Appendix 12.1

1. Introduction

1.1 Project Background

Arup was commissioned by Google Ireland Limited (GIL) to prepare a site-specific Flood Risk Assessment (FRA) to support a planning application for the proposed data centre development DC3 (hereafter referred to as the "Proposed Development") at the existing GIL Campus in Grange Castle Business Park, Dublin 22.

The aim of the Proposed Development when in operation is to support the IT sector by providing additional cloud storage across GIL's network. The Proposed Development is described in detail in Chapter 4 (Description of the Proposed Development).

The FRA has been undertaken in accordance with the 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' published in November 2009, jointly by the Office of Public Works (OPW) and the Department of Environment, Heritage, and Local Government (DEHLG), referred to as 'The Guidelines'.

1.2 Scope

The scope of the FRA includes the following:

- Review of the availability and adequacy of existing information;
- Confirmation of the sources of flooding which may affect the Proposed Development site (also referred to as the site);
- A qualitative assessment of the risk of flooding to the site and to adjacent sites;
- A quantitative assessment of the risk of flooding to the site and to adjacent sites through hydraulic modelling; and
- Identification of possible measures which could mitigate the risk of flooding to acceptable levels.

1.3 Summary of Data Used

Data relating to flood risk relevant to the Proposed Development and surrounding area has been obtained from the following sources:

- Eastern Catchment Flood Risk Assessment and Management Study (CFRAMS) and predictive flood mapping (https://www.floodinfo.ie/);
- OPW National Flood Hazard Mapping Website (www.floodinfo.ie);
- FSU catchment information from the Flood Studies Update web portal (https://opw.hydronet.com/);
- Geological Survey Ireland Open topographic data;
- Survey of the watercourse within the proposed site boundary, completed by Murphy Geospatial Ltd in February 2024;
- Topographic survey of the site, conducted by Land Surveys Ltd in 2019;
- LiDAR data, obtained from the open topographic data viewer website, maintained by the Department of the Environment, Climate & Communications. Downloaded on 22nd February 2024;
- Site services layout drawing, as prepared by PM Group in Sept 2020, showing as-built information of existing culvert diversion through existing site; and
- Proposed Development Site Layout Plan.

All Ordnance Datum (OD) levels referred to in this report are to Malin Head Ordnance Datum, unless otherwise noted.

1.4 Site Description

The GIL Campus is situated within the Grange Castle Business Park, between the N7 and N4 motorways (ITM: 703356,730251), see Figure 1.1. The Proposed Development will be developed on a 20.44ha greenfield site at the location described above.

The site is bounded by Baldonnel Road to the south and Profile Business Park to the east, with residential properties to the west and south. The surrounding land comprises commercial and industrial properties and agriculture. Grange Castle Golf course is east of the site, and Casement Aerodrome, operated by the Department of Defence, is to the south.

Figure 1.1: Site location. Source: OSM Standard Map.

The subject site and the lands surrounding the site are primarily greenfield and commercial/industrial premises as shown in Figure 1.2 below.

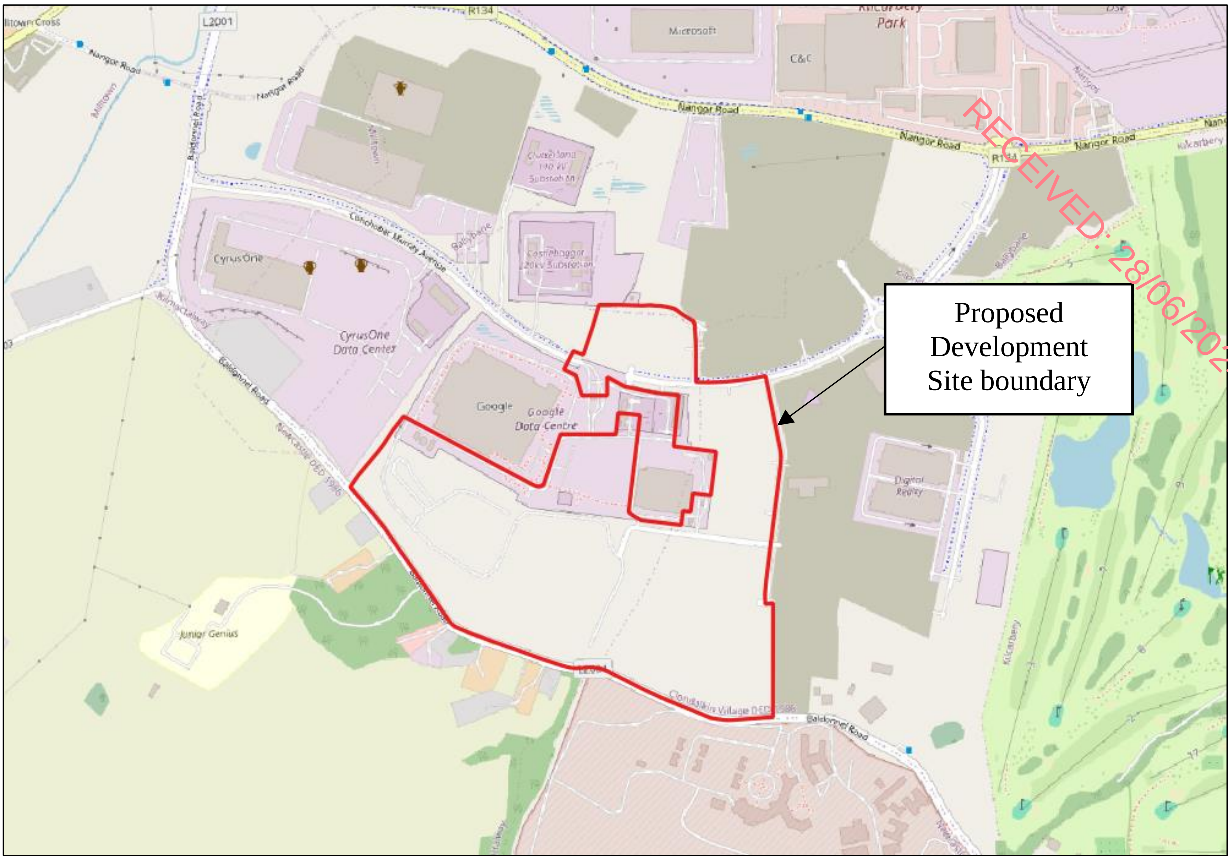

Figure 1.2: Subject site: existing data centre, boundary of the site (red line) and land surrounding the site. Source: OSM Standard Map.

1.5 Watercourse and Structures on the Site

A watercourse crosses the Proposed Development site from south to north. The watercourse is unnamed and does not appear on EPA mapping on the EPA website (https://gis.epa.ie/EPAMaps/). It joins Baldonnell Stream (waterbody code IE_EA_09L012100) downstream of the site boundary, which then discharges to Griffeen River.

The Proposed Development site boundary and the watercourse that crosses the site are shown in Figure 1.3.

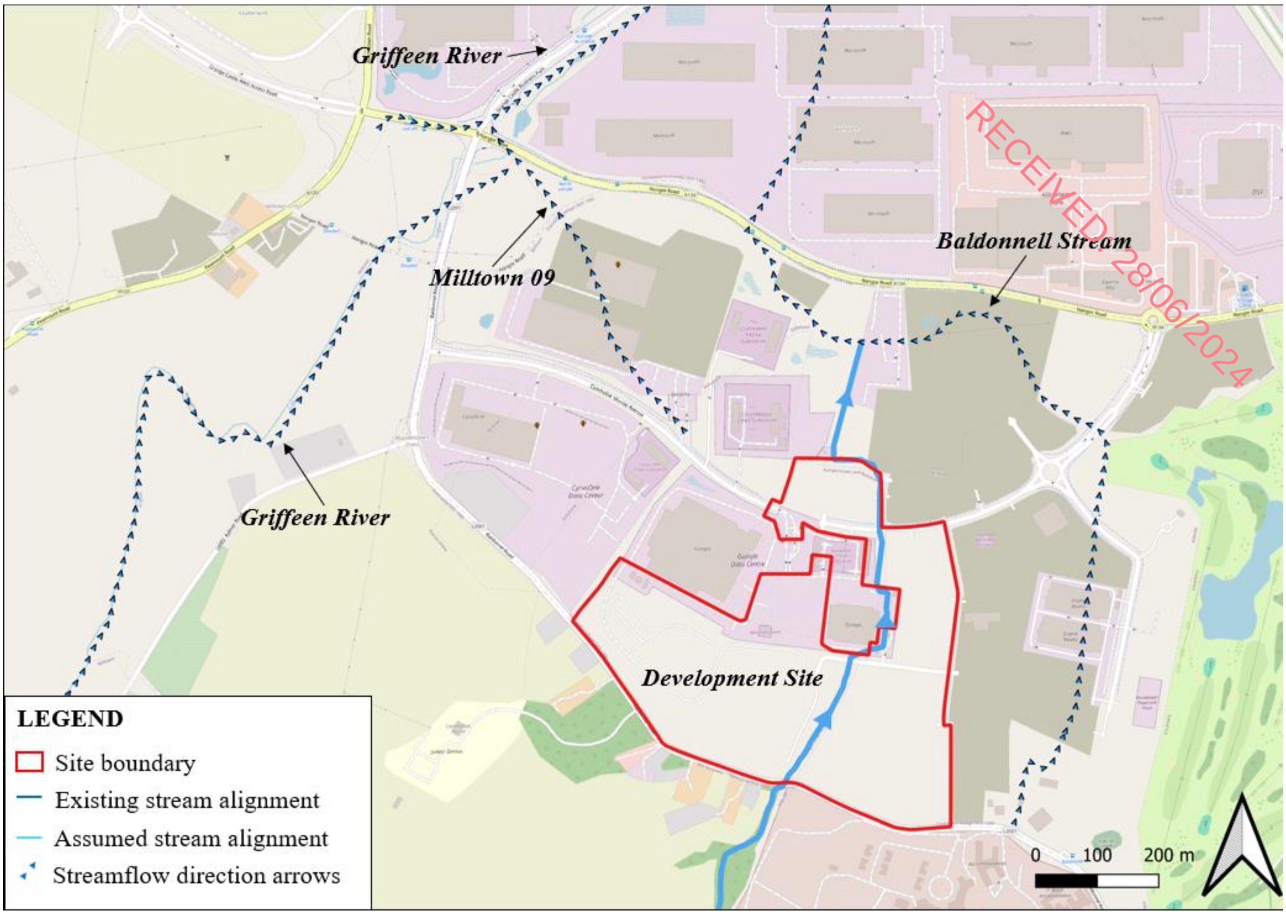

Figure 1.3: Watercourses at and around the site. Source: EPA maps

There are a number of culverts on this watercourse, as shown in Figure 1.4. The existing watercourse enters the site from the south under Baldonnel Road (Culvert 1) and flows through the site for 187m, separated by a 16m culvert (Culvert 2). It is then culverted again under the existing buildings in the northern part of the site for 382m (Culvert 3). The watercourse becomes an open stream again after exiting the site boundary.

Culvert 1 is 16m in length and is located directly upstream of the site beneath Baldonnel Road. It takes the form of an irregular arch with a 1.35m width and 0.74m height. The outlet of the culvert within the site is showing signs of degradation, with a metal barrel and large stone holding the outlet open.

Culvert 2 is located 47m downstream from the first culvert. It is circular, 600mm in diameter, and it is 15m long. The top of the culvert is overgrown with woodland scrub.

Culvert 3 is located 140m downstream of Culvert 2. It is a circular culvert with a 600mm diameter inlet. 7m downstream of the inlet the size of the culvert increases to 1000mm diameter, and changes between 1000mm and 1050mm throughout the rest of its length. The slope of the 600mm diameter culvert section is steeper than 1:10, while the rest of the culvert has a gentle slope of 1:400. The overall length of Culvert 3 is 382m. The outfall of Culvert 3 is located at the northern part of the red line boundary under Profile Park Road. The culvert pipe size at the outlet is 1000mm diameter.

The open stream section through the site has an approximate width of 0.8-1.2m at the base and approx. 5-6m at the top (bank to bank). Overall, the watercourse has a steep slope of 1:80.

Figure 1.4: Culvert locations within site boundary

1.6 Site Visit

A site visit was undertaken by Arup on the 11th of March 2024. The watercourse within the site boundary, as well as the outfall location of Culvert 3 at the north of the site, were inspected and photos are shown below.

Figure 1.5: Outlet of upstream culvert (Culvert 1) under Baldonnel Road

Figure 1.6: Spoil material and overgrowth on top of Culvert 2 within the site

Figure 1.7: Culvert 3 inlet

Figure 1.8: Culvert 3 outlet

Figure 1.9: Open stream within the site

A river channel survey of the open part of the watercourse within the site was undertaken by Murphy Geospatial on 14th February 2024. The upstream and downstream faces of the culverts within the site were recorded where possible, including information on invert levels and structure dimensions.

1.7 Site Topography

A topographic survey of the site was undertaken by Land Surveys Ltd in 2019. Contours and levels from the survey, in 1m spacing, are shown below in Figure 1.10. The watercourse that crosses the site from south to north is shown in the Figure 1.10 in a blue line.

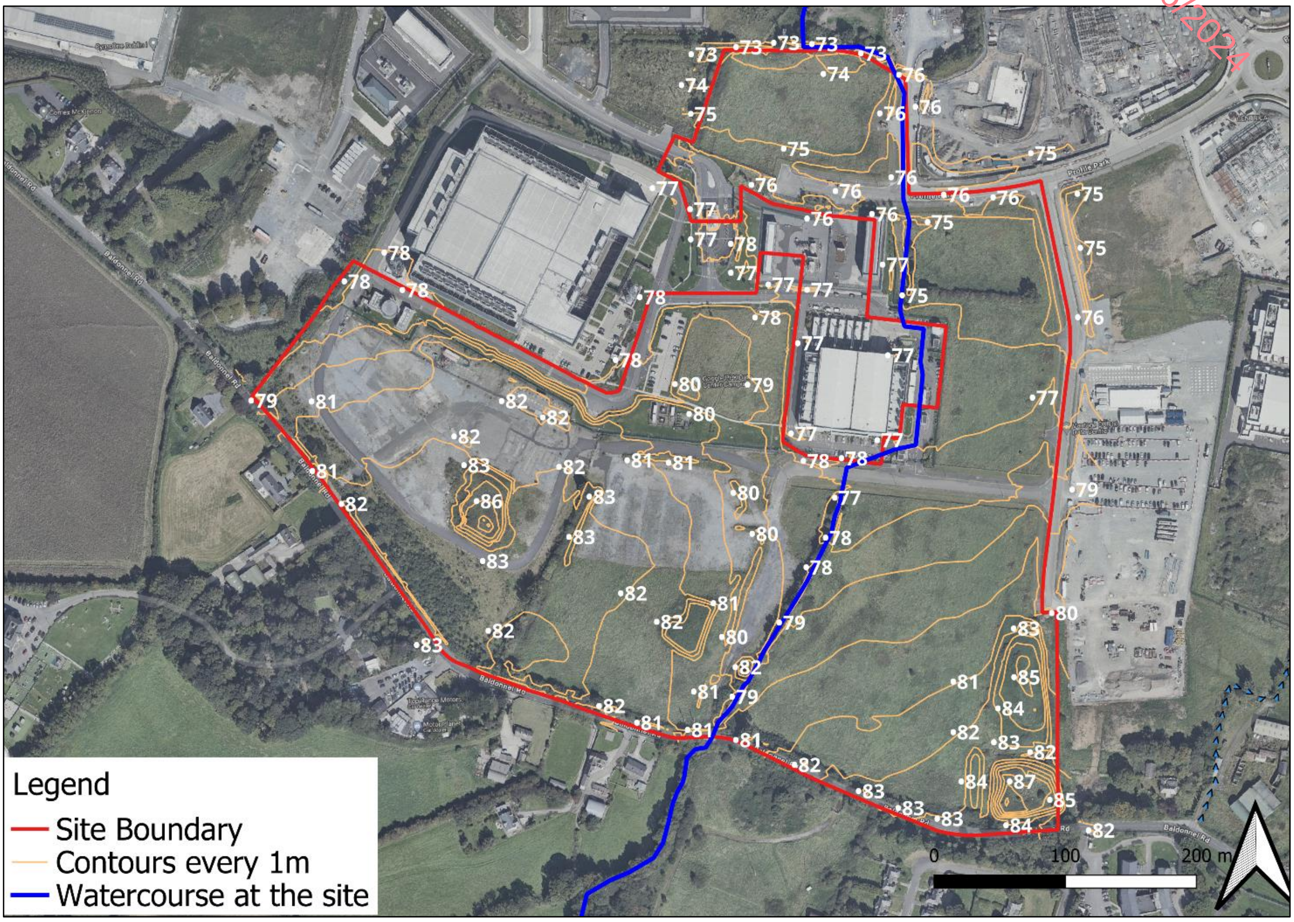

Figure 1.10: Site contours and levels (generated from the site-specific topographic survey)

The overall topography of the area gradually decreases from south to north. Ground levels vary across the site from 83m OD at the south along Baldonnel Road to 73m OD near the existing open stream north of the site. Spoil material from previous construction activities are deposited at the southeast and southwest parts of the site, reaching local high levels of 85 to 87m OD.

1.8 Proposed Development

1.8.1 General

The Proposed Development comprises of a main building (Data Centre), a Mechanical Yard consisting of an air-cooled chillers arrangement, an Electrical Yard including generators and modularised electrical buildings and site structures/ trestles/conveyances. Details on the Proposed Development can be found in Chapter 4 of the EIAR. An illustration of the key development areas is shown in Figure 1.11.

