of development proposed is 45,478.65m² on a site of circa 4ha.

A Natura Impact Statement (NIS) and Environmental Impact Assessment Report (EIAR) have been prepared in respect of the proposed development

Figure 1-1 Development Proposal



1.4 Report Structure

Section 2 of this report gives a complete overview of the site, its location, proposed development and relevant watercourses. Section 3 contains information on flood history and identifies flood risk at the site. Flood risk mitigation and the impacts associated with development are discussed in Section 4. The justification test is provided in section 5. The Conclusion is 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.

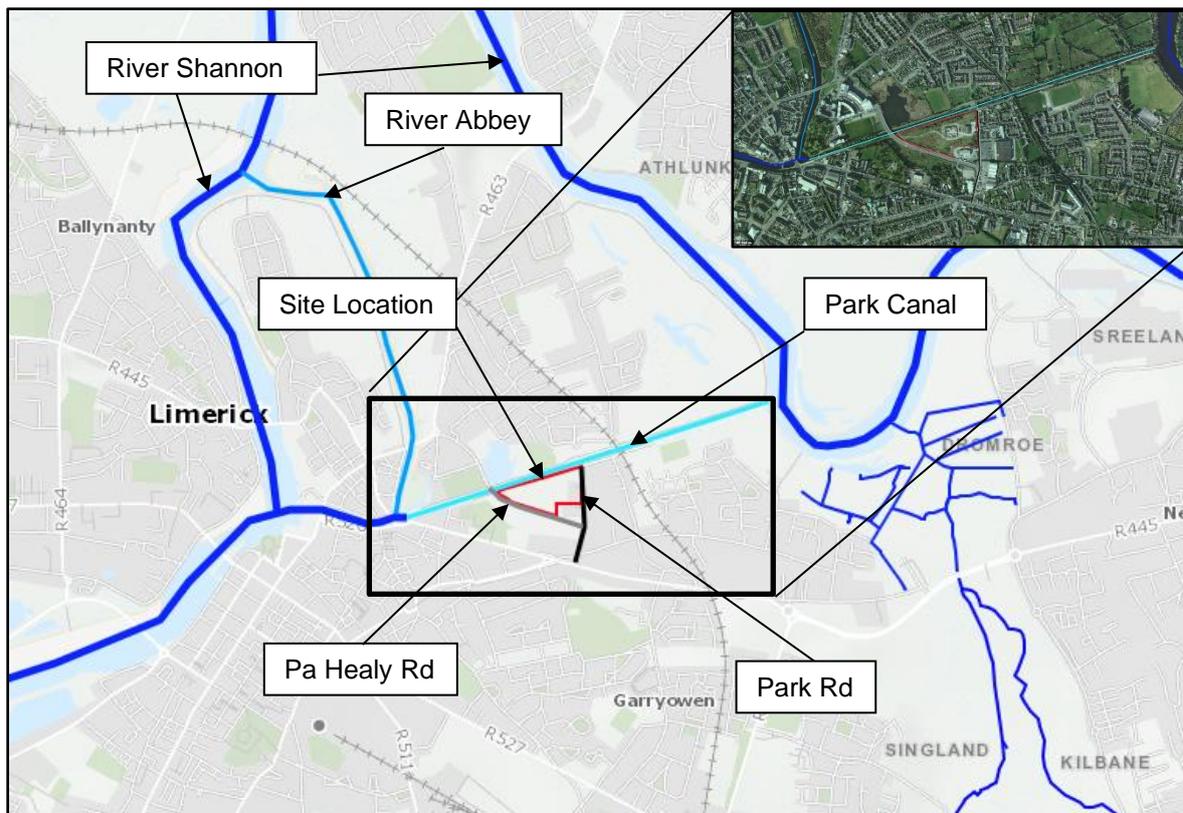
2 Site Background

This section describes the development site in Limerick including the adjacent watercourse and the wider geographical area.

2.1 Location

The proposed site location is shown in Figure 2-1 below. The site is located within the urban environment of Limerick City and is located <1km north east of the city. The site is bound to the north by Park Canal, to the south by the Pa Healy Road and to the east by Park Road. Commercial properties also run along the park road to the east of the site. The Limerick School of Art & Design is located to the south and a broader mix of commercial and residential properties.

Figure 2-1 Geographical Setting



2.2 Watercourses

Figure 2-1 above outlines the main watercourses near the site. There are no overland watercourses located in the vicinity to the site or surrounding area. The nearest watercourse to the site is the Abbey River which resides c. 1km west of the site. The Abbey River is part of the River Shannon which forms the eastern channel around King's Island.

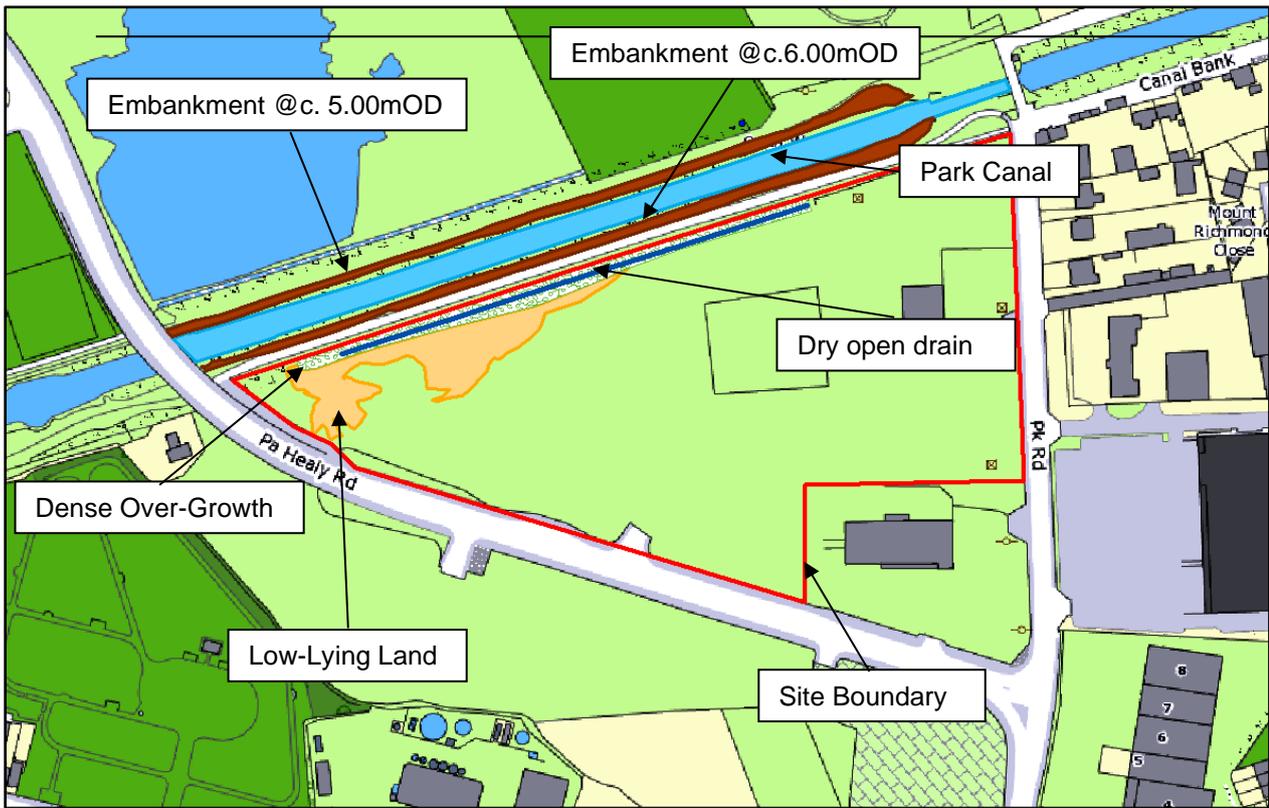
The River Shannon is the main watercourse in the area and resides c.1.1km northeast of the site. The River Shannon meanders through Limerick City and runs around the western end of King's Island.

