Flood Risk Assessment

Cherry Orchard Point – Proposed Development at Sites 4 and 5, Park West Avenue, Dublin 10

October 2023

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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015 and BS EN ISO 14001: 2015)

Issue	Date	Prepared by	Checked by	Approved by
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Comments

Disclaimer

This report has been prepared by Waterman Moylan, with all reasonable skill, care, and diligence within the terms of the Contract with the Client, incorporation of our General Terms and Condition of Business and taking account of the resources devoted to us by agreement with the Client.

We disclaim any responsibility to the Client and others in respect of any matters outside the scope of the above.

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1. Introduction

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the planning documentation for a proposed development at Sites 4 and 5, Park West Avenue, Dublin 10.

The report has been prepared by Robert Walpole HCEng, B Eng BEng MIEI (B Eng in both Environmental Engineering and Biological and Environmental Engineering) with over 4 years experience working on similar schemes in scale and nature, and checked by Ian Worrell BScEng DipEng CEng DipPhysPlg MIEI, Chartered Engineer and Associate with Waterman Moylan with over 27 years post-graduate experience working on similar projects.

This Flood Risk Assessment has been carried out in accordance with the *DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management* published in November 2009. This assessment identifies the risk of flooding at the site from various sources and sets out possible mitigation measures against the potential risks of flooding. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater, and human/mechanical errors. This report provides an assessment of the subject site for flood risk purposes only.

This report has further been prepared in accordance with, or cognisant of as appropriate, with the following documents:

- Ordnance Survey Mapping
- Dublin City Council Development Plan (2022-2028).
- Park West & Cherry Orchard LAP.
- Ground investigation details as per the Site Investigation Report.
- Site Specific Topographic Survey.
- Archer Heritage & Planning: Archaeological Testing Report.
- Building Regulations Technical Guidance Document Part H.
- Dublin City Council's SuDS Design and Evaluation Guide.
- Dublin City Council's Green and Blue Roof Guide.
- The SuDS Manual.
- Greater Dublin Strategic Drainage Study.
- Green Roofs Over Dublin: A Green Roof Policy Guidance Paper for Dublin.
- Greater Dublin Regional Code of Practice for Drainage Works.
- OPW Guidelines.
- OPW flood maps.
- Department of Environment Flooding Guidelines.
- Geological Survey of Ireland maps.
- Dublin City Council's Climate Action Plan 2019-2024.

- Strategic Flood Risk Assessment Guidelines.
- OPW Vulnerability Classifications Guidelines.
- OPW National Flood Hazard Maps.
- Dublin City Council's Surface Water Management Plan.

The objective of this site-specific Flood Risk Assessment is to assess all types of flood risk to a development. The assessment investigates potential sources of flood risk and include for the effects of climate change. The assessment examines the impact of the development and the effectiveness of flood mitigation and management procedures proposed. It should also present the residual risks that remain after those measures are put in place. This approach is based on the identification of flood zones for river and coastal flooding. "Flood Zones" are geographical areas used to identify areas at various levels of flood risk. It should be noted that these do not consider the presence of flood defences, as the risks remain of overtopping and breach of the defences.

1.1 Site Location and Description

The subject masterplan development is comprised of 2 No. sites. Site 4 & Site 5 are bisected by Park West Avenue and lie to the west and east of this roadway respectively, as per the blue boundary lines indicated on *Figure 1* overleaf.

The Site Investigation Report undertaken by Ground Investigations Ireland (GII) is included as an appendix to the Preliminary Construction Environmental Management Plan, submitted under a separate cover, determined that Site 4 is combination of Greenfield and Brownfield, with evidence of fill material in the area of the site previously used as a construction compound. Site 5 is predominantly a brownfield site, with fill material found for the same reason.

Site 4 is bound to the west by the M50, to the south by the Dublin-Kildare rail line and the Park West & Cherry Orchard station, and to the east and north by Park West Avenue. Site 5 is bound to the west by Park West Avenue, the northwest by Cedar Brook Way, the northeast and east by Barnville Park, and to the south by the Dublin-Kildare rail line and the residential unit of 62 Barnville Park.

Site 4 is currently access via a secured gate from Park West Avenue. Site 5 is accessed via a similar arrangement from Cedar Brook Way.

The area of the subject application is indicated by the red boundary line, also on *Figure 1* overleaf. A letter of consent has been obtained for the area of public works required.

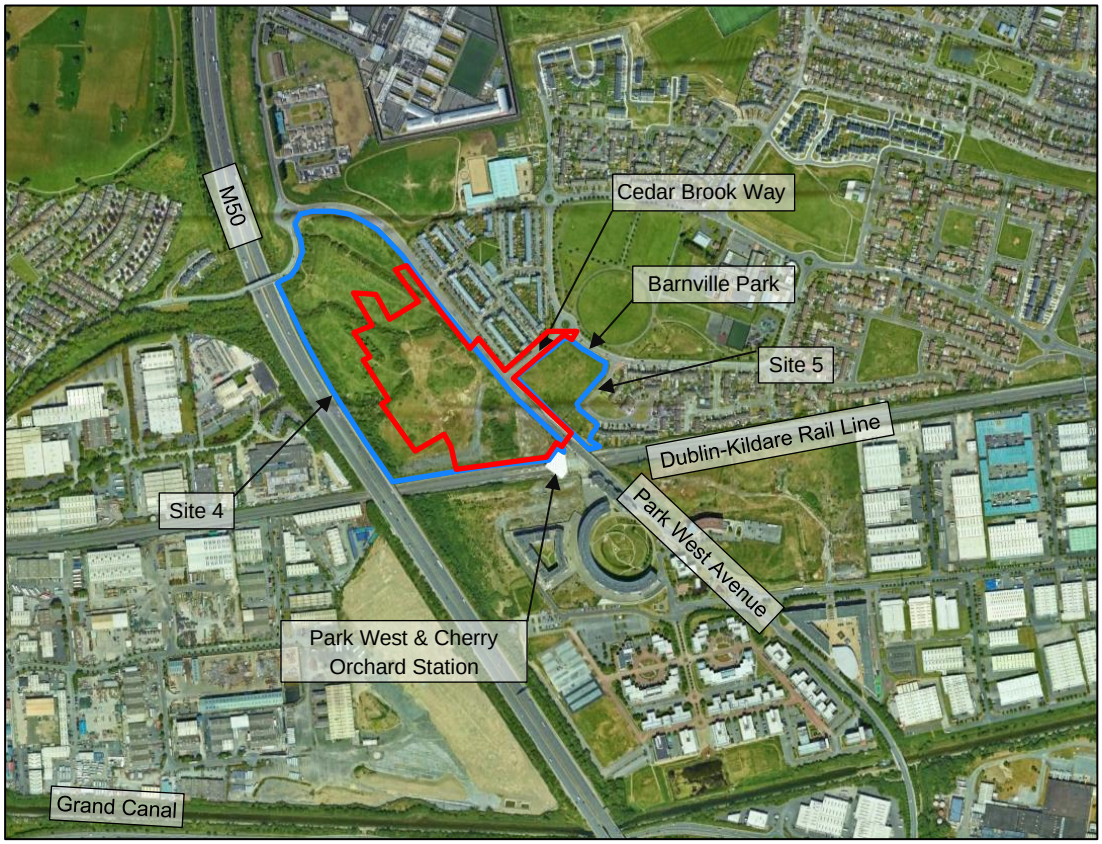

Figure 1 | *Site Location (Source: Google Earth)*

The overall masterplan development area as per the blue line boundaries is c. 13.02ha, with Site 4 being c. 11.41 ha and Site 5 being c. 1.61ha. The area of the subject application indicated by the redline boundary, including for works in the public domain, is 6.16ha (61,648m²).

