Hazelhatch Road, Celbridge, Co. Kildare Flood Risk Assessment

Technical Report

August 2022

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Garyaron Homes Ltd.

Unit H2,

Merrywell Business Park,

Lower Ballymount Road,

Dublin 12

JBA Project Manager

Ross Bryant
24 Grove Island
Corbally
Limerick
Ireland

Revision History

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S3-P02 / November 2021	Update site and drainage details	Garyaron Homes Ltd
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Contract

This report describes work commissioned by Gareth MacHale of Garyaron Homes Ltd, by a signed acceptance form dated 1st September 2021. Garyaron Homes' representative for the contract was Patrick Kavanagh of Kavanagh Burke. Orla Hannon and Ross Bryant of JBA Consulting carried out this work.

Prepared by ....Orla Hannon BSc (Hons)
Analyst

Reviewed by ....Ross Bryant BSc MSc CEnv MCIWEM C.WEM
Principal Analyst

Purpose

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Abbreviations

1D .... One Dimensional (modelling)

2D .... Two Dimensional (modelling)

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

CC.................................. Climate Change

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

HEFS .... High End Future Scenario

HFS................................ Hazelhatch Further Study

MRFS............................. Medium Range Future Scenario

OPW .... Office of Public Works

PFRA .... Preliminary Flood Risk Assessment

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) a proposed development must undergo a Flood Risk Assessment (FRA) to ensure sustainability and effective management of flood risk.

1.1 Terms of Reference and Scope

JBA Consulting was appointed by Garyaron Homes Ltd to undertake a Flood Risk Assessment (FRA) of a site adjacent to the Hazelhatch Road in Celbridge, Co. Kildare.

1.2 Flood Risk Assessment; Aims and Objectives

The study is being completed as a site-specific Flood Risk Assessment (FRA) and it will aim to identify, quantify and communicate to Planning Authority officials and other stakeholders the risk of flooding to land, property and people and the measures taken to manage the risk.

The purpose is to provide sufficiently detailed information to determine whether the proposed development is deemed appropriate through the application of both proper planning and flood risk management principles.

The objectives of the study are to:

- Identify potential sources of flood risk, including fluvial and surface water;
- 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
- Review the necessity for the Justification Test for Development Management and complete if required.

Recommendations for development have been provided in the context of the OPW / DECLG 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.

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

Garyaron Homes Ltd intends to apply for a 5 year planning permission for a Large Scale Residential (LRD) Development scheme on lands at Glencarrig House, Simmonstown, Celbridge, Co. Kildare, W23Y9PY on a site of approximately 2.1 ha.

The proposed development will consist of: (a) the demolition (total area approx. 800 sqm) of the existing buildings on site and the existing front boundary treatment; and (b) the construction of a new residential and creche scheme of 138 no. units in a mixture of houses and apartment units ranging from 2 to 5 storeys in height as follows;

- Block A (3-5 storey apartment block) comprising 39 no. apartments (19 no. 1 bed and 20 no. 2 bed units)
- Block B (4-5 storey apartment block) comprising 51 no. apartments (24 no. 1 bed and 27 no. 2 bed units)
- Block C (3-4 storey apartment block) comprising 25 no. apartments (11no. 1 bed and 14no. 2 bed units)
- Houses (2 -3 storeys) comprising 22 no. house units (5no. 4-bed semi-detached, 4no. 3 bed semi-detached, 4no. 3-bed terraced and 9no. 3-bed end of terrace)

A separate building will accommodate a Childcare Facility/creche of approx. 248 sqm with outdoor play area of 460 sqm. Bike Store building (86 sqm) and Plant Room/ ESB-Sub-station building (66.9 sqm).

Each residential unit will be afforded with private open space in the form of a balcony or terrace in the case of the apartment units and a rear garden in the case of the housing units. Public open space is proposed in the form of play areas, outdoor seating and planting and pedestrian and cyclist links (approx. 4,380 sqm).

A total of 135no. car parking spaces are provided at surface level, including 7 no. Accessible spaces; 80 no. bicycle spaces (for Visitors and Residents, in bike stands) together with 124 no. Secure bicycle spaces within 4no. Bike stores. The development shall be served via a new vehicular access point from the L5062. Upgrade works are proposed to the vehicular access point from the R405 onto the L5062 to facilitate the proposed development and to provide for improved access and egress for the overall development. New pedestrian and cyclist access points will be provided on to the R405 from the site. The associated site and infrastructural works include provision for water services; foul and surface water drainage and connections; attenuation proposals; permeable paving; all landscaping works; boundary treatment; internal roads and footpaths; waste storage areas and electrical services and all associated site development works.

1.4 Report Structure

Section 2 of this report gives an overview of the study requirements. Section 3 contains background information and initial assessment while Section 4 carries out a hydraulic modelling study. The Flood Risk Assessment (FRA) and site-specific mitigation details are included in Section 5. The Justification Test is applied in Section 6 while Conclusions are provided in Section 7.

Figure 1-1: Proposed Site Layout

2 Site Background

2.1 Location

The site is located adjacent to the Hazelhatch Road in Celbridge, Co. Kildare, Figure 2-1. It is bound to the north and west by housing estates (The Close and The Dr) and to the south by greenfields. Main access to the site is via to Hazelhatch Road and a local access road along the eastern boundary. The site is a greenfield site with one existing property which is to be demolished.

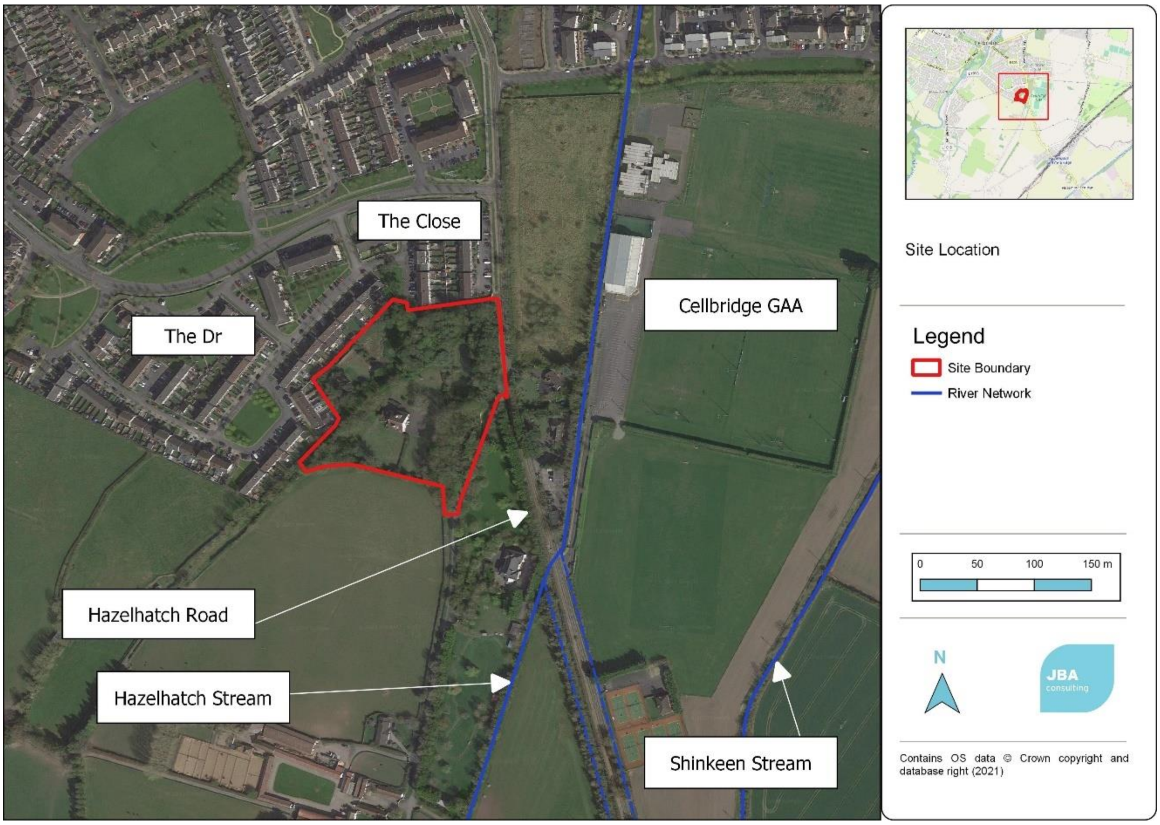


Figure 2-1: Site Location

2.2 Watercourses

The Hazelhatch Stream has a catchment area of approximately 6.1km^2. Its source is just south of the Grand Canal and it flows through fields until it reaches the R405, of which it is culverted under. It flows through the residential estate, Willow Park, and is culverted under the main Dublin Road (R403) before it joins the River Liffey.

The Shinkeen Stream has an approximate catchment area of 10km^2 consisting of very flat land. The stream's source is south of the Grand Canal, which it flows under (there is an overflow channel from the Grand Canal to the Shinkeen which operates intermittently to control the water level of the canal). The stream channel has been redirected and culverted under the Dublin-Cork railway line and road at Hazelhatch. It flows around the east of Celbridge where it is culverted under the main Dublin Road (R403). The Shinkeen Stream is a tributary of the River Liffey.

Two local drains run along east and west side of the Hazelhatch Road. Both of these drains discharge into the Hazelhatch Stream.

The catchment area of each stream is predominantly rural, sloping from South (160mOD) to North (56mOD). The Annual Average Rainfall is approximately 735mm with no significant attenuation features. The Shinkeen is an ungauged catchment, whereas a water level and flow gauge is located on the Hazelhatch Stream adjacent to the site.

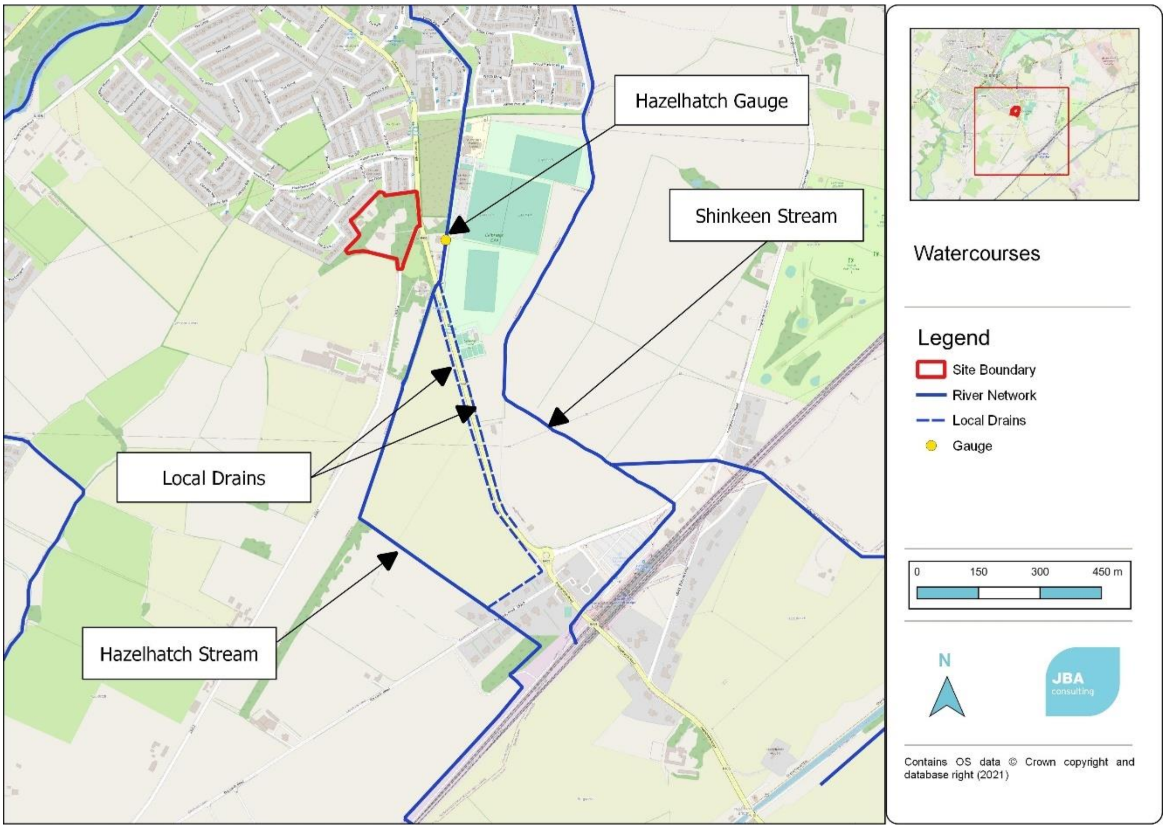


Figure 2-2: Local Watercourses

2.3 Site Geology

The Geological Survey of Ireland (GSI) groundwater and geological maps of the site were reviewed. The subsoil present under the site is till derived chiefly from limestone (Figure 2-3). The underlying bedrock is classified as the Lucan Formation which is described as dark limestones and shale.