The City Canal runs adjacent to the northern border of the site, it links the Shannon with the Abbey River.

2.3 Topography

The site is classified as a brownfield site with existing buildings located onsite. There is a general shallow fall towards the west towards the canal and Abbey River. To the north of the site there is an embankment along the canal that rises gradually from 5.5-6.6mOD. This acts as a defence from canal overtopping.

Figure 2-2 Site Topography



2.4 Site Geology

The Geological Survey of Ireland (GSI) groundwater and geological maps of the site were reviewed. The bedrock of this area consists of volcanoclastic rocks among the Dinantian limestones and Visean Limestones. Within the site boundary, according to the GSI, there is a mix of Marine deposits and man-made formations. (See Figure 2-3). This would indicate some historic tidal flooding - most likely prior to the construction of the canal and local defences.

The associated groundwater vulnerability, which indicates the risk to the underlying groundwater body for the site, is classified as 'low'.

Figure 2-3 ArcGSI Database



3 Flood Risk Identification

To commence the FRA process, an assessment of the potential 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. Further detail on the Planning Guidelines and technical concepts is provided in Appendix A.

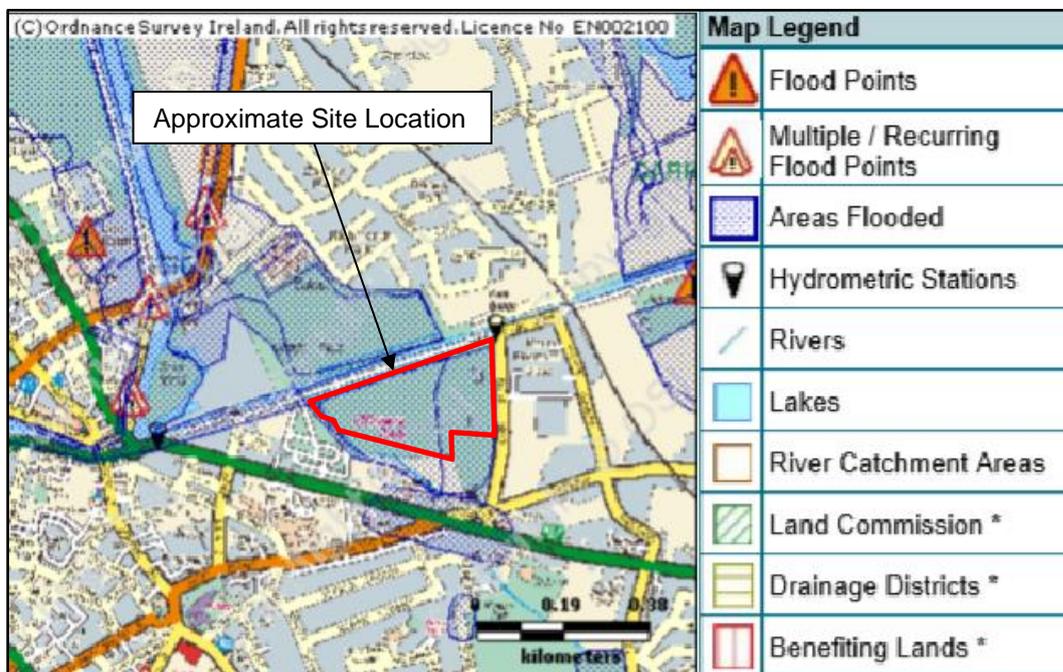
3.1 Flood History

Several 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.

3.1.1 Floodmaps.ie

The OPW host a National Flood hazard mapping website, www.floodmaps.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. Refer to Figure 3-1 for location of the identified historic flood events in the area.

Figure 3-1 www.floodmaps.ie



Flood Extent mapping is available which confirmed that a recorded flood event occurred within the site boundary. The flooding occurred onsite during the December 1999 flood event. Flooding was also noted along Clare St, primarily because of surcharging of the stormwater system. We understand that the issue was resolved following completion of the Limerick Main Drainage Project.

There have been no other recorded instances of flooding at the site. Concerning the surrounding area, there are several flood events recorded in the wider area which are listed as follows;

- December 1954-Shannon Lower-Overtopping of the River Shannon following extreme rainfall.
- 1961-Widespread flooding of Limerick City
- February 1990-Shannon Lower-Overtopping of the River Shannon resulting from heavy rainfall. Appears to have resulted in inundation of a section of the site, refer to Figure 3-1
- May 1994-Abbey River- Athlunkard
- Jan / Feb 1995- Harrys Mall
- Feb 1997-Lee Estate Island, Corbally, Harry's Mall and Reboge
- Dec 1999-Flooding on the O'Brien's Park. Appears to have resulted in inundation of a section of the site, refer to Figure 3-1
- February 2000-Harry's Mall & Athlunkard St

- February 2001-Athlunkard Street
- February 2002-Corbally & Harrys Mall
- December 2006-River Shannon
- Corbally and Cathedral Place- Recurring

3.2 Internet Searches

An internet search was conducted to gather information about whether the site was affected by flooding previously. No flooding incidents were recorded at the site. However, there was one report of flooding in the Corbally area on the 12/12/15 after the Park Canal burst its banks ¹. During this event high levels in the Park Canal resulted from extremely high discharge rates from Parteen Weir causing flow to be conveyed down the canal from the Shannon, to the north west.