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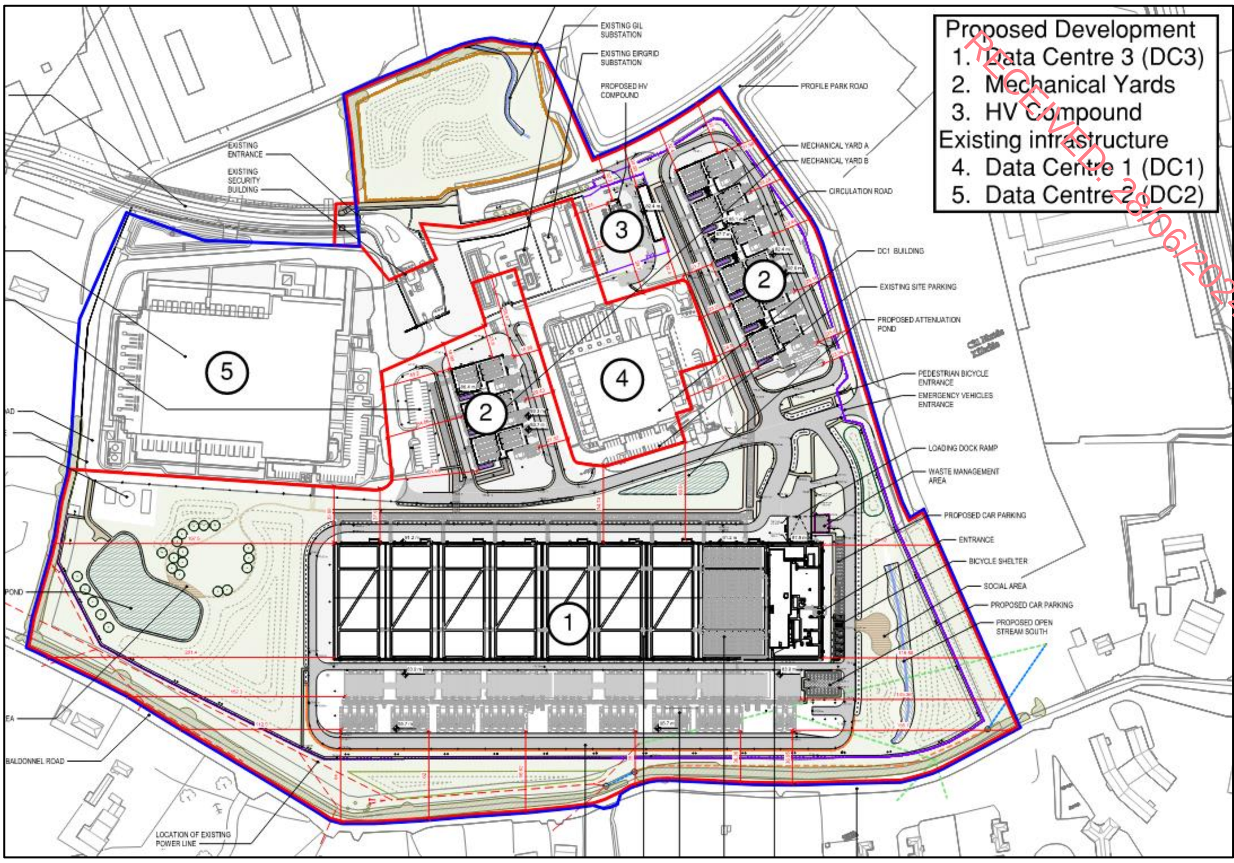


Figure 1.11: Proposed development of DC3

The DC3 Building is a large capacity data centre. It includes a data hall building at the south part of the campus site. A mechanical yard, split into two blocks, will be located north of the data centre building, housing all mechanical cooling plant and future proofing for district heating. South of the data centre hall, an electrical yard will house external generators for power backup. The data hall building will connect to the rest of the campus via a network of roads, designed for car access for workers and visitors, and other vehicles for deliveries, maintenance, and part replacements.

Two attenuation ponds are proposed to serve the Proposed Development, one west and one north of the building. The site is protected by a secure fence on the south, east, and west. The existing substation north of the site will be expanded with the addition of an HV Compound.

1.8.2 Watercourse Realignment Works

The watercourse at the south of the site is proposed to be diverted around the building as shown in Figure 1.12. Every effort was made to provide an open watercourse where possible. At times, this was not achievable due to other constraints described below. Parts of the existing culvert within the biodiversity area will be de-culverted (daylighting) to provide further biodiversity benefits. Overall within the site, the watercourse within the site will comprise of three open stream sections of total length of 262.7m (compared to 187.8m presently), with 2 long culverts at the south and north of the data hall building of total length of 641.6m (compared to 403.6m of culverted watercourse presently on site). The total length of the watercourse due to the realignment works will increase by 312.9m. Details of the proposed structures are found in Table 1.1.

A step-pool arrangement is proposed at the end of the open stream before connecting to the northern culvert to allow for a steep drop in elevation of 2m, shown in magenta. This arrangement will allow for a relatively shallow and gentle stream that can slow down flows and encourage habitat creation, as well as maintaining gentle culvert slopes.

The process followed for the design of culverts and open stream is described below:

1. The two existing 600mm culverts within the Proposed Development site will be disconnected from the system. Culvert 2 will be removed and the 600mm inlet to Culvert 3 will not be used anymore by the new re-aligned watercourse. This new configuration and removal of the two culverts that cause pinch points to flow will improve the flood situation and flow conveyance on site.

2. The new re-aligned watercourse is designed to convey the 1 in 100-year event with 20% increase in flows allowed to account for climate change (design flood event). Where the watercourse is designed as open stream, a minimum of 300mm freeboard to the bank is allowed.

3. At the south part of the site, the corridor between the perimeter road of the development and the site boundary is very narrow. There are a number of utilities that run west to east parallel to the building that reduce the corridor even further. Consideration was given to the use of an open box culvert (concrete channel with vertical walls, no lid) however the health and safety concerns outweigh the few biodiversity benefits of a narrow and shaded open concrete stream. As such, a 1.5m wide x 1m high box culvert is considered the most viable option at the location (Culvert A). The inlet and outlet of the culvert will be embedded in gravel to prevent perching, as per IFI recommendations.

4. At the eastern part of the Proposed Development site, an open stream channel is proposed to convey the watercourse flows. The open stream is designed with 1m base width to mimic existing low flow conditions and will take the form of a two-stage channel to improve channel lateral connectivity. This will allow the health and functionality of the river and its surrounding ecosystem to be maintained. The channel will have bank levels with a minimum of 300mm freeboard above the design flood event. The stream is kept shallow as much possible to ensure low velocities within the channel (<1m/s).

5. The inlet of the existing Culvert 3 is 600mm in diameter with an initial slope of 1:10, increasing to 1000mm downstream. From then onwards, the culvert has a gentle slope and increases again in size to 1050mm to manhole S3.0 (refer to Figure 1.12). As such, it is proposed that the 600mm inlet is avoided and the new Culvert B connects directly to the 1050mm pipe at manhole S3.0. At this location, the existing culvert is much lower than the existing watercourse levels (S3.0 IL:73.92m OD).

6. The proposed ground levels at the site in the vicinity of Culvert B are proposed to be set at approx. 80m OD. An open stream at the location of Culvert B would therefore require a depth of 3 to 4m. Several spatial limitations prevent the use of an open stream: the available land is narrow and does not allow 1:3 bank slopes, the watercourse is proposed to be crossed by 2 road crossings and a stormwater attenuation pond is proposed adjacent to the watercourse. As such, an open stream is not viable at this location and the most suitable design was deemed to be a circular culvert (Culvert B), which is 189.5m long.

7. Between the open stream and Culvert B, a 2m vertical transition was designed to prevent steep slopes and high velocities in the stream and in Culverts A and B. To enable the 2m vertical transition, a series of 4 step pools of 0.5m height and 5m length each will be positioned between the open stream and Culvert B. The total length of the step pools is 25m (to include 5m of gentle slope at the end of the step pools before entering Culvert B). The step pools will also allow for movement of any potential fish in the future. They are designed with stones and coarse bed material to prevent erosion due to high local velocities. The surrounding ground levels are proposed to be set to 80m OD, with the base of the step pools between 75.7 and 77.75m OD. The difference with surrounding levels therefore varies from 2.25m to 4.3m. A combination of retaining structures at the base and sloping grounds at higher levels are proposed to allow for this vertical transition. A security railing will be positioned around the step pools to prevent fall.

8. The existing culvert is required to be diverted around the proposed HV Compound (number 5 in Figure 1.12). This is referred to as Culvert C and is 141m long, leading to an open stream section. The entire structure from Culvert B inlet to Culvert C outlet, including the existing culvert between the two to be maintained, is referred to as Culvert B/C.

9. Manholes are located at every bend and as a minimum every 50m, to provide access for inspection and maintenance.

10. Efforts are made to de-culvert the watercourse where space allows. The section of the existing culvert under Profile Park Road will be diverted to the adjacent biodiversity area through Culvert C and opened up for 98.7m. The open stream will outfall straight to the existing watercourse north of the site.

Figure 1.12 illustrates the intended stream realignment. The figure shows the current watercourse and culverts within the site (grey and blue dashed lines). The proposed stream realignment is shown in green line, two new culverts and altered culvert in brown lines and step pools in magenta. Plans, long sections and cross-sections of the proposals are included in the drawing package submitted under the planning application. See list of drawings below:

- Plans: DC3-C-9300-SDT-X, DC3-C-9301-SDT-X, DC3-C-9302-SDT-X, DC3-C-9303-SDT-X, DC3-C-9304-SDT-X
- Long sections: DC3-C-3201-SDT-Z, DC3-C-3202-SDT-Z, DC3-C-3203-SDT-Z
- Cross sections: DC3-C-3211-SDT-Z, DC3-C-3212-SDT-Z, DC3-C-3213-SDT-Z, DC3-C-3214-SDT-Z, DC3-C-3215-SDT-Z.

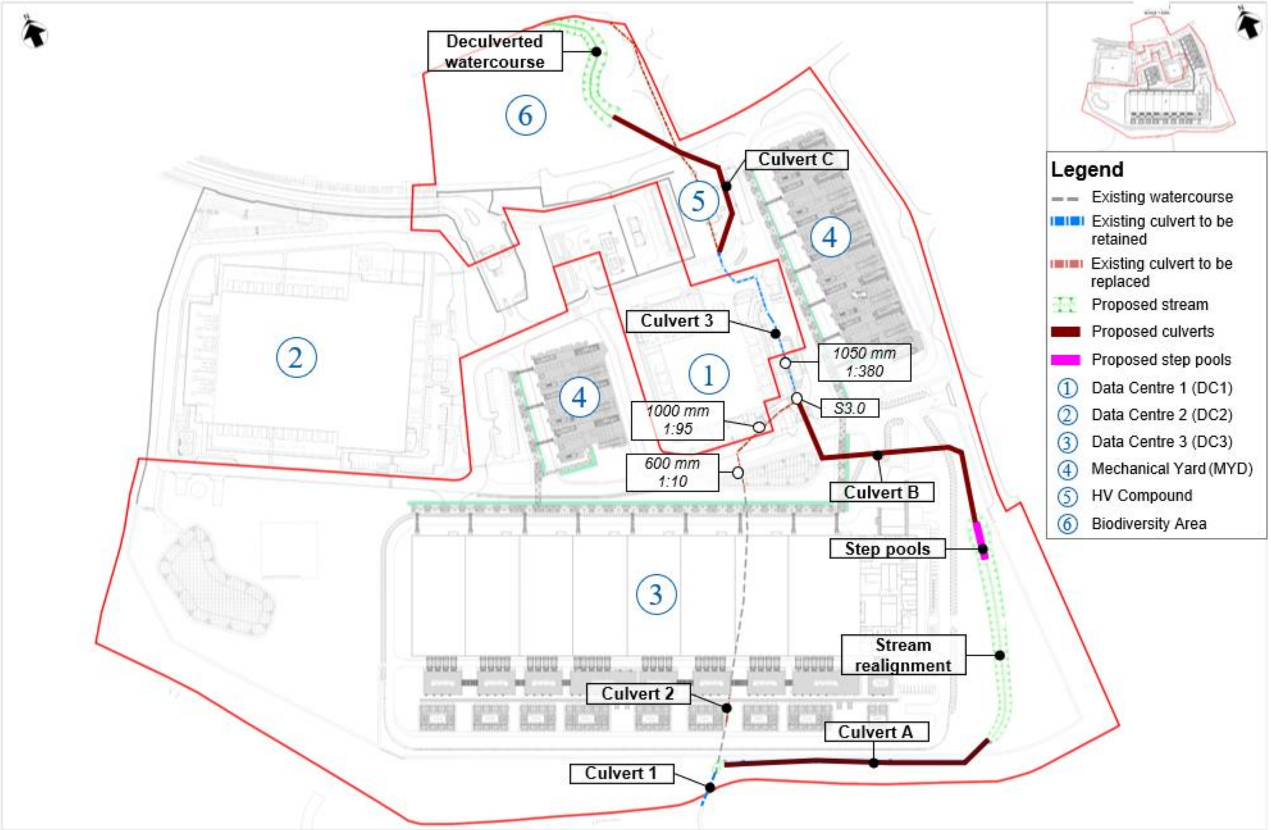


Figure 1.12: Proposed watercourse structures and re-alignment

Table 1.1: Design parameters of the realigned watercourse and proposed structures

Structure/element	Length (m)	Size & features	Upstream IL (m AOD)	Downstream IL (m AOD)
Stream realignment	10m	1m base width, 1:3 side slopes, 300mm freeboard, 1:116 longit slope	79.1	79.014
Culvert A	186m	1.5m wide x 1m high Box culvert, 1:360 longit slope Security screen at inlet	79.014	78.5
Stream realignment	129m	1m base width, two-stage channel with 1:2.5 side slopes, 300mm freeboard, 1: 172 longit slope	78.5	77.75

Structure/element	Length (m)	Size & features	Upstream IL (m AOD)	Downstream IL (m AOD)
Step pools	25m	1.5m base width, vertical retaining structure with earth on top at 1:3 side slopes, 2.05m total drop in 4 steps	77.75	75.7
Culvert B	189.5m	1050mm diameter circular culvert, 1:106 longit slope	75.7	73.91
Existing culvert (to be maintained, not a new structure)	127m	1000/1050mm diameter circular culvert, 1:352 longit slope	73.91	73.55
Culvert C	139.1m	1050mm diameter circular culvert, longit slope varying from 1:125 to 1:500	73.55	72.77
De-culverted watercourse	98.7m	1m base width, 1:3 side slopes, 300mm freeboard, 1: 490 longit slope	72.77	72.57

The design and construction of culverts should be such that flood risks are not increased, or, where no other viable options exist, are restricted to acceptable levels, and should comply with any flood risk management objectives and plans established for the area. Under the Arterial Drainage Act (1945) the consent of the OPW is required to carry out construction/alteration works on culverts. A 'Section 50' application has been applied for the proposed culverts within the Proposed Development.

1.8.3 Security Screen

The inlet of Culvert A and outlet of Culvert B/C is located outside the security fence of the site and as such it could become accessible to potential trespassers. A security screen is required at the two locations to prevent trespassing and to reduce health and safety risks to any potential trespassers. An additional security screen will be positioned at the inlet of Culvert B/C to prevent entry and risk of person being trapped in the long culvert, especially following the introduction of a security screen at the outlet, in line with recommendations from CIRIA Culvert, screen and outfall manual C786 .

An initial security screen need assessment has been completed using the guidance from CIRIA C786 (Appendix A2 of the manual – Initial Need Assessment for Security Screens).

Table 1.2: Security screen needs assessment, according to CIRIA C786.

Factors	Project Evidence	Inlet of Culvert A and inlet/outlet of Culvert B/C	
		Sub-factor	Score
Factor A – Rate of water level rise	Time to peak: 3.25hrs	A4 – 2-12hrs for significant rise in water levels	3
Factor B – Culvert length	185m and 455.6m	B6 - 100-500m	10
Factor C – Flow conditions in the culvert barrel	Modelling	C1 - Never flows full for any parts of its length	1
Factor D – Possibility of being trapped inside the culvert if swept inside	The site is a critical national infrastructure, with the security arrangements meeting those of existing strategic sites.	D9 – Exceptional reasons requiring prevention of unauthorised entry into the culvert (e.g. restricted military area)	40

Factors	Project Evidence	Inlet of Culvert A and inlet/outlet of Culvert B/C	
		Sub-factor	Score
Factor E – Accessibility /Mitigation	Unrestricted access possible upstream of Culvert A and downstream of Culvert B/C	E1a - Unrestricted access possible to the culvert or channel 500 m upstream and 200 m downstream	0
Total score			54

Table 1.3 Decision rule based on the initial security screen need assessment score (CIRIA C786)

ISSNS score	Outcome	Next step(s)
0–40	A security screen is not required	Record final decision and reasons for it
41–65	A security screen is probably not required	Consider other measures to prevent access, and if none are suitable, undertake a more detailed risk assessment.
66+	A security screen is required	Design a suitable security screen and check that overall safety risks have reduced as a result.

The decision according to the above score and exercise is 'A security screen is **probably** not required'. The guidelines recommend review of the sub-factors to assess if other mitigation can be provided to reduce the score. However, revisiting the above criteria, it was not possible to reduce the scoring to below 41 through the design (where a screen would not be required).

The screen will be essential to the security of the data centre and it is necessary to ensure no gaps in security. The site is considered critical national infrastructure, with the security arrangements meeting those of existing strategic sites.

The screen bar spacing is proposed at 150mm centre-to-centre with a 10mm proposed bar width, as per recommendations from CIRIA C786. The total reduction in culvert conveyance area by the screen is only 6.5% at each culvert.