The associated groundwater vulnerability is classified as 'Moderate' (Figure 2-4), with a depth to bedrock of 5-10m. There are no karst features within or near the site. These classifications are based on relevant hydrogeological characteristics of the underlying geological materials. There is no GSI Groundwater flooding probability mapping available for the area covering the site.

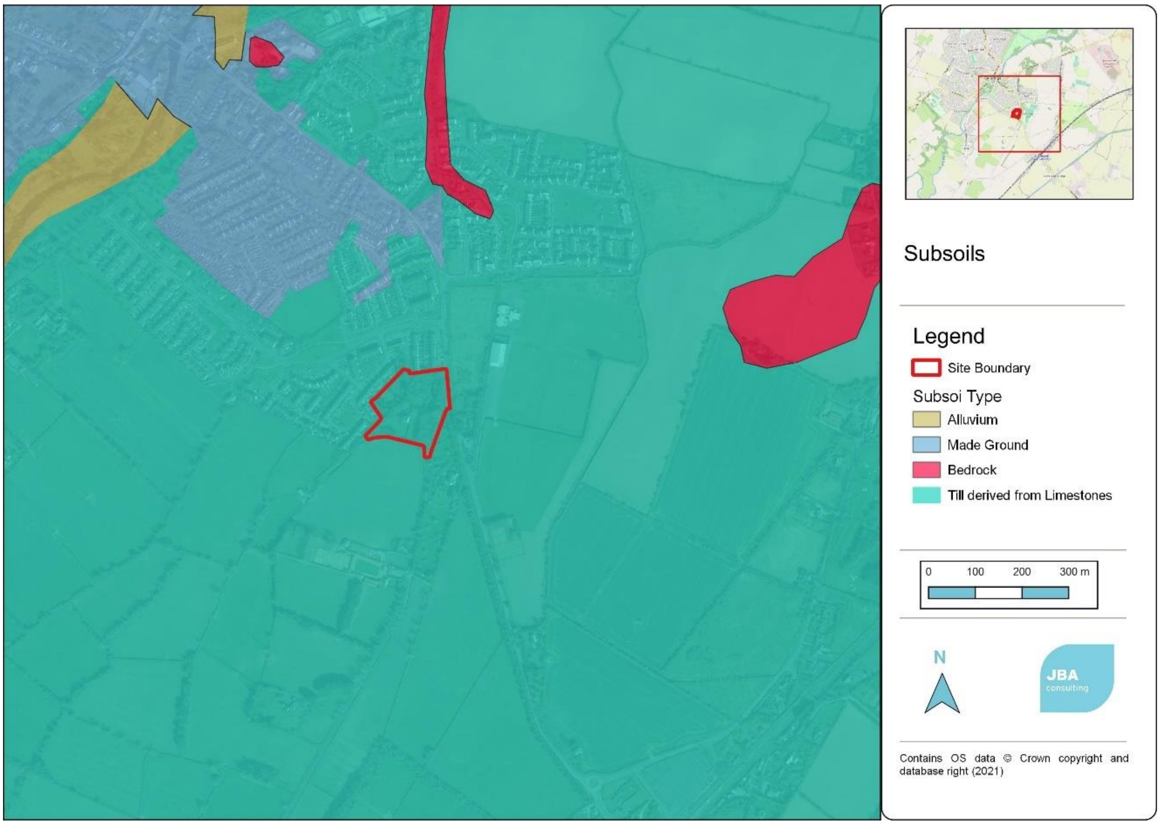


Figure 2-3: Site Subsoils

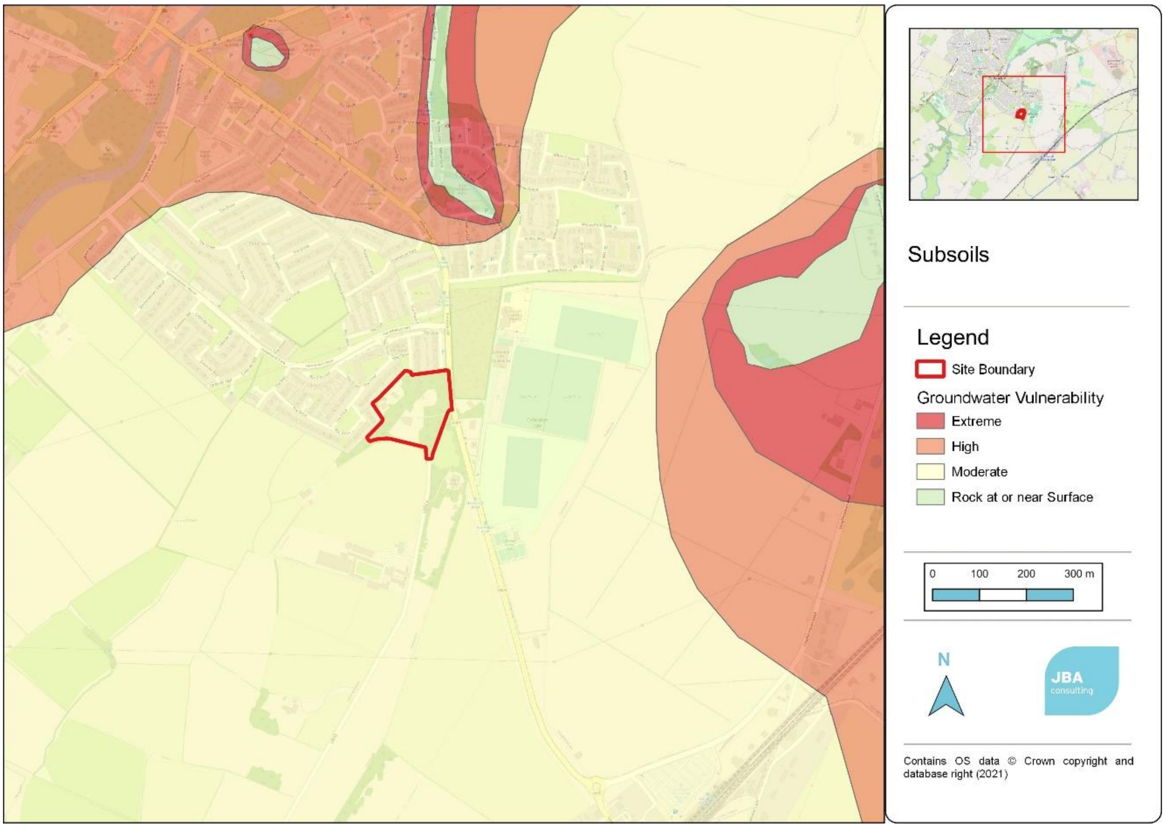


Figure 2-4: Groundwater Vulnerability

3 Flood Risk Identification

An assessment of the potential for and scale of flood risk at the site is conducted using 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

Several sources of flood information were reviewed to establish any recorded flood history at, or near the site. This includes the OPW's website, http://www.floodinfo.ie and general internet searches.

There is a significant history of flooding in the local area, and this has been summarised by many previous reports. Notable flood events were in June 1993, August 1996, April 1998, September 1999, November 2000 (after which the Shinkeen Stream was subject to flood relief works), and in November 2014, November 2017 and November 2019. Table 3-1 below describes the historic flood events in the area.

Table 3-1: Flood History

Event Date	Description	Source
10th June 1993	Flooding reported on the Railway Line and Hazelhatch Rad. Extensive flooding throughout Celbridge, and the County, as a result of an extreme event, approx. 200yr rainfall event from the rainfall records.	Floodinfo.ie
August 1996	Flooding to Hazelhatch Road	Floodinfo.ie
9th April 1998	Flooding to homes on the Hazelhatch Road, Celbridge, tennis courts and Celbridge GAA club.	Floodinfo.ie
September 1999	Parts of Hazelhatch flooded to depths of more than 500mm and was impassable for some time. Hazelhatch Road flooded to depths varying from 100mm to 300mm causing traffic disruption. 5no. or 6no. houses on the Hazelhatch Road were surrounded with water, up to the doorstep at some properties. Celbridge tennis courts were inundated with silt deposits causing damage. Celbridge GAA clubhouse carpark and basement were flooded as well as the football pitch.	Floodinfo.ie
5th November 2000	Flooding to Hazelhatch railway lines caused closure of the southern train services. The Celbridge GAA club suffered damage.	KCC / Met Office
14th November 2014	Celbridge GAA club pitches, the primary school and 2no courts of the tennis club were flooded.	GAA & Tennis Clubs, Primary School
22nd/23rd November 2017	Celbridge GAA club pitches and 2no. courts of the tennis club were flooded.	GAA & Tennis Clubs
8th November 2019	Celbridge GAA club pitches and tennis club were flooded.	GAA & Tennis Clubs

3.2 OPW Drainage Scheme: Shinkeen Stream - 2001

The OPW completed flood relief works on the Shinkeen Stream in 2001 to protect the Dublin-Cork railway line, residential houses, sports clubs and agricultural land from flooding. It is noted that at this time the Hazelhatch Stream was not subject to any such improvement works.

The Shinkeen Stream has been protected to a 1% AEP standard by appropriate re-sizing of the channel. Flows significantly larger than the 1% AEP flood may exceed channel capacity and cause out of bank flow. A detailed assessment of the overflow from the Grand Canal was not assessed as part of the OPW scheme, calculations confirmed that the volume of overtopping could not be the sole cause of flooding on the watercourse, and it is assumed that the design capacity of the scheme includes for a degree of freeboard to account for a proportion of canal overflow.

3.3 Predictive Flooding

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

- OPW Preliminary Flood Risk Analysis (PFRA)
- Eastern Catchment Flood Risk Assessment and Management Study (CFRAM)
- Hazelhatch Further Study (HFS)

The level of detail presented by each method varies according to the quality of the information used and the approaches involved.

3.3.1 OPW Eastern CFRAM

CFRAM flood maps were published in 2016 and the history of extensive flooding could not be replicated by it. This led to the Flood Risk Management Plan for the area recommending that a detailed assessment is carried out, including data collection and an assessment of potential non-fluvial sources, in order to achieve greater understanding of the detailed flood mechanisms in the area and to identify an integrated option to manage the existing risk in Hazelhatch.

3.3.2 Hazelhatch Further Study

Flood extent and depth maps from the Hazelhatch Further Study (HFS) are published on the Kildare County Council website and represent the best available dataset for flooding. An extract of the mapping is replicated over page in Figure 3-1 (refer to Appendix B for full mapping). The study improved the representation of the channels and has extended the channel survey. The maps show an increase in the extent and frequency of flooding in the local area.

As seen in Figure 3-1 below, the site is identified as being at risk of flooding during the 0.1% AEP event. There is no risk to the site identified in the 1% AEP event. It is clear from the increase in flood extents between the CFRAM and the HFS study that the flow and/or hydrograph shape have been increased for the Hazelhatch system. As a new hydrometric gauge was installed in 2017 which captured the 2017 and 2018 flood events it is likely the hydrograph shape has been updated to be more representative of the system.

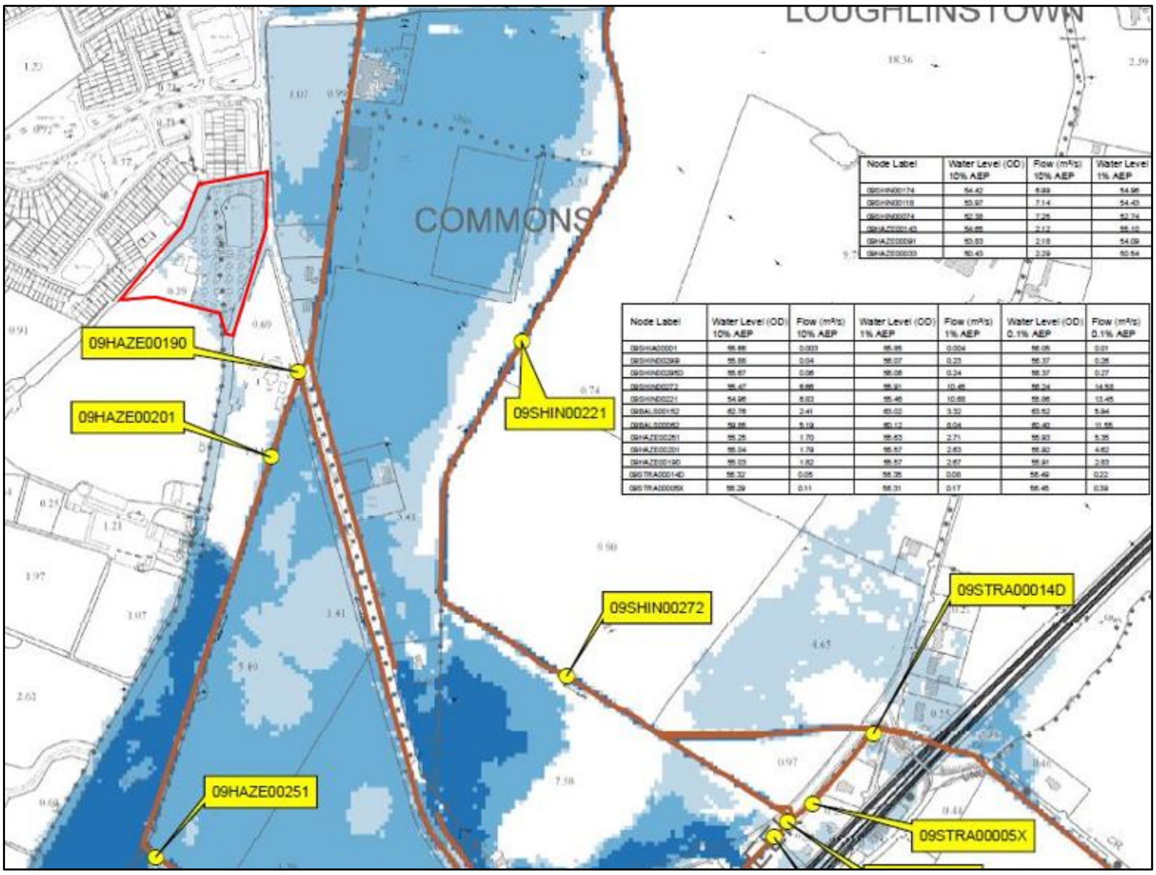


Figure 3-1: HFS Flood Extents

3.4 Flood Sources

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

3.4.1 Fluvial

All available sources of flooding have been researched as part of the FRA and indicate the site is at risk of fluvial flooding during a 0.1% AEP event. The Hazelhatch Stream flows north approx. 80m east of the proposed site. Further detailed analysis is required to further investigate the flood risk to the site and the potential impact of the proposed development. This is discussed in Sections 4 and 5.