For Site 4, the topographic survey of the area indicates that the low point of the site has a level of 55.72m OD. This is located on the eastern site boundary approximately 140m north of the junction of Park West Avenue and Cedar Brook Way. The remainder of the site generally slopes to this location owing to the embankments and subsequent site grading from the Dublin-Kildare Rail line to the south, M50 to the west, and approach road to the overpass on the M50 to the north.

Site 5 has a central high point with a level of 58.05m OD, and slopes outwards to all boundaries. The boundaries of Site 5 typically have levels between 54.80m and 56.00m, with the higher of these levels being located to the south of the site, adjacent to the retaining wall of the Park West Avenue Bridge over the rail lines.

Ordnance survey and topographic survey mapping indicates that Site 4 contains static ditches with no outfall. These ditches previously had hydrological connectivity and flow, which has been cut-off by the construction of the M50 to the east and the Cedar Brook housing development to the west, as discussed in Chapter 11 of the EIAR report. These ditches normally remain dry except in heavy rainfall events where water that is not percolated via the site's naturally grassed landscaping, would collect locally in these static ditches for infiltration to the groundwater table. Site 5 does not have any form of surface drainage network

and conveys rainfall directly to the soils via its grassed landscape. There is potential, during heavy rainfall events, that the ground may become saturated and unable to further infiltrate rainfall, which would then run from the surface, over the boundary and to the adjacent road networks to outfall to the storm drainage networks serving these roads. The sites are located in the catchment of the Blackditch stream, a tributary of the Camac River which has an ultimate outfall to the River Liffey at Heuston Station.

The project archaeologist, Archer Heritage Planning Ltd., have identified the ploughed out remains of a Fulacht Fia located centrally on site 4, adjacent to the convergence of 2 No. static ditches on their southern side. The archaeologist has recommended that the remains of the Fulacht Fia be preserved by record prior to further works being undertaken on site.

1.2 Proposed Subject Development

The subject application is for Phase 1 of a 4-phase masterplan development as per *Figure 2* below.

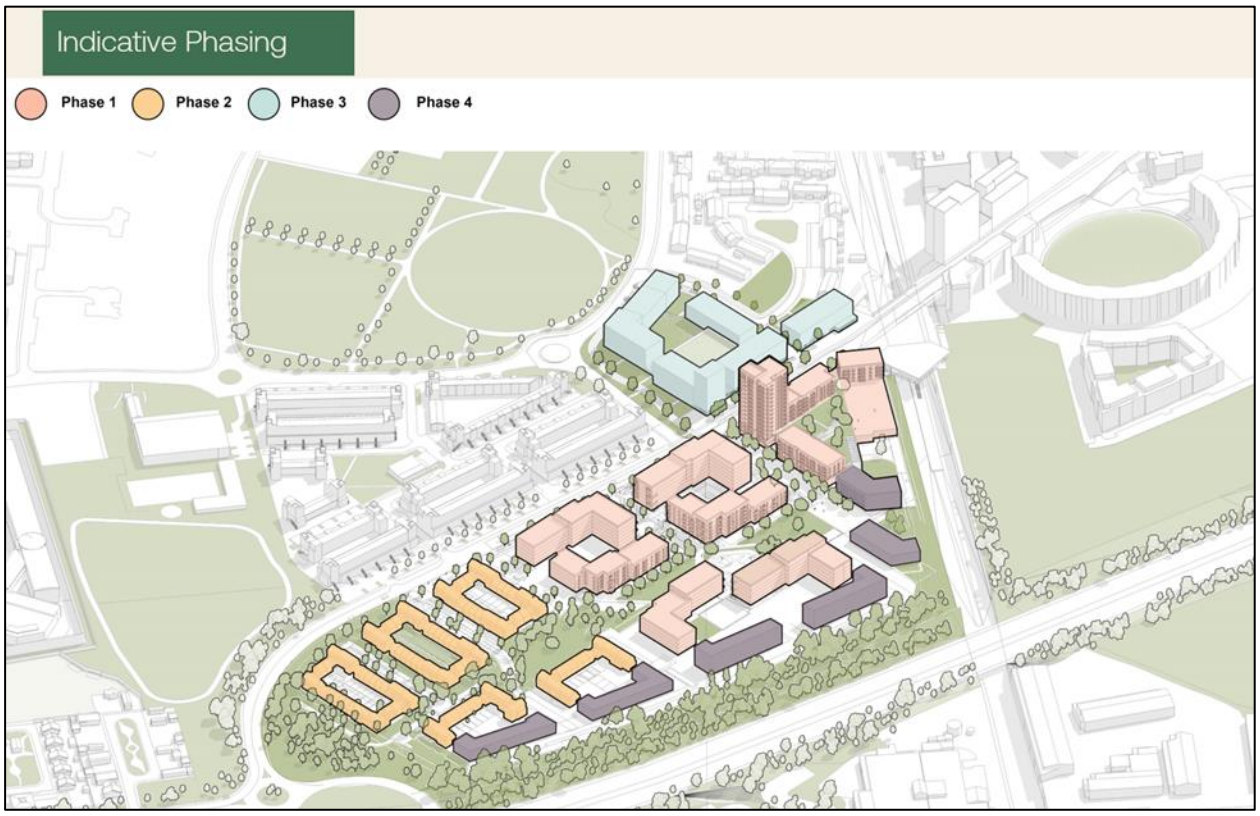

Figure 2 | *Phasing Layout*

Phase 1 is the medium and high-density area and the subject application area, which will provide a total of 708 residential units ranging in size from studio to 3-bed apartments, a 2,523m² supermarket, a combined area of 373m² for retail over 7 units, a 672m² creche and 1,222m² of community spaces over 13 buildings. A breakdown of the schedule of accommodation for the subject application is provided in *Table 1* overleaf.

Block	Studio	1-bed Apt	2-bed Apt	3-bed Apt	Total	Total Area
1	-	13	-	11	24	-
2A	-	8	14	5	27	-
2B	1	43	66	-	110	-
3	-	12	23	-	35	-
5A	10	16	28	-	54	-
5B	-	10	14	5	29	-
6A	-	20	32	6	58	-
6B	-	8	12	4	24	-
7A	6	35	40	-	81	-
7B	-	5	25	-	30	-
8A	6	17	34	6	63	-
8B	5	13	10	5	33	-
9A	-	29	13	5	47	-
9B	-	8	10	4	22	-
10A	-	16	22	4	42	-
10B	-	10	14	5	29	-
Supermarket					1	2,523m²
Retail					7	373m²
Community					13	1,222m²
Creche					1	672m²

Table 1 | *Phase 1 Schedule of Accommodation*

The development includes all associated site works, undergrounding of overhead lines, boundary treatments, drainage, and service connections.

