Clondalkin LPF Strategic Flood Risk Assessment

Technical Report

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South Dublin County Council

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Contract

This report describes work commissioned by South Dublin County Council. Ken Mealiff, David Casey, and Ross Bryant of JBA Consulting carried out this work.

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Purpose

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Abbreviations

1D ..... One Dimensional (modelling)
2D ..... Two Dimensional (modelling)
AEP ..... Annual Exceedance Probability
CDP ..... County Development Plan
CFRAM ..... Catchment Flood Risk Assessment and Management
DoEHLG ..... Department of the Environment, Heritage and Local Government
FARL ..... FEH index of flood attenuation due to reservoirs and lakes
FB ..... Freeboard
FFL ..... Finish Floor Levels
FRA ..... Flood Risk Assessment
FSR ..... Flood Studies Report
FSU ..... Flood Studies Update
GSI ..... Geological Survey of Ireland
LHB ..... Left Hand Bank
LPF ..... Local Planning Framework
OPW ..... Office of Public Works
PFRA ..... Preliminary Flood Risk Assessment
RFI ..... Request for Further Information
RHB ..... Right Hand Bank
RR ..... Rainfall-Runoff
SAAR ..... Standard Average Annual Rainfall (mm)
SDCC ..... South Dublin County Council
SFRA ..... Strategic Flood Risk Assessment
URBEXT ..... FEH index of fractional urban extent
WL ..... Water Level

1 Introduction

1.1 Commission

JBA Consulting Engineers was commissioned by South Dublin County Council (SDCC) to prepare a Strategic Flood Risk Assessment to supplement the Clondalkin Local Plan Framework (LPF). The LPF will shape the future growth of Clondalkin over the period of the plan and beyond.

1.2 Scope

The scope of this report is as follows:

- Provide an assessment/identification of flood risk for the LPF area in accordance with "The Planning System and Flood Risk Management – Guidelines for Planning Authorities" (The Guidelines), 2009, published by the Department for the Environment, Heritage and Local Government and the Office of Public Works (OPW).
- Undertake a Flood Risk Assessment Report assessing the hydrology and hydraulics and determining mechanisms of flooding in the LPF area, taking into account anticipated future increases in rainfall, river flows and sea level rise as a result of climate change.
- Provide recommendations for future flood risk assessments for proposed developments and planning applications, in accordance with The Guidelines.
- Delineate Riparian Corridors at a strategic level and detail requirements for hydromorphological assessments to aid in meeting our obligations under the Water Framework Directive and Floods Directive. Riparian Corridors are identified to protect and enhance watercourses and their natural regimes including ecological, biogeochemical, hydromorphological and flood resilience in the face of climate change.
- Liaison with Consultants completing the Strategic Environmental Assessment (SEA), Appropriate Assessment and South Dublin County Council as well as public consultation.

A Stage 1 Flood Risk Identification has been undertaken to identify any flooding or surface water management issues related within the County that may warrant further investigation. As part of this stage the most up to date available data at the time of preparation was acquired from the Office of Public Works (OPW) and South Dublin County Council. The Eastern and Dodder CFRAMS has generated flood zone mapping which has been deemed suitable as a Stage 2 Initial Flood Risk Assessment. This flood risk information has enabled SDCC to apply 'The Guidelines' sequential approach, and where necessary the Justification Test, to appraise sites for suitable land zonings and identify how flood risk can be managed as part of the LPF.

Although great care and modern widely accepted methods have been used in the preparation and interpretation of flood risk areas, there is inevitably a range of inherent uncertainties and assumptions made during the estimation of design flows and the construction of flood models. The inherent uncertainty necessitates a precautionary approach when interpreting flood extent mapping.

1.3 Study Area

The subject area comprises lands in Clondalkin, South Dublin County, 11km west of Dublin city centre. Clondalkin is situated on the River Camac and is classed as a secondary administrative centre for South County Dublin and a Level 3 Retail Centre in the Regional Spatial and Economic Strategy (RSES).

The hydrological environment is provided in Figure 1-1.

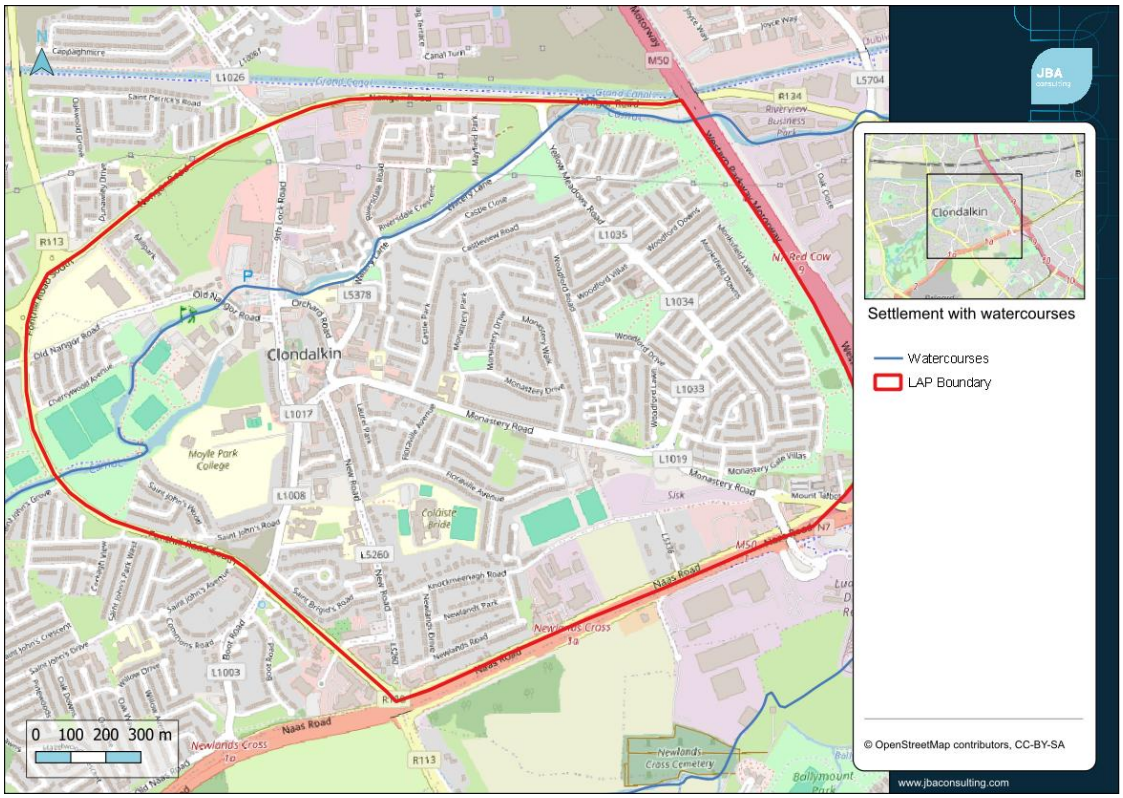


Figure 1-1: Rivers within Clondalkin

1.3.1 Catchment Description

The Development Plan area lies within the Hydrometric Area 09 Liffey-Dublin Bay within the catchment of the River Camac. The River Camac is one of the most modified river catchments in Dublin, with extensive hydromorphological changes extending back through centuries to accommodate milling, agriculture, and urban expansion. It flows in a north easterly direction to its confluence with the Liffey at Heuston Station.

The River Camac catchment suffers from flooding which impacts heavily populated areas near the city centre including large areas of Clondalkin.

2 Methodology

2.1 Introduction

This report has been prepared in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' herein referred to as 'The Guidelines' as published by the Office of Public Works (OPW) and Department of Environment, Heritage and Local Government (DoHLG) in 2009.

2.2 Objectives and Principles of the Planning Guidelines

The principal actions when considering flood risk are set out in the planning guidelines and are summarised below:

- "Flood hazard and potential risk should be determined at the earliest stage of the planning process..."
- "Development should preferentially be located in areas with little or no flood hazard thereby avoiding or minimising the risk...."
- "Development should only be permitted in areas at risk of flooding when there are no alternatives, reasonable sites available..."
- "Where development is necessary in areas at risk of flooding an appropriate land use should be selected"
- "A precautionary approach should be applied, where necessary, to reflect uncertainties in flooding datasets and risk assessment techniques..."
- "Land required for current and future flood management... should be proactively identified..."
- "Flood risk to, and arising from, new development should be managed through location, layout and design incorporating Sustainable Drainage Systems (SuDS) and compensation for any loss of floodplain..."
- "Strategic environmental assessment (SEA) of regional planning guidelines, development plans and Masterplans should include flood risk as one of the key environmental criteria..."