3.4.2 Groundwater

The predominant subsoil type in the surrounding area is classified as Limestone Till (TLs). There are no alluvium subsoils surrounding the site, the presence of alluvium can indicate potential historic flooding. The overlying podzolic soils typically indicate well drained minerals. There are no karst features, wells or springs on the site or in the surrounding area. The associated groundwater vulnerability is classified as 'Moderate', with a depth to bedrock of 5-10m.

3.4.3 Pluvial/ Surface Water

Pluvial flooding is the result of rainfall-generated overland flows that arise before run-off can enter a watercourse or sewer. It is particularly sensitive to increases in hard-standing ground/urbanised areas and is usually associated with rainfall events of high intensity.

Figure 3-2 presents the OPW Preliminary Flood Risk Assessment (PFRA) pluvial flood mapping. Extensive flooding is observed across the Commons / Hazelhatch area due to the flat topography. This pluvial mapping provides conservative flood extents due to the exclusion of drainage within the model, as such it identifies areas where water may pond, but does not consider that it can potentially drain away into local ditches and watercourses.

Any potential site development will need to consider ground conditions and devise a suitable surface water management strategy that collects, attenuates and discharges surface water at an appropriate location and greenfield rate.

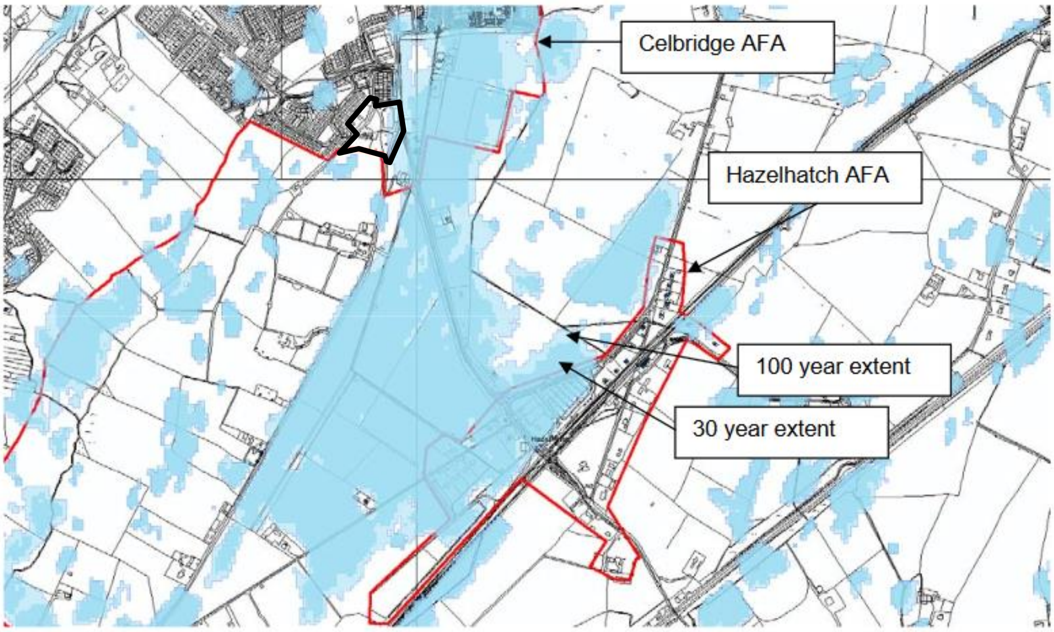


Figure 3-2 OPW PFRA Pluvial Mapping (30 year and 100 year return periods) from ECFRAM HA09 Hydraulics Report

4 Flood Risk Assessment

4.1 Hydrology

Flows and hydrographs have been estimated based on a hydrological analysis of the Hazelhatch Stream using appropriate methods. These have been prepared as the CFRAM Study and the HFS hydrology reports are not available online. Comparison with the HEPs for each of these studies is therefore not possible. The HFS flows at each model node are available online and are used for comparisons where necessary.

Upstream of the culvert under the railroad (HFS Node 09HAZE00365I) was selected as the upstream extent of the model. The OPW has confirmed that, as far as they are aware, there is just a single culvert in place; the one included in the Hazelhatch Further Study. This was a correction from the CFRAM which had a culvert in the wrong location and with the wrong dimensions under the Canal.

The Hazelhatch Stream catchment at the upstream extent of the model has an area of 4.8km², refer to Figure 4-1. The catchment was delineated using 2m LIDAR available for the area. The FSU catchment descriptors (CDs) are usually used when calculating hydrology. However, when reviewing the FSU CDs, the Hazelhatch Stream is not included as an FSU watercourse and so has no node along its length to determine CDs. Therefore, the CDs from the adjacent Shinkeen catchment (Node 09_501_1) are used instead. Results from the analysis are presented in Table 4-1 up to the 0.1% AEP event.

It is clear from the HFS Flood Extent Maps there is a split in flow with some entering the culvert under the railway and some flowing east, crossing the railway line further downstream. To investigate how much flow is being delivered overland towards the Hazelhatch Station and the proposed site Table 4-2 compares the local HEP (as calculated by JBA) to channel flows upstream of the culvert inlet (HFS Node 09HAZE00365I, refer to Appendix B). It indicates that channel flows are circa 40% of catchment flows at the 1% AEP and circa 30% at the 0.1% AEP. It was therefore decided that the best approach to replicate the flows was to apply the flows at node 09HAZE00365I to the culvert, while the 'Difference' flows were applied as the overland flows east of the railway structure.

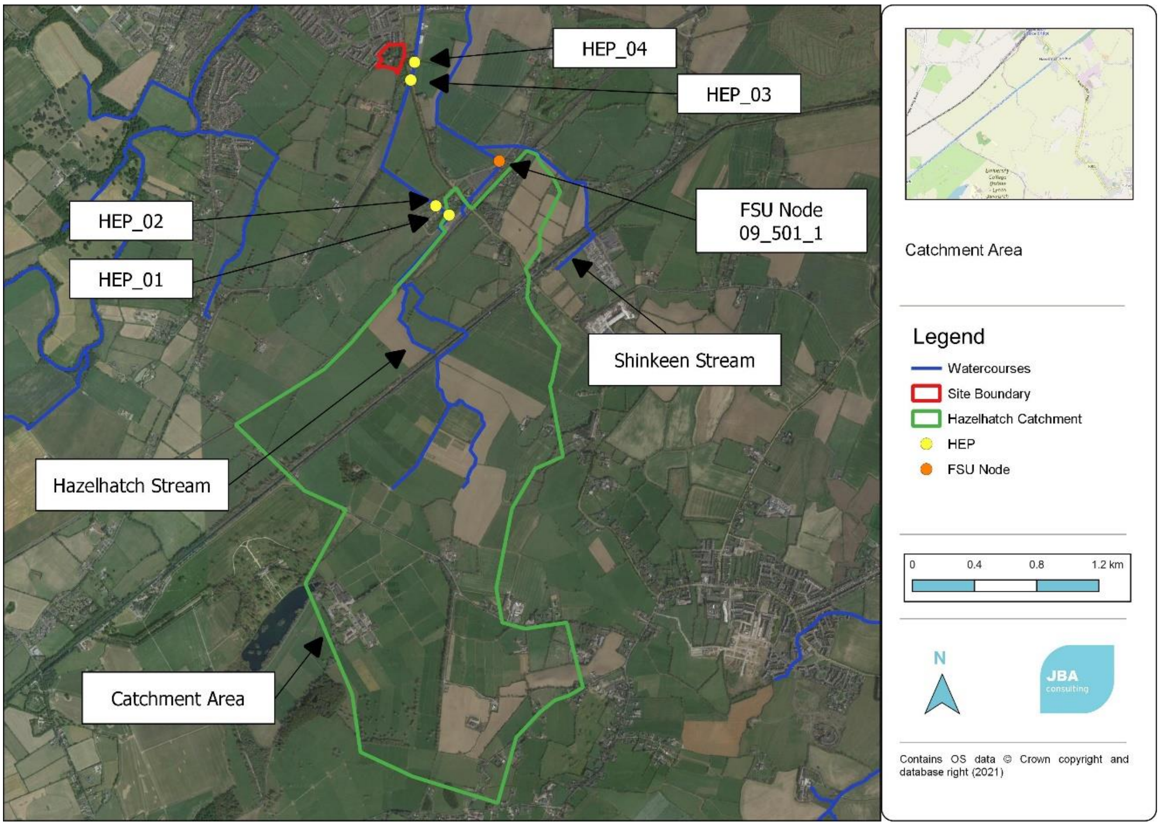


Figure 4-1: Catchment Area

Table 4-1: Final Flows for Model

Return Period (yrs)	2	5	10	20	50	100	1000
Flow (m^3/s)	1.09	1.58	1.95	2.37	3.02	3.61	6.44

Table 4-2 HEP Catchment Flow and Channel Conveyance Comparison

HEP/Model Node	10% AEP (m^3/s)	1% AEP (m^3/s)	0.1% AEP (m^3/s)
JBA HEP_001	1.95	3.61	6.44
HFS Node 09HAZE00365I	1.58	2.09	2.41
Difference	-0.37	-1.52	-4.03

Lateral inflows were also applied along the reach of the Hazelhatch Stream. These lateral inflows were based on the on the difference in flow between each of the calculated HEP points in the model, as shown in Figure 4-1 above. Refer to Table 4-3 for the lateral flows applied in the JBA model.

Table 4-3: Lateral Inflows

HEP/Lateral Inflow Name	1% AEP (m^3/s)	0.1% AEP (m^3/s)
HEP_002	0.25	0.45
HEP_003	0.36	0.63
HEP_004	0.20	0.36

The FSU Portal was used to generate a hydrograph shape for the site using a pivotal gauge. This hydrograph shape was then validated by comparing it to the shape of previous flood events, from

November 2017 and January 2018, on the Celbridge gauge (water-level based hydrograph shape). Figure 4-2 below shows the FSU Portal generated hydrograph shape and the hydrograph shape of the two flood events at the Celbridge gauge. The FSU shape is shown to match well in terms of flood duration and hydrograph width.

The hydrograph shape is now more representative of the system than the CFRAM hydrograph which was generalised for small catchments and clearly did not fit the Hazelhatch regime, refer to Figure 4-2.

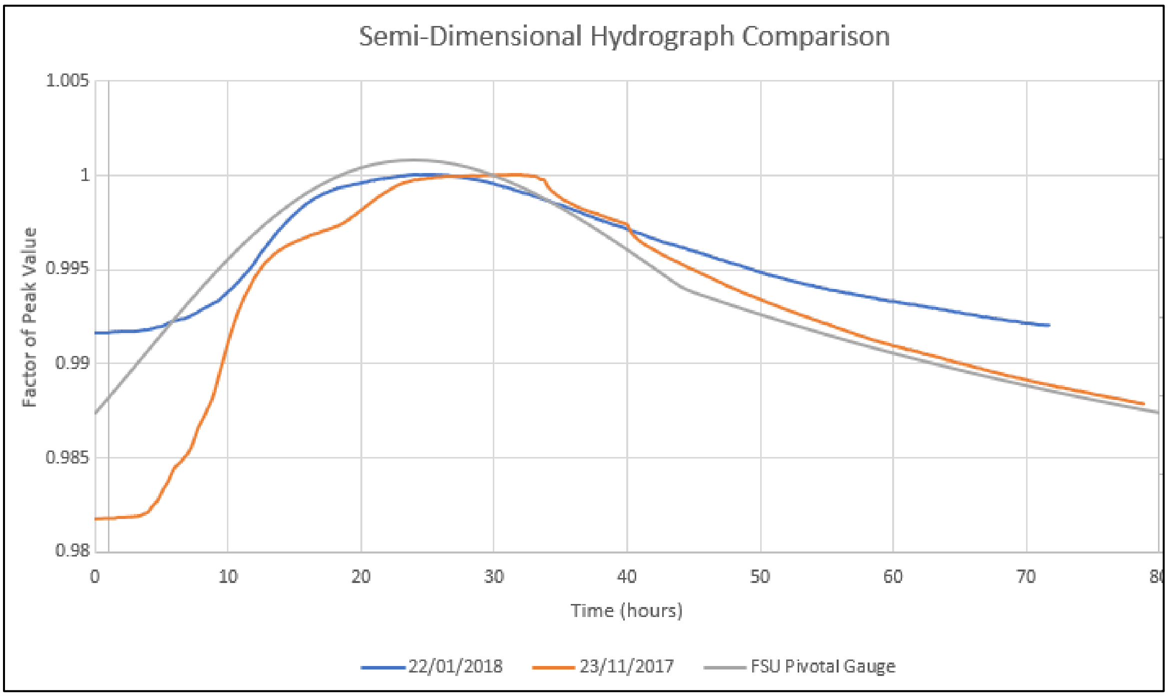


Figure 4-2: Comparison of FSU pivotal gauge and Celbridge Gauge flood events

4.2 Hydraulic Modelling

4.2.1 Hydraulic Modelling Overview

The hydraulic modelling for this study was completed using a Tuflow - Estry 'linked-model'. A linked-model allows flow in the river channel and structures to be represented using 1D modelling equations (Estry) and allows any out-of-bank volumes to be represented by 2D routing equations (Tuflow).