Overtopping occurred underneath Pa Healy Road bridge and inundated lands to the north. The overtopping occurred because of operational failure at the lock gate downstream. Since 2015, levels along the canal bank (at Pa Healy Road) have been raised.

3.3 Predictive Flood Mapping

The subject area has been assessed by three flood mapping or modelling studies which are listed below:

- OPW Preliminary Flood Risk Analysis (PFRA) (2011);
- Shannon CFRAM (2016);
- Limerick City Development Plan (2011).

The level of detail presented by each method varies according to the quality of the information used and the approaches involved. The CFRAM is the most detailed assessment of flood extent and these supersede the fluvial flood outlines presented by the OPW PFRA and Limerick City SFRA studies.

3.3.1 OPW PFRA

The Preliminary Flood Risk Assessment (PFRA) is a requirement of the EU Flood Directive (2007/60/EC). One of the PFRA deliverables is flood probability mapping for various sources: pluvial (surface water), groundwater, fluvial and tidal. The PFRA is a preliminary or 'indicative' assessment and analysis has been undertaken to identify areas potentially prone to flooding. The OPW PFRA study has been largely superseded by the CFRAM programme, however it does provide valuable information regarding pluvial and groundwater flooding. The PFRA flood maps are also the main source of flood risk in areas not covered by the CFRAM programme. See Figure 3-2 for the OPW PFRA flood extents at the site and surrounding area.

Review of the PFRA study highlights no groundwater flooding at the site. However, it does indicate possible pluvial flooding adjacent to the south eastern boundary of the site.

Figure 3-2 OPW PFRA Pluvial Mapping



3.3.2 Shannon Catchment Flood Risk Assessment and Management Study (Shannon CFRAM)

The primary source of data with which to identify flood risk is the Shannon Catchment Flood Risk Assessment and Management Study (Shannon CFRAM Study). This study involved detailed hydraulic modelling of rivers and their tributaries along with tidal flooding.

Both the River Shannon and Abbey were included as part of the assessment.

3.3.2.1 Fluvial Flooding

Review of Figure 3-3 Shows that a small section in the southern corner of the site is in Flood Zone B.

The mechanism of flooding originates from overtopping of the Park Canal; causing overland flow which follows a generally low lying pathway along St. Lelia Place and onto Clare Street. The Park Canal is represented within the CFRAM model and flows are generated down the canal by high fluvial levels upstream on the Shannon. The model includes a weir (upstream of Pa Healy Road) and a single lock gate near the Abbey River, which is closed - worst case scenario assuming no-operational mitigation.

Flood waters from the overtopping of the canal are prevented from entering the site in the north west corner because of the high level of Pa Healy Road blocking the passage of flow in the height model. It is noted that in reality there is an underpass here and flows could probably impact the north western part of the site in a similar manner to the defended area annotated in Figure 3-5. The overflow from the canal heads off in a south westerly direction following the general topographic fall of the area. Flow marginally enters the southern boundary of the site but since the levels here are circa 1m above the levels at Clare Street and then rise further, the impacts of fluvial flooding are minimal, with very shallow flood depths of 0-0.25m at the 0.1% AEP event over a very small margin of the site (see Figure 3-3).

The nearest 'node' to the site is identified as '01ABB00639' which is located c. 350m to the north-west. The corresponding 1% AEP and 0.1% AEP flood levels at this node are 3.88mOD and 4.12mOD respectively. However, it is noted that flood levels at the proposed site are related to the volume overtopping the canal bank and the area/volume into which it is flowing - the actual levels reached by the floodwater is likely to be circa 4.6mOD.