1.3 Proposed Masterplan Development

The remainder of phases as per *Figure 2* will be subject to their own planning permission applications, however their preliminary details are outlined below so that the subject development may be assessed as part of the full masterplan development in its full context. It should be noted that the trunk foul and surface water drainage, including attenuation storage, to serve phases 2, 3, & 4 are part-provided under the subject application for Phase 1.

Phase 2: This is the low-density housing area located to the north of Site 4 and contains 153 residential units comprising 100 apartment/duplex units and 53 houses.

Phase 3: This will be the development of Site 5, and comprises 254 residential units, 1,200m² of retail space, with community facilities to be confirmed.

Phase 4: This will be the construction of commercial office space over 6 blocks with a total area of c. 16,310m².

1.4 Background to the Report

This Flood Risk Assessment report follows the guidelines set out in the *DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management* published in November 2009.

The components to be considered in the identification and assessment of flood risk are as per Table A1 of the above guidelines:

- Tidal – flooding from high sea levels
- Fluvial – flooding from water courses
- Pluvial – flooding from rainfall / surface water
- Groundwater – flooding from springs / raised groundwater
- Human/mechanical error – flooding due to human or mechanical error

Each component will be investigated from a Source, Pathway, and Receptor perspective, followed by an assessment of the likelihood of a flood occurring and the possible consequences.

1.4.1 Assessing Likelihood

The likelihood of flooding falls into three categories of low, moderate, and high, which are described in the OPW Guidelines as follows:

Flood Risk Components	Likelihood: % chance of occurring in a year		
	Low	***Moderate***	***High***
Tidal	*Probability < 0.1%*	*0.5% > Probability > 0.1%*	*Probability > 0.5%*
Fluvial	*Probability < 0.1%*	*1% > Probability > 0.1%*	*Probability > 1%*
Pluvial	*Probability < 0.1%*	*1% > Probability > 0.1%*	*Probability > 1%*

Table 2 | *From Table A1 of "DEHLG/OPW Guidelines on the Planning Process and Flood Management"*

The risks associated with flooding are categorized in Zones based on the likelihood of flooding occurring, namely:

Zone A – High Probability of Flooding. Where the average probability of flooding from rivers and sea is highest (greater than 1% annually or 1 in 100 for river flooding or 0.5% annually or 1 in 200 for coastal flooding).

Zone B – Moderate Probability of Flooding. Where the average probability of flooding from rivers and sea is moderate (risk between 0.1% annually or 1 in 1000 years and 1% annually or 1 in 100 years for river flooding, and between 0.1% or 1 in 1000 years and 0.5% annually or 1 in 200 for coastal flooding).

Zone C – Low Probability of Flooding. Where the probability of flooding from rivers and sea is moderate (risk is less than 0.1% annually or 1 in 1000 years for both rivers and coastal flooding).

For groundwater and human/mechanical error, the limits of probability are not defined and therefore professional judgment is used. However, the likelihood of flooding is still categorized as low, moderate, and high for these components.

From consideration of the likelihoods and the possible consequences a risk is evaluated. Should such a risk exist, mitigation measures will be explored, and the residual risks assessed.

1.4.2 Assessing Consequence

There is not a defined method used to quantify a value for the consequences of a flooding event. Therefore, in order to determine a value for the consequences of a flooding event, the elements likely to be adversely affected by such flooding will be assessed, with the likely damage being stated, and professional judgement will be used in order to determine a value for consequences. Consequences will also be categorized as low, moderate, and high.

1.4.3 Assessing Risk

Based on the determined 'likelihood' and 'consequences' values of a flood event, the following 3x3 Risk Matrix will then be referenced to determine the overall risk of a flood event.

		Consequences		
		Low	***Moderate***	***High***
Likelihood	**Low**	*Extremely Low Risk*	*Low Risk*	*Moderate Risk*
	Moderate	*Low Risk*	*Moderate Risk*	*High Risk*
	High	*Moderate Risk*	*High Risk*	*Extremely High Risk*

Table 3 | *3x3 Risk Matrix*

1.4.4 Flood Risk Management

After a risk has been assessed, flood risk management is the next stage. Flood risk management aims to minimize the risks to people, properties and the environment arising from flooding, in Line with Dublin City Council's Climate Action Plan 2019-2024. Design mitigation measures against flooding and for climate change resilience, have been incorporated as Per Dublin City Councill's Strategic Flood Risk Assessment Section 4.3.1. The design of these measures and the general design are discussed in Detail in the Engineering Assessment Report, submitted under a separate cover as part of the planning package, and have been designed and incorporated in accordance with The SUDS Manual, Greater Dublin Strategic Drainage Study, Dublin City Council's Surface Water Management Guidance & Sustainable Drainage Design and Evaluation Guide, & Green and Blue Roof Guide.

1.4.5 Residual Risk

The residual risk is the risk which remains after all risk avoidance, substitution, and mitigation measures have been implemented.

1.5 Executive Summary

The site and surrounding lands have been assessed for the risk of flooding from tidal, pluvial, fluvial, groundwater, and mechanical sources. As detailed in the following chapters, the site and surrounding areas have determined as being located in Flood Zone C, as per the OPW'S Vulnerability Classifications. Zone C is and area at "low probability of flooding". Thus, the justification test (as required in the 2009 guidelines and SFRA DCC Development Plan) does not need to be applied.

Zone C is defined as: "low probability of flooding where the probability of flooding from rivers and sea is moderate (risk is less than 0.1% annually or 1 in 1,000 years for both river and coastal flooding).

The nearest location at risk of flooding as identified in the below flood maps as extracted to the following chapters is approx. 1.5km away from the site to the south. The site is c. 5m higher topographically than these areas at risk of flooding. Thus, the site as considered separated sufficiently, both in distance and height, from these identified flood zones.

The following Chapters have also identified potential flood risks from the various sources, incorporated mitigation measures to the design and assessed the residual risk as low to negligible in all cases.

2. Tidal

2.1 Source

Tidal flooding occurs when normally dry, low-lying land is flooded by seawater. The extent of tidal flooding is a function of the elevation inland flood waters penetrate, which is controlled by the topography of the coastal land exposed to flooding.

2.2 Pathway

The site is approximately 13.1km southwest of the nearest coastline at Dublin Bay. The Dublin Coastal Protection Project indicated that the 2002 high tide event reached 2.95m OD Malin. The lowest proposed finished floor level at the development is to be constructed at 56.00m OD Malin, well above the historic high tide event.

The Office of Public Works provides flood mapping on their website floodinfo.ie. An extract of the tidal flood mapping is shown below in *Figure 3* below. The map extract indicates that the nearest extent of tidal flooding is located at Islandbridge on the River Liffey, c. 4.7km from the subject site.