The hydraulic modelled was carried out in the following stages:

- A new 1D (Estry) model of the Hazelhatch Stream was created using survey data from the CFRAM study plus the additional survey carried out for the HFS (as provided by the OPW).
- A 2D (Tuflow) model grid enclosing the study area was created. Lidar captured in 2011 formed the basis of the 2D grid.
- 1D and 2D components were linked along the bank crest lines along with the deactivation of the floodplains from the 1D domain and of the channels from the 2D domain.
- Design simulations were run to derive the existing risk flood extents.

The model schematisation is shown in Figure 4-3 below.

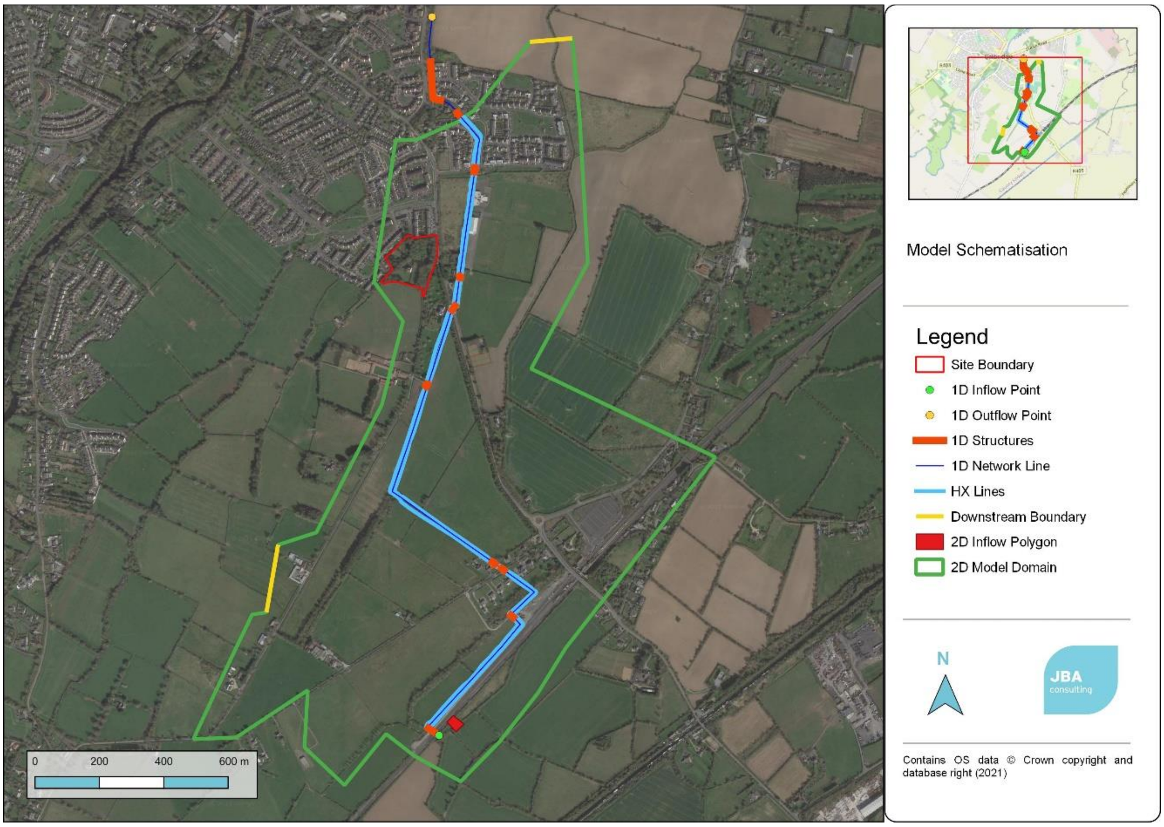


Figure 4-3: Model Schematisation

4.2.1.1 Shinkeen Watercourse

The Shinkeen watercourse has not been represented in the 1D model. The flood map indicates an area of spill in the 0.1% AEP event. The Model Nodes at the 0.1% AEP indicate the flow decreases by 1.13m^3/s in the downstream direction between Node 09SHIN00272 and 09SHIN00221, refer to Figure 4-4 and Table 4-4. This would imply that this is the approx. flow is leaving the Shinkeen and entering the Hazelhatch catchment, and which would likely flow downstream rather than in a southwest direction across the road and impact adjacent the flows at the site. For this reason, the Shinkeen watercourse has not been directly represented in the model.

A comparison between the HFS model water levels and flows and JBA model results is carried out in Section 4.2.2 below, which confirms the two models match well together suggesting the impacts of the Skinkeen watercourse do not impact the JBA model area.

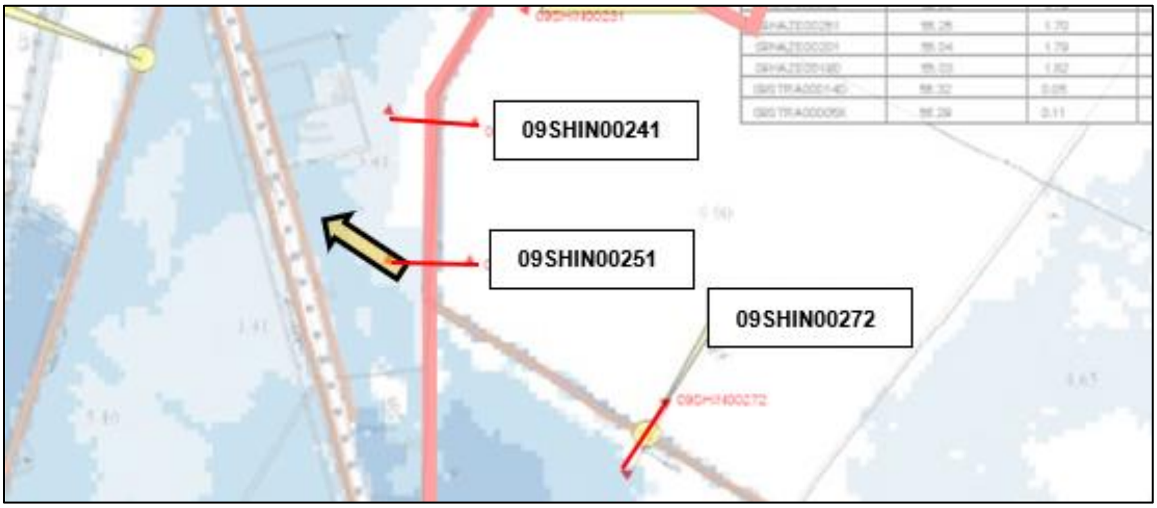


Figure 4-4: HFS Shinkeen Watercourse and Model Nodes

Table 4-4 Shinkeen HEP Flow Comparison

Model Node	1% AEP (m3/s)	0.1% AEP (m3/s)
Node 09SHIN00221	10.68	13.45
Node 09SHIN00272	10.45	14.58
Difference	+0.23	-1.13

4.2.2 Baseline Results

Model results for the 1% and 0.1% AEP events (Flood Zone A & B) are shown in Figure 4-5 below. The site is indicated as being primarily within Flood Zone B and C. Flood Zone A does not extend to the site. This means the probability of flooding from rivers and the sea is moderate to low. Figure 4-5 also shows the 1% AEP + 20% Climate Change (CC) flood extents (MRFS) and the 1% AEP + 30% CC flood extents (HEFS). It shows the climate change scenarios do not impact the site, apart from a very small section along the south eastern boundary.

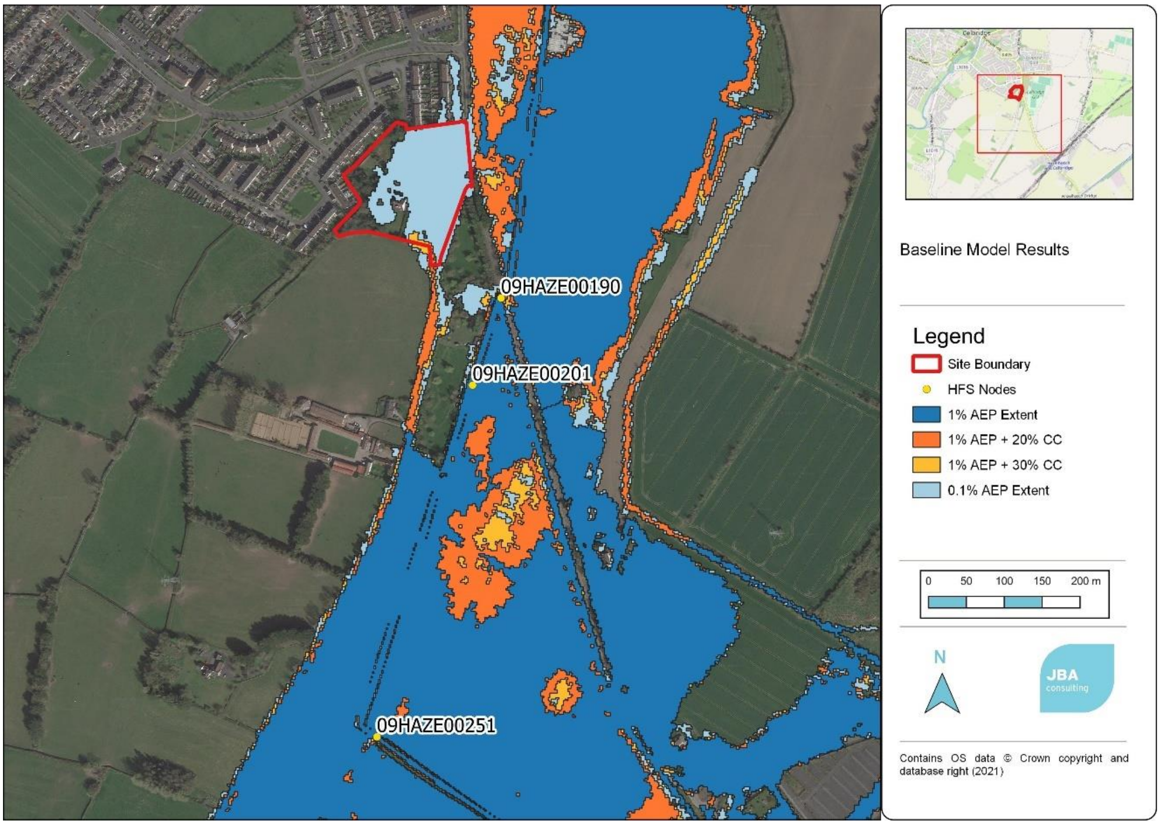


Figure 4-5: Baseline Model Results

The results of the JBA model are shown in Table 4-5 and Table 4-6. The JBA water levels and flows are compared against the HFS modelled water levels and flows at a number of locations adjacent to the site. The MRFS climate change results are also compared in Table 4-7. The HEFS results from the HFS were unavailable online so this comparison could not be made. As seen in the tables below, the JBA results are very similar to the HFS results. Generally, the JBA results are slightly higher that the HFS results. The variability of the flows across the three nodes is most likely a result of the digitising of the reporting lines in the 2D domain - the wide floodplain (particularly at 09HAZE00251) makes it difficult to get an exact flow across the node. The water levels in the JBA model are slightly more conservative than the HFS levels, with levels up to 30mm higher in the Q100 event and 40mm higher in the Q1000 event.

For the MRFS results in Table 4-7, the JBA modelled water levels only match well with the HFS at node 09HAZE00190. It is noted that the HFS water levels increases by 1m for each of the other two nodes. As the water levels for the 1% AEP and 0.1% AEP are generally consistent across the nodes, it is likely the HFS water levels from the map are incorrect. The MRFS flow values quoted for the HFS are also lower than the 1% AEP flows, and it would be expected that the MRFS flows are between the 1% and 0.1% AEP event. It is therefore assumed that the flow values are based on the 1D only flow values, rather than both 1D and 2D flows as is the case for the 1% and 0.1% AEP nodes. Therefore the quoted JBA values are the 1D only values for consistency and these are shown to match well with the HFS values.