Figure 3-3 Fluvial CFRAM

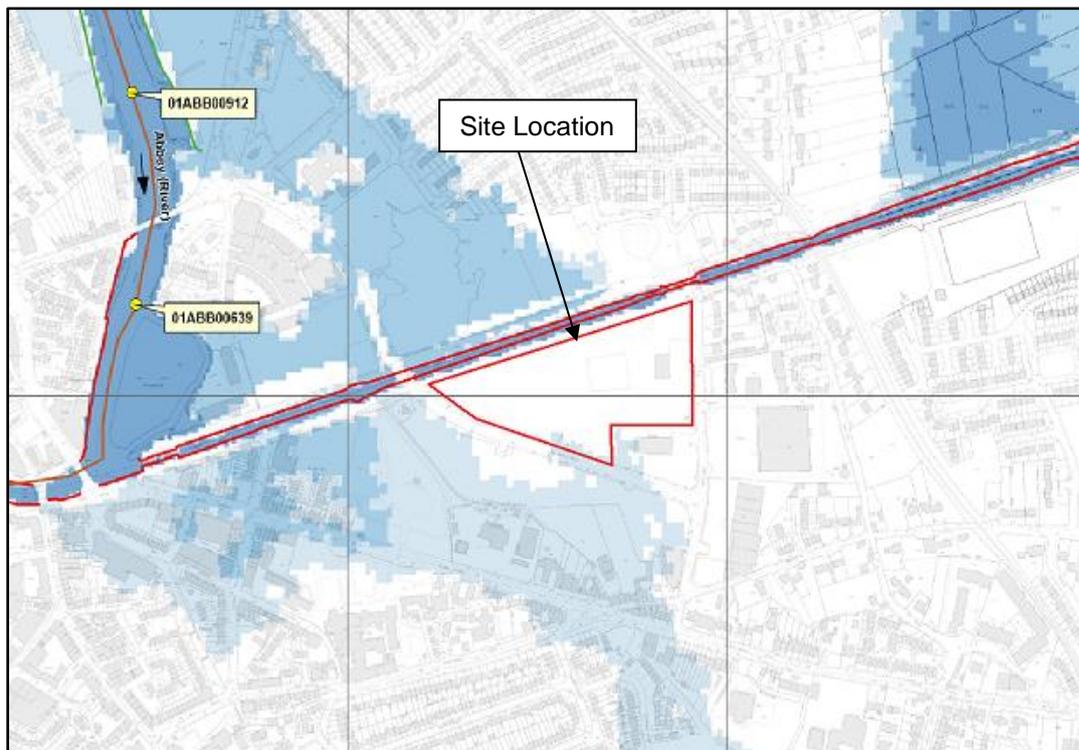


Figure 3-4 Fluvial CFRAM Flood Depth Map 0.1% AEP

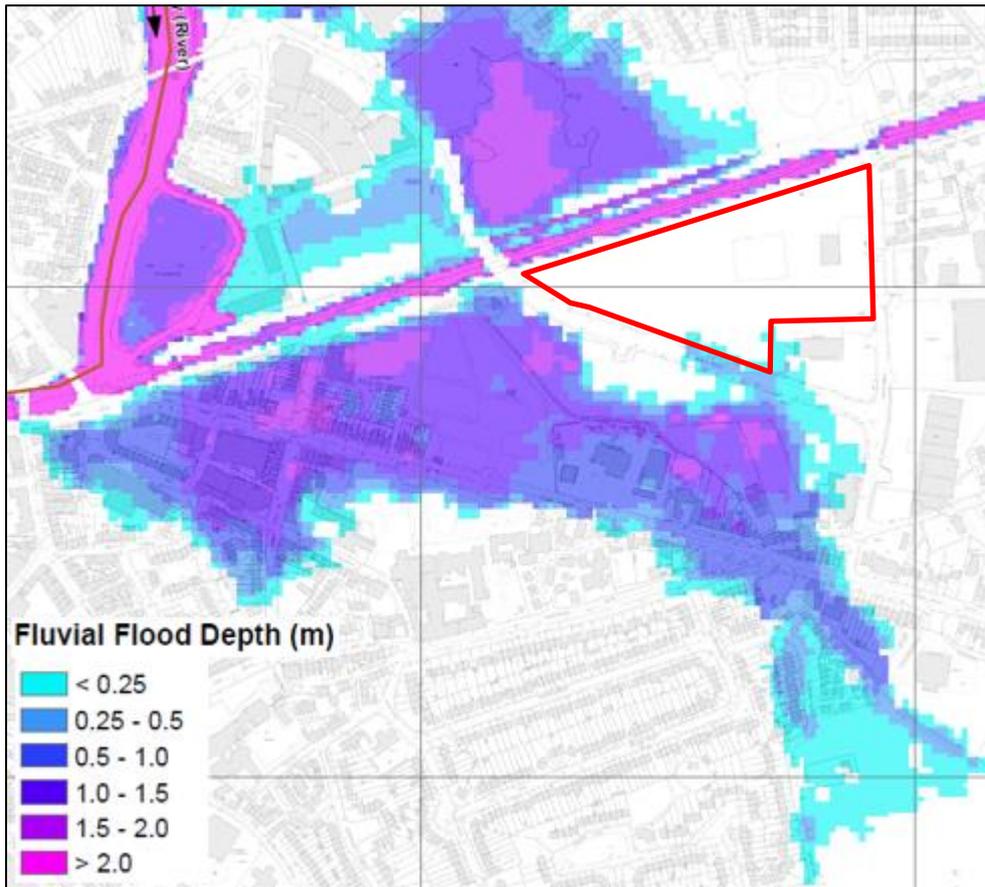


Table 3-1 Fluvial Water Level results from CFRAM

Node	Type of Flooding	10% AEP (mOD Malin)	1% AEP (mOD Malin)	0.1% AEP (mOD Malin)
01ABB00912	Fluvial	3.8	3.97	4.24
01ABB00639	Fluvial	3.75	3.88	4.12

3.3.2.2 Tidal Flooding

The predicted water levels are higher than that generated by fluvial flooding at this location along the Abbey River, for the 0.5% AEP and 0.1% AEP flood events. The corresponding flood level at node '01ABB00639' is 4.75mOD and 5.15mOD for the 0.5% and 0.1% AEP flood events respectively.

The flood map over the page in Figure 3-5 indicates that the site is not at risk from overtopping from the 0.1% AEP event but a small section of the southern part of the site lies within an area that is defended by the canal bank/canal lock (at the 0.5% standard of protection). This extent is defined by a complete removal of the defence, rather than breach/overtopping, it is therefore a very conservative estimate of risk.

Mitigation measures for this will be discussed in section 4.

Figure 3-5 CFRAM Tidal Study

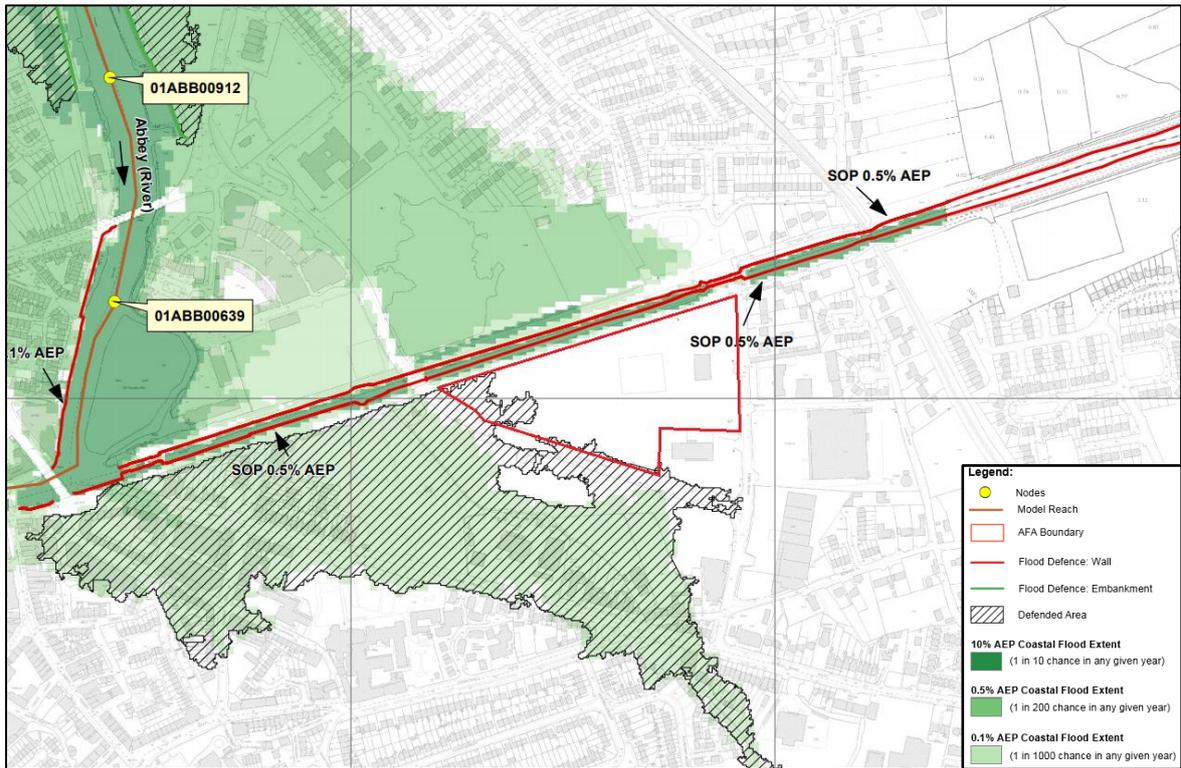


Figure 3-6 Tidal CFRAM Flood Depth Map (0.1% AEP)