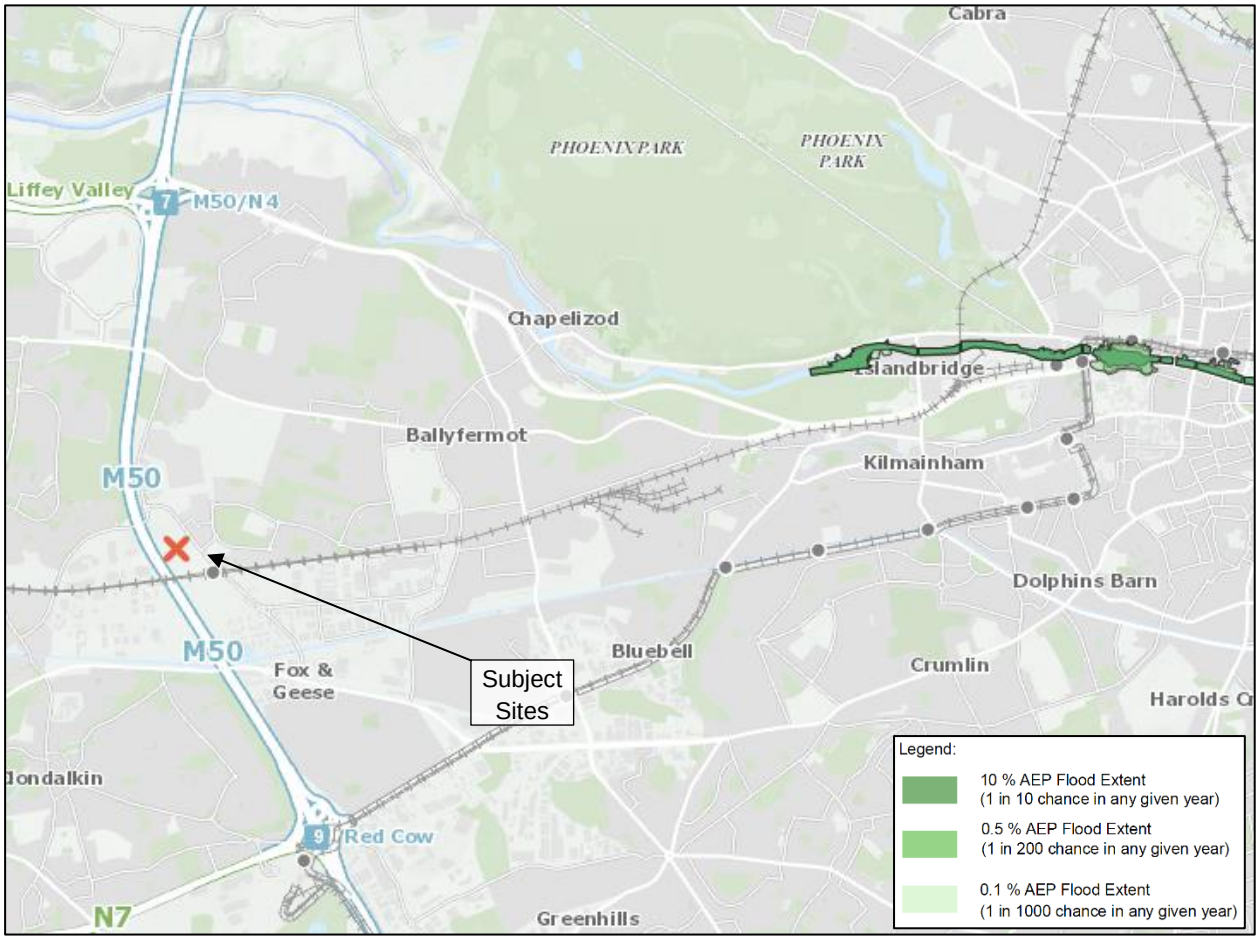

Figure 3 *| Extract from Tidal Flood Extent Mapping (Source: floodinfo.ie)*

High probability flood events, as shown in the above map, are defined as having approximately a 1-in-10 chance of occurring or being exceeded in any given year (10% Annual Exceedance Probability), medium probability flood events are defined as having an AEP of 0.5% (1-in-200 year storm), while low probability events are defined having an AEP of 0.1% (1-in-1,000 year storm). The map indicates that the subject development is not at risk of flooding for the 1 in 1,000-year event.

Given that the site is located 13.1 kilometres inland from the Irish Sea, 4.7 kilometres from the nearest location at risk of tidal flooding, and that there is at least a 53.05m level difference between the lowest proposed building floor level (56.00m) and the record high tide event and given that the site is outside of the 1-in-1,000 year flood plain, it is evident that a pathway does not exist between the source and the receptor. The risk from tidal flooding is therefore extremely low and no flood mitigation measures need to be implemented.

3. Fluvial

3.1 Source

Fluvial flooding occurs when a water course / river's flow exceeds its capacity, typically following excessive rainfall, though it can also result from other causes such as heavy snow melt and ice jams.

3.2 Pathway

The subject site is located within the Blackditch Stream catchment. The Blackditch stream is a tributary of the Camac River which outfalls to the River Liffey at Heuston Station. There are no direct hydrological links (surface water drainage systems or natural watercourses) between the subject sites and the Blackditch stream. The is potential for indirect hydrological connectivity whereby during heavy rainfall events, surface water runs overground to the surface water gullies in the adjacent road networks.

Similar to the tidal map discussed in the previous section, *Figure 4* below, shows an extract of the extent of potential fluvial flooding in the vicinity of the site. This extract indicated that the site is not at risk of flooding for even the 1 in 1,000 year flood event.