Table 4-5: JBA vs HFS Model Results - Q100

Node	Water Level (mOD)		Flow (m³/s)	
	HFS	JBA	HFS	JBA
09HAZE00251	55.63	55.62	2.71	2.52
09HAZE00201	55.57	55.60	2.63	2.74
09HAZE00190	55.57	55.60	2.67	2.59

Table 4-6: JBA vs HFS Model Results - Q1000

Node	Water Level (mOD)		Flow (m³/s)	
	HFS	JBA	HFS	JBA
09HAZE00251	55.93	55.96	5.35	5.17
09HAZE00201	55.92	55.96	4.62	4.78
09HAZE00190	55.91	55.95	2.83	3.53

Table 4-7: JBA vs HFS Model Results - MRFS (1% AEP ~+ 20% CC)

Node	Water Level (mOD)		Flow (m³/s)	
	HFS	JBA	HFS	JBA
09HAZE00251	57.43	55.75	1.95	1.57
09HAZE00201	56.59	55.74	1.99	1.86
09HAZE00190	55.77	55.78	2.77	2.68

A peer review of the FRA by RPS confirmed that the above tables represent " good correlation" which "would be a strong indication that the JBA approach to the modelling of both the Hazelhatch watercourse and Shinkeen Stream is valid", refer to Appendix D.

Figure 4-6 below presents the flood extents overlying the Lidar, with annotations regarding the flood mechanism;

1. There is a high point on the road of 55.71mOD adjacent to the stud farm. This high point prevents the 1% AEP flood level from reaching the site, as the flood level is below the threshold of the road (55.62mOD).
2. Once this threshold is overtopped (as it is in the 1% AEP + CC and 0.1% AEP event), the flow then enters a drain running along the west of the road and flows north towards the site.
3. Flood water then inundates the site as it ponds behind the Hazelhatch Road, before eventually overtopping the road (55.83mOD) and continuing north.

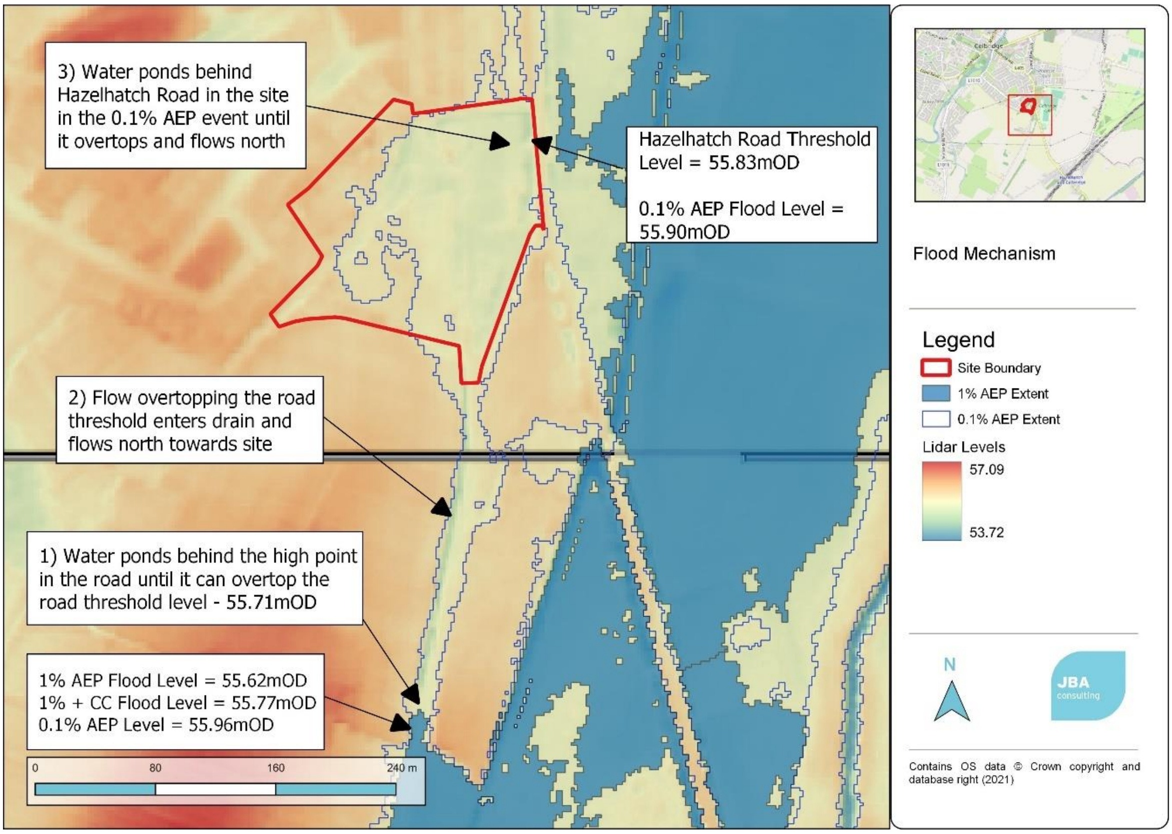


Figure 4-6 Flood Mechanism

4.2.3 Design Scenario

As part of the post-development scenario, the site design was read into the model. This included raising the FFL and the hardstanding areas. Green areas along the eastern and northern boundaries remained unchanged for the most part as the trees in these areas will be maintained.

As the site is not inundated in the 1% AEP event, there is no impacts to flood levels or extents during that event.

Figure 4-7 below shows the 0.1% AEP flood extents for the post-development scenario. This confirms the proposed development and roads within the site boundary are not at risk of flooding in the 0.1% AEP event. It is noted however that the main access road remains flooded in this extreme scenario. Figure 4-8 below shows a depth difference plot comparing the pre- and post-development water levels in the 0.1% AEP event. As shown in the figure, water levels in the surrounding floodplain remain unchanged as a result of the development. There are negligible impacts on flood levels in the green area to the south of the site and along the access road into the site. The impacts to the housing estate to the north in the 0.1% AEP event have been removed as a result of the landscaping along the northern boundary of the site.

A peer review of the FRA by RPS confirmed that "the mitigation measures provided in relation to fluvial and surface water flooding are to a high standard of protection and would be over and above that required in The Guidelines", refer to Appendix D.

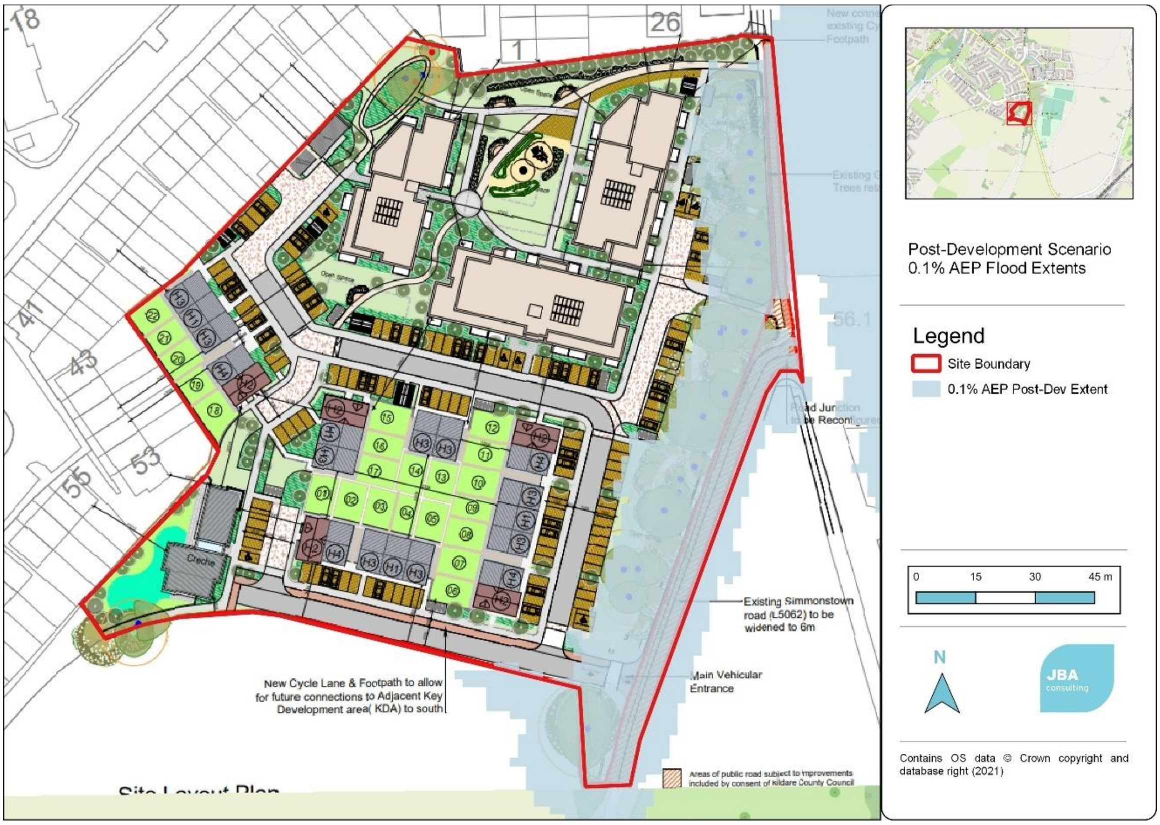


Figure 4-7: 0.1% AEP Post-Development Flood Extent

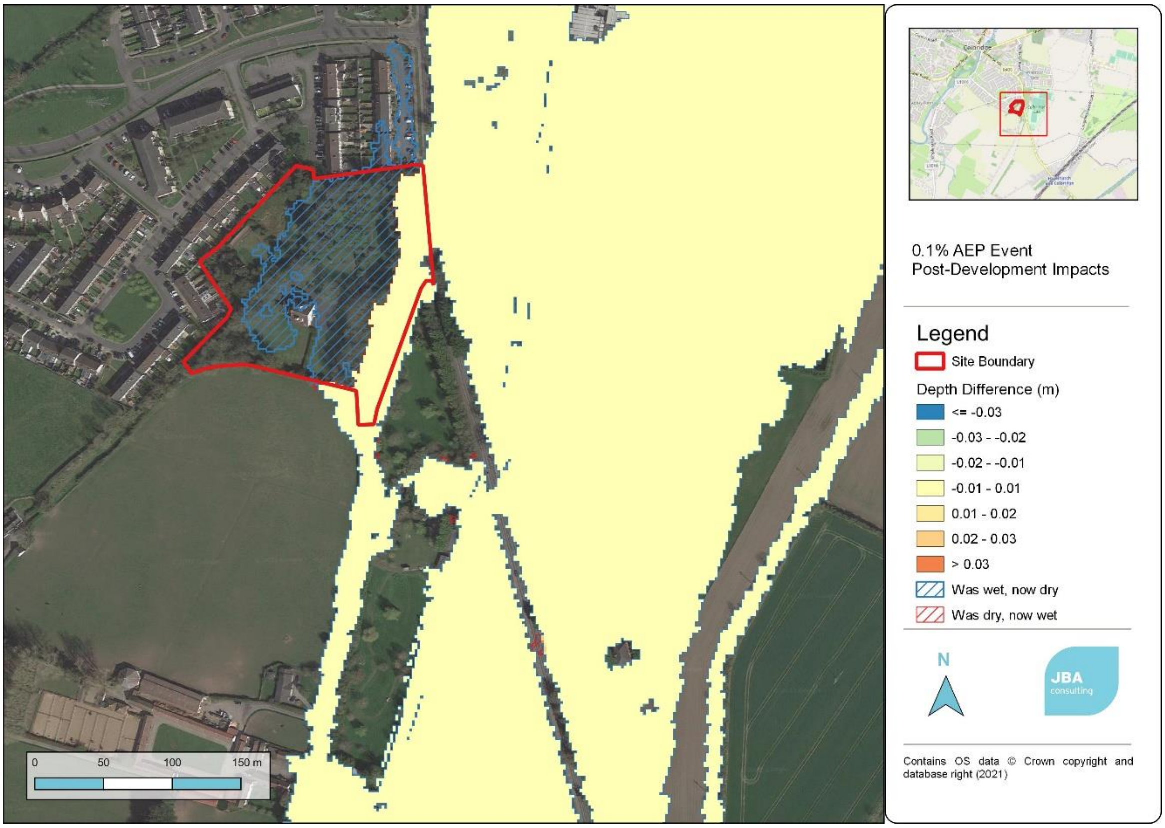


Figure 4-8: 0.1% AEP Post-Development Impacts

5 Flood Risk Mitigation

5.1 Mitigation Measures

5.1.1 Finished Floor Levels

The proposed finished floor levels (FFL) for the development range from 56.85mOD to 56.60mOD. The 0.1% AEP post-development flood level is 55.91mOD. This means the proposed development is placed above the 0.1% AEP flood level with over 690mm freeboard. The FFL is also placed above the MRFS and HEFS climate change flood levels, with over 1m freeboard for both CC events.