2.3 Definition of Flood Risk

Flood risk is a combination of the likelihood of a flood event occurring and the potential consequences arising from that flood event and is then normally expressed in terms of the following relationship:

Flood Risk = Likelihood of flooding x Consequences of flooding

To fully assess flood risk, an understanding of where the water comes from (i.e., the source), how and where it flows (i.e., the pathways) and the people and assets affected by it (i.e., the receptors) is required. Figure 2-1 below shows a source-pathway-receptor model reproduced from 'The Guidelines'.

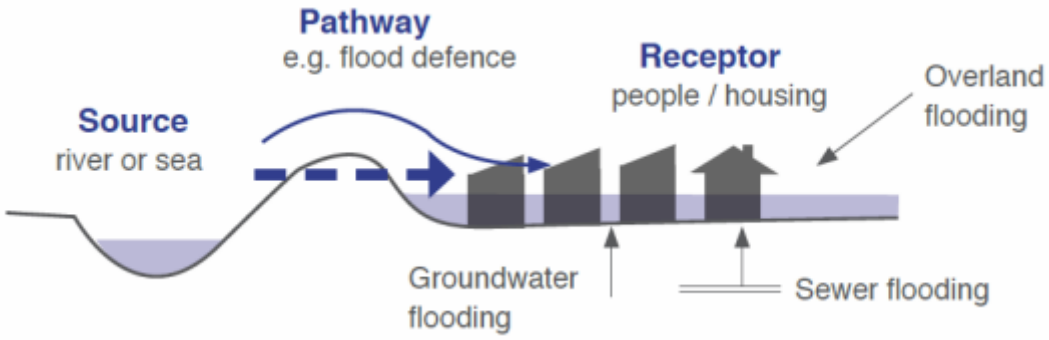


Figure 2-1 Source-Pathway Receptor Model

The principal sources of flooding are rainfall or higher than normal sea levels. The principal pathways are rivers, drains, sewers, overland flow and river and coastal floodplains. The receptors

can include people, their property, and the environment. All three elements as well as the vulnerability and exposure of receptors must be examined to determine the potential consequences.

2.4 Likelihood of Flooding

The Guidelines define the likelihood of flooding as the percentage probability of a flood of a given magnitude or severity occurring or being exceeded in any given year. It is generally expressed as a return period or annual exceedance probability (AEP). A 1% AEP flood indicates a flood event that will be equalled or exceeded on average once every hundred years and has a return period of 1 in 100 years. Annual Exceedance Probability is the inverse of return period as shown in Table 2.1 below.

Table 2.1: Probability of Flooding

Return Period (Years)	Annual Exceedance Probability (%)
2	50
100	1
200	0.5
1000	0.1

2.5 Definition of Flood Zones

Flood zones are geographical areas within which the likelihood of flooding is in a particular range and are split into three categories in The Guidelines, which has been provided in Table 2.2.

Table 2.2: Definition of Flood Zones

Zone	Description
Zone A High probability of flooding.	This zone defines areas with the highest risk of flooding from rivers (i.e. more than 1% probability or more than 1 in 100) and the coast (i.e. more than 0.5% probability or more than 1 in 200).
Zone B Moderate probability of flooding.	This zone defines areas with a moderate risk of flooding from rivers (i.e. 0.1% to 1% probability or between 1 in 100 and 1 in 1000) and the coast (i.e. 0.1% to 0.5% probability or between 1 in 200 and 1 in 1000).
Zone C Low probability of flooding.	This zone defines areas with a low risk of flooding from rivers and the coast (i.e. less than 0.1% probability or less than 1 in 1000).

It is important to note that The Planning System and Flood Risk Management Guidelines for Planning Authorities and Technical Appendices, 2009 ignore the presence of flood defences when defining Flood Zones; this is due to the fact that even areas that benefit from an existing flood defence can still be vulnerable due to the speed when overtopping or a breach or other failure takes place. Therefore, this residual risk of flooding where appropriate should be assessed as part of the application of the Justification Test and, if the site is zoned for development, through the site specific flood risk assessment.

2.5.1 Consequences of Flood Risk

The consequences of flooding depend on the hazards associated with the event, including: depth of water, speed of flow, rate of onset, duration, wave action effects and water quality. The consequences are also determined by the vulnerability of people, property and the environment potentially affected by a flood. The recovery time following flooding is also important.

The Planning System and Flood Risk Management Guidelines for Planning Authorities and Technical Appendices, 2009 provide three vulnerability categories based on the type of development which are detailed below in Table 2.3 source The Planning System and Flood Risk

Management Guidelines for Planning Authorities and Technical Appendices, 2009). This illustrates the types of development that would be appropriate to each Flood Zone and those that would be required to meet the Justification Test. Inappropriate development that does not meet the criteria of the Justification Test should not be considered at the plan-making stage or approved within the development management process.

Table 2.4 provides the matrix of vulnerability vs flood zone

Table 2.3: Classification of Vulnerability of Different Types of Development

Vulnerability Class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential Infrastructure, such as primary transport and utilities distribution, including: electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for; retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Water treatment (except landfill and hazardous waste); Mineral working and processing; and Local Transport Infrastructure.
Water compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling , dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Table 2.4: Matrix of Vulnerability vs Flood Zone to illustrate application of the Justification Test

	FLOOD ZONE A	FLOOD ZONE B	FLOOD ZONE C
Highly vulnerable development	**JUSTIFICATION TEST**	**JUSTIFICATION TEST**	APPROPRIATE
Less vulnerable development	**JUSTIFICATION TEST**	APPROPRIATE	APPROPRIATE
Water-compatible development	APPROPRIATE	APPROPRIATE	APPROPRIATE

2.6 The Sequential Approach and Justification Test

The sequential approach is the key tool in ensuring that development, particularly new developments, first and foremost is directed towards land that is at low risk. Figure 2-2 sets out the broad philosophy underpinning the sequential approach.