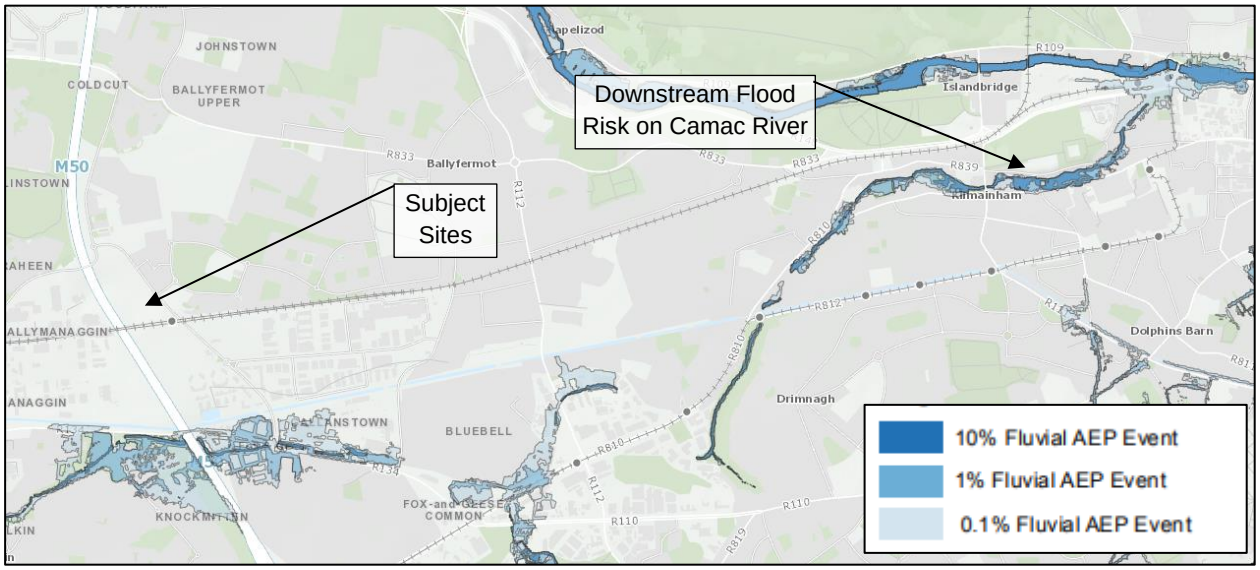

Figure 4 | *Extract from Fluvial Flood Extent Mapping (Source: floodinfo.ie)*

Figure 4 above, indicates the potential for pluvial flooding to the south of the site across the grand canal on the Camac River. A closer study of the fluvial flood map ref: e09cam_exfcd_f1_17, an extract of which is included as *Figure 5* below, as downloaded from the OPW website, shows the relevant node points along the flood route of the Camac River. The nearest node point to the site is 09CAMM007501. The tabulated data for this node point informs that the water level of the 0.1% AEP (1 in 1,000 year storm), will be 51.08m OD. This is 4.92m below the lowest existing ground level of 56.00m OD on site.

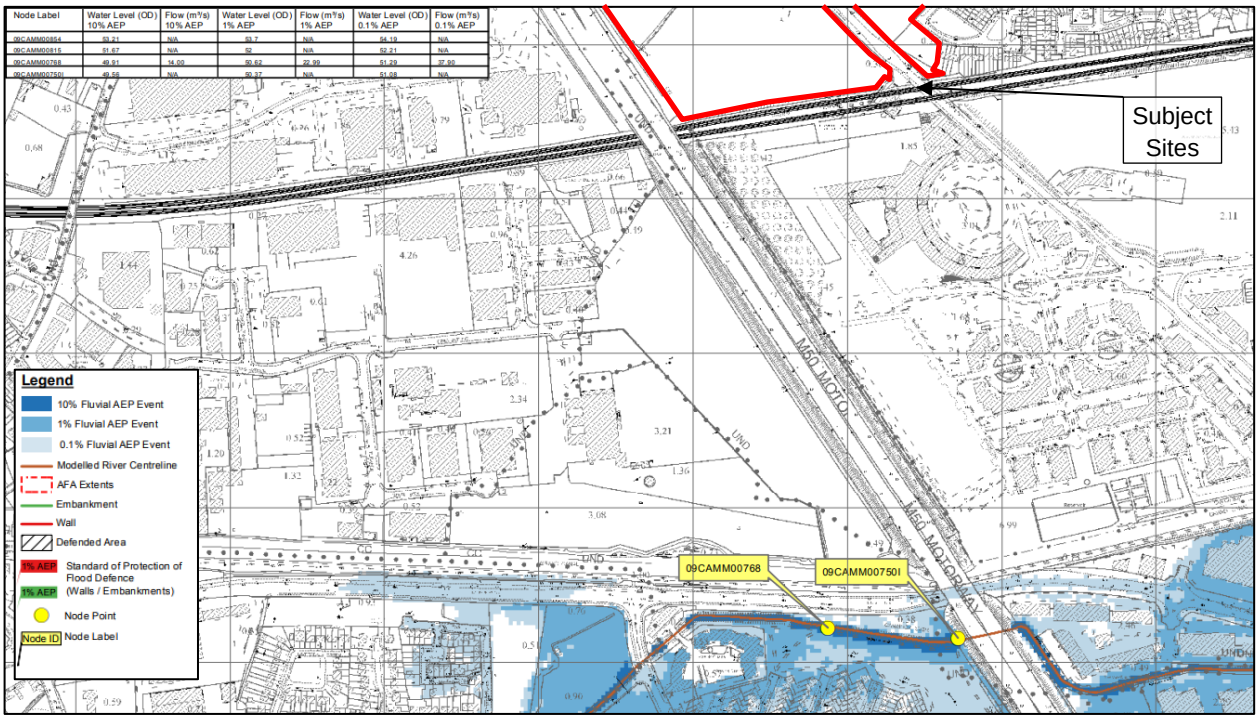

Figure 5 | *Extract from Flood Map: e09cam_exfcd_f1_17*

The OPW website further provides details of historic flood events. *Figure 6* overleaf, shows an extract of the historic flood events map for the vicinity of the site. Recorded flood events in the vicinity of the site are in the location of the identified flood plains on the Camac River, south of the Grand Canal as noted earlier.

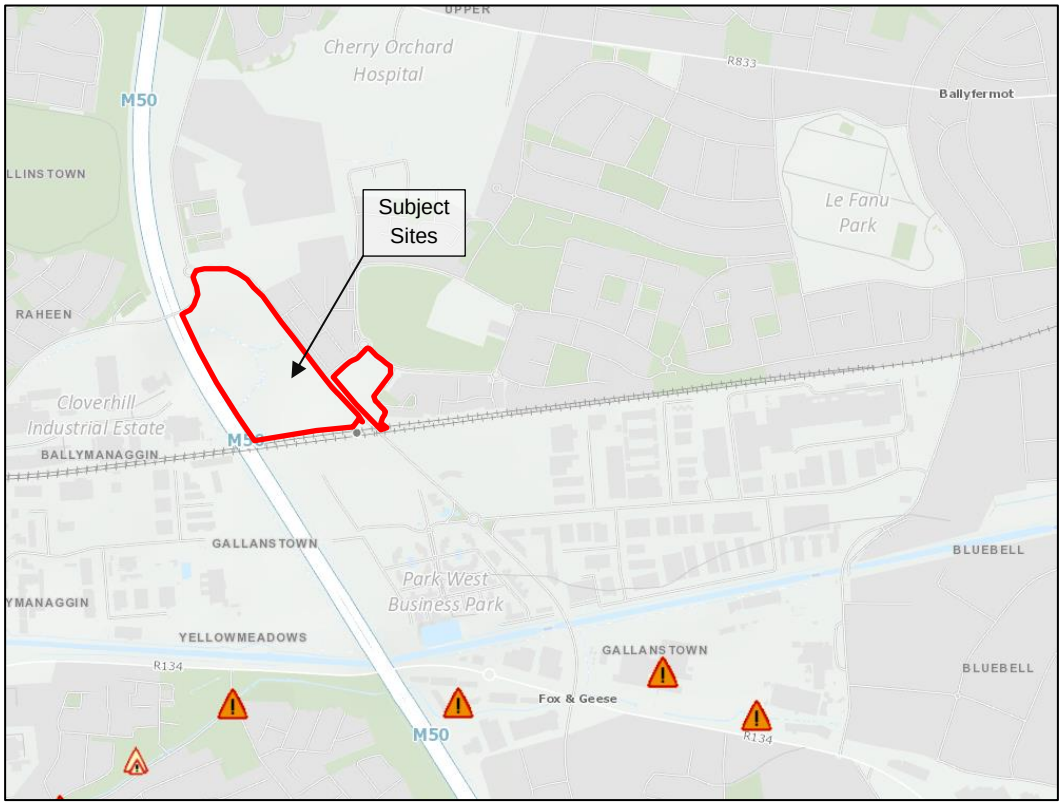

***Figure 6** | Extract from historic flood event map (Source: floodinfo.ie)*

3.3 Likelihood

Given that the site is outside of the 1-in-1,000 year flood plain the likelihood of fluvial flooding is extremely low.