5.1.2 Access and Egress

The site and associated access roads are not at risk of flooding in the 1% AEP event, therefore access to the site is maintained during this event. Access is also maintained in the 1% AEP + 20% climate change (CC) event, which is the design scenario. The site design was also stress tested using the 1% AEP + 30% CC event. A section of the access road into the site is inundated but depths are shallow enough (approx. 50mm) that both domestic and emergency vehicles can still pass through.

In the 0.1% AEP event, the main access to the site is inundated with flood depths up to 350mm. This water depth will still allow emergency access to the site. Residents and visitors can also remain within the site during the 0.1% AEP event, which is at a low risk of flooding, until access and egress via the vehicular entrance is possible, this containment approach would only be necessary under a 0.1% AEP flood event and is in accordance with the Celbridge Local Area Plan 2017 - 2023 (LAP) SFRA.

5.1.3 Surface Water Runoff

The proposed storm water system as designed by Kavanagh Burke is a geocellular underground attenuation tank. There are 3No. proposed attenuation tanks across the site with an overall attenuation volume of 878m³. the tanks will attenuate all storm events of any duration up to 1 in 100year return period +30% CC. It is also proposed to install a hydrobrake to the stormwater outfall to limit the flow to the greenfield runoff rate QBAR = 4.1l/sec, as per criterion 4.3 “River Flood Protection” chapter 6.3 of GDSDS. As the existing site is primarily greenfield, the current run off rate would be equal to the greenfield runoff as calculated above, therefore there will be no increase in the runoff rate from the site as a result of the development. Please refer to the Drainage Design Report for further information on the drainage design.

Flood risk associated with pre-existing surface water overland flow routes from adjacent lands will not be increased as a result of proposed development. Refer to Figure 5-1 for the overland flow routes. Housing estates to the north and west have low points along the existing roads so any surface water within these developments flow onto the existing roads and do not flow into the existing site. Surface water falling on the greenfield to the south would likely flow to the north, towards the site. Surface water runoff will either continue to flow along the local access road to the east, in a northerly direction. Some of the run-off might reach the southwest corner of the site. There is a designated green space in this area which will allow the surface water from the south to continue drain away and will not impact the flow route.

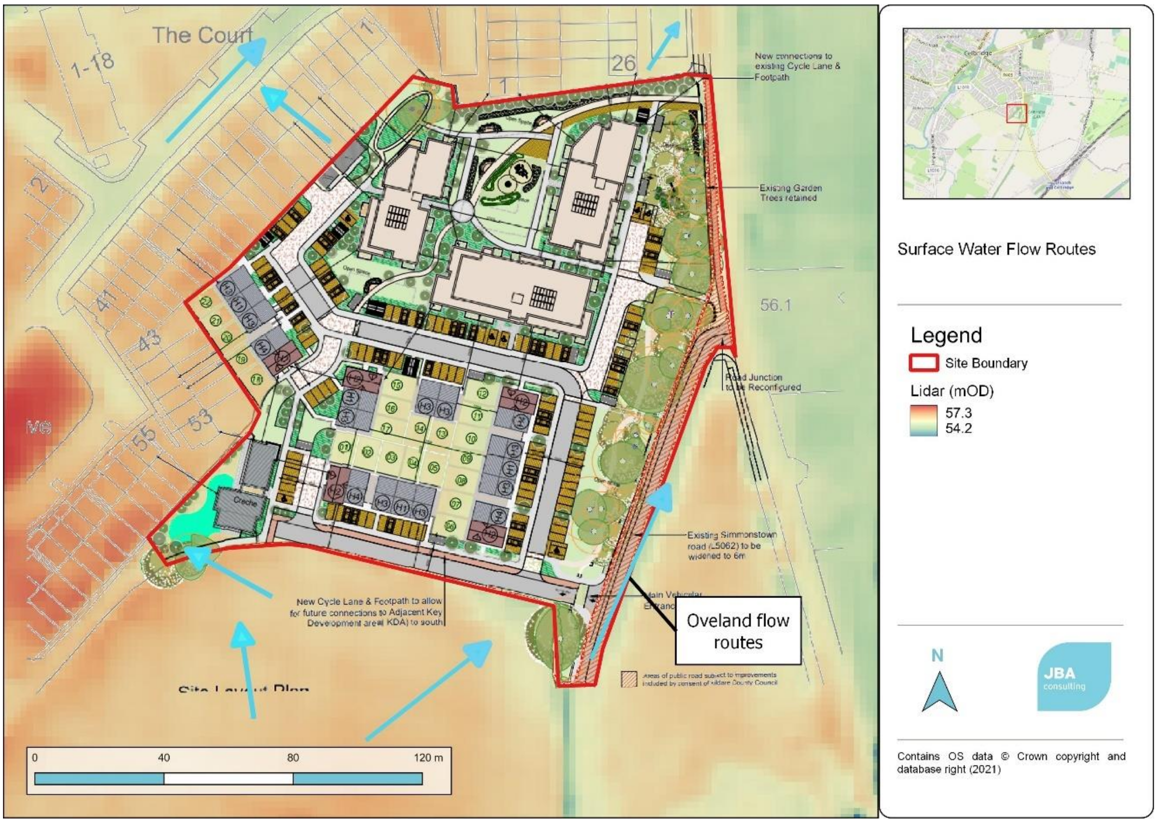


Figure 5-1: Surface Water Flow Routes

5.2 Residual Risk

Residual risks are the risks remaining after all risk avoidance, substitution and mitigation measures have been taken. Two residual risks have been identified and are discussed in detail below.

5.2.1 Drainage system design exceedance or failure events.

In the event of a drainage system design exceedance or failure event, flood waters will be directed towards the low-lying parts of the site. This is the green open space along the eastern and northern section of the site. There is a freeboard of approx. 1.2m between the open space levels and the FFLs of the proposed development. Even if such an exceedance or failure event was to coincide with a 0.1% AEP fluvial flood event, there is over 690mm freeboard between the FFL and the 0.1% AEP flood level, meaning there is a low risk of flooding from any additional surface water flooding.

5.2.2 Impact of future climate change on groundwater flood risk

The impact of future climate change was also assessed and while the exact impact cannot be quantified, the freeboard allowance between the existing ground levels and FFL is sufficient to reduce the risk between rising groundwater levels as a result of climate change. As with the section above, even if the groundwater climate change impacts were to coincide with a 0.1% AEP fluvial flood event, there is over 690mm freeboard between the FFL and the 0.1% AEP flood level, meaning there is a low risk of groundwater impacts as a result of climate change

6 The Justification Test for Development Management

As discussed in Section 4, the site is partially within Flood Zone B and is at risk during the 0.1% AEP event. The development is a high vulnerability development type and so the Justification Test (JT) is required, as indicated in The Planning System and Flood Risk Management, refer to Figure 6-1 below.

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.

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

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Figure 6-1: Matrix of vulnerability verses flood zone to illustrate appropriate development and that required to meet the Justification Test

6.1 Justification Test: Part 1

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

Under the Celbridge Local Area Plan 2017 - 2023 (LAP) and the associated SFRA, the site is zoned 'Existing Residential/Infill'. As stated above it is considered that the proposed development complies with the land use zoning at the site.

Conclusion: It has been outlined that the proposed residential development complies with the Residential land use zoning onsite.

6.2 Justification Test: Part 2

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

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

As part of the FRA, a hydraulic model has been constructed to confirm the existing flood risk to the site. The site is identified as being partially within Flood Zone B. The proposed site layout was then modelled which confirmed the development was not at risk of flooding (though the raising of ground levels within the site). The 1% AEP flood levels and extents remained unchanged and in the 0.1% AEP event the impacts of the proposed design are negligible. A number of properties to the north of the site which are in Flood Zone B are no longer at risk of flooding as a result of the landscaping proposed as part of the development.

Conclusion: A hydraulic model constructed for the site compared the flood risk with and without the proposed development, and it confirms the impact to flood extents as a result of the development is negligible. The flood risk to properties to the north in the 0.1% AEP event has been removed. Therefore, there will be no increase in flood risk resulting from any development within the site and risk to existing development to the north is reduced.

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

The FFL of the development will be located above the 0.1% AEP flood level plus an additional 690mm freeboard. This also places the development above the 1% AEP + MRFS climate change event and the HEFS climate change event.

Conclusion: All developments onsite will be located above the 0.1% AEP flood level with a 690mm freeboard. Therefore, the flood risk to people and property onsite has been minimised.

(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 FFL levels of the proposed developments are placed above the 1% + MRFS and HEFS CC events with sufficient freeboard, therefore they are at a low risk of flooding from future events. Access to the site is not impacted in the 1% and 1% + MRFS event. Third party roads are flooded in the 1% AEP + HEFS event and the 0.1% AEP extreme event, but flood levels are low enough that domestic vehicles can pass in the HEFS event and emergency service vehicles can still access the site in both events.

The residual risk associated with drainage system design exceedance or failure events and also the impacts of future climate change on groundwater flood risk have also both been considered. The freeboard between the 0.1% AEP flood levels is sufficient (690mm) that in the event of either of these residual risks occurring at the same time as the 0.1% AEP, the properties have a lower risk of inundation.

Conclusion: The impacts of climate change have been assessed in the hydraulic model and they were confirmed to be low as the FFL are above the 1% AEP+CC levels. Access is still maintained in the 1% and 1%+MRFS event. Access is maintained for domestic and emergency vehicles in the HEFS event and emergency service vehicles can still access in the 0.1% AEP event. Therefore, residual risks have been accounted for within the design. Impacts as a result of drainage system design exceedance or climate change impacts on groundwater were also considered and are shown to have a low risk due to the freeboard of the properties.

(iv) The development proposed will 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.

To address Part iv of the JT, please refer to supplementary planning report provided as part of the application.

7 Conclusion

JBA Consulting has undertaken a Flood Risk Assessment (FRA) for the proposed residential development on the Hazelhatch Road in Celbridge, Co. Kildare. The site is greenfield with one existing property within the boundary which is to be demolished.

The site is identified as being partially within Flood Zone B in the Hazelhatch Further Study (HFS). In order to assess the impacts of the proposed site layout and implement mitigation measures the site and surrounding area has been re-modelled.

The updated model confirms the site is partially within Flood Zone B from an overland flow route along the local access road from the south. When the proposed site development is represented in the model this overland flow route is maintained but is contained to the main access road to the site and also the green space along the eastern boundary, rather than inundating the site. The impacts as a result of the proposed development are negligible in the wider floodplain. The flood risk to the properties to the north of the site is removed due to the proposed landscaping within the site boundary.

The Justification Test was applied and passed as the hydraulic modelling confirms the impact on surrounding water levels is not significant and the development can manage the risk to itself and surrounding lands.

The proposed minimum floor level for the site places the developments above the 0.1% AEP event plus an additional 690mm freeboard. This level also protects the development from the 1% AEP MRFS and HEFS climate change flood events. The residual risk of drainage system design exceedance or the impacts of future climate change on groundwater flood risk will also be lessened due to the freeboard of the developments.

This report was subject to a peer review carried out by RPS which confirms this FRA was completed and agrees that "the Development Management Justification Test has been passed and the proposed development is complaint with The Guidelines".

The Flood Risk Assessment was undertaken with The Planning System and Flood Risk Assessment Management guidelines and agrees with the core principles contained within.