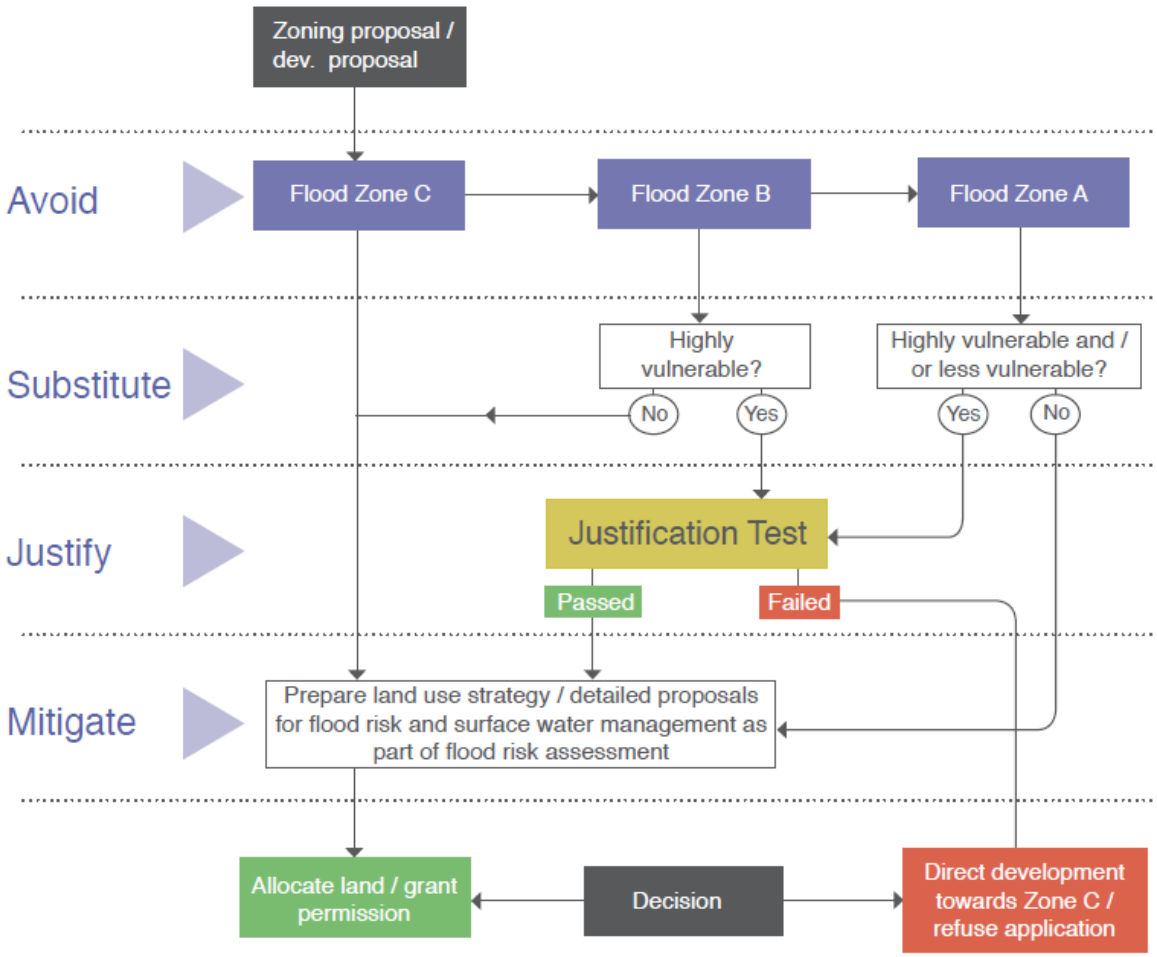


Figure 2-2 Sequential Approach (The Guidelines)

The sequential approach to flood risk makes use of flood risk assessment and of prior identification of Flood Zones for river and coastal flooding and classification of the vulnerability of flooding of different types of development. This approach highlights the importance of taking into account the risks of other sources of flooding in all areas and at all stages of the planning process.

The sequential approach is based on the following principles:

Avoid – Substitute – Justify – Mitigate – Proceed.

Where possible, development in areas identified as being at high flood risk for that type of development should be avoided. This may necessitate rezoning lands within the Development Plan from a higher vulnerability land-use, such as residential, to a less vulnerable use, such as open

space. Where rezoning is not possible, development restrictions are provided for through the application of the Justification Test, as set out below.

2.6.1 Justification Test for Development Plans

The primary approach for managing flood risk has been to either avoid development in Flood Zone A or B, or substitute a lower vulnerability development. However, it is only when both avoidance and substitution cannot take place should consideration be given to mitigation and management of risks, which can only be provided for through the Justification Test.

The plan making Justification Test has been carried out as part of the SFRA using mapped Flood Zones. It applies where South Dublin County Council (SDCC) has reviewed the need for development of areas at a high or moderate risk of flooding for uses which are vulnerable to flooding and which would generally be inappropriate, and where avoidance or substitution is not appropriate. Where land-use zoning objectives have been retained, SDCC is satisfied that it has clearly demonstrated that the designation for development has satisfied the Justification Test for Development Plans. In such cases, all of the following criteria have been satisfied:

1. *The urban settlement is targeted for growth under the National Planning Framework and Regional Spatial and Economic Strategy, statutory plans, as defined above or under the provisions of the Planning and Development Act, 2000, as amended.*
2. *The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and, in particular:*
    - *i. Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement;*
    - *ii. Comprises significant previously developed and/ or under-utilised lands;*
    - *iii. Is within or adjoining the core of an established or designated urban settlement;*
    - *iv. Will be essential in achieving compact and sustainable urban growth and*
    - *v. There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.*
3. *A Flood Risk Assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the Development Plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere.*

N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment.

Source: The Planning System and Flood Risk Management Guidelines for Planning Authorities (2009)

Circular letter PL2/2014 from DECLG dated 13 August 2014 states that for existing developed areas at risk of flooding, and proposed regeneration areas, the Planning Authority or Development Plan must 'specify the nature and design of structural or non-structural flood risk management measures prior to future development in such areas to ensure that flood hazard and flood risk to the area and other locations is not increased, or if practicable, will be reduced.' In many cases through this SFRA, flood risk to existing development has been identified and appraised. The extent and depth of flooding has been assessed and it has been determined that risks can be managed through development control measures, as detailed in the later sections of this SFRA. However, there are a number of areas where further development would be considered premature until ongoing or planned defence works have been completed and these have been identified (Areas to be confirmed) they arise (see Part 3 of the Justification Tests in Appendix A for further details).

2.7 Strategic Hydromorphological Assessment

A Strategic Hydromorphological Assessment has been undertaken of the main watercourses within South Dublin County. The assessment will aid in delineating floodplain boundaries using morphological features to identify functional riparian zones. The goal being to provide the basis for sustainable zoning policies that provides "room for the river" and in time allow river systems to return to a state of equilibrium with rich biodiversity, developed ecosystem service provision and resilience

to future shocks such as climate change. This approach will aid in meeting our objectives under the Water Framework and Floods Directives.

2.7.1 Hydromorphic Assessment and Riparian Corridor Designation Methodology

Hydromorphological integrity is identified in the WFD as one of the three key criteria for determining Waterbody Status (the others being ecology and chemical). Currently in WFD Ecoregion 17 (The Island of Ireland) classification of Hydromorphology only contributes to the classification of water bodies at high ecological and chemical status. Nonetheless, high status Hydromorphology is an indicator of overall high-good waterbody status as well as resilience within the catchment. A Strategic Hydromorphological Assessment of major rivers within Clondalkin has been undertaken as part of the River Camac Flood Alleviation Scheme (FAS). Parts of this assessment are reproduced here in Section 4. The strategic hydromorphological Assessment considered a range of parameters including:

- Quaternary Alluvial Deposits
- Alluvial sediments are deposited during flood events and can indicate areas of historic flooding or natural routes of subsequently modified watercourses.
- Slope Analysis - Break in Slope and Terrace Definition
- High-definition LiDAR was assessed to identify prominent changes in slope and terraces adjacent to watercourses. These terraces are formed due to long term erosional processes and their presence often corelate with recurring flood extents. In the uplands of the Dublin mountains breaks in slope defined the extents of steep valleys.
- Historical Mapping Review
- Mapping available from the early 19th century indicate land uses, areas liable to flood as well as modifications to watercourses and their floodplains.
- Review of aerial photographs for Riparian Vegetation Extents.
- Riparian vegetation is crucial to the stability and resilience of riparian corridors and the biodiversity potential they promote. Riparian Corridors boundaries were identified to minimise fracturing of vegetated areas directly adjacent to watercourses.

The Clondalkin SFRA will build upon the works carried out as part of the County Development Plan.

3 Data Collection and Review

3.1 Introduction

This section reviews the data collection and the flood history for the Clondalkin so that any additional information on flooding can be included within this SFRA. It will confirm the extent of extreme flooding (through the Flood Zone mapping) and key sources of flood risk.

A number of flood investigation and management studies have been undertaken that covers Clondalkin. This encompasses either historical or predicted flood extents. The aim of the flood risk identification stage of the SFRA is to identify flood risk based on the data available, including historical records, considering all sources of flooding, and to appraise the quality and usefulness of the data.

A wide range of data was collected and reviewed for completeness, applicability, quality, and confidence in its accuracy. One of the key outcomes of the SFRA is to produce a Flood Zone Map which, along with other planning considerations, will inform land-use zoning / development decisions. The accuracy of the flood extent may vary across the study area depending on the origin and quality of available data, but the best available or readily derivable information has been used to form the composite map.

In all cases, the outlines have been reviewed against each other, any additional available data and against local engineering knowledge and have been refined where appropriate. In particular, the datasets that have been used are the Eastern CFRAM flood extents. The extents have been supplemented with records of historical flood events, walkover survey and consultation with local authority area engineers.

3.2 Data Sources

The various sources of data are briefly discussed in the following paragraphs, which also give an indication of how each dataset was used in the SFRA study. More detail regarding each of the datasets is available from the relevant study specific reports. Table 3.1 and Table 3.2 sets out the available flood data utilised within the SFRA document.

The Camac FAS flooding study carried out a detailed analysis on the River Camac. The principal output was an analysis of the flood risk based on extreme flood events and included options for flood prevention and protection for properties at risk. It is noted in comparison to the CFRAM study, that the Camac FAS developed an integrated catchment model that incorporated both fluvial flood sources (Camac River) and the wider stormwater system. Whereas the CFRAM Study is solely a fluvial flood model that applies the flood flows directly to the river system. At the time of writing of this SFRA the Camac FAS extents are unavailable and CFRAM extents will be used to define the Flood Zones.