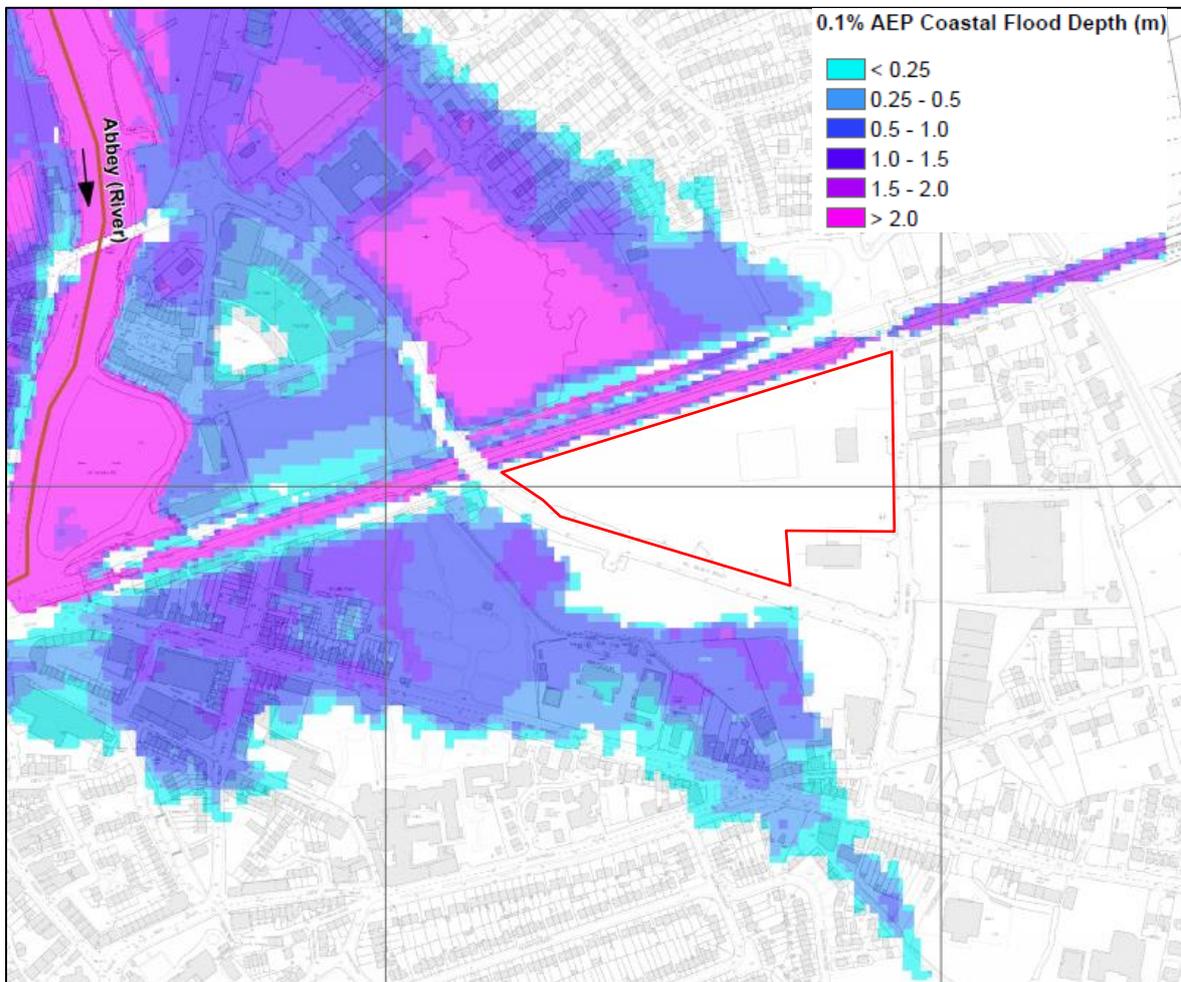


Table 3-2 Tidal Water Level Results CFRAM

Node	Type of Flooding	10% AEP (mOD Malin)	0.5% AEP (mOD Malin)	0.1% AEP (mOD Malin)
01ABB00912	Coastal	4.09	4.76	5.15
01ABB00639	Coastal	4.08	4.75	5.15

3.3.3 Limerick City Development Plan 2010-2016

Limerick City and its environs fall under the governance of the Limerick City Development Plan 2010-2016. The development plan aims to identify the critical planning issues and to ensure the growth of the city and infrastructure requirements. As part of the development plan a Strategic Flood Risk Assessment (SFRA) was undertaken to guide development in areas at risk of flooding. Specific regeneration areas were reviewed within the SFRA regarding flood risk however this review did not cover the proposed site location. The flood outlines within the SFRA are based on the finalised Shannon CFRAM flood maps. Specific objectives and policies regarding surface water and flooding are provided in Appendix B.

3.4 Sources of Flooding

The initial stage of a Flood Risk Assessment requires the identification and consideration of probable sources of flooding. These sources are described in the following sections:

3.4.1 Fluvial

The main flood study undertaken for the area is the Shannon CFRAM study which incorporated detailed hydraulic modelling of the River Shannon and Abbey River, the nearest watercourses to the site. The CFRAM also includes the conveyance channel of the Park Canal which links the Shannon with the Abbey River.

In modelling the canal, the CFRAM assumes that the lock gates are closed, and this results in overtopping of the canal bank at St Lelia Place, the water flowing out from the canal at this point marginally effects the southern boundary of the site.

The fluvial flood maps indicate that the site is not at risk from a 1% AEP fluvial event, however it is marginally at risk from a 0.1% AEP event and a very small section of the site adjacent to the boundary lies within Flood Zone B. It should be noted that predicted fluvial flood levels are lower than tidal levels for the proposed development. There is an operational management plan to discharge water through the lock in order to avoid the overtopping scenario, residual risk is discussed further in Section 4.2.