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

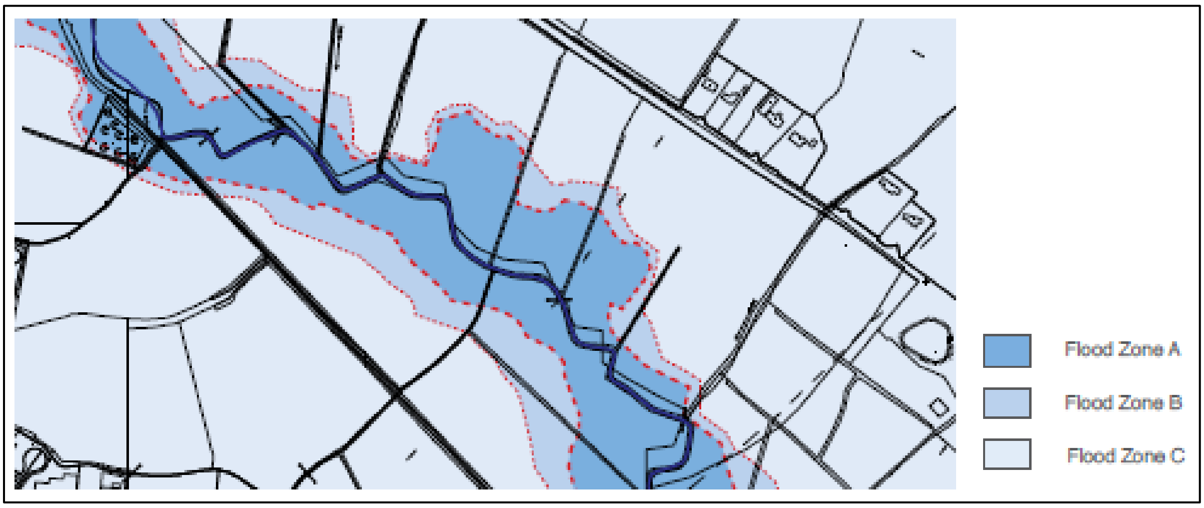
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

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, les 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

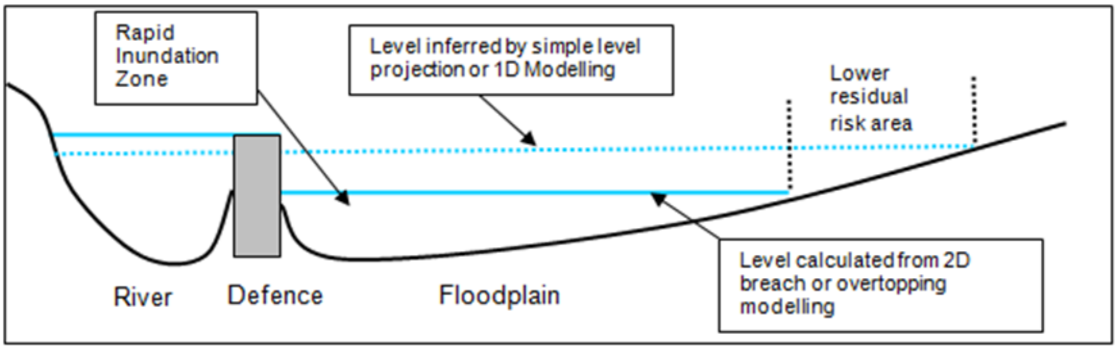
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation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

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

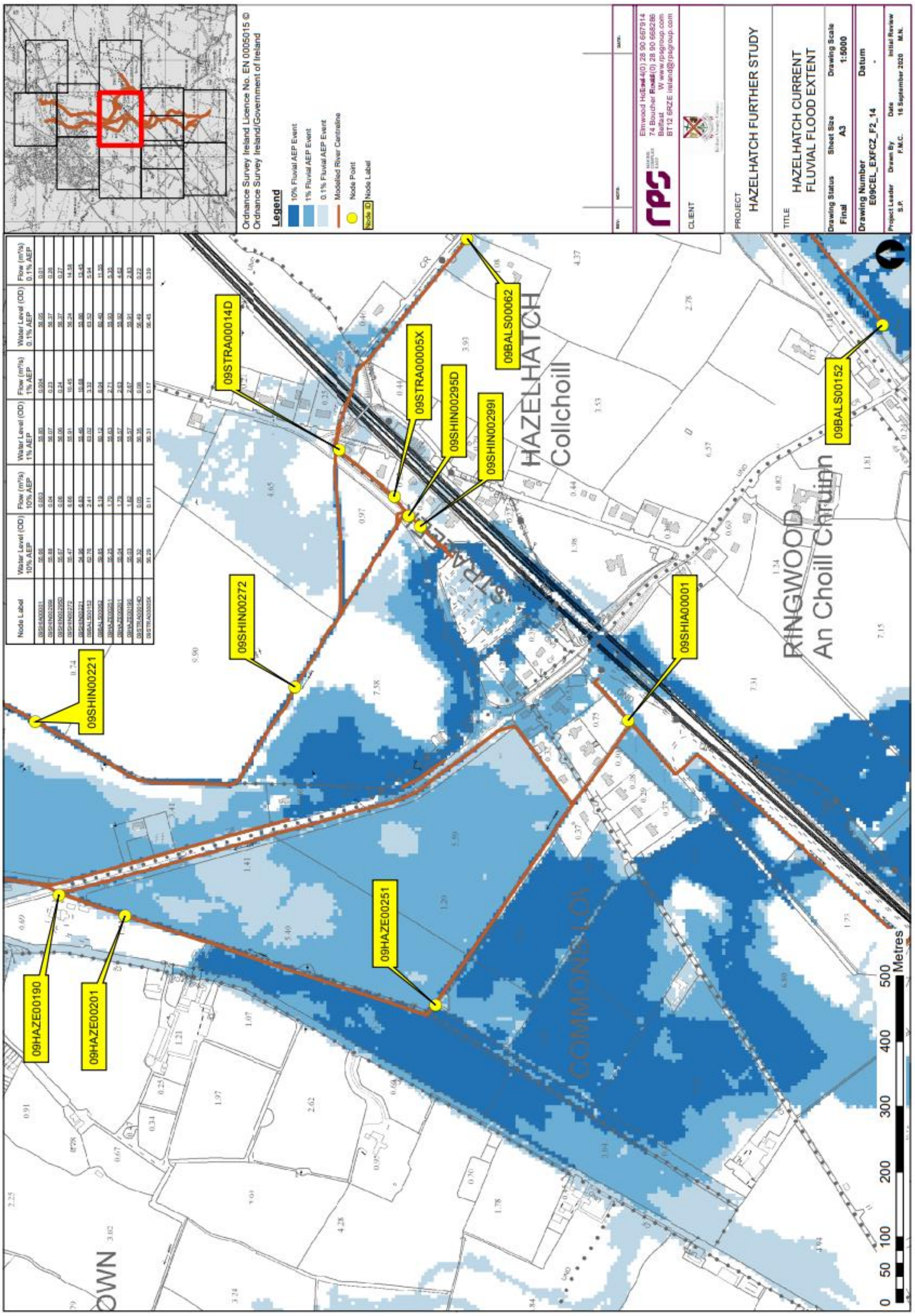
- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities
- **Less vulnerable**, such as retail and commercial and local transport infrastructure, such as changing rooms.
- **Water compatible**, including open space, outdoor recreation and associated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

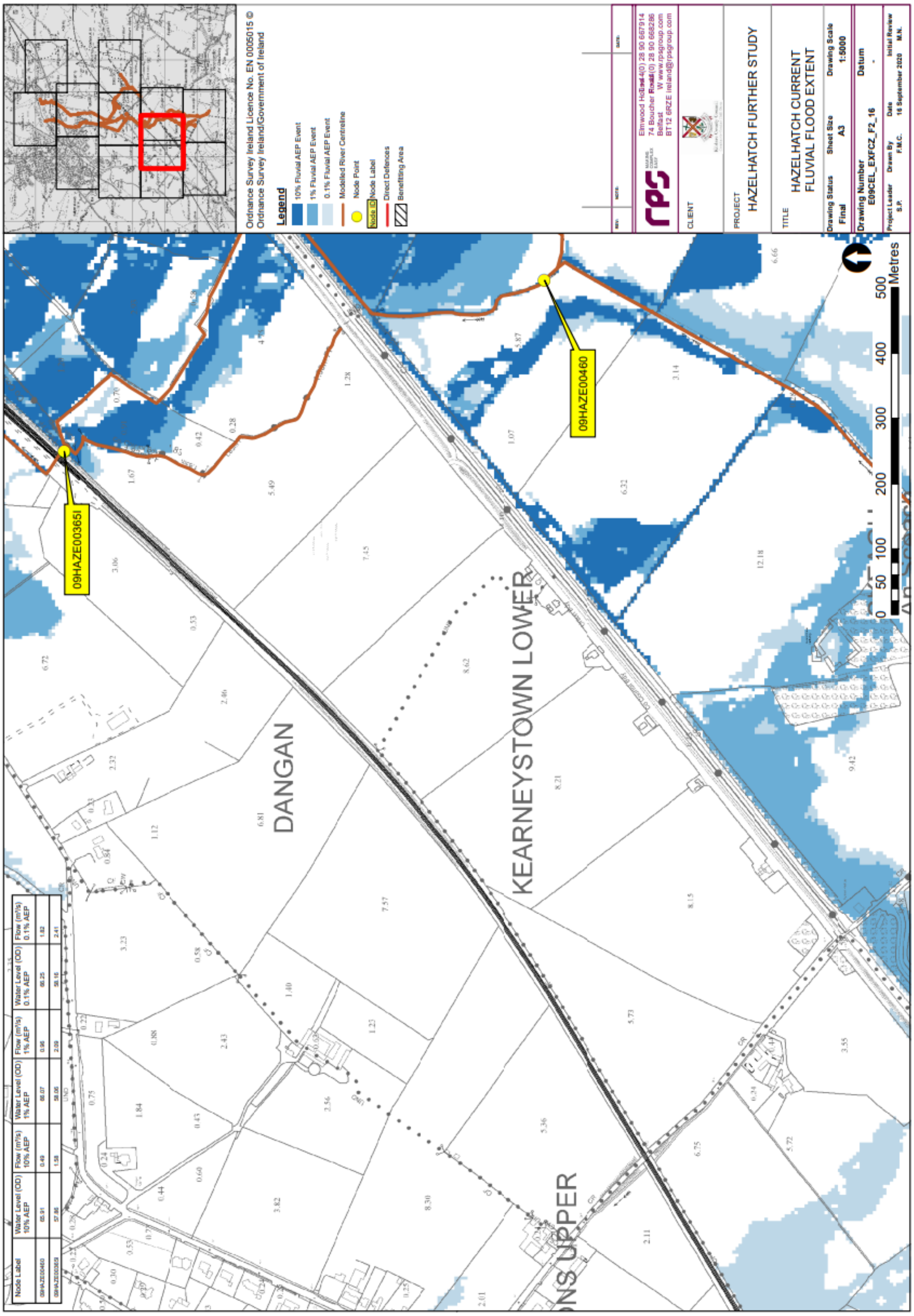
A.4 Residual Risk

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 Hazelhatch Further Study





Node Label | Water Level (OD) 10% AEP | Flow (m³/s) 10% AEP | Water Level (OD) 1% AEP | Flow (m³/s) 1% AEP | Water Level (OD) 0.1% AEP | Flow (m³/s) 0.1% AEP
09HAZE00460 | 65.91 | 0.49 | 66.07 | 0.96 | 66.25 | 1.82
09HAZE00365I | 57.86 | 1.58 | 58.06 | 2.09 | 58.16 | 2.41
09HAZE00365I
09HAZE00460
DANGAN
KEARNEYSTOWN LOWER
NS UPPER
0 50 100 200 300 400 500 Metres
Ordnance Survey Ireland Licence No. EN 0005015 ©
Ordnance Survey Ireland/Government of Ireland
Legend
10% Fluvial AEP Event
1% Fluvial AEP Event
0.1% Fluvial AEP Event
Modelled River Centreline
Node Point
Node ID Node Label
Direct Defences
Benefitting Area
BT12 6RZE ireland@rpsgroup.com
CLIENT
PROJECT
HAZELHATCH FURTHER STUDY
TITLE
HAZELHATCH CURRENT
FLUVIAL FLOOD EXTENT
Drawing Status
Final
Sheet Size
A3
Drawing Scale
1:5000
Drawing Number
E09CEL_EXFCZ_F2_16
Datum
-
Project Leader
S.P.
Drawn By
F.M.C.
Date
16 September 2020
Initial Review
M.N.

C Response to Kildare County Council Comments

#	KILDARE CC COMMENTS	JBA COMMENTS
1	Groundwater flood risk (3.4.2) assessment should include results of site investigation, groundwater monitoring and OPW and GSI groundwater flood mapping.	No Site investigation or groundwater monitoring has been carried out on site at this stage. GSI groundwater information classified the groundwater vulnerability to the site as 'Moderate', refer to Section 2.3 and 3.4.2. No OPW GI mapping is available in the Celbridge area.
2	The HFS node flows in Table 4.2 are not the same as the HFS mapping.	The HFS Node 09HAZE00365I shown in Table 4.2 match those shown in the HFS mapping (Appendix B). This is the only HFS Node in this table. 'JBA HEP_001' flows are calculations completed by JBA for the study. The 'Difference' flows are the difference between the JBA HEP and the HFS node.
3	It is recommended that HEFS climate change scenario be used ie +30% (4.2.2).	The HEFS climate change scenario has been modelled and is now included in the study as well as the MRFS climate change scenario. Refer to Section 4.2.2.
4	Overland fluvial flood flows from the adjacent Shinkeen watercourse should be taken into the account in the site specific flood model.	The Shinkeen watercourse has been considered as part of this study. The input from the Shinkeen was shown not to be significant and the JBA model results match well with the HFS model results at each of the nodes. Refer to Section 4.2.1.1.
5	The highest 1%, 1% plus 30%CC and 0.1% flood levels and flow values between HFS and JBA shall be used (Tables 4.4 and 4.5).	Table 4-5 shows the 1% comparison between the two models at each of the relevant nodes. Table 4-6 shows the same for the 0.1% AEP event. The 1% plus 30% CC flood levels and flows were not available for the HFS online. Only the 1% plus 20% CC HFS results are available, so these have been added to Table 4-7.
6	The proposed flood wall construction details along the northern site boundary shall be included.	The site design has been updated, and due to the proposed landscaping, a flood wall is no longer required as flood waters no longer reach the northern boundary. Refer to Section 4.2.3.
7	The proposed development should not increase an existing flood risk or create a new flood risk outside the subject site. 0.1% AEP event flood levels outside the site are increased and this represents an increase in flood risk on the Hazelhatch road and the adjoining land to the south (figure 4.6). Therefore, Development Management Justification Test part 2 i) (SSFRA 6.2) has not been complied with and on-site compensatory storage therefore required.	The site design has been updated and post-development modelling of the site design now confirms there is no increase to existing flood risk and no additional flood risk has been created in any modelled event up to and including the 0.1% AEP event. Refer to Section 4.2.3. The Justification Test has been reapplied and the site design complies with part 2 i) of the test. Refer to Section 6.2.
8	Compliance with GDSDS Regional Drainage Policy no 2 Chapter 6 Stormwater Drainage Design Criterion 3 Site Flooding Level of Service shall be demonstrated.	Refer to engineering reports.