Information on historical flood events provided a useful cross-check on the Flood Zones and allowed verification of the outputs. Details of recent flood events are provided in Section 3.2.1. This was coupled with the area engineer's knowledge of the watercourses and their catchments.

The CFRAM Programme is complete and implementation of the outputs from this work is underway by the OPW. The EU Floods Directive requires Member States to review the PFRA, the FRMPs and the flood maps on a six yearly cycle and consequently, the OPW completed the National Indicative Fluvial Mapping (NIFM) Programme in 2019 and it continues to update predictive flood mapping to provide the best available flood risk information through the map review programme. Further information on the above is available at www.floodinfo.ie.

The OPW's National Indicative Fluvial Mapping (NIFM) and Preliminary Flood Risk Assessment (PFRA) mapping (now obsolete) provides indicative flood extents for fluvial, coastal, groundwater and surface water risks.

The flood maps for the whole area comprise a 'Composite Flood Map', see Appendix 8 (and a set of Flood Zone Maps overlaid on the Land-Use Zoning Maps for Clondalkin, which are available for viewing on the SDCC Development Plan Website.

Table 3.1: Available Flood Data for Flood Zone Development

Description	Coverage	Robustness	Comment on usefulness
Eastern CFRAM Flood Mapping	Covers the River Camac and its tributaries	High AFA status	Detailed 1D/2D CFRAM HPW model and is useful. Site verified by walkover and consultation with local authority. In general, CFRAM provides all information needed to apply the Justification Test (JT) for Plan Making under the SFRA.
Historical Flood Event Outlines	Coverage of most of LPF area from previous flood event	Moderate	Used indirectly to validate flood zones. Useful background information for flooding in specific areas of the settlement.

Table 3.2 Other Available Data

Description	Coverage	Robustness	Comment on usefulness
GSi Groundwater and Surface Water flood information	Full Study Area	Moderate	Provides both historic and predictive flood extents for groundwater and historic surface water flooding.
Alluvial Soils Maps	Full Study Area	Low	Used to provide indication of risk in areas with no other mapping available.
Groundwater vulnerability maps	Broadscale, County wide	Moderate	Initial assessment of groundwater vulnerability. Provides a screening tool for use in FRA.
Site Walkover	Specific areas of interest	Moderate	Helpful for assessing flood risk in areas where mapping is unavailable. Used to verify existing mapping and
Historic Flood Records including photos, aerial photos and reports.	Coverage of most of LPF area from 2009 flood event and spot coverage for other events	Various	Highly useful oversight of historic flooding issues provided by Local Authority.
LiDAR height model	Clondalkin area	High	Aerial survey is used to appraise the topography and identify low spots, floodplain and areas potentially susceptible to flooding.

Specific guidance is provided for Clondalkin based on the data review and the site visit is used to confirm the most appropriate dataset and flood extents to define the Flood Zones. During the site visit (attended by Local Authority Engineers and Planners) the flood mapping was appraised on site by an experienced flood risk manager and professional opinion and judgement has been used to develop the recommendations within the Settlement Review of Section 8.

- The review of the suite of flood risk data has been developed as a spatial planning tool to guide SDCC in making land-use zoning and development management decisions. The data sets have been deemed appropriate for the planning decisions being made at this stage of the plan making process and where flood risk is identified the following approach has been undertaken;
- Application of the Justification Test and/or;

- Further detailed analysis, or;
- Rezoning to a less vulnerable use, or;
- Further assessment at Development Management stage in limited circumstances where it has been determined that development should be possible in principle, taking into account a site specific opinion.

3.2.1 Historic Flooding

A number of areas in the Clondalkin area have been affected by flooding historically. Several sources were consulted to identify previous flood events including the OPW floodinfo.ie website, newspaper articles and previous flood studies. Floodinfo.ie provides information on historical flood events across the country and formed the basis of the Regional Flood Risk Assessment. Information is provided in the form of reports and newspaper articles which generally relate to rare and extreme events. A map of affected areas is shown in Figure 3-1. Table 3.3 provides details of recent flood events that have impacted on Clondalkin, arising from a range of source but primarily fluvial and pluvial.

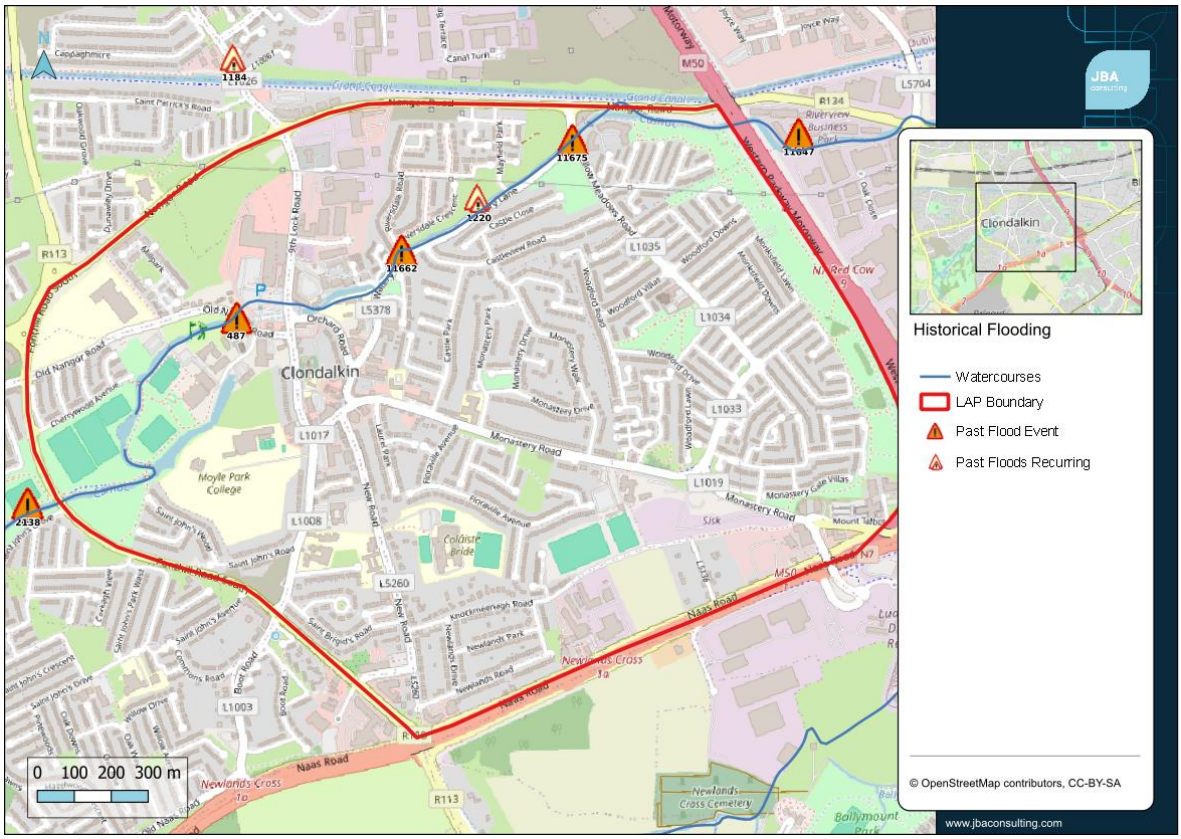


Figure 3-1 Historical Flood events (floodinfo.ie)

Table 3.3: Summary of Recent Flood Events in Clondalkin

Date	Source of Flooding	Areas impacted
Nov 1982	Camac overtopping	Cherrywood
June 1993	Camac overtopping	Clondalkin and Cherrywood
Feb 1994	Camac overtopping	Cherrywood
Oct 2011	Camac overtopping	Several locations in Clondalkin and surrounding
Nov 2000	Camac overtopping	Clondalkin
Recurring	Camac overtopping	Beech Row Ronanstown
Recurring	Camac overtopping	Cappaghmore Ronanstown

Date	Source of Flooding	Areas impacted
Recurring	Camac overtopping	Camac Culvert Old Naas Road
Recurring	Camac overtopping	Watery Lane

3.2.2 Site Walkover

As part of the SFRA process a site walkover and consultation was undertaken in Clondalkin by an experienced Flood Risk Manager alongside the Local Authority Engineer. The site walkover aimed to assess risks presented by potentially unmapped watercourses and to verify the flood mapping.