There is an inherent risk of blockages with the introduction of security screens. A trash screen assessment has been undertaken in line with the CIRIA C786 to assess the potential of debris accumulation to the two culverts. The presence of the existing upstream culvert under Baldonnel Road with smaller conveyance area would naturally prevent large debris to arrive on site (debris would accumulate upstream of the site). Furthermore, there is no loose debris observed within the watercourse. Small dry weeds are present, however these originate from within the site, not upstream. As the watercourse within the site will be relocated and backfilled, the existing shrubs, trees and vegetation will also be removed. Native grasses with dense root systems are proposed for the banks which will help stabilise the stream, with no trees. As such, the risk of large debris being washed into the stream and trapped behind the security screens is therefore low.

There is a risk that due to the introduction of the security screen, small leaves will collect behind it. As such, the screen at the inlets will be rakable (positioned in an angle and not vertically).

GIL will perform regular checks to the security screen for any debris accumulation and remove it promptly.

A blockage assessment has been performed to assess the impacts of a blockage due to debris accumulation on the security screen. This is presented in Section 6.4.4.

2. Planning Context

2.1 Introduction

The following planning policy documents are relevant to the flood risk assessment of the Proposed Development:

- The Planning System and Flood Risk Management Guidelines for Planning Authorities November 2009;
- South Dublin County Council Development Plan 2022-2028 and the Strategic Flood Risk Assessment (SFRA) July 2022.

2.2 The Planning System and Flood Risk Management

2.2.1 Introduction

In November 2009, the DEHLG and the OPW jointly published a Guidance Document for Planning Authorities entitled 'The Planning System and Flood Risk Management'. The Guidelines are issued under Section 28 of the Planning and Development Act 2000; and Planning Authorities and An Bord Pleanála are therefore required to implement these Guidelines in carrying out their functions under the Planning Acts.

The aim of the Guidelines is to ensure that flood risk is neither created nor increased by inappropriate development. The Guidelines require the planning system to avoid development in areas at risk of flooding, unless they can be justified on wider sustainability grounds, where the risk can be reduced or managed to an acceptable level. They require the adoption of a Sequential Approach (to Flood Risk Management) of Avoidance, Reduction, Justification and Mitigation and they require the incorporation of a Flood Risk Assessment into the process of making decisions on planning applications and planning appeals.

Fundamental to the Guidelines is the introduction of flood risk zoning and the classification of different types of development having regard to their vulnerability. The management of flood risk is now a key element of any development proposal in an area of potential flood risk and should therefore be addressed as early as possible in the site master planning stage.

2.2.2 Definition of Flood Zones

Flood zones are geographical areas, within which, the likelihood of flooding is in a particular range. There are three types of flood zones defined in the Guidelines as follows:

Table 2.1: Flood Zone Categories

Zone category	Description
Flood Zone A	Probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
Flood Zone B	Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding).
Flood Zone C	Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

2.2.3 Definition of Vulnerability Classes

Table 2.2 summarises the Vulnerability Classes defined in the Guidelines and provides a sample of the most common type of development applicable to each.

Table 2.2: Vulnerability Classes

Vulnerability Class	Land Uses and Types of Development which include:
Highly Vulnerable Development	Includes Garda, ambulance and fire stations, hospitals, schools, residential dwellings, residential institutions, essential infrastructure, such as primary transport and utilities distribution and SEVESO and IPPC sites, etc.
Less Vulnerable Development	Includes retail, leisure, warehousing, commercial, industrial, and non-residential institutions, etc.
Water Compatible Development	Includes Flood Control Infrastructure, docks, marinas, wharves, navigation facilities, water-based recreation facilities, amenity open spaces and outdoor sport and recreation facilities.

2.2.4 Sequential Approach and Justification Test

The Guidelines outline the sequential approach that is to be applied to all levels of the planning process. This approach should also be used in the design and layout of a development and the broad philosophy is shown in Figure 2.1. In general, development in areas with a high risk of flooding should be avoided as per the sequential approach.

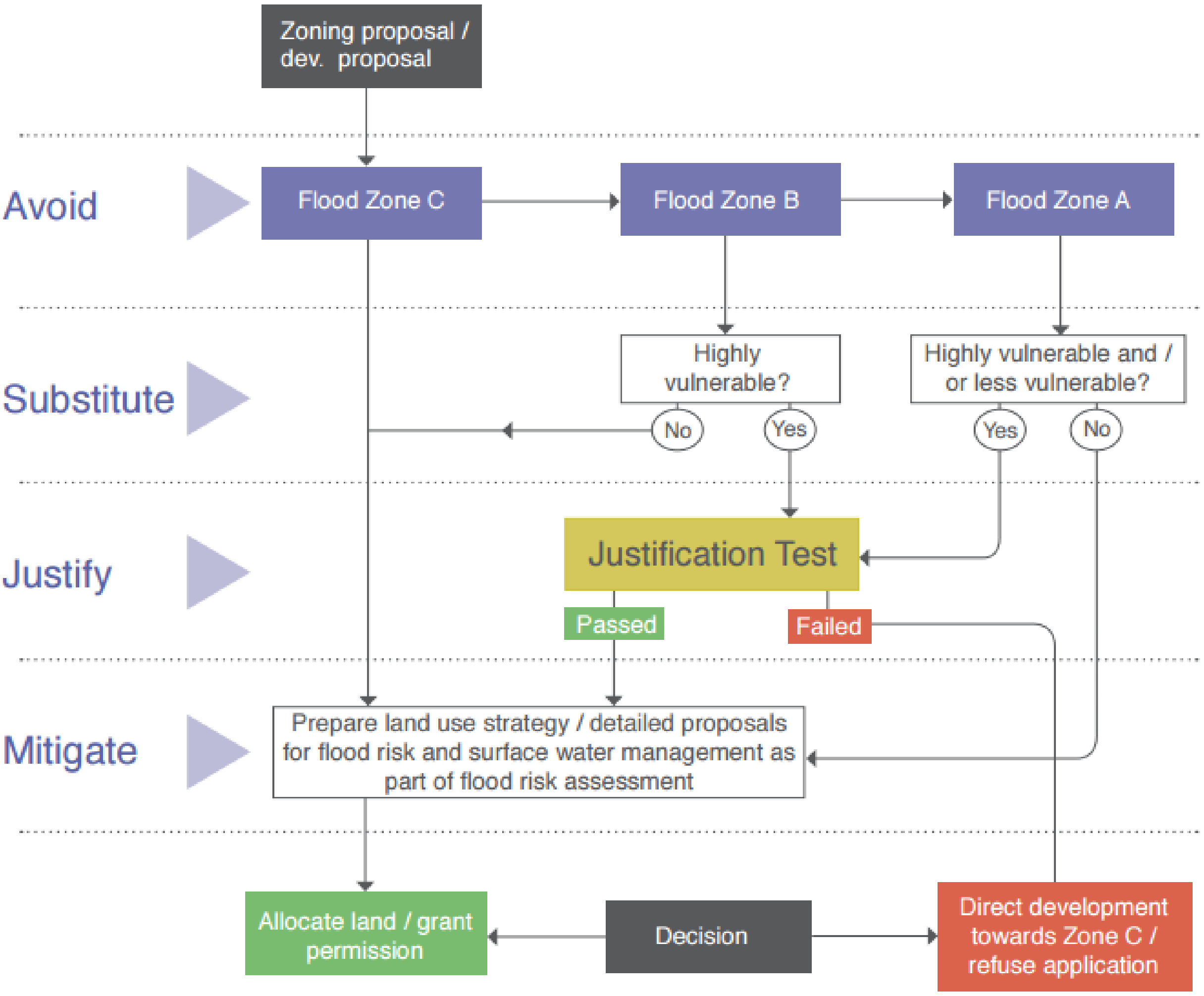


Figure 2.1: Sequential approach (reproduced from the Guidelines)

The Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of developments that are being considered in areas of moderate or high flood risk. The test comprises the following two processes.

- The first is the Plan-making Justification Test and is used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding.

- The second is the Development Management Justification Test and is used at the planning application stage where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land.

Table 2.3 illustrates the different types of Vulnerability Class appropriate to each zone and indicates where the Justification Test is required.

Table 2.3: Flood Risk compatibility and Justification Test

	Flood Zone A	Flood Zone B	Flood Zone C
Highly Vulnerable	Justification Test	Justification Test	Appropriate
Less Vulnerable	Justification Test	Appropriate	Appropriate
Water Compatible	Appropriate	Appropriate	Appropriate

2.3 South Dublin County Development Plan 2022-2028

The South Dublin County Development Plan (2022-2028) (SDCDP) was adopted on 22nd June 2022 and came into effect on 3rd August 2022.

The Development Plan sets out the framework to guide future development within South Dublin County with the focus placed on the places we live, the places we work, and how we interact and move between these places while protecting our environment. The aim is to progress to a more sustainable development pattern for South Dublin in the immediate and long-term future up to 2040 and beyond.

2.3.1 SDCDP Relevant Policies

The Plan includes policies and actions specific to flood risk management which have been informed by the Flood Risk Management Guidelines. The following summarises policies of particular interest to the proposed development in South Dublin County with relation to flood risk and watercourses.

Table 2.4: SDC DP policies relating to flood risk and watercourses

Chapter	Policy	Objective	Application to proposed development
4 - Green Infrastructure	Policy GI 3: Sustainable Water Management: Protect and enhance the natural, historical, amenity and biodiversity value of the County's watercourses. Require the long-term management and protection of these watercourses as significant elements of the County's and Region's Green Infrastructure Network and liaise with relevant Prescribed Bodies where appropriate. Accommodate flood waters as far as possible during extreme flooding events and enhance biodiversity and amenity through the designation of riparian corridors and the application of appropriate restrictions to development within these corridors.	GI3 Objective 4: To uncover existing culverts where appropriate and in accordance with relevant river catchment proposals to restore the watercourse to acceptable ecological standards for biodiversity wherever possible improving habitat connection and strengthening the County's GI network.	Where possible, culvert has been uncovered and restored to a two-stage open stream, in line with IFI recommendations (Figure 1.12, de-culverted culvert). Where the watercourse is diverted around the data hall, it is not possible to keep the watercourse as open stream and culverts have been introduced. An open stream is proposed anywhere possible to protect and enhance the biodiversity of the watercourse. Please refer to the Hydromorphological assessment which demonstrates improvements to the watercourse due to proposals in terms of hydromorphology.
	Policy GI 4: Sustainable Drainage Systems: Require the provision of Sustainable Drainage Systems (SuDS) in the County and maximise the amenity and biodiversity value of these systems.	GI4 Objective 6: To maintain and enhance existing surface water drainage systems in the County and promote and facilitate the development of Sustainable Drainage Systems (SuDS), including integrated constructed wetlands, at a local, district and County level, to control surface water outfall and protect water quality.	Two open attenuation ponds are proposed to attenuate stormwater volumes. A number of swales have been placed across the site to cater for runoff from the roads.
	Policy GI 5: Climate Resilience: Strengthen the County's GI in both urban and rural areas to improve resilience against future shocks and disruptions arising from a changing climate.	GI5 Objective 1: To protect and enhance the rich biodiversity and ecosystems in accordance with the ecosystem services approach to development enabling mitigation of climate change impacts, by absorbing excess flood water, providing a buffer against extreme weather events, absorbing carbon emissions and filtering pollution.	The proposals for the realignment of the watercourse include removal of flow obstructions (small culverts) and sizing the new culverts to include allowances for climate change. The new open stream sections of the watercourse allows freeboard for extreme events to be accommodated. Riparian planting will be introduced within the open streams and attenuation ponds.
		GI5 Objective 2: To protect and enhance the natural regime of the watercourses of the County to more efficiently capture their flood resilience value.	As per above.

Chapter	Policy	Objective	Application to proposed development
11 - Infrastructure and Environmental Services	Policy IE4: Flood Risk Ensure the continued incorporation of Flood Risk Management into the spatial planning of the County, to meet the requirements of the EU Floods Directive and the EU Water Framework Directive and to promote a climate resilient County.	IE4 Objective 1: To require site specific flood risk assessments to be undertaken for all new developments within the County in accordance with The Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009) and the requirements of DECLG Circular P12 / 2014 and the EU Floods Directive and Chapter 12: Implementation and Monitoring and the policies and objectives of this chapter.	Site Specific floor risk assessment undertaken in accordance with required guidelines.
		IE4 Objective 2: To require all developments in the County to be designed and constructed in accordance with the "Precautionary Principle" detailed in the OPW Guidelines.	The Proposed Development been designed to ensure no increase in flood risk to other sites or the site itself during the 1 in 100 year event with appropriate allowances for climate change, in line with the OPW guidelines.

2.3.2 Land Use Zoning Maps

The South Dublin County Development Plan 2022-2028 sets out the land use framework to guide future development within the County.

The majority of the subject site is zoned under objective 'EE' - 'To provide for enterprise and employment related uses' in the South Dublin County Development Plan 2022-2028. An element of the site, to the south east, is zoned objective 'RU' 'To protect and improve rural amenity and to provide for the development of agriculture'. There is no proposed development of infrastructure in this area, improved landscaping will introduce native trees planting, native meadows and a realigned open stream with riparian buffer. The map showing the land uses according to the plan is included in Appendix A.

This allocation signifies a strategic intention to foster economic activity, job creation, and support businesses within the locality.

2.3.3 Strategic Flood Risk Assessment (SFRA)

The SDCDP was subject to a Strategic Flood Risk Assessment (SFRA) in accordance with the "Plan Making Justification Test" in the 'The Planning System and Flood Risk Management' Guidelines for Planning Authorities published in November 2009.

The flood zones mapping has been prepared in accordance the Guidelines identifying Flood Zones A, B and C. The flood zone maps are largely derived from the Eastern CFRAM and the Dodder CFRAM mapping. These maps are the most comprehensive flood maps produced for South Dublin since the introduction of the Guidelines and the Floods Directive. Flood extent mapping for areas that are not covered in the CFRAM Studies are supplemented by fluvial mapping from the earlier OPW Preliminary Flood Risk Assessment (PFRA) Report and assessments undertaken as part of existing Local Area Plans. The above maps were used when undertaking this FRA.

A Justification Test was undertaken for the development plan. The Justification Test includes the subject site at Aungierstown and Ballybane Lands – Grange Castle. The recommended land use following the Justification Test for the site is EE – enterprise and employment.

According to the Justification Test, all new developments shall be subject to a Site-specific Flood Risk Assessment as per the guidelines to demonstrate the developments would not have an adverse flood risk impacts. The FRA should consider the following:

- The sequential approach should be applied through site planning and should avoid encroachment onto, or loss of, the flood plain.
- Development in Flood Zone A should consist of water compatible development only.
- Highly Vulnerable Development shall not be permitted in Flood Zone A or B.
- FRAs should address surface water management for development, demonstrating consideration of GDSDS policies and incorporation of SuDS in accordance with SDCC SuDS Guidance policy.
- FRAs should consider the hydromorphological impacts on riparian corridors.
- Existing open spaces and water compatible uses in Flood Zones A and B should be retained to maintain flood storage areas.
- FRAs should examine residual risk associated with culvert blockages, defence failure and climate change (High End Future Scenario) to set finished flood levels where appropriate.
- The FRAs should ensure development does not block flow paths, does not increase flood risk elsewhere, is designed to appropriate standard of flood resilient construction and demonstrates emergency evacuation procedures during flood events.

2.4 Climate Change Allowance

Future climate change is predicted to result in several effects, including more extreme rainfall, more severe Floods, and an increase in mean sea level. In Ireland, current OPW guidance on climate change for flood risk management defines two possible future scenarios of varying severity:

- Mid-range future scenario (MRFS)
- High-end future scenario (HEFS)

OPW's recommended allowances for both of these scenarios is shown in Figure 2.2.

	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year[1]	- 0.5 mm / year[1]
Urbanisation	*No General Allowance – Review on Case-by-Case Basis*	*No General Allowance – Review on Case-by-Case Basis*
Forestation	- 1/6 Tp[2]	- 1/3 Tp[2] + 10% SPR[3]

Note 1: Applicable to the southern part of the country only (Dublin – Galway and south of this)

Note 2: Reduce the time to peak (Tp) by a third: This allows for potential accelerated runoff that may arise as a result of drainage of afforested land

Note 3: Add 10% to the Standard Percentage Runoff (SPR) rate: This allows for increased runoff rates that may arise following felling of forestry.

Figure 2.2: OPW recommended allowances for climate change in future scenarios

According to the SDCDP SFRA, there is an increasing likelihood that Ireland's climate will be similar to that depicted in the High End Future climate change scenario by the year 2100. Therefore, it is prudent to consider the HEFS parameters when planning for vulnerable infrastructure and developments. This approach will also assist in achieving our obligations under the Water Framework Directive (WFD).

The proposed data centre infrastructure is considered highly vulnerable to flooding. The HEFS is therefore used to set finished floor levels for the site as well as test the culvert design and ensure no adverse flood impacts.

For the purposes of the design of the new culverts and the Section 50 application, which has been submitted to the OPW and is currently under review, the MRFS event is used. The culverts and watercourse realignment were also modelled and tested for the HEFS and found to perform well, maintaining flows within the culverts and open stream, without causing overland flooding.

3. Flood Mechanisms and Historic Flooding at the Site

3.1 Potential Flood Mechanisms at the Site

The following potential sources of flood risk have been assessed for the Proposed Development:

- Fluvial flooding (river or stream): fluvial flooding can occur when excessive rainfall creates a situation where the flow capacity of the river is exceeded and bank overtopping occurs, flooding nearby areas.

- Pluvial flooding/urban drainage: pluvial flooding can occur when the capacity of the local surface water drainage network is exceeded during periods of intense rainfall and results in surface water ponding in low spots in the ground surface topography.
- Groundwater flooding: groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.
- Coastal/ tidal flooding: coastal/tidal flooding can occur when tides are high and/or during a storm surge, where an abnormal rise in water generated by high winds and low atmospheric pressure due to a storm which increases sea level above the astronomical tide.