9	The surface water overland flow element of pluvial flood risk shall also be assessed, particularly where pre-existing overland flows into the subject site will be prevented from entering the subject site post-development, thus increasing flood risk or creating a new flood risk elsewhere.	The surface water overland flow element has been assessed and the proposed development is not shown to impact on pre-existing overland flows. Refer to Section 5.1.3 for further discussion on this.
10	The residual flood risks associated with drainage system design exceedance or failure events and the impact of future climate change on groundwater flood risk shall be assessed. DM Justification Test part 2 iii) therefore has not been complied with (SSFRA 6.2).	These residual risks were assessed and confirmed to be low due to the freeboard at the proposed developments. Refer to Section 5.2.

D RPS Peer Review

Our ref: ibe2073_F1

Elmwood House
74 Boucher Road, Belfast
Co. Antrim BT12 6RZ
T +44 2890 667 914

Date: 23 August 2022

Dear Mr Bryant,

HAZELHATCH ROAD, CELBRIDGE FRA – PEER REVIEW

Terms of Reference

RPS were commissioned in August 2022 by JBA Consulting Engineers and Scientists Ltd to undertake an independent peer review of a Flood Risk Assessment (FRA) completed by JBA for Garyaron Homes Ltd in support of a planning application for a residential development on lands at Glencarrig House, Simmonstown, Celbridge, County Kildare. The peer review had been requested by Kildare County Council.

The RPS review will comment on the appropriateness and logic of the work undertaken and compliance with the Planning System and Flood Risk Management Guidelines but the liability for the analysis and mitigation set out in the FRA remains with JBA Consulting.

Scope

The scope of this commission was

- Provide a review of the JBA report and check the flood history and newly available predictive flood information (where available) for the site and local area.
- Review the proposals, hydrology/modelling approach and mitigation set out within the FRA
- Respond directly to the items listed for peer review by the Kildare County Council Water Services Division:
    - Review of the appropriate representation of the Shinkeen stream in the flood model and taking into account the flood protection standard remaining from the 2001 Flood Alleviation Scheme and the Hazelhatch Flood Study.
    - The assessment of increased flood risk posed to adjacent properties and Hazelhatch and Simmonstown roads as a result of the proposed development shall be rigorous
- Provide a Letter Report drawing on the data collected and the subsequent review, summary findings and recommendations in the FRA in accordance with the Planning System and Flood Risk Management Guidelines and Kildare County Council Policy. The Letter Report will provide a recommendation on the robustness of the FRA and will outline the scope of additional assessment needed, if any gaps are identified.

FRA Peer Review

The Planning System and Flood Risk Management Guidelines (The Guidelines) were produced in 2009 by the Department for Environment. Heritage and Local Government and the Department of Finance. The Guidelines set out a Sequential Approach by which the assessment of flood risk must be considered with respect to new development at all stages of the planning process. This peer review will be undertaken in the context of a Site -Specific Flood Risk Assessment in support of a Planning Application as detailed in Figure 1.1 of The Guidelines.

Consideration and Identification of Existing Risk

Review of Flood History

The JBA FRA provides a list of historical flood events that have affected this area of Celbridge. These have been obtained from the RPS Hazelhatch Further Study (HFS) report which was completed on behalf of Kildare County Council in September 2020. This was considered all available historical information relevant to the Celbridge area when this report was produced. As part of this peer review a further check of the OPW floodinfo.ie website was untaken by RPS and a media search of any recent flooding events. No new information was discovered.

Summary - RPS would consider the historical review section of the FRA to be comprehensive.

Review of Flood Sources

The FRA has considered risk of pluvial, fluvial and groundwater flooding and has concluded there is a fluvial risk to the site.

The FRA briefly considers pluvial flood risk suggesting this can be managed as part of the drainage design. This is not a comprehensive assessment of pluvial risk but, given the nature of the catchment which is predominantly flat and rural upstream of the proposed development site and drained by a series of watercourses, it is reasonable to assume that the risk of pluvial flooding is low.

Summary - RPS would agree that pluvial flooding presents a low risk of flooding to the site but surface water from the proposed development needs to managed appropriately by means of suitable attenuation measures.

The groundwater risk is considered moderate which is the correct interpretation of GSI vulnerability classification. There is however no historical evidence of this occurring or GSI mapping of groundwater flooding.

The FRA identifies the main sources of flooding to be the Hazelhatch Stream but fails to mention the Shinkeen stream. The Shinkeen Stream runs approximately parallel to the Hazelhatch Stream but further to the East. The Shinkeen is not the main source of flooding to the site but it has an impact which needs to be considered in the hydrological analysis methodology and hydraulic modelling.

Summary - RPS would agree with the determination within the FRA that fluvial flood risk is the predominate source of flooding.

Determination of Flood Zoning

Survey Information and Model Schematisation

JBA have utilised the cross-section information from the Eastern CFRAM and HFS to construct a new model of the Hazelhatch stream. The upstream extent of the model extends from immediately upstream of the railway line to just downstream of the Willow Avenue Culvert. The LiDAR used is the most up to date for the area and was used in the HFS.

RPS would suggest the chosen downstream boundary is appropriate as the model can capture the hydraulic effect of the Willow Avenue Culvert. The upstream boundary for the HFS extends beyond the Grand Canal and included the culverts beneath the Canal, Railway and Lords Road. These have important hydraulic impacts as each of them restrict the flow of water downstream and hence affect flood levels on the Hazelhatch Stream. Ideally the JBA model could have extended to include the Grand Canal culvert but as the FRA model was only required for a Site Specific FRA, and not a study of the entire catchment, this approach may be adequate providing the hydrological analysis and subsequent modelling produces similar flows and levels at the proposed development site.

The decision to not model the Shinkeen as a 1D watercourse would not be appropriate for the HFS but for a single site flood risk assessment this may suffice. The predominate flow during extreme events is from the

Hazelhatch to the Shinkeen which would further justify this approach providing similar levels and flows are achieved in the JBA model at the proposed development site.

Summary - RPS would have some reservations on the upstream extent of the Hazelhatch Stream within the model as well as the decision not to model the Shinkeen as a 1D channel. That said, for a single site analysis within a Site Specific FRA this approach can be justified providing similar flows and levels are achieved.

Hydrological Analysis

JBA have used a valid approach in the substitution of Catchment Descriptors from the adjacent Shinkeen catchment to derive flood flows for the Hazelhatch stream. Hydrograph shape has been derived by an appropriate method and achieves good correlation with previous events.

JBA provided a diagram within the report indicating the delineated catchment size of the Hazelhatch stream this is consistent if not slightly larger than the catchment delineated by RPS in the HFS. The estimated flows within the JBA report correlate well with the hydrological nodes within the HFS.

The hydrological analysis undertaken has allowed for the Shinkeen catchment by considering the flow of water from the Shinkeen to the Hazelhatch by the addition of a point flow. This is to replicate hydrologically the flow between the Shinkeen and Hazelhatch. The approach of considering the difference in flow between Shinkeen model nodes is a reasonable approach providing the JBA model results at the proposed development site are similar to those from the HFS.

Summary – The Hydrological analysis undertaken by JBA correlates well with the HFS. The representation of flows from the Shinkeen to the Hazelhatch hydrologically is a reasonable approach providing the hydraulic model at the proposed development site derives similar levels and flows to the HFS.

Hydraulic Modelling

JBA have constructed a 1D/2D dynamically linked hydraulic model of the Hazelhatch Stream using a Tuflow – Estry model. This has used Eastern CFRAM and HFS procured cross sections which gives sufficient resolution and accuracy to replicate the hydraulic capacity of the Hazelhatch Stream. RPS would consider this an appropriate model for a Site Specific FRA.

The Shinkeen watercourse has not been modelled in 1D as part of the Site Specific FRA.. The fact that the JBA models provide good correlation with the HFS both in terms of model flows and levels is indicative that the chosen approach to hydrology and modelling is sufficient.

Summary – RPS would consider the approach in model construction has merit in that the analysis is required for a single site to inform a Site-Specific FRA. The provided tables 4-5 to 4-7 in the FRA compare the flows within the HFS and JBA models and there is good correlation. This would be a strong indication that the JBA approach to the modelling of both the Hazelhatch watercourse and Shinkeen Stream is valid.

Production of flood zone mapping

It is a requirement of The Guidelines that a flood zone map is provided to show the 1% and 0.1% AEP outlines. Figure 4-5 in the JBA report indicates that the site lies within the 0.1% AEP flood extent but not the 1% AEP. This would be designated as Flood Zone B. Considering the proposed residential use the FRA has correctly determined that the Development Management Justification Test is required in accordance with Table 3.2 of the Guidelines.

Summary –. The FRA correctly concludes that the proposed development site is located within Flood Zone B. The sequential approach has been correctly followed concluding that the Development Management Justification Test will be required given the residential (highly vulnerable) use in Flood Zone B. These flood zones correlate with the 1% and 0.1% extents produced as part of the HFS.

Mitigation Measures

JBA have designed finished floor levels and checked access and egress for a 0.1% event ensuring a minimum of 690mm freeboard to all properties. This is over and above the 1% + Climate Change requirement stated in

5.16 of The Guidelines and would be considered a high standard of protection. JBA have noted the 350mm depth of flooding on the access road into the development during a 0.1% event. In RPS' opinion this is acceptable, in the context of The Guidelines, for an event of this magnitude, especially as the properties remain well elevated and it is safe for residents to remain in their homes.

Figure 4.8 indicates there is an overall reduction in flood extent in the 0.1% AEP event because of the protection now afforded to the adjacent development, "The Close". This would be considered a major benefit of the proposed development. The Guidelines only require the impact assessment of the 1% + Climate change event so by using the 0.1% event this would be considered a conservative approach.

JBA have also tested the vulnerability of the development for the 1% + 30% Climate Change event and have proven that the proposed development is not at risk and a very small depth of flooding exists on the roads which would not be sufficient to prevent safe access and egress. This is compliant with the standard of protection required in The Guidelines.

The drainage design proposes to attenuate flows to 4.1 l/s via use of a hydrobrake. The attenuation provided ensures no increase in the rate of run off during a 100yr +30% Climate Change storm event. This is a high standard of design above that considered within the Greater Dublin Strategic Drainage Strategy.

Summary – The mitigation measures provided in relation to fluvial and surface water flooding are to a high standard of protection and would be over and above that required in The Guidelines. RPS are satisfied that there is no net increase in fluvial flood risk to the area shown in Figure 4.8, and the reduction of risk to The Close is an added benefit.

Development Management Justification Test

The JBA FRA has applied the Development Management Justification Test to the proposed development and the mitigation measures currently proposed. RPS have not reviewed Part 1 of the Test relating to the zoning of land for the current use nor part 2 (iv) which are matters related to planning designation and good urban design respectively.

In relation to:

- Part 2 (i) the development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk

RPS would agree this statement has been met given Figure 4.8 indicating no increase in risk and a reduction in risk "The Close" development.

- Part 2 (ii) the development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;

RPS would agree the mitigation measures proposed ensure the proposed development has been mitigated to a high standard of protection and therefore meets this criterion.

- Part 2 (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

RPS are satisfied that the high standard of protection (0.1% AEP) is sufficiently conservative, the residual risk is reduced to the overall area and that funding of future FRM measures or emergency services access would be impeded.

Summary – RPS would agree that the proposed development is compliant with Parts 2(i), 2(ii) and 2(iii) of the Development Management Justification Test.

Summary

The JBA FRA has undertaken hydrological analysis and hydraulic modelling which in terms of the output flood levels and extents appear to correlate well with the Hazelhatch Further Study.

The FRA has correctly followed the Sequential Approach in The Guidelines.

The standard of protection against fluvial flooding is based on the 0.1% AEP event. This is a higher standard than that required in The Guidelines (1% AEP + Climate Change) so can be considered conservative.

The storm water design provides a high level of attenuation and ensures no net increase in run off from the application site in the proposed development scenario.

RPS would agree that the Development Management Justification Test has been passed and the proposed development is complaint with The Guidelines.

Yours sincerely,
for RPS Ireland Limited

Andrew Jackson
Director - Flood Risk Management
andrew.jackson@rpsgroup.com
028 9694 9732

Offices at
Dublin
Limerick

Registered Office
24 Grove Island
Corbally
Limerick
Ireland

t: +353 (0) 61 345463
e:info@jbaconsulting.ie

JBA Consulting Engineers and Scientists Limited
Registration number 444752

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ISO 9001:2015
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