The walkover took place at specific locations throughout Clondalkin based on the Flood Zone and OSi mapping. The CFRAM mapping was also found to be in agreement with observations made during the walkover.

3.2.3 Camac Flood Alleviation Scheme

While some current defences exist in Clondalkin the Camac FAS is currently underway and the intention is to prevent overtopping during the 1% AEP flood event while including an allowance for climate change and freeboard. Additional flood alleviation measures (flood storage) will also be adopted by the scheme. The flood extents produced by the Camac Flood Alleviation Scheme project are not available at present.

3.2.4 GSI Groundwater Flood

The winter of 2015/2016 saw the most extensive groundwater flooding ever witnessed in Ireland. The lack of data on groundwater flooding and fit-for-purpose flood hazard maps were identified as serious impediments to managing groundwater flood risk in vulnerable communities. Geological Survey Ireland - in collaboration with Trinity College Dublin and Institute of Technology Carlow - initiated the groundwater flood project GWFlood to address these deficits. Data available as a result of the project include national-scale flood maps for both historic and predictive groundwater flooding.

The historic groundwater flood map is primarily based on the winter 2015/2016 flood event, which in most areas represented the largest groundwater flood event on record. The map was produced based on the SAR imagery of the 2015/2016 event as well as any available supplementary evidence.

The predictive groundwater flood map presents the probabilistic flood extents for locations of recurrent karst groundwater flooding. It consists of a series of stacked polygons at each site representing the flood extent for specific AEP's mapping floods that are expected to occur every 10, 100 and 1000 years (AEP of 0.1, 0.01, and 0.001 respectively). The map is focussed primarily (but not entirely) on flooding at seasonally inundated wetlands known as turloughs. Sites were chosen for inclusion in the predictive map based on existing turlough databases as well as manual interpretation of SAR imagery.

The mapping process tied together the observed and SAR-derived hydrograph data, hydrological modelling, stochastic weather generation and extreme value analysis to generate predictive groundwater flood maps for over 400 qualifying sites. It should be noted that not all turloughs are included in the predictive map as some sites could not be successfully monitored with SAR and/or modelled.

The winter surface water extent is displayed over page in Figure 3-2 which shows a small area of historic flooding along the Camac River is identified in the eastern area of Clondalkin.

3.2.5 GSI Surface Water Flooding

Geological Survey Ireland - in collaboration with Trinity College Dublin and Institute of Technology Carlow - initiated the groundwater flood project GWFlood to address deficits in groundwater flooding and fit-for-purpose flood hazard maps.

In addition to the historic groundwater flood map, the flood mapping methodology was also adapted to produce a surface water flood map of the 2015/2016 flood event. This flood map encompasses

fluvial and pluvial flooding in non-urban areas and has been developed as a separate product. The historic surface water flood map is displayed within Figure 3-2 and was reviewed on site during the walkover.

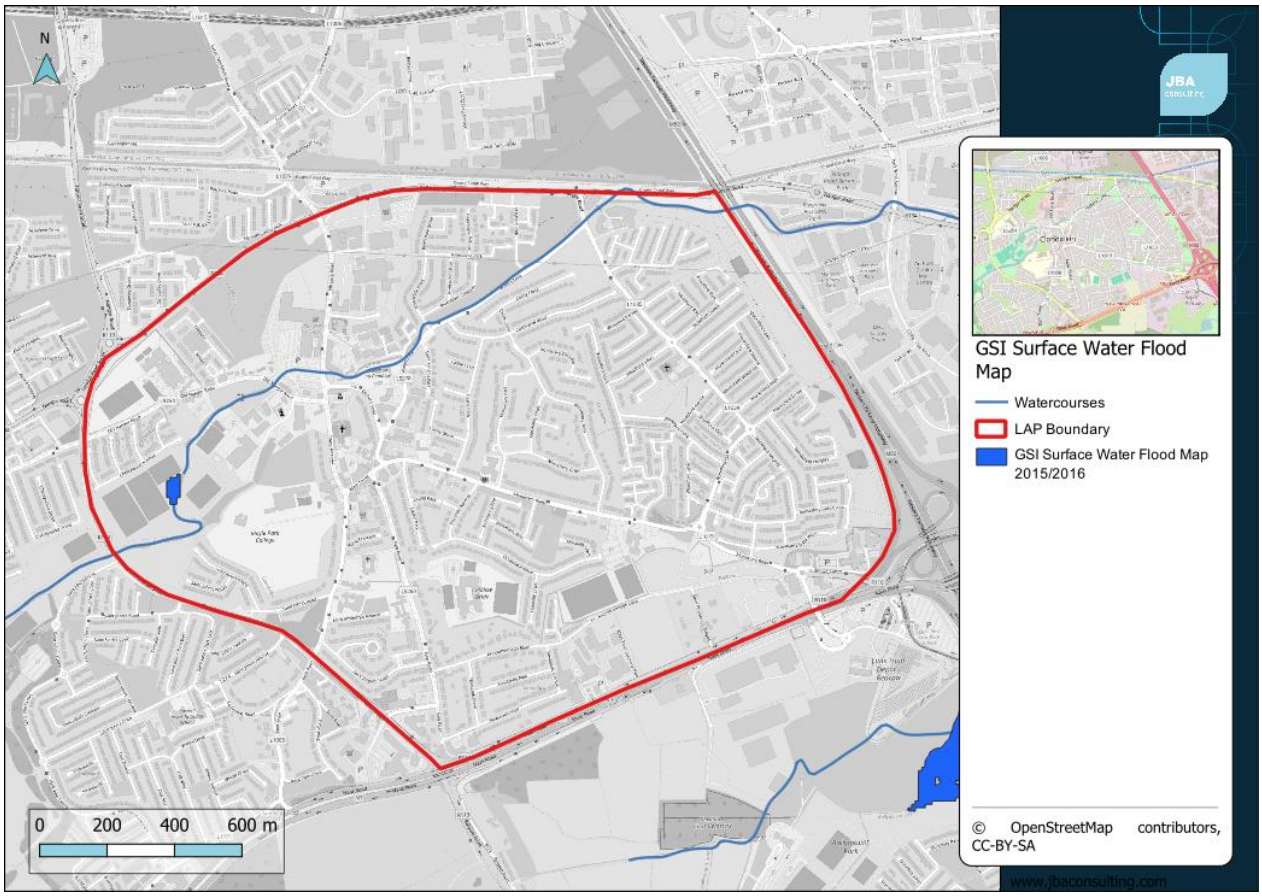


Figure 3-2 Winter 2015/2016 Surface water flood extent (GSI)

3.2.6 CFRAM

In 2011 the OPW commenced appointment of consultants to carry out a more detailed flood risk assessment on key flood risk areas. This work was undertaken under the CFRAM programme across seven river basin districts in Ireland. The Eastern RBD includes the entire catchment of the River Camac. The RBD covers parts of Wicklow, Kildare, Dublin, Meath, Westmeath, Offaly, Louth, Monaghan, and Cavan.

The initial Flood Risk Review (FRR) stage of the of the Eastern CFRAM included a site-based review of the PFRA flood outlines at a number of settlements. Several communities were identified through this process as being at potentially significant flood risk in the Eastern River Basin, which included County Dublin, including Clondalkin. Following this review, any sites recommended as an Area for Further Assessment (AFA) were included in the subsequent detailed assessment stage of each CFRAM study.

A set of flood maps, indicating the areas prone to flooding, has been developed and published for the Joint Urban Area Plan. The Plan builds on and supplements the national programme of flood protection works completed previously, that are under design and construction at this time or that have been set out through other projects or plans, and the ongoing maintenance of existing drainage and flood relief schemes.

Climate change is likely to have a considerable impact on flood risk in Ireland, such as through rising mean sea levels, increased wave action and the potential increases in winter rainfall and intense rainfall events. Land use change, for example, through new housing and other developments, can also increase potential future flood risk. In order to assess this risk, the Eastern CFRAM study also included detailed assessments of flooding and impacts for potential future climate change scenarios.

The 1% AEP and 0.1% AEP current scenario extents which define the flood zones are shown in Figure 3-3. The high end future scenario outlines are displayed over page in Figure 3-4 and although not used to define flood zones, are a key part of informing zoning decisions for Clondalkin. More information on this methodology can be seen in the following Section 3.2.7.