3.4.2 Tidal

Sources of coastal flooding were researched and were found to provide the primary risk of flooding to the proposed development. The site resides approximately 520m from the Abbey River/Shannon Estuary which is heavily influenced by tidal surges along the Shannon Estuary.

The Shannon CFRAM tidal flood maps show that a small part of the site is within Flood Zone A (defended).

Specific mitigation measures will be discussed in Section 4 to minimise the risk of flooding to the site.

3.4.3 Pluvial

Pluvial or surface water flooding is the result of rainfall-generated flows that arise before run-off can enter a watercourse or sewer. The OPW PFRA mapping shows a section in the south of the site within the site boundary.

Specific mitigation measures regarding Pluvial flooding will be discussed further in Section 4.

3.4.4 Groundwater

The OPW PFRA was reviewed and does not indicate groundwater flooding at the site or sounding area. The GSI groundwater vulnerability classification ranges from 'low-medium' which indicates a

groundwater depth greater than 10m. Furthermore, there are no karst features in the area which would indicate areas at risk of groundwater flooding. In summary, there is a low risk of groundwater flooding in this area.

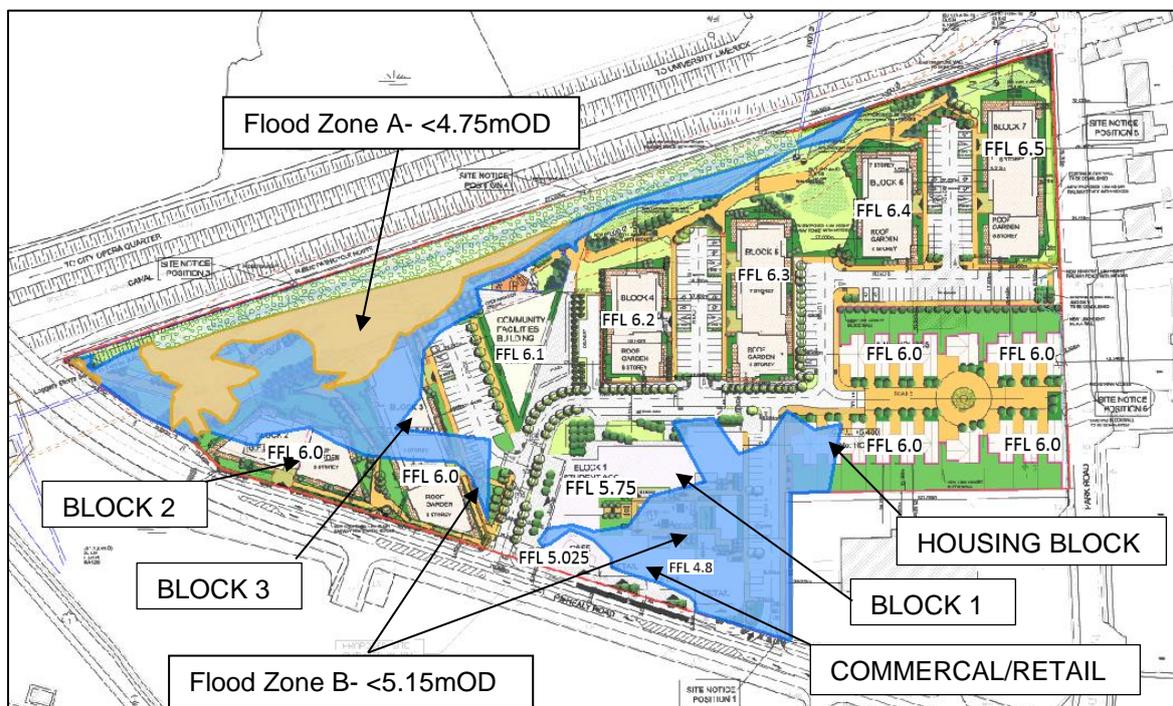
4 Mitigation & Management of Flood Risk

4.1 Overview

The site is predominantly in Flood Zone C, but has some encroachment of Flood Zone A (defended tidal) and Flood Zone B. A revised Flood Zone map is presented below in Figure 4-1, it is based on the site specific topographic survey and simply projects the extreme tidal levels of 4.75mOD and 5.15mOD across the site and is regardless of any defences. The presentation of the Flood Zones is different to the CFRAM maps due to the more site specific view on the topography, it must again be noted that the defended outline is essentially a residual risk and would only occur under a complete removal of defences.

As it is proposed to locate a highly vulnerable development partially within Flood Zone A/B, a Justification Test is required as part of the FRA. The Justification Test (JT) is undertaken in Section 5. A discussion on residual risk is provided below in Section 4.2 and mitigation is discussed in Section 4.3. A schematic of the site and Flood Zones is presented below in Figure 4-1.

Figure 4-1 Site Layout with Flood Zones



4.2 Residual Risk

In 2015 high levels in the Park Canal resulted in overtopping underneath Pa Healy Road bridge and inundated lands to the north. The overtopping occurred because of operational failure at the lock gate downstream. Since 2015, levels along the canal bank (at Pa Healy Road) have been locally raised. Topographic survey completed in 2018 confirms that the levels on the southern bank of the canal are circa 1.0m higher than the northern bank. The residual risk of overtopping of this section of the canal is therefore very low - the northern bank of the canal adjacent to the site is much more likely to overtop, levels to the west of Pa Healy Road are also much lower and are at greater risk of overtopping.

The principal risk to the proposed site is from the canal overtopping the bank crest at 4.7mOD (circa 0.5% AEP level) to the west of Pa Healy Road, with spill flowing down St Lelia Place and onto Clare Street before reaching the southern margin of the site. This condition is represented by the Shannon CFRAM fluvial mapping, which assumes no operational influence on the closed lock gates.

Since the overtopping in 2015 a revised protocol has been put in place to prevent a recurrence of unchecked high levels in the canal. The mitigation method involves releasing water into the Abbey River by operation of the lock gate.

Proposals from the Shannon CFRAM will seek to install an additional lock gate upstream of Pa Healy Bridge to provide a further measure of control on the conveyance route along the canal from the Shannon upstream.

In summary, the residual risk from tidal flooding is low - managed by the Abbey River defences. The principal residual risk to the site is from overtopping of the canal resulting from high fluvial flows not being released from the lock gate and even then the risk has a marginal impact on a small part of the site. A new operational protocol that manages water levels on the canal has been put in place, but this is not failsafe. In the worst case condition (operational failure) is represented by the Flood Zone mapping in Figure 4-1 above.