Past flood events, along with predictive maps indicating fluvial flood risk, have been reviewed, alongside other sources of information concerning fluvial, pluvial, and groundwater flooding, as described in Section 4.

It is noted that given the considerable distance from the site to the coast (16.2km), as well as the elevation of the site at approximately 80m AOD, tidal flooding was deemed to pose no risk and is not considered further in this report.

3.2 Past Flood Events

Past flood event information was obtained from two sources: the OPW National Flood Hazard Mapping website (www.floodinfo.ie) and the Geological Survey Ireland (GSI).

According to the OPW National Flood Hazard Mapping website, there is one past flood event in the vicinity of the site, as can be seen below in Figure 3.1. This singular flood incident is approximately 1km from the site at the junction of the R134 and R120, and is dated November 5th, 2000. The origin of this flooding event is unknown.

Geological Survey Ireland (GSI) have produced the Synthetic Aperture Radar (SAR) Seasonal Flood Maps of historic flooding. The maps are made using satellite images of past flood events, and show observed peak flood extents for events that took place between Autumn 2015 and Summer 2021.

As the flood maps show flood extents from observed flood events, a lack of flooding in any part of the map only implies that a flood was not observed. It does not imply that a flood cannot occur in that location at present or in the future.

Figure 3.2 shows a composite map of all the SAR seasonal flood maps between 2015-2021. As can be seen, there is no historical flood extents recorded within the site.

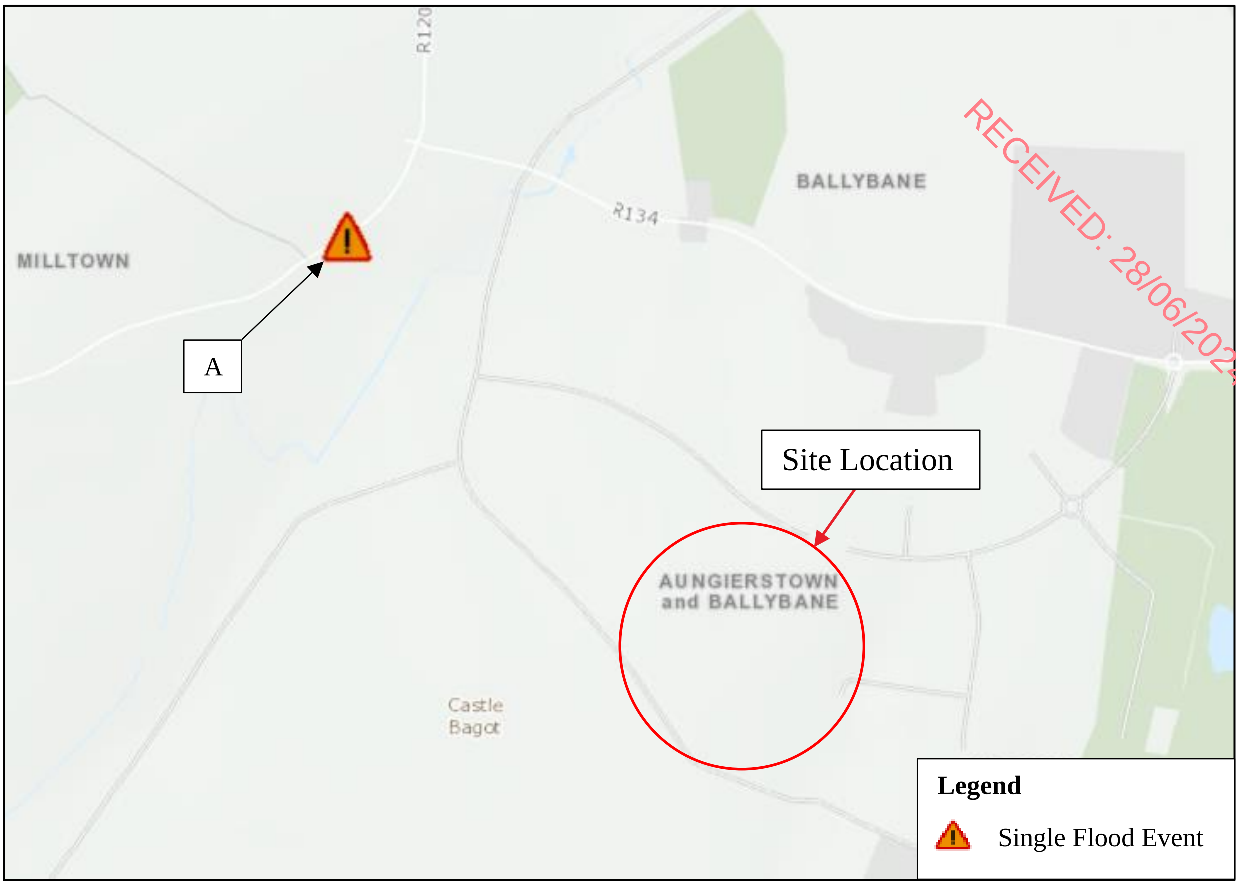


Figure 3.1: Extract from the National Flood Hazard Mapping Website Summary Report

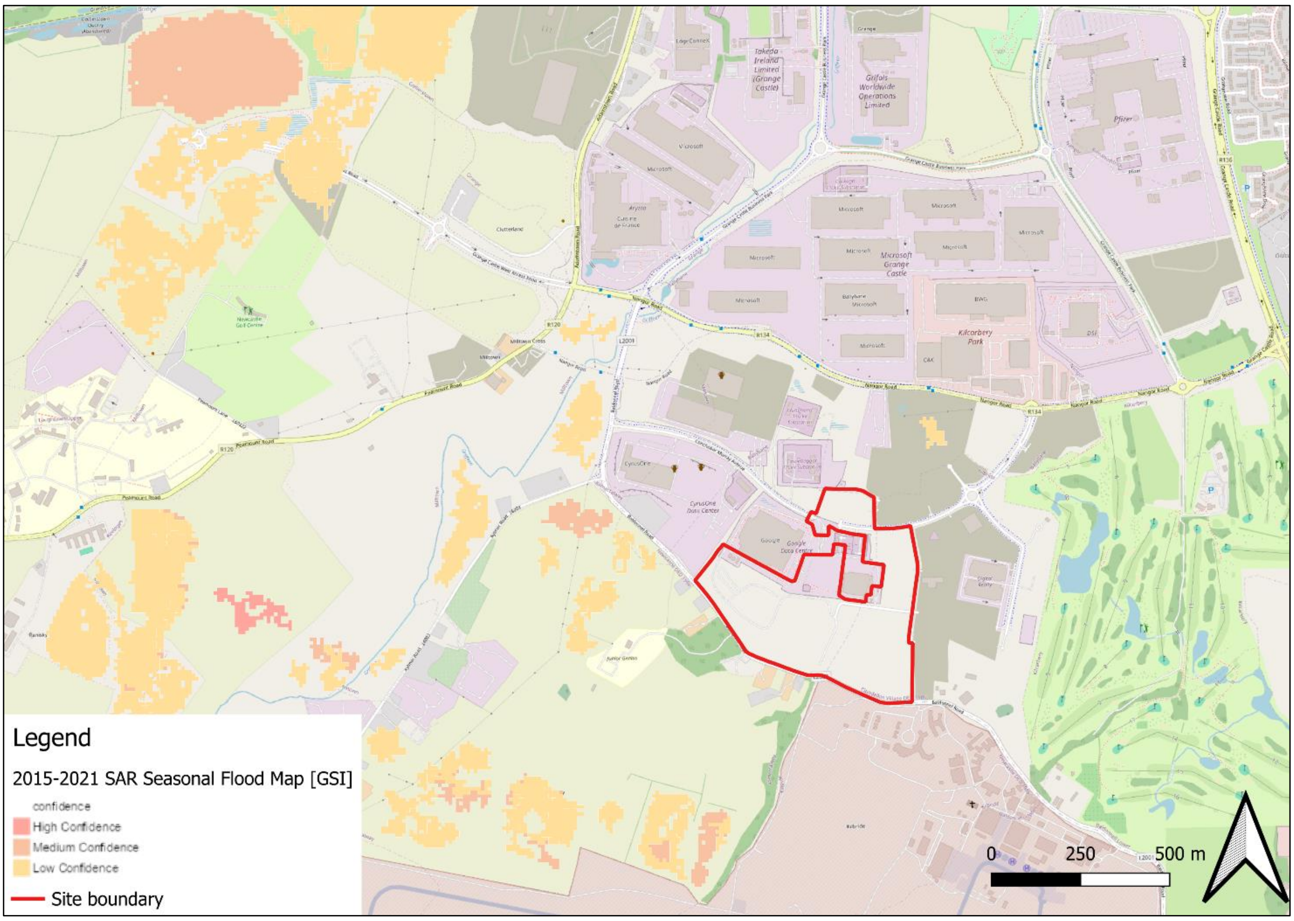


Figure 3.2: Historical flood extents for the period 2015-2021 (source: Geological Survey Ireland SAR maps)

4. Existing Flood Risk

4.1 Fluvial Flood Risk

4.1.1 Eastern CFRAM Study

A tributary of Baldonnell Stream, which then flows into River Griffeen, crosses the site from south to north. This watercourse was modelled by the Eastern CFRAMS in 2D only. It is believed that culverted sections of the watercourse were not modelled. As such, the flood extents presented are not representative of the conditions on site and are overestimating the risk of flooding and extents.

An extract from the CFRAM Study fluvial flood extent map is presented in Figure 4.1. The predicted extent for three separate return periods is shown: the 1 in 10-year return period event (or 10% AEP), the 1 in 100-year return period event (or 1% AEP), and the 1 in 1000-year return period event (or 0.1% AEP).

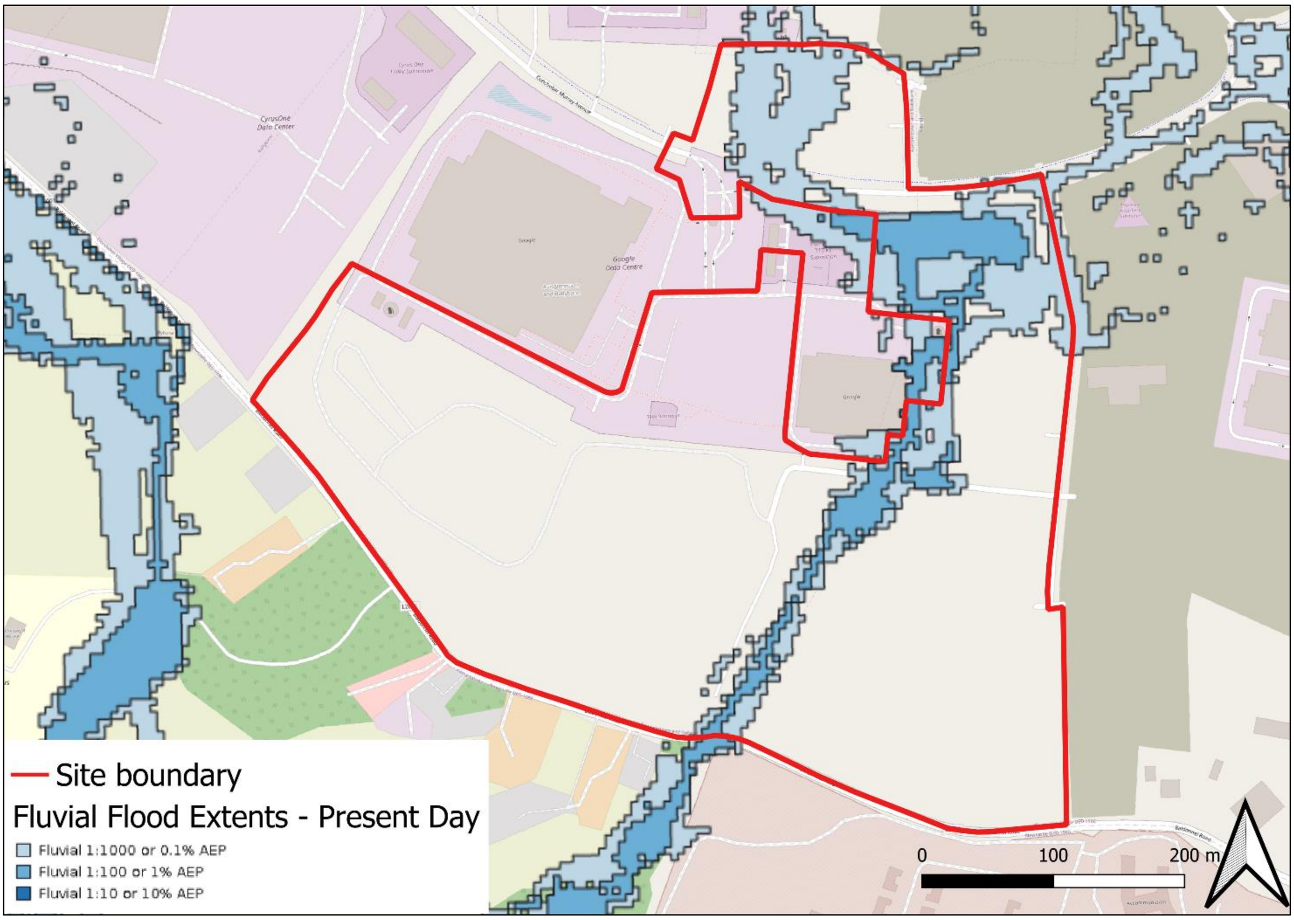


Figure 4.1: Extract from CFRAM fluvial flood extent map, current scenario

This map shows that parts of the site lie within the 1 % AEP (or 1 in 100-year) and 0.1% AEP (or 1 in 1000-year) flood extents. These correspond to Flood Zones A and B respectively, with the majority of the site in Flood Zone C. An updated hydrological assessment and detailed hydraulic modelling that includes the existing culverts were undertaken to assess risk of flooding to the site from the watercourse. The model was also used to test the proposed realignment of the watercourse and assess the risk of flooding to the site following site development. This is described in Sections 5 and 6.

4.2 Pluvial Flooding

Pluvial flooding occurs when extreme rainfall overwhelms drainage systems or soil infiltration capacity, causing excess rainwater to pond above ground at low points in the topography.

A site can be at risk of pluvial flooding due to the limited coping capacities of the existing drainage system, the presence of depressions within the site that can cause ponding, or overland flows from areas outside the site entering the site premises.

The site to be developed does not have an existing drainage system in place, however there is existing drainage network surrounding the proposed development site and serving DC1 and DC2. The system is restricted by hydrobrakes to greenfield rates of runoff. In the unlikely event that the existing network was surcharged, the ground levels of the existing site indicated that overland flows would flow northerly and away from the Proposed Development site of the data hall (DC3) or the Mechanical Yards and would not impose risk of flooding to the proposed development.

To assess the risk of pluvial flooding for the development, the existing topographic survey of the site has been reviewed to pinpoint any localised ground depressions where water accumulation might occur within the site. A small depression has been identified in the centre of the site (at 80m OD) that could accumulate surface water runoff if the rainfall intensity exceeds the soil's infiltration capacity. However, no significant ponding areas have been observed within the site.

In the proposed scenario, the proposed data hall building will be constructed on top of the area where the depression is observed.

By reviewing LiDAR data of the site and surrounds, it was noted that overland flows from areas directly south of the site would be intercepted by drainage ditches, whereas lands east, west and north of the DC3 slope away from the Proposed Development site.

Considering the above, the likelihood of significant pluvial flooding to the Proposed Development site is considered to be low.

4.3 Groundwater Flooding

Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.

To assess the risk of groundwater flooding to the site and the development, two sources were consulted: the Geological Survey Ireland (GSI) groundwater flooding data maps and groundwater resources (Aquifers) maps were reviewed (GSI, 2019).

The groundwater flooding maps do not show any extent of groundwater flooding within this development.

Groundwater resources (Aquifers) maps show the potential of areas in Ireland to provide water supplies and this information can be used as an indication of the risk of groundwater flooding. Groundwater flooding is generally associated with regionally important aquifers, but not locally important aquifers.

In the locally important aquifers, the groundwater levels are generally relatively shallow (often following topography), and bedrock has a limited capacity to accept more rainwater falling on the land. In this geology, once the bedrock aquifer is “full”, the excess rainfall flows across the ground surface as water runoff. This is not considered groundwater flooding, but purely surface water runoff assessed in Section 4.2.

Groundwater resources (Aquifers) maps show that the site is on a locally important aquifer (Figure 4.2).