3.4 Consequence

The consequence of fluvial flooding would be some minor damage to open spaces. Therefore, the consequences of fluvial flooding occurring at the proposed development is considered low.

3.5 Risk

There is an extremely low risk of fluvial flooding as the likelihood is extremely low and the consequence is extremely low.

3.6 Flood Risk Management

The finished floor levels throughout the development have generally been set at least 300mm above the level of the adjacent road channel line.

Should fluvial flooding occur, surface water can flow overland towards the attenuation areas and ditch networks via open spaces as shown in the figure overleaf. This figure is extracted from Drawing Number: 22-010-P220 which is submitted as part of the planning package.

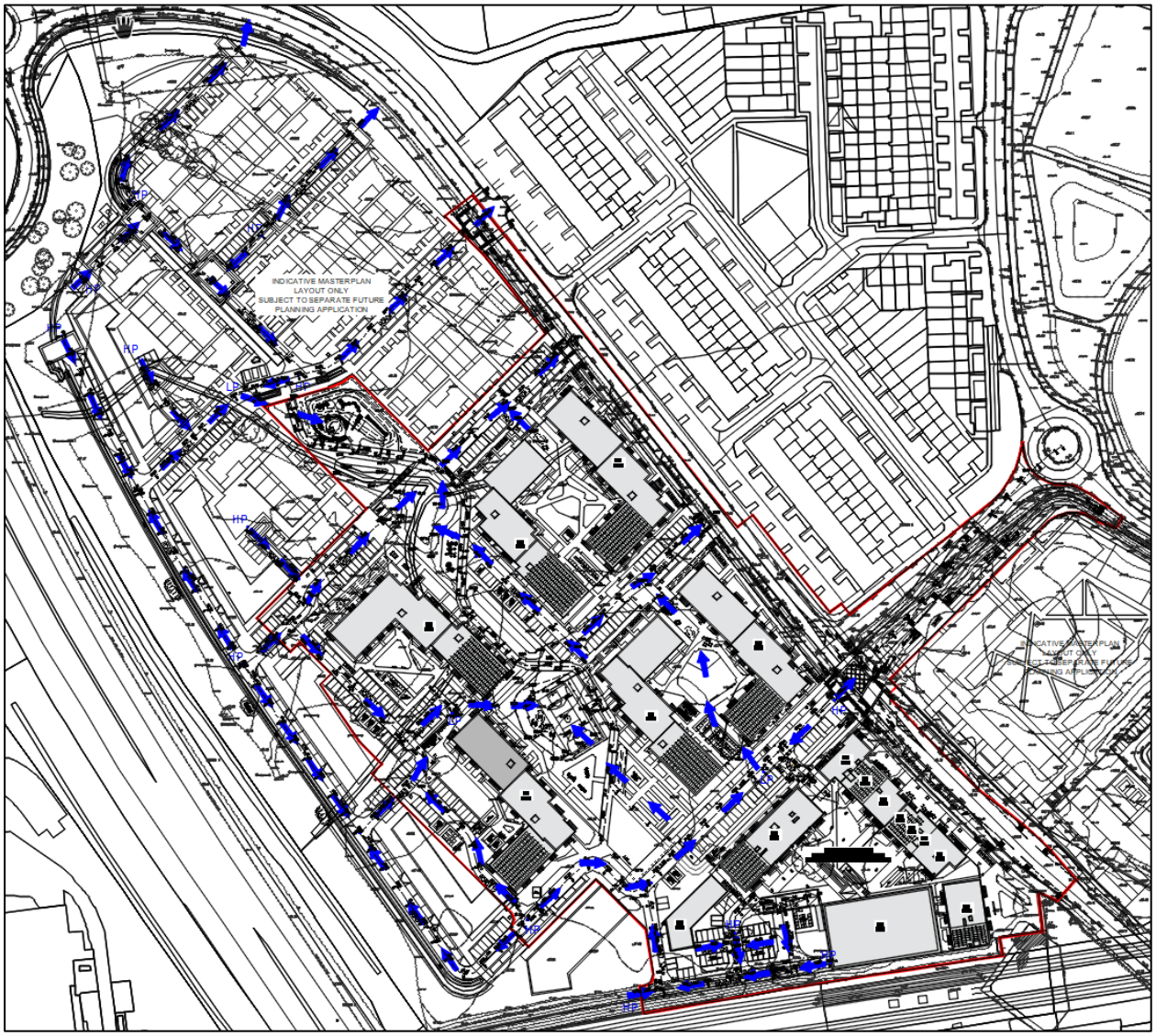

Figure 7 | *Overland Flood Route*

3.7 Residual Risk

The residual risk of fluvial flooding is considered extremely low.

4. Pluvial

4.1 Source

Pluvial flooding occurs when heavy rainfall creates a flood event independent of an overflowing water body. Pluvial flooding can happen in any urban area, including higher elevation areas that lie above coastal and river floodplains.

4.2 Pathway & Receptors

During periods of extreme prolonged rainfall, pluvial flooding may occur through the following pathways:

	Pathway	Receptor
1	Surcharging of the proposed internal drainage systems during heavy rain events leading to internal flooding	Proposed development – properties and roads
2	Surcharging from the existing surrounding drainage system leading to flooding within the subject site by surcharging surface water pipes	Proposed development – properties and roads
3	Surface water discharging from the subject site to the existing drainage network leading to downstream flooding	Downstream properties and roads
4	Overland flooding from surrounding areas flowing onto the subject site	Proposed development – properties and roads
5	Overland flooding from the subject site flowing onto surrounding areas	Downstream properties and roads

Table 4 | *Pathways and Receptors*

4.3 Likelihood

The likelihood of each of the 5 pathway types are addressed individually as follows:

4.3.1 Surcharging of the proposed on-site drainage systems:

The proposed on-site surface water drainage sewers have been designed to accommodate flows from a 5-year return event, which indicates that on average the internal system may surcharge during rainfall events with a return period in excess of five years. Therefore, the likelihood surcharging of the on-site drainage system is considered high.