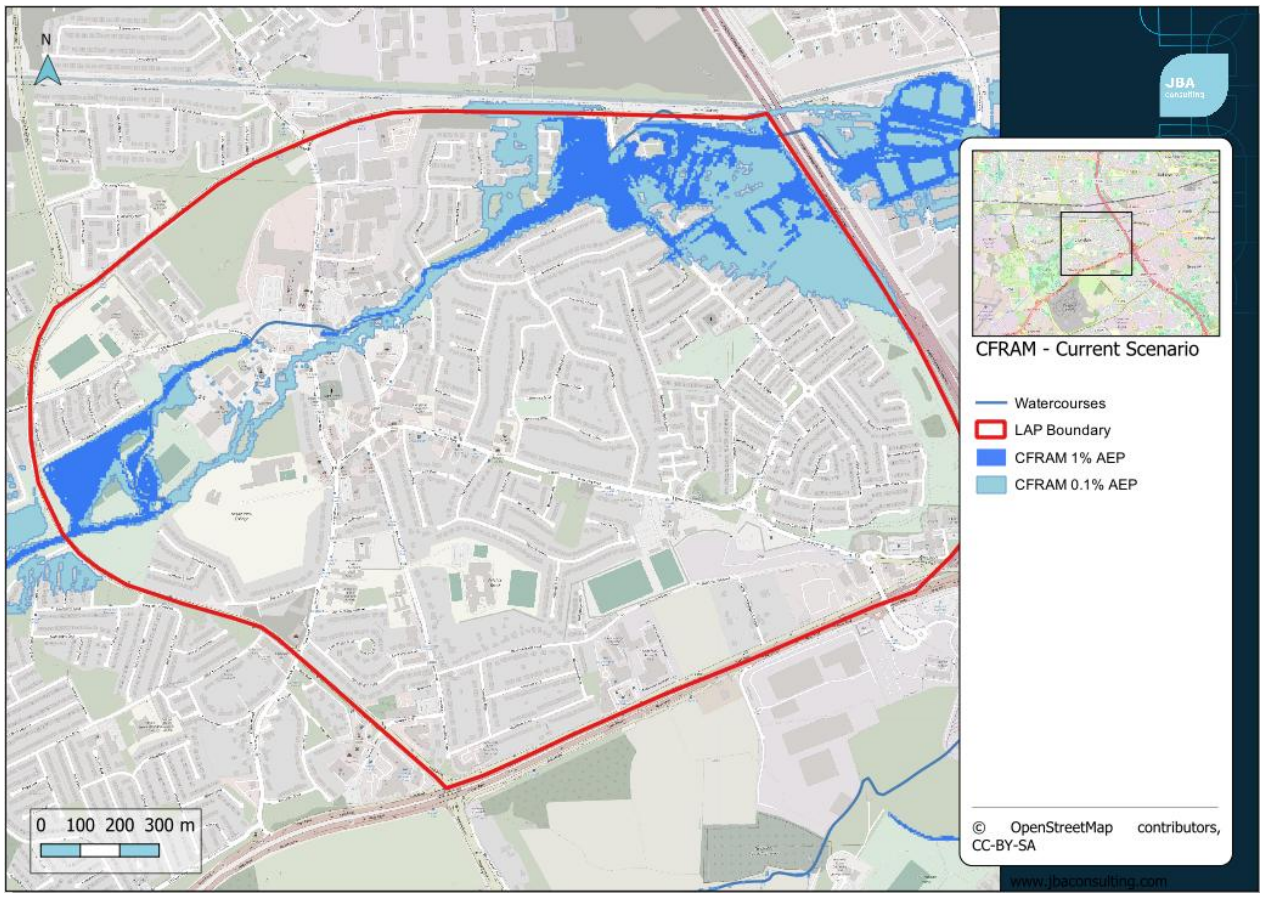


Figure 3-3 CFRAM Current Scenario Extents

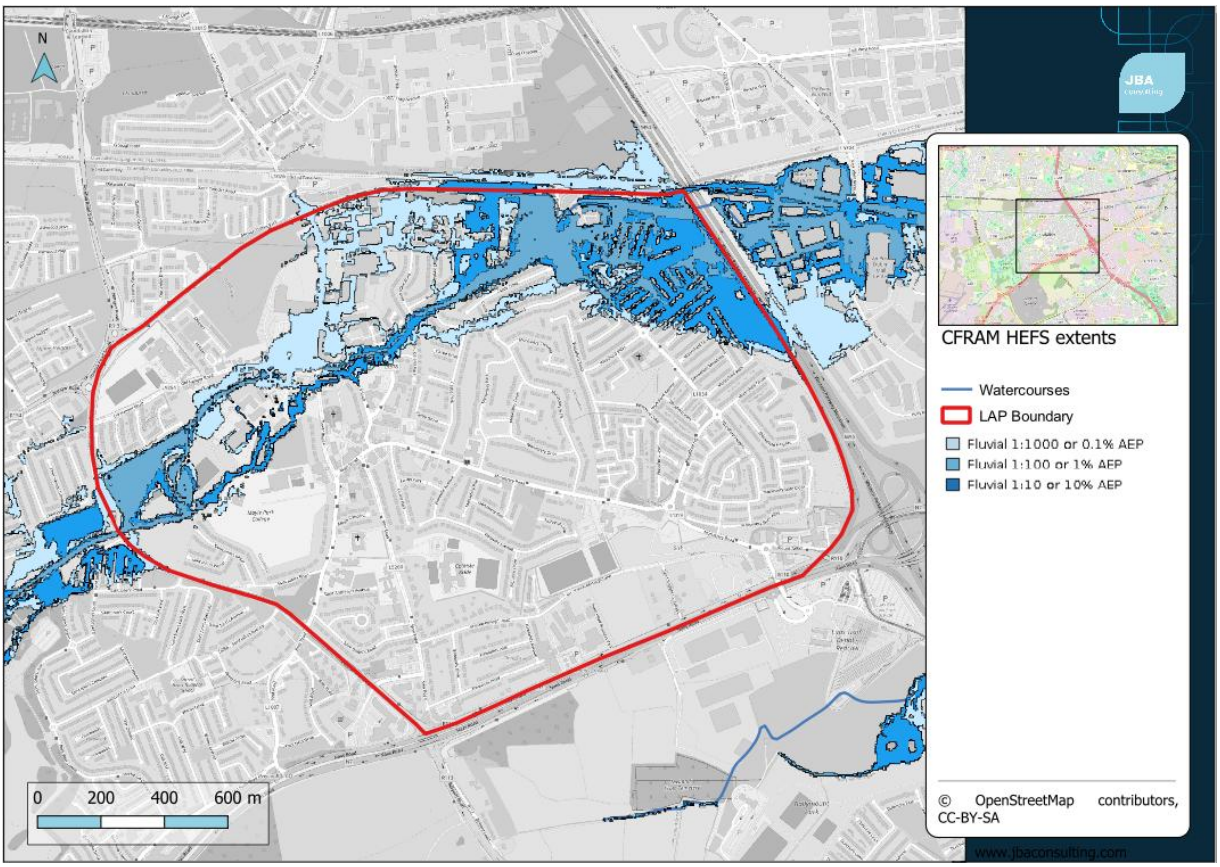


Figure 3-4 CFRAM 1% AEP and 0.1% AEP High End Future Scenario

3.2.7 Climate Change

The Planning Guidelines recommend that a precautionary approach to climate change is adopted recognising the uncertainty associated with its potential effects. Specific advice on the expected impacts of climate change and the allowances to be provided for future flood risk management in Ireland is given in the OPW Climate Change Sectoral Adaptation Plan[1]. The allowances are displayed below in Table 3.4.The assessment of climate change is based on two scenarios identified as the Mid-Range Future Scenario (MRFS) and High-End Future Scenario (HEFS). The differences between each scenario are also provided in Table 3.4.

Table 3.4 OPW Climate Change Allowances

Parameter	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Peak 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)

1 OPW Climate Change Sectoral Adaptation Plan, Flood Risk Management, 2019

Note 2: Reduction in the time to peak (Tp) to allow 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 temporary increased runoff rates that may arise following felling of forestry

Climate change has been addressed at both the plan making and development management stages as part of this SFRA.

From a plan making perspective, Flood Zones A and B represent the current flood risk scenario, as derived from the CFRAM Study. These extents define the present day probability of flooding and form the primary basis for flood risk assessment in this Plan. Consideration was also given to the presence or otherwise of flood defences, and where a flood relief scheme is ongoing or planned, it was noted that an adaptation plan would be an integral part of the scheme design. The findings of this assessment are noted in the relevant risk reviews in Appendices B and C.