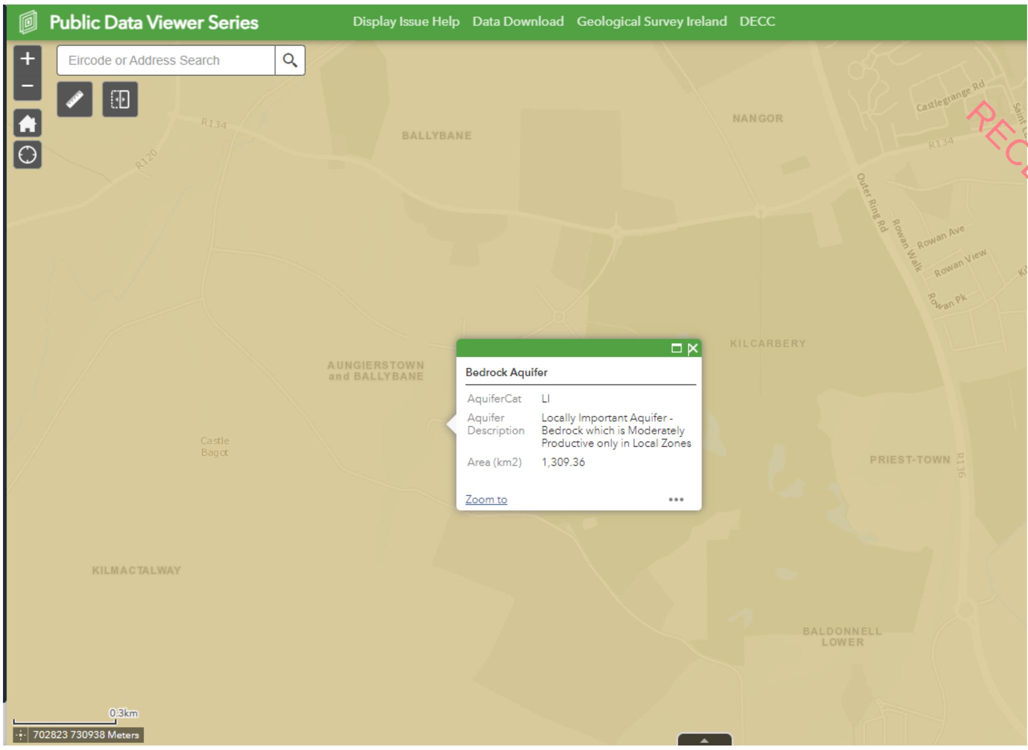


Figure 4.2: Bedrock aquifer productivity (GSI)

Since the site of the Proposed Development is not underlaid by any regionally important aquifer and given that the GSI groundwater flood maps do not indicate any groundwater flood extents at the site, it is considered that the risk of groundwater flooding in the site is low.

4.4 Summary of Existing Flood Risk

The risk of flooding to the existing site from fluvial, pluvial and groundwater sources has been assessed and is summarised as follows:

- A tributary of Baldonnell Stream crosses the site from south to north. According to the Eastern CFRAM study, parts of the site are shown to be within the 1 in 100-year extent for fluvial flooding (Flood Zone A) and the 1 in 1000-year extent for fluvial flooding (Flood Zone B). The rest of the site lies within Flood Zone C. However, the CFRAM modelling at the site is considered unrealistic as the culverted sections were not modelled. As such, an updated hydrological assessment and hydraulic modelling were undertaken and described in Sections 5 and 6.
- The risk of pluvial flooding to the site is considered to be low.
- The risk of groundwater flooding to the site is considered low.

5. Hydrological Analysis

This section offers a summary of the hydrological calculations conducted by Arup for the purposes of this application.

5.1 Estimation of Peak Flows

LiDAR data was obtained from the GSI Open Topographic Data Viewer for the site and surrounds for the purposes of the hydrological assessment, as well as modelling.

Catchment analysis was undertaken using the LiDAR data in order to extract the catchment area (AREA) draining to the site and the mainstream slope (S1085). The catchment area is shown in Figure 5.1 below.

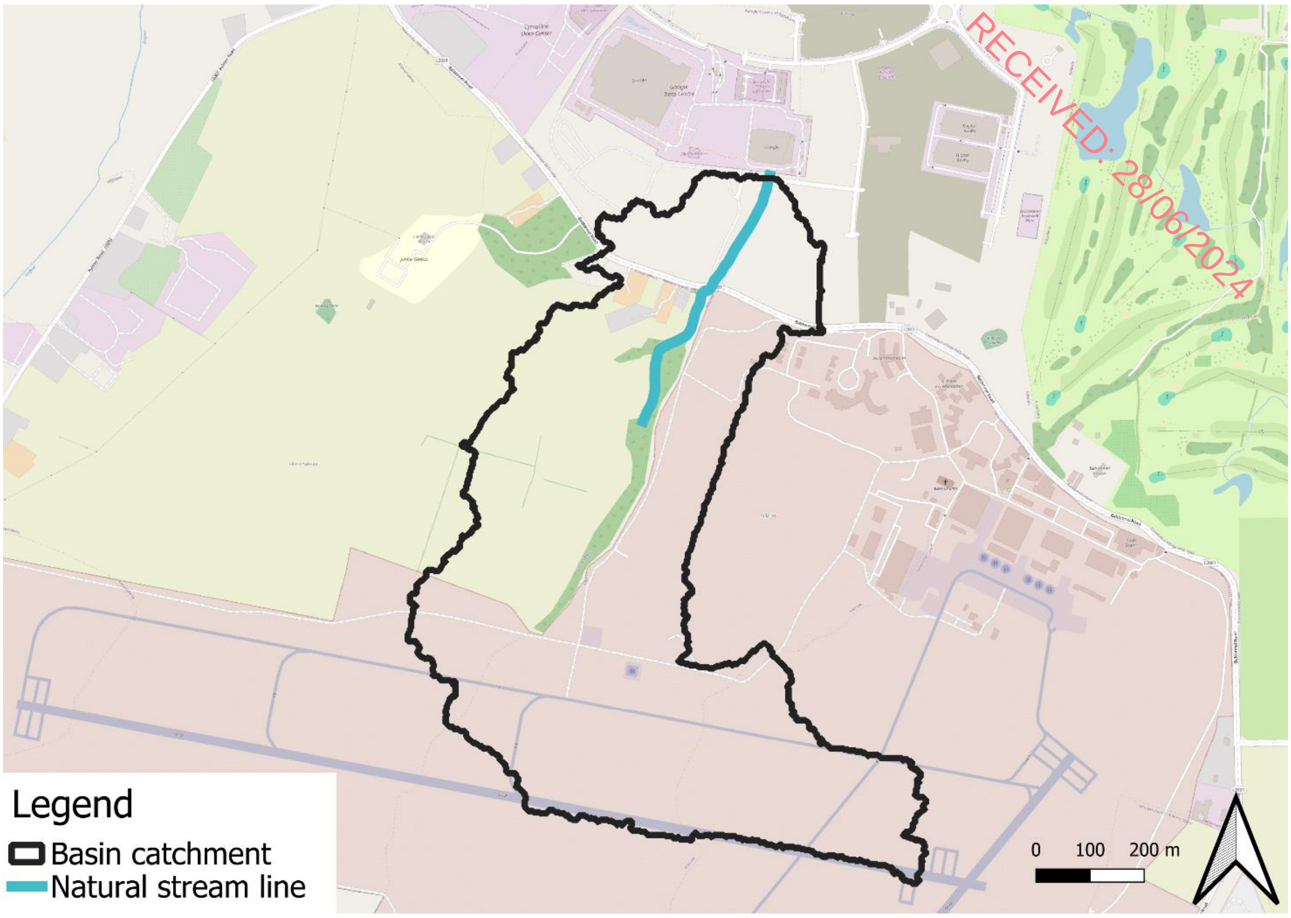


Figure 5.1: Local catchment area

The peak flood flows for the watercourse have been estimated using the FSU4.2a (5-variable) equation for small and urbanised catchments (FSU WP4.2, OPW). The parameters used are listed in Table 5.1 below.

Equation 1 FSU4.2a (5-variable), FSU WP4.2, OPW

$$Qmed = (2.0951*10^{-5})*(AREA^{0.9245})*(SAAR^{1.2695})*(BFI^{0.9030})*(FARL^{2.3163})*(S1085^{0.2513})$$

The FSR regional Growth Curves (1975) were used to develop peak flows for the 1% AEP and 0.1% AEP events.

Table 5.1: Flow calculations for on site watercourse

Parameter	Value	Source
Catchment area	0.616 km^2	Catchment analysis (see Figure 5.1)
SAAR	714.8 mm	FSU Web Flood estimation Application
BFISOIL	0.5199	FSU Web Flood estimation Application
FARL	1	FSU Web Flood estimation Application
S1085	6.653	Calculated from catchment analysis
Qmed	0.16 m^3/s	
Factors		

Parameter	Value	Source
Factorial Standard Error	1.684	FSU WP4.2
Flood frequency growth curves	1% AEP = 1.96 0.1% AEP = 2.6	FSR (1975)
1% AEP Flood flows (95% confidence)	1% AEP = 0.91 m^3/s 0.1% AEP = 1.21 m^3/s	FSE applied twice for 95% confidence
Climate change allowances	20% and 30%	
Design flows for Section 50	**1.09 m^3/s**	**1%AEP +20% CC**
Design flows for setting finished floor levels	**1.18 m^3/s**	**1%AEP +30% CC**

Three other methods were used to estimate the catchment flows and were compared with the above method to provide confidence in the results. These are detailed in Table 5.2.

Table 5.2: Comparison of flow estimates using alternative hydrological methods

	Qbar/med	Q100	Q100+CC	Q100+20%CC 95%FSE	FSE
FSU 7-variable	0.10	0.19	0.23	0.43	1.37
IH124	0.13	0.26	0.31	0.86	1.65
FSU4.2a	0.16	0.32	0.38	1.09	1.684
FSU 3-variable	0.20	0.40	0.48	2.02	2.06

The FSU 3-variable method has a very high factorial standard error than the FSU4.2a method. Analysis done by the OPW as part of WP4.2 showed that the FSU 3-v method overestimated by up to 185% and underestimated by up to 95% (FSU WP4.2, OPW). Thus, a new regression equation was developed within reasonable statistical measures, employing Irish Amax series data and PCDs. The new regression equation FSU4.2a performed better than the FEH-statistical and FSU-3v, with a lower factorial standard error.

The above method needs to still be tested enough before being recommended for wider use. IH124 is still the recommended method for small catchments (<25km^2). However, as the FSU4.2a produced slightly larger (but at similar scale) results than IH124, it was chosen to be used for this analysis.

It should be noted that the above calculation is based on the existing catchment draining to the watercourse upstream of Culvert 3 (0.616km^2). Under the proposed scenario, surface water runoff from the building within the greenfield area (between Culvert 1 and Culvert 3) will drain to an attenuation pond and eventually to an existing system away from the watercourse. As such, the contributing catchment is reduced to 0.546m^2. The proposed design flow will be reduced from 1.09m3/s (calculated above for existing scenario) to 0.98m^3/s. The value of 1.09m^3/s has been used going forward for all model runs in order allow for a like with like comparison in terms of impacts to the watercourse due to the proposed works, as well as to design the culverts using a conservative approach.

The existing drainage system for the existing data centre at the centre of the site (DC2) comprises of a pipe network that conveys flows to the watercourse via Culvert 3. All the flows are controlled by hydrobrakes, that limit the overall flow to the watercourse to approximately 10 l/s (0.01m^3/s). This is negligible compared to the overall flows from the upstream catchment and as such has not been accounted for in the calculations.

A summary table of the calculated flows used in the flood risk assessment and design process is shown below.

Table 5.3: Summary of estimated flows

Flood event	Present	MRFS (20% CC)	HEFS (30% CC)
1% AEP	0.91m3/s	1.09m3/s	1.18m3/s
0.1% AEP	1.21m3/s	n/a	n/a

5.2 Flow Hydrograph

Snyder's synthetic hydrograph method was used to produce a hydrograph for the catchment. Runoff information from the FSU Web Flood estimation Application at 0.125hr intervals for a 5-hour storm duration (Winter profile) were used to assemble the synthetic hydrograph. Once the hydrograph was constructed, it was adjusted to the peak values calculated above. The design hydrograph for the 1% AEP +20%CC is shown in Figure 5.2.

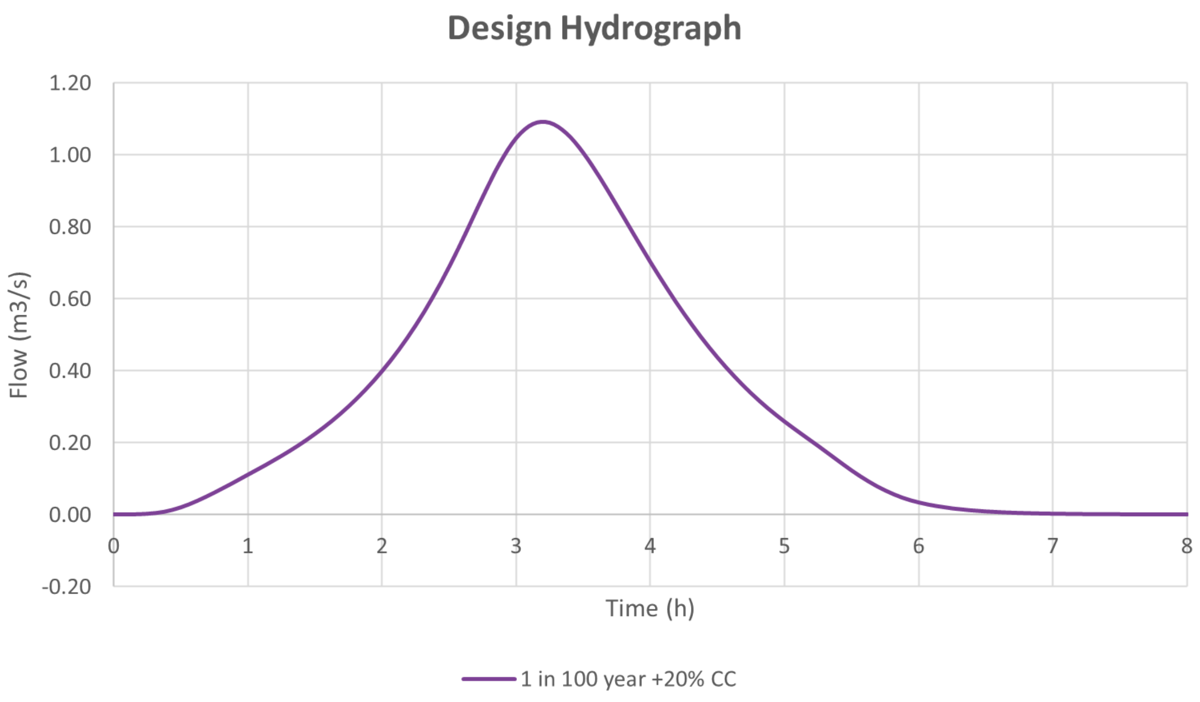


Figure 5.2: Design hydrograph (1%AEP + 20% CC)

6. Hydraulic Modelling and Results

This chapter gives an overview of the hydraulic calculations and modelling conducted by Arup for this application.

A hydraulic model was developed to assess water levels and flood depths on the site for a range of design flood events. Two configurations of the model were created:

1. Existing scenario: including existing watercourse layout and culverts
2. Proposed scenario: including stream diversion and proposed culverts

This section of the report details the creation of the hydraulic models utilised to simulate these scenarios.

6.1 Model Extent

Initially, a coupled 1D/2D model was created for the existing scenario. After reviewing the existing model results, it was determined that a coupled model was not necessary for the proposed scenario. Instead, the proposed culverts and channels were designed to contain all water within the banks during a flood event. Therefore, the existing scenario model utilises a coupled approach (using MIKE Hydro and MIKE 21 software, coupled in MIKE Flood), while the proposed scenario is simulated solely in 1D (MIKE Hydro).

Below, Figure 6.1 illustrates the extent of the existing model. The cyan line indicates the boundaries of the 1D model, while the shaded area represents the domain of the 2D model.

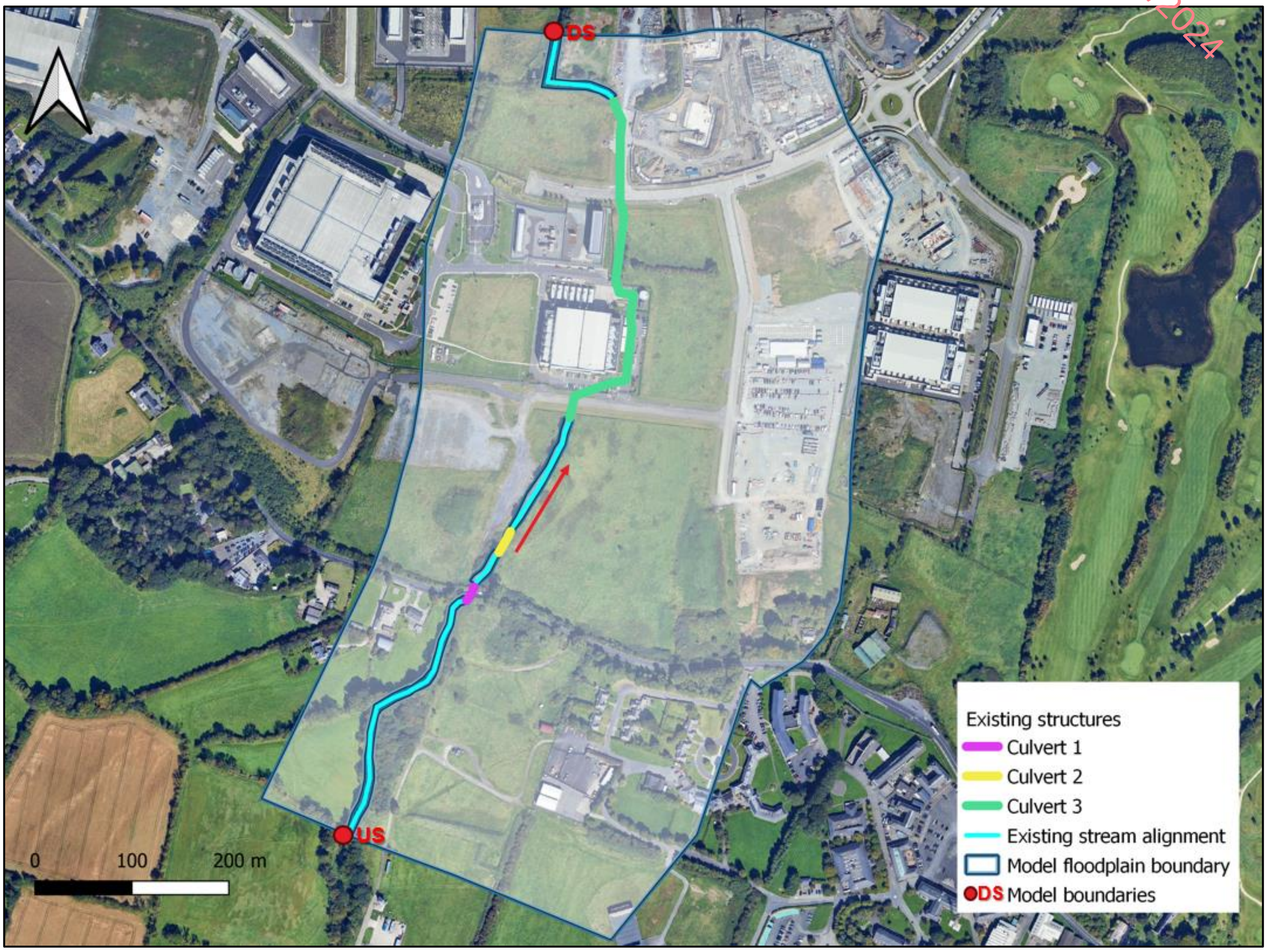


Figure 6.1: 1D and 2D model extent for existing scenario

The extent of the proposed scenario model is shown the Figure 6.2 below.