4.3.2 Surcharging from the existing surrounding drainage system:

The OPW's National Flood Hazard Maps, as discussed in Section 3.2, has been consulted to identify recorded instances of flooding in the vicinity of the site. The nearest recorded flood events occurred on the Camac River on the south side of the Grand Canal, approximately 0.38km south and approximately 5m below the existing ground level of the site, with no recorded flooding in the immediate vicinity of the site.

With no history of flooding in the area due to surcharging, the likelihood of such flooding occurring is considered low.

4.3.3 Surface water discharge from the subject site:

Due to the increase in hard standing area as a result of the proposed development, there is an increased likelihood of surface water discharge from the site leading to downstream flooding. As discussed in Section 3.2, the Camac River, in an area well downstream of the subject site, is at risk of flooding. As such, the likelihood can be considered high.

4.3.4 Overland flooding from surrounding areas:

As noted in Section 4.3.2, it is considered that there is a low likelihood of flooding from surrounding areas.

4.3.5 Overland flooding from the subject site:

Due to the increase in hard standing area as a result of the proposed development, there is an increased likelihood of overland flooding from the site leading to downstream flooding. As such, the likelihood can be considered moderate.

4.4 Consequence

Surface water flooding would result in damage to roads and landscaped areas and could impact the ground floor levels of buildings. The consequences of pluvial flooding are considered moderate.

4.5 Risk

The risk of each of the 5 pathway types is addressed individually as follows:

4.5.1 Surcharging of the proposed on-site drainage systems:

With a high likelihood and moderate consequence of flooding the site from surcharging the on-site drainage system, the resultant risk is high.

4.5.2 Surcharging from the existing surrounding drainage system:

With a low likelihood and moderate consequence of flooding the site from the existing surface water network, the resultant risk is low.

4.5.3 Surface water discharge from the subject site:

With a high likelihood and moderate consequence of surface water discharge from the subject site, the resultant risk is high.

4.5.4 Overland flooding from surrounding areas:

With a low likelihood and moderate consequence of overland flooding from the surrounding areas, the resultant risk is low.

4.5.5 Overland flooding from the subject site:

With a moderate likelihood and moderate consequence of overland flooding from the subject site, the resultant risk is moderate.

4.6 Flood Risk Management

The following are flood risk management strategies proposed to minimise the risk of pluvial flooding for each risk:

4.6.1 Surcharging of the proposed on-site drainage systems:

The risk of flooding is minimised with adequate sizing of the on-site surface water network and SuDS devices. Open grassed areas with low level planting and green roofing on apartment blocks and commercial buildings will ensure that these areas act as soft scape and will significantly slow down and reduce the amount of surface water runoff from the site. Permeable paving in private driveways and parking courts and filter drains around the perimeter of the apartment blocks will provide some treatment volume, with underlying perforated pipes connecting to the storm water sewer network.

These proposed source and site control devices will intercept and slow down the rate of runoff from the site to the on-site drainage system, reducing the risk of surcharging.

Furthermore, a hydro-brake for each catchment will limit runoff to the equivalent greenfield rate. Excess storm water from the main catchment is to be attenuated in underground tanks / crate systems with sufficient volume for the 1-in-100 year storm (accounting for a 20% increase due to climate change), to limit the runoff from the site and minimise the discharge rate into receiving waters.

As per DCC requirements the runoff rate is to be limited by design to a maximum of 2 l/s/ha. This is below the current greenfield runoff rate.

Undercroft entrances have been designed in conjunction with the overland flood routing. Surface water flows from the main circulation roads will be prevented from flowing onto the undercroft access roads due to road gradient design. The undercroft access roads themselves, will be served by double gullies and ACO drains as required to prevent the surface water from the access roads entering the undercroft area.

Vents serving the undercroft areas will have their openings located at least 0.5m above flood levels, and also be 0.5m minimum above the top of water levels for the open attenuation areas.

As a result of these proposed measures, the likelihood of surcharging of the proposed on-site drainage systems is low.

4.6.2 Surcharging from the existing surrounding drainage system:

The risk of flooding due to surcharging of the existing surface water network is minimised with overland flood routing (refer to the Overland Flood Routing figures in Section 3.6 above). The risk to the surrounding buildings is mitigated by generally setting finished floor levels at least 300mm above the adjacent road channel line. In areas where an overland flood route to ditches or open space from low points has not been possible, the nearby highpoint of the road crest has been set below the surrounding FFL's, thus ensuring that should any localised flooding occur, that it will be limited to the road surface and that adjacent units will not experience flooding.

4.6.3 Surface water discharge from the subject site:

Surface water discharge from the subject site is intercepted and slowed down through the use of source control devices, as described in Section 4.6.1 above, minimising the risk of pluvial flooding from the subject site. Sufficient attenuation storage is provided for the 1-in-100 year storm, accounting for a 20% increase due to climate change.

4.6.4 Overland flooding from surrounding areas:

The risk from overland flooding from surrounding areas is low. Overland flood routing and raised finished floor levels will provide protection for the proposed buildings, as described in Section 4.6.2 above.

4.6.5 Overland flooding from the subject site:

The risk of overland flooding from the subject site is minimised by providing SuDS features to intercept and slow down the rate of runoff from the site to the existing surface water sewer system, as described in Section 4.6.1 above. Sufficient attenuation is provided for the 1-in-100 year storm, accounting for a 20% increase due to climate change. Thus, even under extreme storm conditions, the surface water can be attenuated without causing flooding downstream. The attenuation volumes have been calculated to account for the maximum permitted flow rate allowed by DCC of 2 l/s/ha, which is lower than the current greenfield runoff rate.

4.7 Residual Risk

As a result of the design measures detailed above in Section 4.6, there is a low residual risk of flooding from each of the surface water risks.

5. Groundwater

5.1 Source

Groundwater flooding occurs when the water table rises above the ground surface. This typically happens during periods with prolonged rainfall which exceeds the natural underground drainage system's capacity.

5.2 Pathway

The pathway for groundwater flooding is from the ground. Note that although groundwater flooding is typically considered to be when the water table rises above the ground surface, underground services, building undercrofts and foundations could also be affected by high water tables that do not reach the ground surface.

5.3 Receptor

The receptors for ground water flooding would be underground services, roads, and the ground floor of buildings.

5.4 Likelihood

Groundwater vulnerability mapping is available online via the Public Data Viewer Series. This is extracted below to *Figure 8* below. This shows that the site lies within an area of high vulnerability. There is no indication of wells or springs on, or in the vicinity of the site, as also advised by the same data maps.