4.3 Mitigation

4.3.1 Site Layout & FFL

The final FFL for all buildings with highly vulnerable use (residential) is recommended to be a minimum of 5.75mOD. This is based on the 0.5% tidal level (4.75mOD) plus 0.5m climate change and 0.5m freeboard. Setting the buildings at this level (or above) will ensure they are appropriately mitigated for potential future flood events and will also ensure they are at low residual risk from canal breach/overtopping.

Landscaping/open space and car parking areas can be kept at grade as far as possible.

Less vulnerable (café & retail) are at a minimum of 4.8mOD, which is 0.05m above the 0.2% AEP tidal level. These uses are set closer to the levels on Pa Healy Road.

From viewing the site layout in Figure 4-1 it is clear that there is an overlap with defended Flood Zone A/B for Block 3. Flood Zone B overlaps with Blocks 2, and Block 1 including the retail and café area, the rest of the land impacted by Zone A/B is open space or roads with a small amount of car parking. A Housing Block is also in Flood Zone B.

FFLs per block:

Block 1 (student acc)	5.75mOD
Block 2	6.0mOD
Block 3	6.0mOD
Community Facilities	6.1mOD
Block 4	6.2mOD
Block 5	6.3mOD
Block 6	6.4mOD
Block 7	6.5mOD
Housing	6.0mOD
Commercial/Retail	5.02 & 4.8mOD

Since the open space/car parking levels are kept at/close to existing there is no loss of floodplain storage for these areas. That lost within the building footprints is minimal and will not have any significant impact on surrounding land, it is also principally a defended/residual risk and is unlikely to occur given recent mitigation improvements for the operation of the canal.

The commercial/retail buildings are 0.05m and 0.27m above the 0.5% AEP tidal level and consideration should be given to provision of flood resilient building finishes in line with Technical Appendix B of the Planning System and Flood Risk Management Guidelines. This would help manage the potential impacts of internal flooding under an exceedance event.

All FFLs should be 150mm above surrounding hard standing.

4.3.2 Access & Flood Emergency Response Plan

The main access to the site will be via the Pa Healy Rd, which runs along the northern boundary of the site. Review of the Shannon CFRAM flood maps confirm that sections of the Pa Healy Rd across the site boundary are located within Flood Zone B. Due to moderate risk of flooding, no specific measures are required for the site access road within the site boundary.

The predicted flood depths are shallow and will allow emergency access to the site during a 0.1% AEP flood event.

Never the less, it is recommended that a formal emergency plan is drafted and the potential flood risk to the affected areas of the site and access points is communicated to residents/customers.

4.3.3 Surface Water Design

It is proposed that all generated storm waters from the development will be collected via a separate stormwater gravity network and discharged to the Canal which is located along the western boundary of the development site.

The drainage strategy employed for dealing with storm water from the proposed development follows the principles of Sustainable Urban Drainage Systems (SUDS) as set out in CIRIA document C521 'Design Manual for Scotland and Northern Ireland'. Specifically, the Best Management Practices (BMP's) for the control of surface waters, as prepared by Dublin Corporation and as set out in their document 'Storm Water Management Policy for Developers 1999', have been used in the design of the surface water system. The adopted principals are in line with the 'Greater Dublin Strategic Drainage Strategy', April 2005.

A key part of the design strategy is limiting the amount of post-development run-off below the Mean Annual Peak Flow (Rural) (QBARR) associated with the lands in their pre-development state. Given the vulnerability of the receiving Canal which flows into the Abbey River it is proposed to limit run-off below the Annual Peak Flow and adopt a limiting pass forward flow of 2 litres per second per hectare.

Under a scenario where the discharge rate is reduced to zero, PHM have reviewed the Attenuation Vol Requirements for a 1:10 yr and 1:100 yr event including +20% Rainfall for Climate.

A 4 hour storm will require 620 & 1070 m² storage respectively. This is understood to be well within the capacity of the detention basins being provided without inundation of the site. The basins will have circa 0.5m freeboard above the 100 yr design capacity.

Given the physical aspects of the current site condition and essentially the imported material in the past that were used to raise the site levels and in consultation with the Environmental Due diligence report prepared by VERDE Environmental it is not proposed to provide for discharge or permeation to ground.

All surface run-off from roofs, paved areas, and open spaces are to be captured, detained, treated, and eventually discharged to the Canal channel. Storage is provided in 2no. ponds for the 1% AEP rainfall event plus climate change (20%).

Full details of the system are provided in the infrastructure report by PHM Consulting, under separate cover.

5 The Justification Test for Development Management

5.1 Strategy

The planning guidance appropriate to this development is, "The Planning System and Flood Risk Management" and sets out a framework within which the planning authority should consider proposals for new development in areas of flood risk. This framework is called the Justification Test for Development Management.

Since the proposed development is considered as highly vulnerable to the impacts of flooding and is located within Flood Zone A/B, a Justification Test (JT) must be applied and passed in order to satisfy the Guidelines.

In the following text, each of the criteria within the JT is responded to as they relate to the proposed school. For ease of reading, where the responses are supported by technical detail which is contained in later parts of the report, an appropriate chapter has been referenced.

5.2 Justification Test: Part 1

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

The Limerick City Development Plan includes a Flood Risk Assessment for the plan area. The FRA is based on a range of data sources, as recommended by the Planning Guidelines, including predictive flood mapping, historical flood event data and other indicative data sets such as benefiting land maps. The Development Plan shows the site to be zoned for Mixed Use.