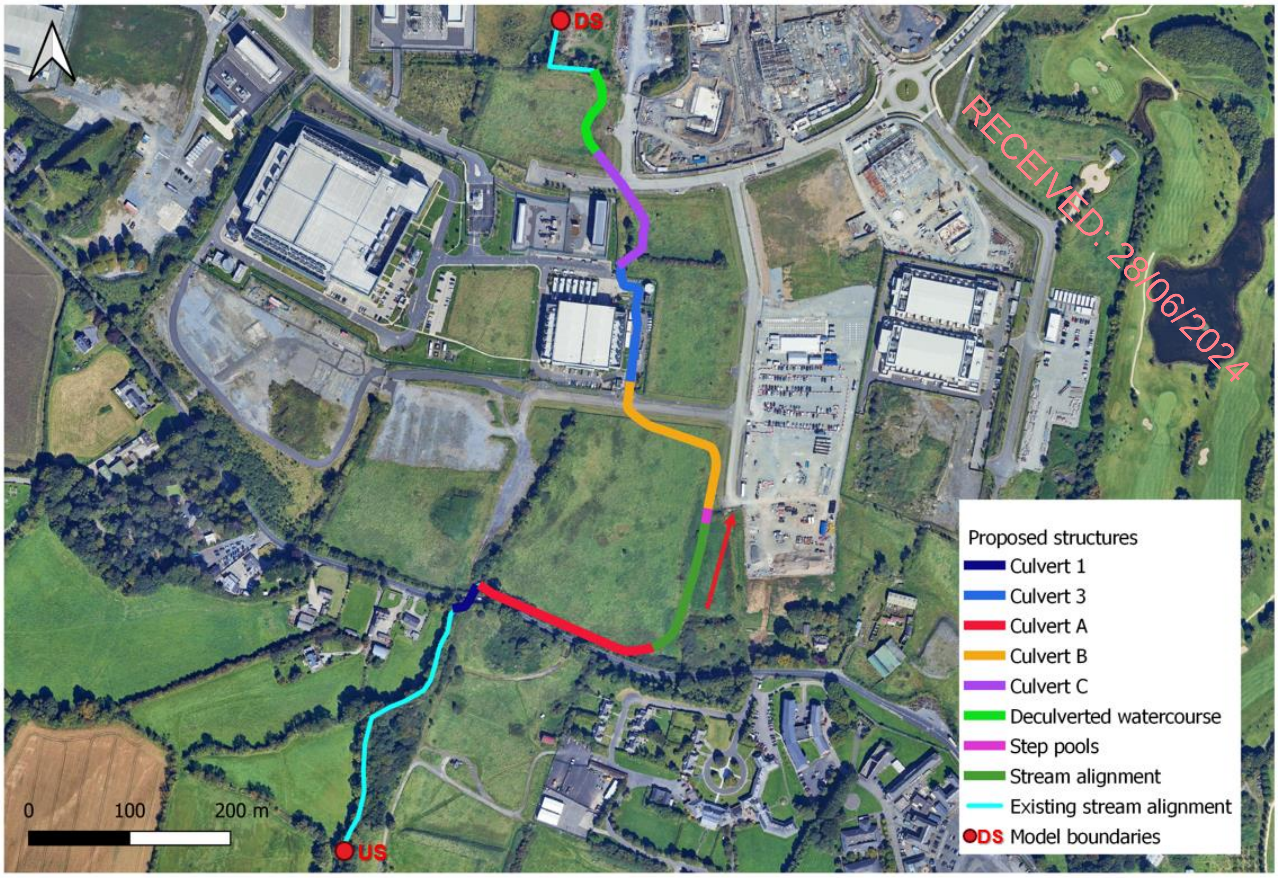


Figure 6.2: 1D model extent for proposed scenario

6.2 Overview of Model Parameters

6.2.1 Head losses

All culverts in the MIKE Hydro models (existing and proposed) use default inflow and outflow head losses. Due to limitations in the MIKE modelling software, certain assumptions were made to account for head losses within the culvert due to bends. The long culverts (Culvert 3 in the existing model and Culvert B/C in the proposed model) were included in the model as one single, continuous culvert. One head loss factor was then applied to the culvert as a whole, based on culvert geometry, using the in-built head loss factor tool in MIKE. The bend head loss factor for each culvert was calculated by adding up each bend in the culvert and applying a head loss based on the geometry of the bend. The head loss factor per bend used in this calculation are given below in Table 6.1.

Table 6.1: Bend head loss factors

Bend Angle	Headloss Factor Applied
Less than 45 degrees	0.1
Between 45 and 90 degrees	0.2
Greater than 90 degrees	0.3

A number of sensitivity runs were completed, using varying bend head loss factors. Informed by the sensitivity runs and based on the above calculations, the head loss factor calculated for Culvert 3 and Culvert B/C in the models was set to 1.

6.2.2 Manning's

For the 1D river channel, a Manning's n value of 0.07 was used for the riverbanks in the existing scenario, which equates to a roughness associated with "medium to dense brush". This aligns with observations from a site visit, as well as a 2024 survey of the watercourse, which showed that the banks were heavily overgrown with vegetation. A Manning's n value of 0.035 was used for the riverbed, equating to the roughness of a channel with few bends or deep pools, with some stones and weeds. A photograph from the 2024 survey of the watercourse showing the channel and banks is presented in Figure 6.3.

Figure 6.3: Watercourse on site showing stream bed and banks.

The Manning's value used in the model for culverts was 0.013.

A constant Manning's n value of 0.031 was applied across the 2D mesh for the floodplain roughness, in the existing scenario. This equates to a roughness associated with a floodplain of pasture or farmland with high grass. This value aligns with site observations.

Sensitivity testing of the model with different Manning's values in the 1D channel have demonstrated that the simulated water levels within the site are not sensitive to using different roughness values, given the steep nature of the watercourse in the key area of interest.

6.3 List of Design Runs

A complete list of design runs undertaken is presented below in Table 6.2.

Table 6.2: Model Runs

Run no.	Model	Description	Climate Epoch	Fluvial (AEP)
1	Existing	Current watercourse arrangement and culverts	Current	1%
2	Existing	Current watercourse arrangement and culverts	MRFS (+20% in flows)	1% (+20% in flows)
3	Existing	Current watercourse arrangement and culverts	Current	0.1%
4	Proposed	Current watercourse u/s of site, including stream diversion, stepped channel, proposed culverts and de-culverted watercourse	Current	1%
5	Proposed	As above	MRFS (+20% in flows)	1% (+20% in flows)
6	Proposed	As above	HEFS (+30% in flows)	1% (+30% in flows)
7	Proposed	As above	Current	0.1%
8	Proposed w/ blockage	As above, with Culvert A blocked by 33% to simulate blockage of the security screen	MRFS (+20% in flows)	1% (+20% in flows)

6.4 Results

6.4.1 Existing Model Results

The existing model was used to simulate water levels and flood extents for the existing scenario for both the 1% AEP (1 in 100-year) event and the 0.1% AEP (1 in 1000-year) event in order to reproduce the Flood Zone maps. The flood extents for the 1% and 0.1% AEP flood events for the existing scenario are shown below in Figure 6.4.

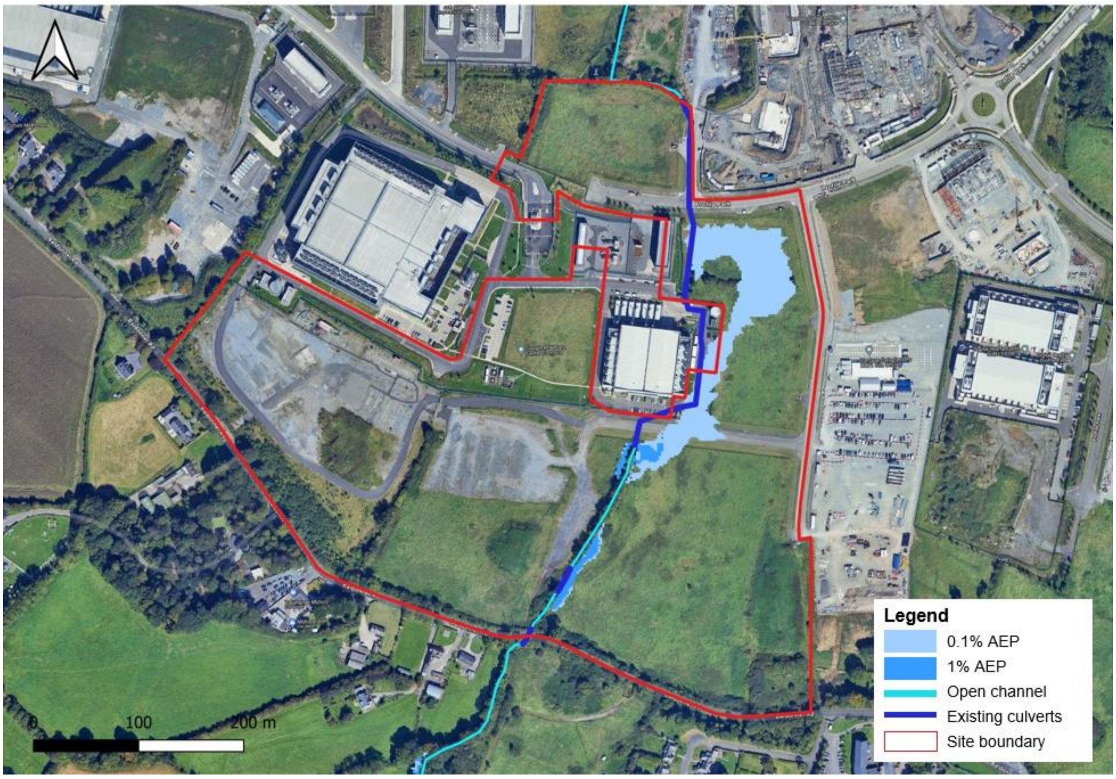


Figure 6.4: Flood Zone Map: flood extents from existing model, for 1% AEP and 0.1% AEP events

The updated existing flood maps show reduced flood risk on site compared to the CFRAM extents (Figure 4.1). This is mainly due to the inclusion of the culverts in the Arup model which allow conveyance of the flows within the underground conduits and reduce the overground flows.

It can be seen from Figure 6.4 that the majority of the site is located outside the 0.1% AEP flood extents (Flood Zone C). During the 0.1% AEP event (light blue above), the watercourse overtops Culvert 3 which has only 600mm diameter, and flows out of bank to the east of the existing DC2, and ponds at the northeast part of the site. Areas flooded during this event are classified as Flood Zone B. During the 1% AEP event (dark blue above), the majority of flows are conveyed via the existing culvert system to the north of the site. A small portion of the site, along the existing alignment of the river, is shown to be within the flood extents of the 1% AEP, and as such classified as Flood Zone A. Refer to Table 2.1 for flood zones category definitions.

The 1%AEP with 20% CC (MRFS) event was also modelled for the existing conditions. The long section of the run is shown below. This event cannot be contained within the 600mm diameter Culvert 3 and overtopping occurs. The event was run to enable comparison of levels with the proposed scenario.

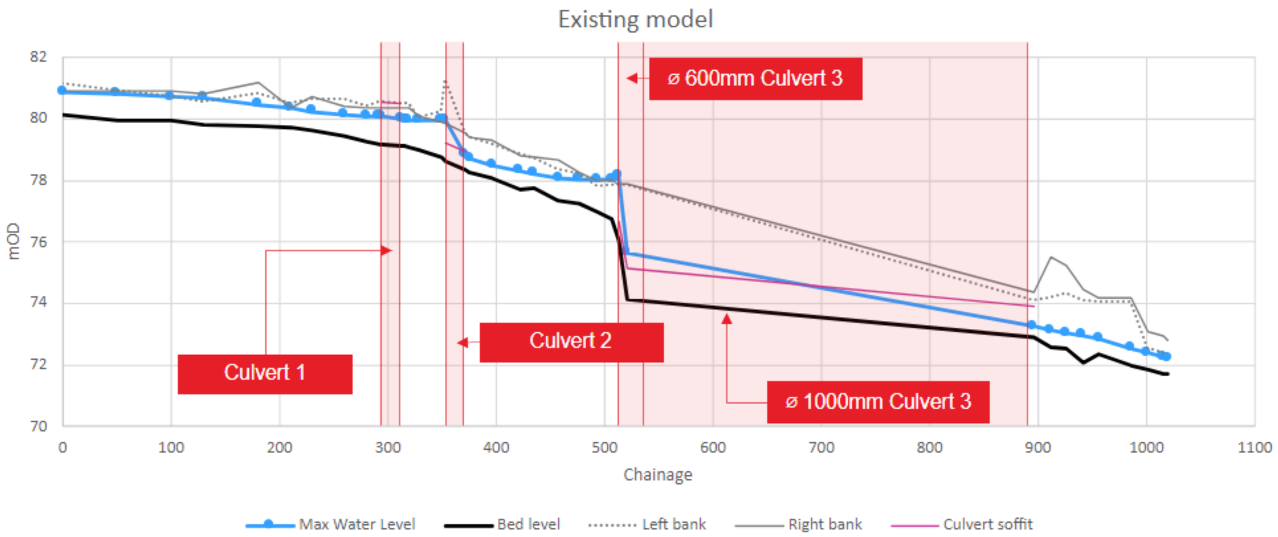


Figure 6.5: Long-section of water levels in the existing scenario for the 1% AEP +20% climate change (MRFS)

6.4.2 Proposed Model Results

With the watercourse proposals in place (re-alignment, new stream design, removal of culverts and replacement with larger culverts), the flooding for the 1% AEP, 1%AEP +20%CC (MRFS) and 0.1% AEP are all maintained within bank. No overland flows are expected during such events once the development proposals are in place.

Figure 6.6 shows the longitudinal plot of maximum water levels in the 1D channel in the proposed scenario for the 1% AEP event with a 20% allowance for climate change (MRFS). The flow conditions within the proposed culverts during such an event is free flow with no surcharging or overtopping of culverts or open stream.

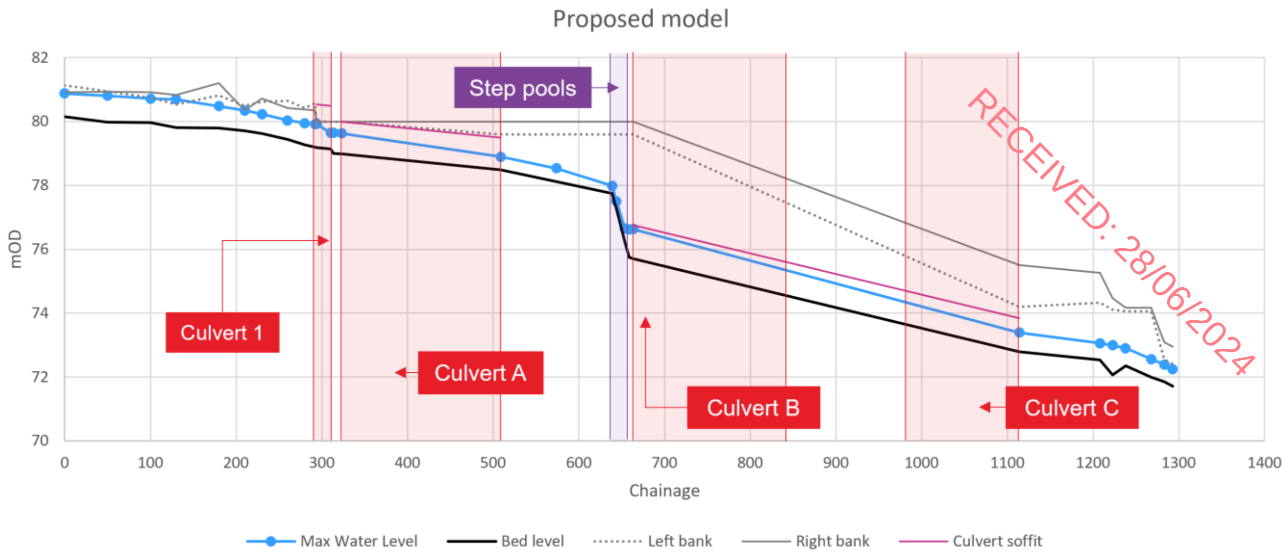


Figure 6.6: Long-section of water levels in the proposed scenario for the 1% AEP with a +20% allowance for climate change (MRFS)

The plan view in Figure 6.7 below presents a comparison of the maximum water levels in the 1D component of the model for both the existing and proposed scenarios for the 1% AEP with a +20% allowance for climate change (MRFS).