While HEFS extents are not used to delineate Flood Zones, they provide valuable information to inform zoning decisions, particularly where development is proposed in areas that may be vulnerable under more extreme climate scenarios. Therefore, the HEFS flood extents have been used as part of the Justification Test appraisal of the opportunity sites undertaken in Appendix A. This approach aligns with the National Planning Framework (NPF), which identifies flood risk management and climate adaptation as key components of sustainable spatial planning. The NPF Strategic Flood Risk Assessment emphasises that flood risk should be a core consideration in land use planning, that the sequential approach should guide zoning decisions and that climate resilience must be embedded in all plan-making processes.

Climate change risk mitigation through development management is also addressed in the recommendations for the scope of site-specific FRAs and in the discussion on potential flood mitigation measures, including consideration of site layouts and landscaping, finished floor levels and design of drainage systems and SuDS. This is detailed in Section 6.

As part of the Camac FAS, consideration will be given to the management of climate change risks within the scheme design and as part of a climate change adaptation plan. This may follow an adaptive approach whereby the defence height is based on current design levels but the foundations of the walls and embankments are designed to take additional loading should the defences be raised in the future.

3.3 Sources of Flooding

Over the last few decades, the risk of flooding has continued to increase in Ireland. Much of this has been attributed to:

- Climate change, resulting in increased and more intense rainfall (e.g. more thunderstorms), increased sea water levels, and
- Increasing levels of urbanisation. The main types of flooding are from (i) tidal/coastal flooding which arises from the sea or estuaries, (ii) river or fluvial flooding which arise from rivers or streams,
- Pluvial or surface water flooding which arises directly from rainfall,
- Groundwater flooding
- Dam breach and
- Sewer/ infrastructural failure.

3.3.1 Fluvial Flooding

The main river system in the Clondalkin is the River Camac. Flooding from the Camac arises when the capacity of the channel is exceeded and water flows out over the river banks. This is normally linked to prolonged rainfall and surface water run-off entering the channel. Flooding from the rivers can also occur if the channel, or the inlet to a culvert becomes blocked.

Review of the CFRAM flood maps confirms that significant areas within Clondalkin are at risk of inundation. The flood maps have been used within the SFRA to guide development and associated Justification Test.

The Camac FAS is currently underway, and the intention is to prevent overtopping during the 1% AEP flood event while including an allowance for climate change (20%) and freeboard. Additional flood alleviation measures (flood storage) will also be adopted.

3.3.2 Pluvial Flooding

Pluvial flooding results when heavy, often sudden rainfall, causes flooding before it can infiltrate the ground, or enter a natural or man-made drainage system or a watercourse or a conveyance system (e.g. canal) because the system is already full to capacity. Pluvial flooding is associated with surface water flooding, which is a combination of true pluvial flooding, sewer flooding (due to heavy rainfall), groundwater flooding and flooding from urban watercourses.

The surface water system is managed by SDCC. The combined (surface water and foul) system and foul drainage system are managed by Irish Water. Irish Water policy is to prevent 30-year flooding + estimated global effects to houses and buildings from the combined public drainage network while SDCC has enhanced the local surface water networks to cope with pluvial flooding as far as possible where previous flooding has occurred.

3.3.3 Groundwater Flooding

Groundwater flooding can occur when groundwater rises up from the underlying water table. Water emerges at the ground surface or into basements, flooding both surface and subsurface infrastructure. This tends to occur after much longer periods of sustained rainfall or very high tides. Higher rainfall means that more water will infiltrate into the ground, causing the water table to rise. Groundwater flooding tends to occur in low lying areas, where with additional groundwater flowing towards these areas, the water table can rise to the surface causing flooding. High river, estuary or tide levels can prevent groundwater escaping into them in times of significant rainfall thus causing ground water flooding.

Data available on the Geological Survey Ireland map viewer has been examined and found no particular karst or other ground water systems within the catchment, although a number of springs and wells are recorded across the city (Figure 3-5). There are no recorded historic or predictive groundwater flood extents within the Clondalkin area.

Groundwater risks should be assessed on a site-by-site basis through percolation testing and bore holes as appropriate. Groundwater risk in relation to basement development should be carried out and it is advised that developments require a basement impact assessment to consider groundwater/ surface water flooding and gives a general restriction against the development of basements below the estimated flood levels for Flood Zones A or B.

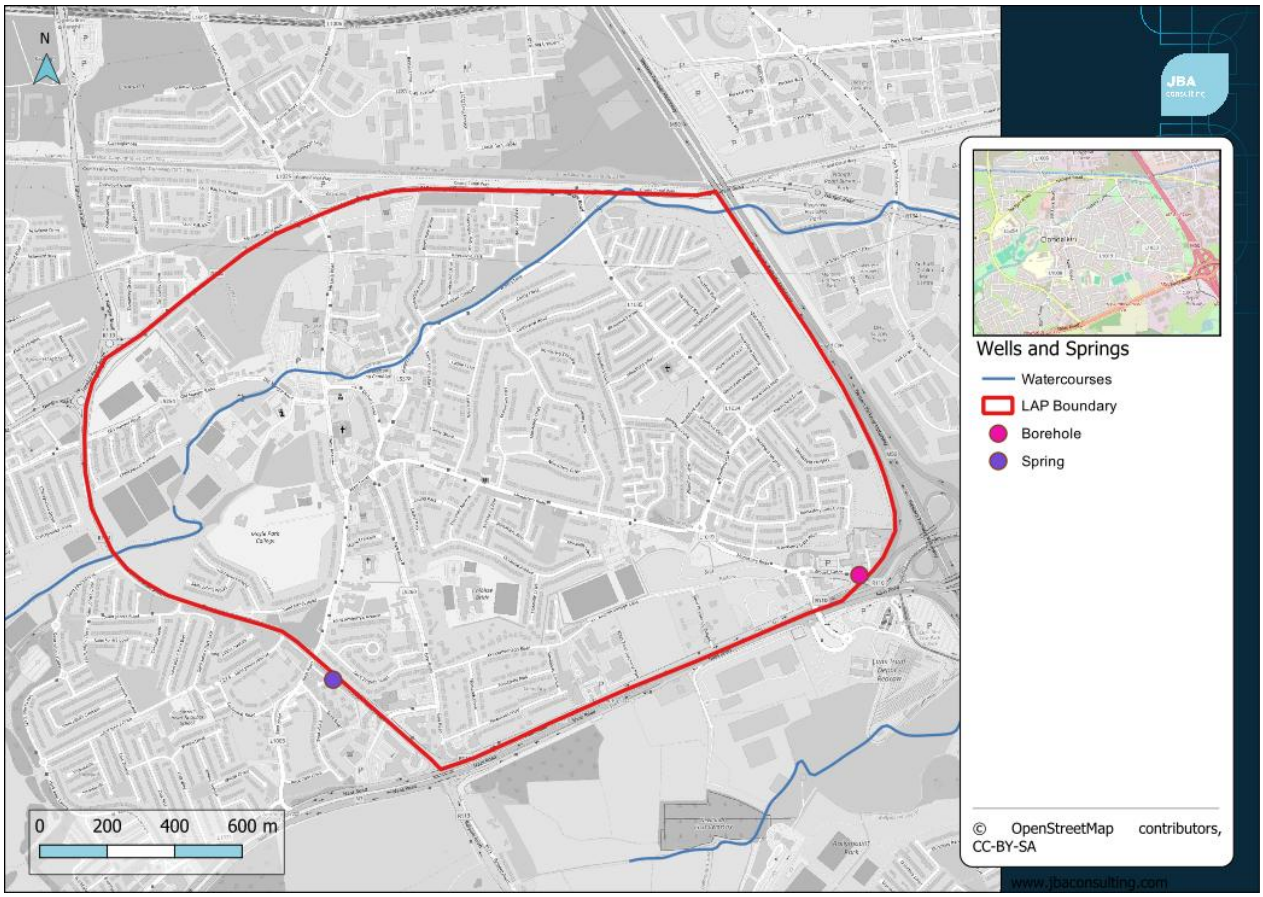


Figure 3-5 Wells and Springs Clondalkin

3.4 Flood Risk Identification Summary

Having regard to all the information sources available to SDCC, it is concluded that Clondalkin is primarily at risk from fluvial flooding. However, as relevant to any urban area pluvial flood risk is present following the potential surcharging of the stormwater system following exceedance rainfall events.