Figure 5-1 Limerick development Plan 2010-2016

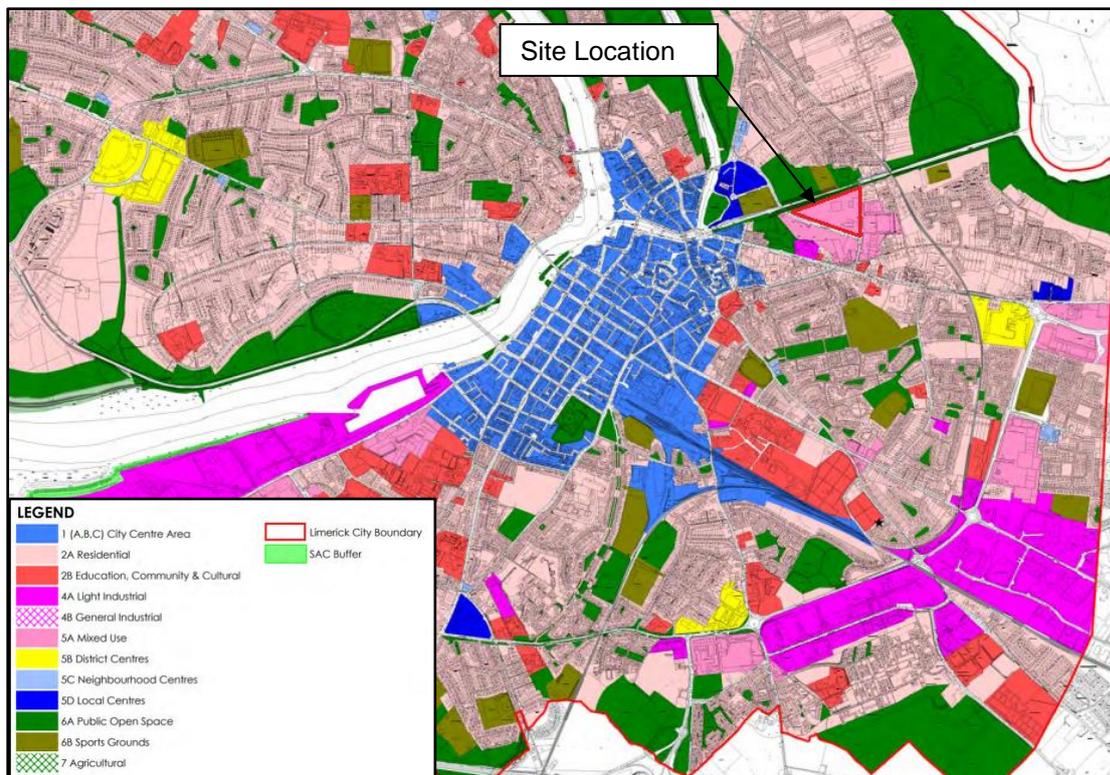


Figure 5-2 Limerick City Development Plan 2010-2016

In addition, the Development Plan includes a specific objective for the assessment and management of flood risks (see Box 1, below). This flood risk assessment has been undertaken in accordance with the requirements of Objective 'IN O 38', which follows the requirements of Part 2 of the Justification Test.

Box 1 - Objective IN O 38: Flood risk assessment It is an objective of the Council to ensure that land uses are zoned, and developments allowed where there is minimum flood risk, prioritising the protection of certain land uses particularly vulnerable to the effects of flooding. To this end:

a) The sequential approach to zoning and assessment recommended in 'The Planning System and Flood Risk Management', DEHLG November 2009 and any subsequent document will be adopted.

5.3 Justification Test: Part 2

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

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

There is an overlap with defended Flood Zone A/B for Block 3. Flood Zone B overlaps with Blocks 2, and Block 1 including the retail and café area, the rest of the land impacted by Zone A/B is open space or roads with a small amount of car parking. The encroachment within Flood Zone A/B will not result in any significant increase in flood risk. The risk is residual and would only occur if defence infrastructure was subject to failure, furthermore since the dominant risk is tidal the impacts of loss of floodplain storage will not impact local levels as the incoming volume of the tide is infinite.

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

The proposed FFL of all buildings on site will be raised above the 0.5% AEP tidal flood level including 0.5m climate change and 0.5m freeboard allowance.

(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 site will not be impacted by the 0.5% tidal flood event, unless there is a breach in the flood defence wall along the Park Canal. If failure of the flood defences were to occur, the highly vulnerable parts of the development will not be impacted due to the proposed FFLs. The proposed development will also be protected against the potential impacts from climate change.

(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 will provide a consistent building design and environment, set back from the main road which not negatively impact on the surrounding environment.

6 Conclusion

JBA Consulting has undertaken a Flood Risk Assessment for a proposed Mixed-Use Development Pa Healy Road Limerick

The proposed works involves the construction of a significant residential development on an underutilised section of land close to the core of Limerick City.

From reviewing the available sources of flooding the site has been shown to reside predominantly within Flood Zone C with some of the proposed accommodation blocks located within Flood Zone A (defended - tidal) and Flood Zone B (fluvial/tidal).

To manage the risk of flooding, it is proposed to raise the FFL of all buildings to a minimum of 5.75mOD, most residential blocks are to be set at 6mOD or above. This will provide adequate mitigation for future flood events including climate change and freeboard. Stormwater is managed appropriately and the open space within the site is configured to avoid conflict with existing Flood Zones. The Justification Test has been applied and passed.

The Flood Risk Assessment was undertaken in accordance with 'The Planning System and Flood Risk Management guidelines and the Limerick Development Plan 2010-2016 and is in agreement with the core principles contained within.

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 (in years). A 1% AEP flood has a 1 in 100 chance of occurring in any given year. In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval, and is the terminology which will be used throughout this report.

Table: Conversion between return periods and annual exceedance probabilities

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

A.2 Flood Zones

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

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

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

Figure: Indicative Flood Zones (OPW & DoEHLG 2009)



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.).

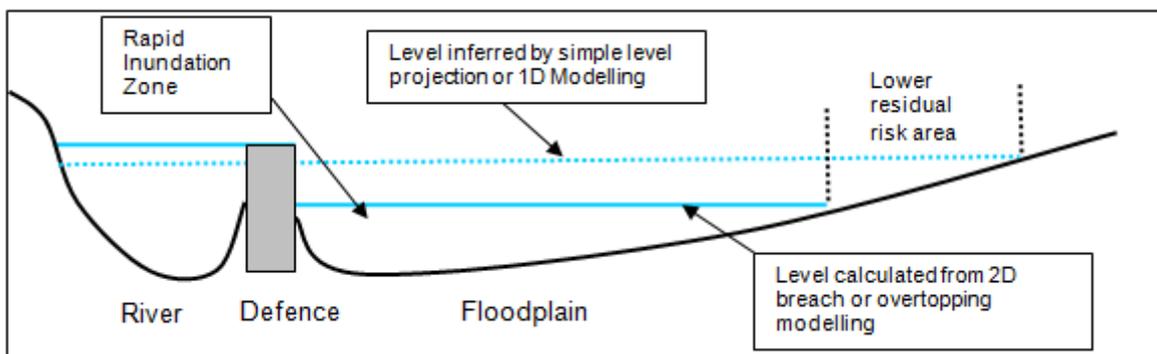
The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on the type of development, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

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

The proposed sports hall development is considered a less vulnerable development, and with flood resilient design could even be considered water compatible.

A.4 Residual Risk

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





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