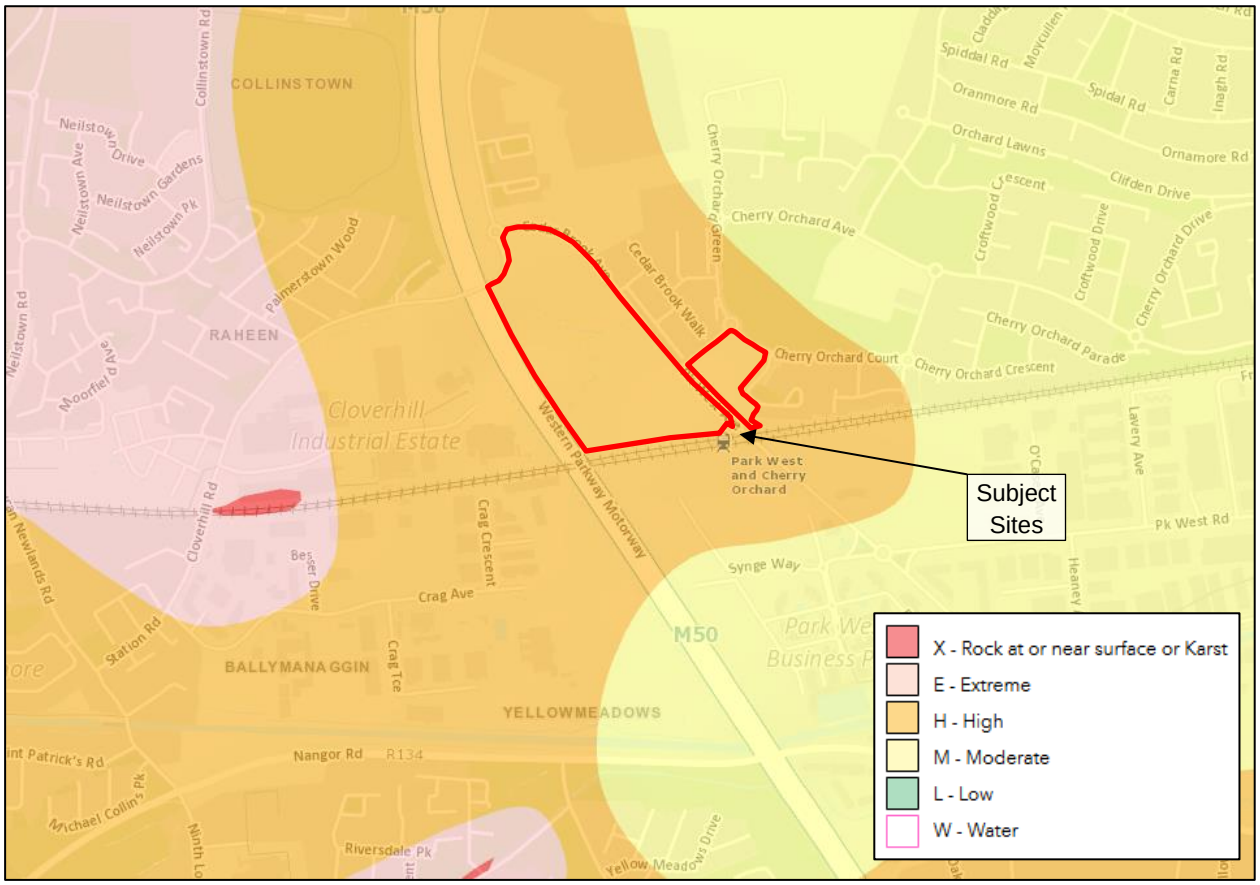

Figure 8 | *Groundwater Vulnerability Map Extract*

5.5 Consequence

The consequence of ground water flooding would be some minor temporary seepage of ground water through the ground around the proposed buildings. Underground services could be inundated from high water tables. Therefore, the consequence of ground water flooding occurring at the proposed development is considered moderate.

5.6 Risk

With a high likelihood and moderate consequences of flooding due to groundwater, the risk is considered high.

5.7 Flood Risk Management

Finished floor levels have been set above the road levels, as described in Section 3.6, to ensure that any seepage of ground water onto the development does not flood into the buildings. In the event of ground water flooding on site, this water can escape from the site via the overland flood routing, also described in Sections 3.6. & 4.6.2.

The buildings' design including undercroft provision, will incorporate suitable damp-proof membranes to protect against damp and water ingress from below ground level.

5.8 Residual Risk

There is a low residual risk of flooding from ground water.

6. Human/Mechanical Errors

6.1 Source

The subject site will be drained by an internal private storm water drainage system, which will discharge to the public surface water infrastructure.

The internal surface water network is a source of possible flooding were it to become blocked.

6.2 Pathway

If the proposed private drainage system blocks this could lead to possible flooding within the private and public areas.

6.3 Receptor

The receptors for flooding due to human/mechanical error would be the ground floor levels of buildings, the roads, and the open landscaped areas around the site.

6.4 Likelihood

There is a high likelihood of flooding on the subject site if the surface water network were to become blocked.

6.5 Consequence

The surface water network would surcharge and overflow through gullies and manhole lids. It is, therefore, considered that the consequences of such flooding are moderate.

6.6 Risk

With a high likelihood and moderate consequence, there is a high risk of surface water flooding should the surface water network block.

6.7 Flood Risk Management

As described in Sections 3.6 & 4.6.2, finished floor levels have been designed to be above the adjacent road network, which will reduce the risk of flooding if the surface water network were to block. In the event of the surface water system surcharging, the surface water can still escape from the site by overland flood routing, as also described in Section 3.6, without causing damage to the proposed buildings.

The surface water network (drains, gullies, manholes, AJs, attenuation system) will need to be regularly maintained and where required cleaned out. Monitoring should be carried out of the water levels in the attenuation basins and tanks at times of extreme rainfall events. A suitable maintenance regime of inspection and cleaning should be incorporated into the safety file/maintenance manual for the development. The SuDS maintenance regime is discussed in the Surface Water Management Plan, submitted under a separate cover.

6.8 Residual Risk

As a result of the flood risk management outlined above, there is a low residual risk of overland flooding from human / mechanical error.

7. Conclusions and Recommendations

The subject lands have been analysed for risks from tidal flooding from the Irish Sea, fluvial and pluvial flooding, ground water, and failures of mechanical systems. *Table 5*, below, presents the various residual flood risks involved.

Source	Pathway	Receptor	Likelihood	Consequence	Risk	Mitigation Measure	Residual Risk
Tidal	*Irish Sea (River Liffey)*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Negligible
Fluvial	*Blackditch Stream & River Camac*	*Proposed development*	*Low*	*Low*	*Extremely Low*	*Setting of floor levels, overland flood routing*	Extremely Low
Pluvial	*Private & Public Drainage Network*	*Proposed development, downstream properties, and roads*	*Ranges from high to low*	*Moderate*	*Ranges from high to low*	*Appropriate drainage, SuDS, and attenuation design, setting of floor levels, overland flood routing*	Low
Ground Water	*Ground*	*Underground services, ground and undercroft level of buildings, roads*	*High*	*Moderate*	*High*	*Appropriate setting of floor levels, flood routing, damp proof membranes*	Low
Human/ Mechanical Error	*Drainage network*	*Proposed development*	*High*	*Moderate*	*High*	*Setting of floor levels, overland flood routing, regular inspection of SW network*	Low

Table 5 | *Summary of the Flood Risks from the Various Components*

As indicated in the above table, the various sources of flooding have been reviewed, and the risk of flooding from each source has been assessed. Where necessary, mitigation measures have been proposed. As a result of the proposed mitigation measures, the residual risk of flooding from any source is low.

UK and Ireland Office Locations