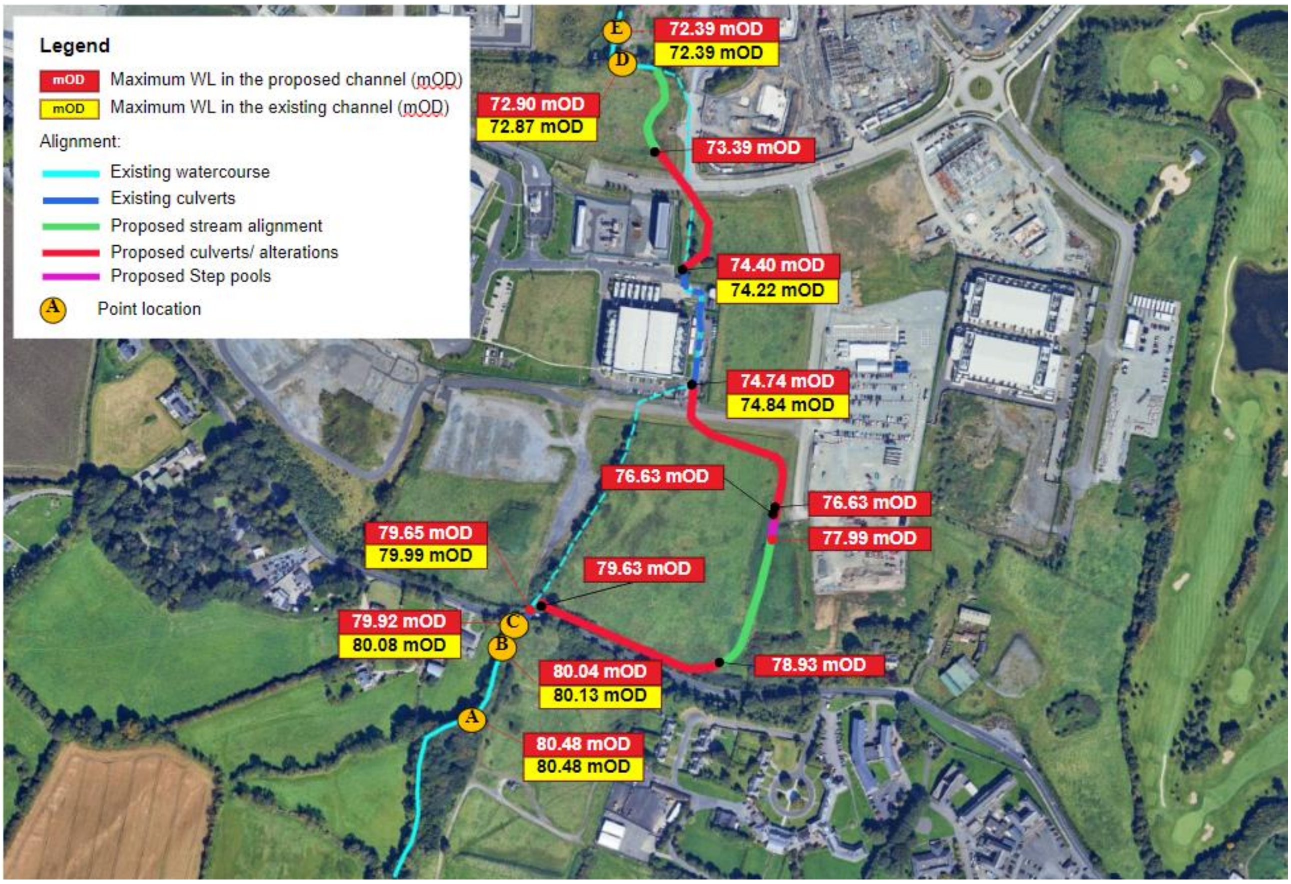


Figure 6.7: Existing and proposed water levels across and around the site for the 1% AEP +20% allowance for climate change (MRFS)

The figures above demonstrate that the proposed culverts and stream diversion have a positive impact on enhancing flow conveyance compared to the existing scenario. The stream diversion effectively bypasses two 600mm diameter culverts (Culvert 2 and the inlet to Culvert 3), which cause water buildup upstream and cause overtopping and out of bank flooding.

The proposed realignment and larger culverts offer an improvement over the current configuration, mitigating the risk of blockages and enhancing watercourse conveyance during flood events. Additionally, water levels within the site in the proposed model remain within the stream banks, including a minimum of 300mm freeboard.

6.4.3 Impact of Proposed Development Offsite

The impact of the proposed culverts and stream diversion on water levels outside the site boundary is minimal. In the proposed scenario, during the 1%AEP +20% climate change allowance, water levels at the upstream end of the site (south) are locally reduced on average by 100mm compared to the existing conditions (points B &C, Figure 6.7), returning to existing scenario levels 115m upstream (point C). At the downstream end of the model, water levels locally increase by 30mm directly downstream of the site (point D). The water levels return to pre-development (existing) levels 75m downstream of the site (point E). It should be noted this increase in levels is only local and occurs during the 1%AEP +20% climate change allowance. There is no impact during the 1% AEP. Table 6.3 shows the flood levels at 5 locations directly upstream and downstream of the site.

Table 6.3 Flood level comparison outside the site for the 1%AEP and 1%AEP MRFS

Point	Existing		Proposed		Changes in flood levels*	
	1% AEP	1% AEP MRFS	1% AEP	1% AEP MRFS	1% AEP	1% AEP MRFS
A	80.43	80.48	80.43	80.48	0.00	0.00
B	80.06	80.13	79.97	80.04	0.09	0.09
C	80.02	80.08	79.82	79.92	0.20	0.16
D	72.89	72.87	72.86	72.90	0.03	-0.03
E	72.42	72.39	72.35	72.39	0.07	0.01

*Negative values show **increase** in flood levels due to proposals, positive values show decrease

During the 0.1% AEP event, the local increase in levels downstream of the site at location D is 50mm. Again, the levels return to pre-development flood levels 75m downstream of the site. There is no impact on receptors as a result of this increase.

6.4.4 Blockage Scenario

Blockage analysis was undertaken to assess a potential partial blockage of Culvert A due to debris build up at a security screen at the upstream face of the culvert. A scenario involving a 33% blockage for Culvert A was simulated, assuming that 33% of the culvert's conveyance area was obstructed by debris. To model this scenario, the flow blockage feature in MIKE Hydro was utilised.

Water levels from the blockage scenario simulation are shown in Figure 6.8 and are compared to water levels from the proposed scenario (Figure 6.6).

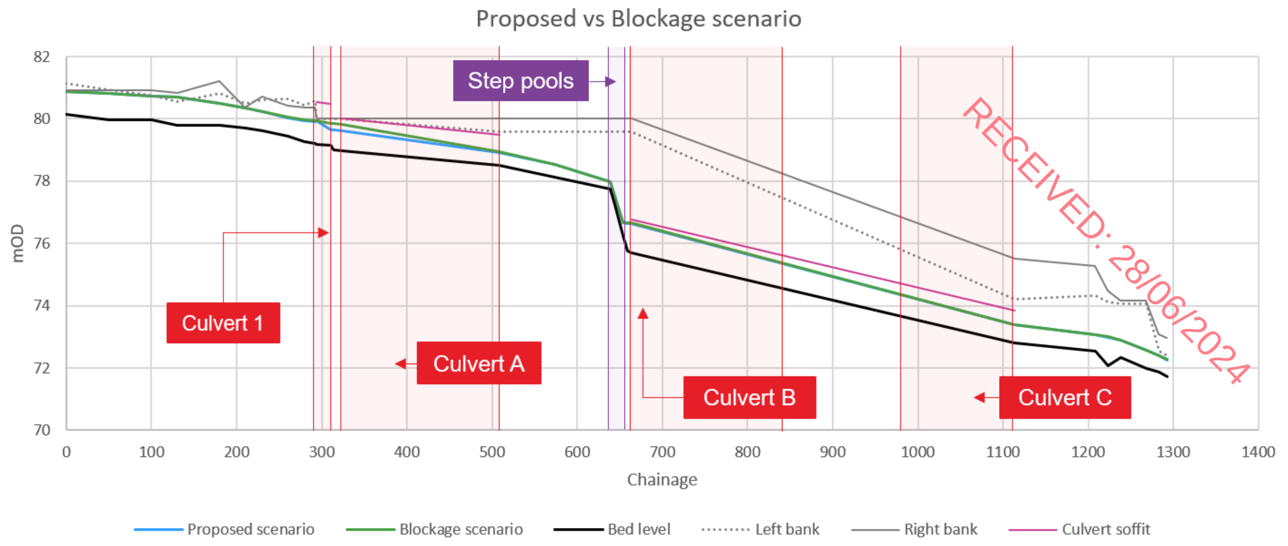


Figure 6.8: Long-section of water levels in the blockage scenario compared to the proposed scenario, both for 1% AEP MRFS

As shown, the water levels are affected for approximately 34m upstream of the blockage. In a blockage event, water levels upstream of Culvert 1 outside the site would be increased by 25mm to 79.94mOD. The nearby dwelling upstream of Culvert 1 according to the LiDAR data is at 81.2m OD, and as such, is not impacted by the increased water levels.

The water levels within the site and directly upstream of Culvert A are increased by 206mm to 79.83mOD. This level is below the proposed Finished Floor Level of the data hall building, which has been set to 80.02m AOD. The perimeter road of the data hall building is set at 79.65m OD and will be at risk of flooding during such event. The simulated blockage only impacts upstream of Culvert A. The impact of a partial blockage of Culvert A to the site or outside the site is not considered significant.

6.4.5 1% AEP HEFS

The proposed scenario was also simulated for the 1% AEP HEFS (i.e. using an increase of 30% to input flows) for the purposes of setting finished floor levels (FFL), as discussed in Section 2.4. The long section of water levels is shown in Figure 6.8. The peak water level within the site is located immediately downstream of Culvert 1 and is simulated as 79.67m OD, an increase of 20mm above the MRFS (which was simulated as 19.65m OD). This HEFS value is used to set the proposed minimum FFL for the data hall building. During such an event, there is no overland flooding to the site.

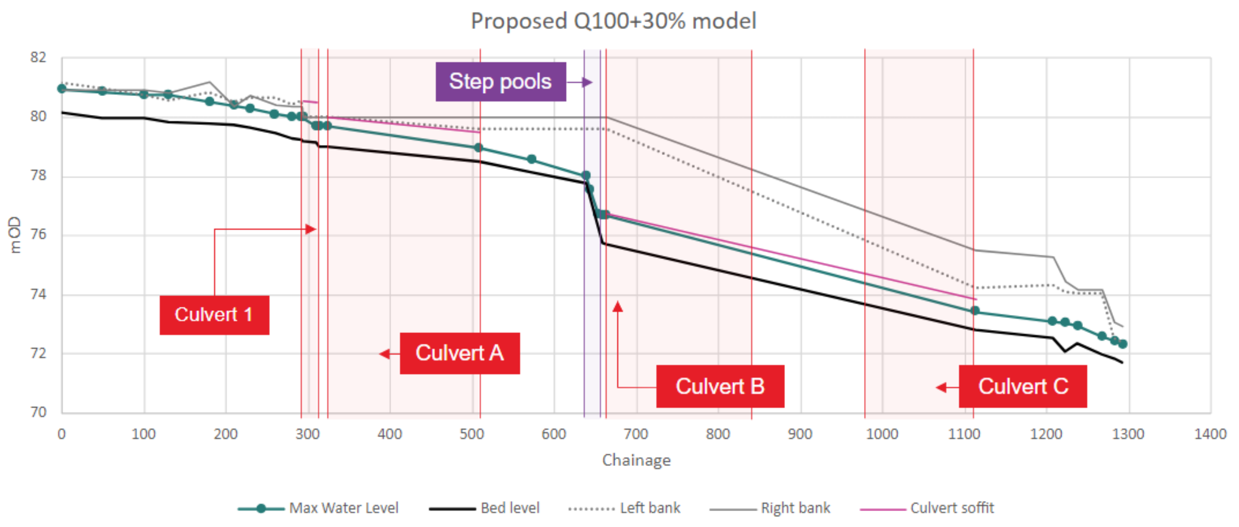


Figure 6.9: Long-section of water levels in the proposed scenario for the 1% AEP with a +30% allowance for climate change (HEFS)

6.5 Summary of Findings from Hydraulic Modelling

A hydraulic model was built using MIKE flood modelling software. The model was used to simulate a number of different scenarios. The results of these simulations were used to assess flood risk at the site, which can be summarised as follows:

- Model results from the existing scenario 1% AEP and 0.1% AEP simulations were used to produce an updated Flood Zone Map showing Flood Zone A and Flood Zone B on the site;
- The site is deemed to be partially in Flood Zone A, B and C;
- The realignment of the stream and provision of larger culverts decreases flood risk to the site and immediate areas upstream and downstream when compared to the existing model;
- The design flood level is taken as 79.67mOD. This was taken from the results from the 1% AEP HEFS proposed model (the 1 in 100-year +30% increase to flows climate change allowance);
- Simulating a blockage of the most upstream proposed culvert does not significantly increase flood risk outside the site and does not significantly impact the operation of the site.

7. Proposed Flood Protection Measures

7.1 Design measures

The following design measures were implemented to reduce risk of flooding to the development, without negatively impacting other sites:

- The proposed development is removing smaller culverts along the stream that are currently acting as pinch points and is providing additional conveyance capacity by the introduction of an open stream and new larger culverts where open stream option is not possible. Flooding within the site is therefore reduced significantly due to the proposed development.
- The offsite impact is very small and local. There is local reduction in levels due to the proposals upstream and a 30mm increase in levels downstream. The flood levels return to pre-development (existing) levels 75m downstream of the site.
- The new re-aligned watercourse is designed to convey the 1% AEP event with 20% increase in flows allowed to account for climate change. Where the watercourse is designed as open stream, a minimum of 300mm freeboard to the bank is allowed.
- The finished floor levels are raised above the Design Flood Event (DFE), with a 30% allowance for climate change (HEFS) and an appropriate freeboard.
- Development is set back from the open stream sections of the watercourse.

7.2 Minimum Finished Floor Level

The flood level in the 1% AEP HEFS flood event directly upstream the data hall building are simulated to reach 79.67mOD. This represents the highest expected water level on the data hall site for that flood event.

While a detailed freeboard analysis was not conducted as part of this study, it was deemed prudent to adopt a minimum freeboard of 300mm as a conservative measure for the purpose of this FRA.

Based on the above, the following flood defence level for the site is recommended:

Recommended FFL: 79.67mOD (1%AEP HEFS) + 300 mm of freeboard = **79.97mOD**

This level is below the proposed Finished Floor Level of the data hall building DC3, which is proposed to be set to 80.02m AOD. The proposed FFL of 80.02m OD is also set higher than the maximum simulated water level from the blockage scenario of 79.83mOD.

The proposed east and west Mechanical Yards and the HV Compound are located in areas further away from the open watercourse and are not deemed to be at risk of flooding from the open stream. They are set at 76.8mOD, 78.1mOD and 75.0mOD respectively. The culverted part of the watercourse (Culverts B/C) are at close proximity to the east Mechanical yard. The flood level within the culvert upstream the yard during the 1%AEP HEFS is 73.42mOD, way below the proposed FFL. As such, the Mechanical Yards are adequately safeguarded from any flooding from the watercourse.

The HV Compound is proposed to be set at 75.0mOD.

All roads/grounds surrounding the proposed buildings will slope away from the buildings to ensure no water ingress during a heavy rainfall event.

7.3 Surface water drainage strategy

The surface water drainage strategy proposes to control the rate of run-off from the new development. The maximum permitted surface water outflow from the new development is proposed to be restricted to 2 l/s/ha, thereby managing any increase in run-off to the existing network.

The flows are proposed to be attenuated using two surface water attenuation ponds and one attenuation tank. Each attenuation pond/tank has a restricted outlet (hydrobrake) as the control device to greenfield rates of runoff. The network has been piped and sized to the following standards:

- 1 in 1 year return period events were used to ensure that the system does not surcharge;
- 1 in 100 year return period events were used to ensure that flooding does not occur;
- A climate change allowance of 40% has been adopted.

The pipework around the data hall building drains to Attenuation Pond 1, the pipework around the east Mechanical Yard drains to Attenuation Pond 2, while the pipework around the west Mechanical Yard drains to the attenuation tank. The outfall from Attenuation Pond 1 and attenuation tank discharges to the existing network around DC2. The outfall from Attenuation Pond 2 discharges to the existing network around DC1 (west of DC2).

A series of forecourt separators have been used across the site to capture flows around the refuelling areas. A number of swales have been placed across the site to cater for runoff from the roads.

Furter details of the proposed drainage network can be viewed in the drawings submitted with the planning application (drawings DC3-C-1200-SDT-X to DC3-C-1204-SDT-X).

7.4 Safe access and egress

There is no flooding anticipated at any parts of the site during the 1% AEP HEFS or the 0.1% AEP. Nevertheless, the emergency evacuation route is demonstrated below.

Access and egress from the site will be via the internal proposed roads which will connect to the existing site road networks, which in turn connects into Grange Castle Business Park South and eventually Baldonnel Road, west of the site.

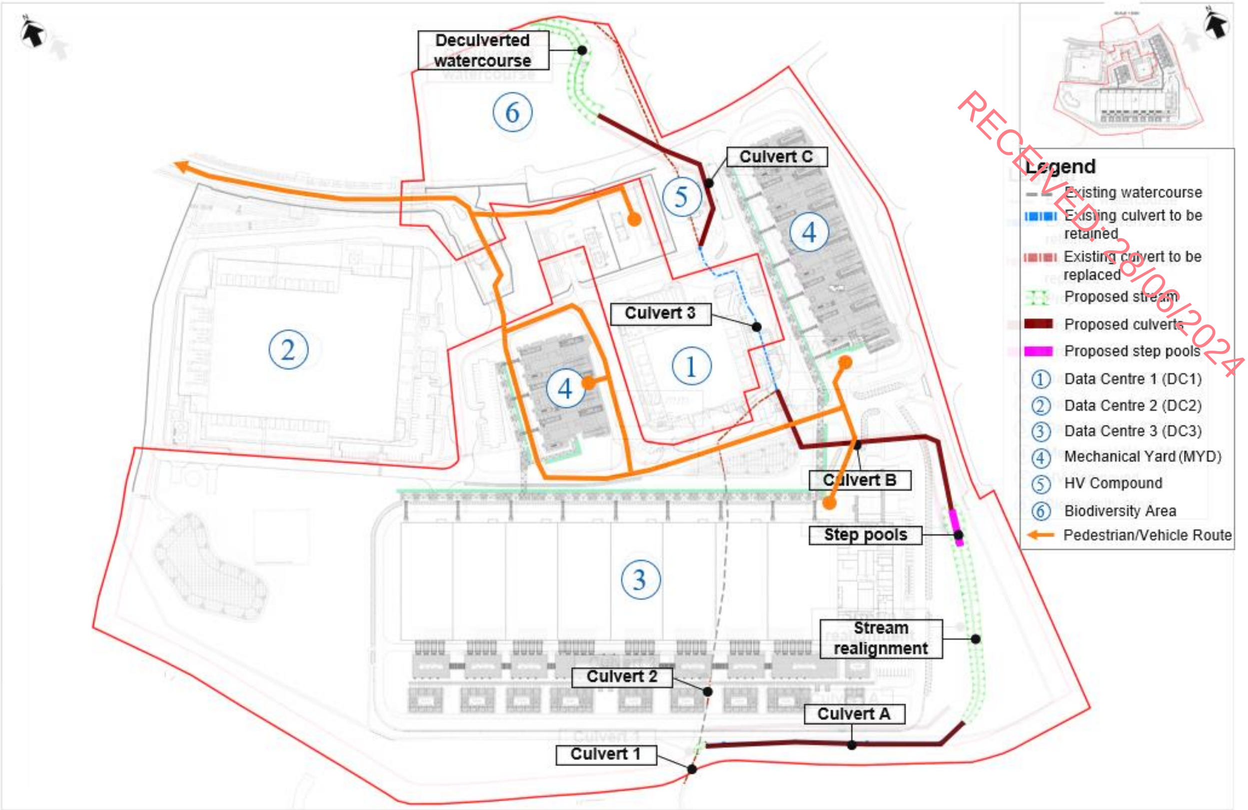


Figure 7.1: Emergency access and egress

7.5 Residual Flood Risk

There is an inherent risk of blockages with the introduction of security screens. GIL will perform regular checks to the security screen for any debris accumulation and remove it promptly.

A blockage scenario run has been undertaken for Culvert A, where a security screen has been modelled to be blocked by potential debris, see Section 6.4.4. The modelling has demonstrated that the water levels within the site and directly upstream of Culvert A are increased by 206mm to 79.83mOD, which is below the proposed Finished Floor Level of the data hall building, set to 80.02m AOD. The simulated blockage only impacts upstream of Culvert A and as demonstrated through modelling, the impact is restricted to only up to 34m upstream of the site, with an increase of 25mm, which is not considered to have a significant impact to nearby residential areas, set 1m higher.

Therefore, the impact of a partial blockage of Culvert A to the site or outside the site is not considered significant and is mitigated sufficiently through monitoring and removal of debris. Due to the provision of a security screen at Culvert A, the risk of debris migrating to the downstream culverts is minimal.

8. Hydromorphological impact on riparian corridor

A hydromorphological assessment was undertaken to support the design of the watercourse realignment. The assessment examined the impacts of the Proposed Development on the on-site watercourse hydromorphology in accordance with the SDCC, 2023 guideline, “Development Hydromorphological Assessment Guidance”. Although the site is not within a Riparian Corridor (SDCC, 2022), it is in a flood zone, necessitating a scoping assessment.

Due to potential variations in stream flow characteristics from the development, a detailed assessment was conducted, involving a quantitative evaluation of the baseline condition of the on-site channel and proposed mitigation measures.

The assessment included a desktop survey and a RHAT analysis, indicating that the current WFD Hydromorphological Status of the watercourse is 7.5 (poor status). After implementing the proposed mitigation measures, which considered flood risk, biodiversity, landscaping, and hydromorphology, the status is expected to improve to 14 (moderate status). The full assessment is included in the Water Chapter Appendix 12.2.

9. Application of the Planning Guidelines

9.1 Flood Zones

As discussed in Section 6.4.1, the majority of the site is in Flood Zone C, with a portion of the eastern side of the site in Flood Zone B. A very small portion of the site, along the existing stream alignment, is in Flood Zone A.

For the purposes of Flood Zone Classification, it is considered that the site is within Flood Zone A.

9.2 Vulnerability Classification

The site is regulated by the EPA under an IE licence. As such, the proposed development is classified as “highly vulnerable development” to flood risk, in accordance with Table 3.1 of The Guidelines (Table 2.2).

9.3 Off-site impact

As discussed earlier in Section 6.4.3, the offsite impact to water levels due to the Proposed Development is very small and local. Water levels upstream of the proposed development site are locally reduced. The proposed development is removing smaller culverts along the stream that were acting as pinch points and is providing additional conveyance capacity. Flood upstream of the site is therefore improved.

During the 1% AEP+20% climate change allowance, there is a 30mm increase in levels locally downstream. The increase in levels reached 50mm during the 0.1% AEP downstream of the site. The flood levels return to pre-development (existing) levels 75m downstream of the site. There are no receptors within the 75m downstream corridor, and the flood flows stay within the banks of the existing watercourse.

9.4 Storage and Conveyance

The Proposed Development is located within the existing Flood Zones A and B. The watercourse is however realigned around the building within a new improved configuration of culverts and open channel. Buildings have been set back from the new watercourse alignment and open space has been allowed on both sides of the proposed open stream. The stream and culverts in the proposed scenario have been designed to ensure there is enough capacity for the 1% AEP MRFS event, with more than 300mm freeboard on the stream banks. As such, the conveyance of the watercourse has been improved.

The impact on storage taken away from the existing floodplain is very small during the 1%AEP event (Flood Zone A), which currently is mainly maintained within bank. The storage volumes taken away from the flood plain is approx..12m^3. Larger storage volume is removed during the 0.1%AEP event (Flood Zone B), where water overtops the 600mm inlet of Culvert 3 and flows towards the northeast part of the site, where it is stored (as demonstrated in Figure 6.4). This volume is estimated at 815m^3. The hydraulic modelling of the existing and proposed situation has proven that during this event the flood levels only increase by 50mm within 75m downstream the site, with no increase further downstream. There are no flood receptors 75m downstream of the site and flows stay within bank. As such, it is considered that this change in storage is not increasing risk of flooding to other sites.

9.5 Sequential Approach of the Justification Test

As the site lies partially within Flood Zones A & B and is classified as ‘Highly Vulnerable’, a Justification Test is required in accordance with The Guidelines.

9.5.1 Application of the Justification Test

The applicable Justification Test is the ‘Development Management’ Justification Test described in Section 5 of the Guidelines.

The Justification Test is adopted by a planning authority when developments vulnerable to flooding are proposed in areas at moderate or high risk of flooding (Flood Zones A and B). Prior to granting permission for the development, the planning authority must be satisfied that the development meets the criteria set out in the Development Management Justification Test in the guidelines. These criteria are shown below in Figure 9.1.

Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

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 these Guidelines.
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;
   (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   (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; and
   (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Refer to section 5.28 in relation to minor and infill developments.

Figure 9.1: Justification Test for development management (extract from The Guidelines)

9.5.2 Justification Test – Part 1

The current Development Plan for the area is the 2022 – 2028 South Dublin County Development Plan (SDCC, 2022). The site is zoned for ‘Objective EE’: to provide for enterprise and employment related uses. The proposed development is a data centre, which is compatible with the zoning of providing enterprise and employment.

An element of the site, to the south east, is zoned objective 'RU' 'To protect and improve rural amenity and to provide for the development of agriculture'. This area has been allocated for open space uses and landscaping, including the open stream diversion.

Therefore, it is considered that the proposed development satisfies the criteria of Part 1 of the development management Justification Test.

9.5.3 Justification Test – Part 2(i)

As described above in Section 6.4.5, the proposed culverts and stream diversion have a positive impact on enhancing flow conveyance compared to the existing scenario. The stream diversion effectively bypasses two 600mm diameter culverts (Culvert 2 and the inlet to Culvert 3), which cause water buildup upstream and cause overtopping and out of bank flooding. The proposed realignment and larger culverts offer an improvement over the current configuration, mitigating the risk of blockages and enhancing watercourse conveyance during flood events. Additionally, water levels within the site in the proposed model remain within the stream banks, including a minimum of 300mm freeboard.

The offsite impact to water levels due to the Proposed Development is very small and local. Water levels upstream of the proposed development site are locally reduced. The proposed development is removing smaller culverts along the stream that were acting as pinch points and is providing additional conveyance capacity. Flood upstream of the site is therefore improved.

There is a 30mm increase in levels locally downstream. The flood levels return to pre-development (existing) levels 75m downstream of the site. There is no impact to upstream or downstream properties.

In relation to surface water runoff, the design of the surface water drainage systems to serve the proposed development will incorporate applicable elements of SuDS and will limit post development run-off in accordance with South Dublin County Council requirements.

Therefore, it is considered that the proposed development satisfies the criteria of Part 2(i) of the development management Justification Test.

9.5.4 Justification Test – Part 2(ii)

The mitigation measures proposed to minimise flood risk to people, property, the economy and the environment are discussed in Section 7 of this report. Culverts that act as pinch points to flow are removed and replaced with a system of culvert with higher conveyance capacity. The realigned open stream and de-culverted watercourse are designed to the 1%AEP MRFS with a minimum of 300mm freeboard. The minimum finished floor levels have been set above the flood levels, with allowances for climate change (HEFS) and freeboard.

It is therefore considered that the proposed development satisfies the criteria of Part 2(ii) of the development management Justification Test.

9.5.5 Justification Test – Part 2(iii)

The measures to ensure that residual risks to the development will be managed to an acceptable level are discussed in Section 7.5. The security screen will be monitored and maintained by the applicant. A safe access and egress route is identified that ensures evacuation of staff if necessary during an emergency.

It is considered that the proposed development satisfies the criteria of Part 2(iii) of the development management Justification test.

9.5.6 Justification Test – Part 2(iv)

The proposed development is consistent with the objectives of the South County Council Development Plan 2022 – 2028 in terms of enhancing existing biodiversity (refer to Chapter 11 of the EIAR), improving resilience to climate change (as per this FRA), enabling the role of green infrastructure in delivering sustainable development (as per Drainage Strategy described in DC3-RP-C-0001), thus overall enabling good urban design.

It is considered that the proposed development satisfies the criteria of Part 2(iv) of the development management Justification test.

10. Conclusion

The FRA has assessed potential risks of flooding to the development from fluvial, tidal, pluvial and groundwater flood sources. The site is at low risk from tidal, pluvial and groundwater sources. Part of the site is at risk from fluvial flooding from a small tributary of the River Griffeen. The Eastern CFRAMS mapping indicates that the site is partially located within Flood Zones A, B and C. However, the CFRAM modelling at the site is considered unrealistic as it is believed that large, culverted sections within the site were not modelled.

A hydrological analysis and hydraulic modelling were therefore undertaken to assess in detail the risk of fluvial flooding from the watercourse. The modelling shows reduction in the flood zones compared to the CFRAMS mapping.

Flood mitigation measures are developed to ensure the development is safe from flooding now and in the future. The measures include realignment of the existing watercourse around the proposed data hall building, removal of existing culverts that restricted flows and introduction of new culverts where an open stream is not possible. The new watercourse alignment and culvert configuration are designed to convey the 1 in 100-year event (1%AEP) with 20% increase in flows allowed to account for climate change. Where the watercourse is designed as open stream, a minimum of 300mm freeboard to the bank is allowed. The proposals result in small local reduction in flood levels upstream and downstream the site and significant reduction in flooding within the site.

Other mitigation measures include raising the finished floor levels raised above the 1%AEP event with a 30% allowance for climate change (HEFS) and an appropriate freeboard. Finally, development is set back from the open stream sections of the watercourse.

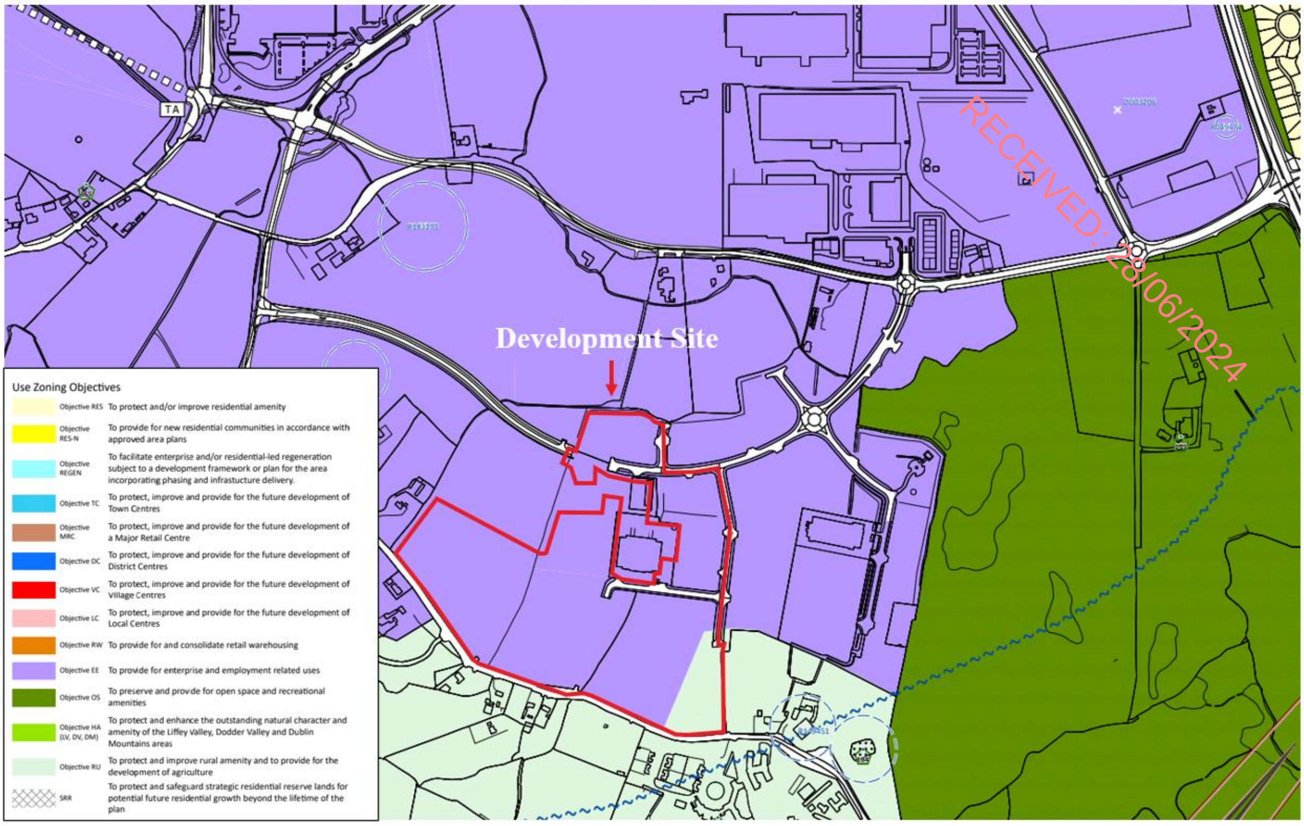
The potential impacts of the development on flood storage, conveyance and surface water run-off were also assessed. No impact was detected on properties upstream and downstream the site. The residual risks to the occupants of the development were also assessed as part of the FRA. A blockage assessment potentially resulting from the security screen at Culvert A shows minimal impact outside the site and small impact to the perimeter road of the development. The residual risk of flooding to the site and environment is therefore considered not significant.

The proposed development is a 'highly vulnerable development' to flooding, and partially lies within the current Flood Zone A. Therefore, a Justification Test in accordance with the OPW Guidelines was carried out. It has been demonstrated that the Proposed Development satisfies all the Development Management Justification Test criteria.

This FRA has demonstrated that the risks relating to flooding can be managed and mitigated to acceptable levels and therefore comply with DoEHLG / OPW and South Dublin County Council planning guidance.

Appendix A

Land Use Zoning Map


TA
Development Site
Use Zoning Objectives
Objective RES To protect and/or improve residential amenity
Objective RES-N To provide for new residential communities in accordance with approved area plans
Objective REGEN To facilitate enterprise and/or residential-led regeneration subject to a development framework or plan for the area incorporating phasing and infrastucture delivery.
Objective TC To protect, improve and provide for the future development of Town Centres
Objective MRC To protect, improve and provide for the future development of a Major Retail Centre
Objective DC To protect, improve and provide for the future development of District Centres
Objective VC To protect, improve and provide for the future development of Village Centres
Objective LC To protect, improve and provide for the future development of Local Centres
Objective RW To provide for and consolidate retail warehousing
Objective EE To provide for enterprise and employment related uses
Objective OS To preserve and provide for open space and recreational amenities
Objective HA (LV, DV, DM) To protect and enhance the outstanding natural character and amenity of the Liffey Valley, Dodder Valley and Dublin Mountains areas
Objective RU To protect and improve rural amenity and to provide for the development of agriculture
SRR To protect and safeguard strategic residential reserve lands for potential future residential growth beyond the lifetime of the plan