Risks from climate change are also likely to be significant.

4 Hydromorphological Assessment and Riparian Corridor Delineation

4.1 The Need for Riparian Corridor Assessments

Riparian Corridors protect watercourses and their natural processes including ecological, biogeochemical, hydromorphological and flood resilience in the face of climate change. These zones act as the interface between rivers and adjoining lands and are key to managing flood risk within catchments of all sizes. Maintaining and enhancing Riparian Corridors creates “room for the river” and the benefits that entails including reducing risk to persons and property from flooding. The sustainable management of riparian zones is crucial to meeting our objectives under the Water Framework and Floods Directives.

Recent decades have seen an increased awareness of the role of riparian zones in controlling the movement and processing of waterborne pollutants. This research was built upon growing interest in the interactions along aquatic-terrestrial fringes initially in relation to fisheries and more recently the effect of ecosystem diversity and resilience to climate change. The relationship between Riparian Corridors and nutrient processing is widely known, by acting as buffers between upland areas and open water, they help treat pollutants.

4.2 Riparian Vegetation

Riparian vegetation acts with flow, sediment, and topography to influence channel form, instream habitat, nutrient dynamics, temperature, and flow patterns. Therefore, removal of upland and riparian vegetation through agriculture and urbanisation disrupts land-water linkages leading to reductions in water quality, simplification of stream channels, less stable thermal and flow regimes, and ultimately, reduced ecosystem integrity. Riparian vegetation is a key source of beneficial in-stream nutrients and carbon, provides shade aiding thermally sensitive species (e.g., salmonids) and directly influences channel morphology (bank stabilisation, source of Large Woody Debris).

Designating and maintaining riparian corridors along the along major watercourses and their tributaries is key to maximising ecosystem services provided by the watercourses. Vegetative riparian buffers ecosystem services include:

- Interception and reduction of potential pollutants from both agricultural and urban sources,
- Attenuating flood waters by providing hydraulic resistance,
- Bank stabilisation,
- Reducing runoff volumes,
- Habitat provision and refuge,
- Ecological corridors
- Vegetal debris that falls into the watercourse is an important source of nutrients for instream biota.
- Thermal shading of watercourse,
- Amenity value

4.3 Hydromorphological Assessment

Riparian corridors protect watercourses and their natural processes including natural functioning ecology, hydromorphology and flood resilience. Riparian corridors are the zone between rivers and the adjoining lands, and are therefore crucial to understanding and managing flood risk. A retained riparian corridor allows space for the river to function naturally, and can help reduce flood risk to people and their properties. Good hydromorphology also contributes to the achievement of WFD and Floods Directive objectives. The WFD primarily relates to water quality but contributes to flood risk management via proper river basin management and associated objectives. Whereas, the Floods Directive sets out specific requirements with the aim of reducing and managing flood risk.

The South Dublin CDP SFRA includes a requirement for Development Hydromorphological Assessments, if the riparian zone forms part of the proposed development site. As outlined in the South Dublin SFRA (Figure 4-1), the strategic hydromorphological assessment will inform the requirements for Development Hydromorphological Assessments.

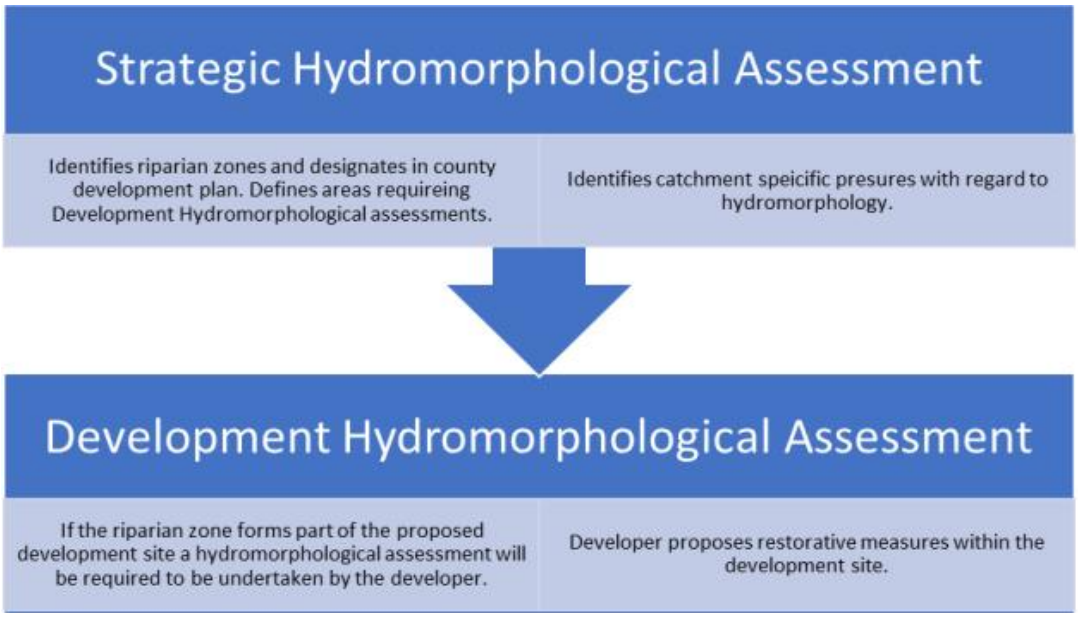


Figure 4-1: Interaction between strategic and development hydromorphological assessment (SDCC SFRA, Roughan & O'Donovan 2022)

Development Hydromorphological Assessments are to be undertaken where lands are partially or wholly within the Riparian Corridors identified as part the LPF. The Development Hydromorphological Assessment will include the following considerations:

- An assessment of the existing river reach, identify existing hydromorphological pressures, determine deviation from a "Natural" form and propose restorative measures to improve Hydromorphological integrity and resilience throughout the river reach.
- Key assessment parameters shall include Flow, River Continuity, Planform, Sediment Regime, & Riparian Vegetation.
- Where proposed development lands are within the Riparian Corridor but are not directly adjacent to a watercourse, measures should focus on SuDS to manage the quality and quantity of surface water runoff and promote biodiversity.
- In general restorative measures should create "Room for the River" and in time allow river systems to return to a state of equilibrium with rich biodiversity, developed ecosystem service provision and resilience to future shocks such as climate change. Potential restorative measures are described below.

4.3.1 Flood Zoning

Lateral connectivity should be maintained where possible throughout catchments. Assessing and identifying floodplains throughout the catchment is key to defining appropriate land use practices and future sustainable development. Much of the historic floodplains within the catchment are defined as part of previous flood studies. Climate change has been taken into account and incorporated in the relevant flood maps, as the areas liable to flood in the near future may increase significantly over present-day extents and within the Riparian Corridors identified within this SFRA.

4.3.2 Riparian Corridor

The immediate riparian buffer should be "re-wilded" as much as possible. Any development within the riparian buffer strip, including pedestrian/cycle paths and highly managed parkland, should be minimised. Within these riparian buffer zones explicit care should be given to the variety of plant species. The vegetation within the riparian buffer should be native and appropriate to the location and soil water regime, preferably from a local source. Inclusion of riparian trees is important as currently the majority of catchments in the Dublin region have very little tree cover.

Providing buffer strips adjacent to the watercourses to comply with the 10m buffer requirements as outlined in the overarching County Development Plan, and limiting instream works maintains existing flow/flood regimes as well as important ecological corridors for aquatic and terrestrial flora and fauna.

4.3.3 Sustainable Agriculture Practices

The nature of land ownership in Ireland means that the majority of riparian land is privately owned. As such educating and involving riparian landowners is key to enhancing riverine environments. This includes:

- Educating farmers on the correct use of nitrates and agricultural fertilisers,
- Use of stock fencing as to minimize livestock access pressure have been seen to result in a decrease in sediment loads, woody vegetation cover increases, increased resistance to erosion, increase in vegetation increases roughness, trapping sediment, which builds banks;
- Designated crossing / access points for livestock along the banks of a watercourse will aid in reducing bank erosion and sediment from entering the watercourse. At such points, the banks could be reinforced to aid in the prevention of bank erosion.
- The provision of riparian buffers and Integrated Constructed Wetlands (ICW) systems adjacent to rivers has been seen to greatly reduce pollutants in agricultural runoff (e.g. effluent, fertilisers & pesticides, etc.) from entering freshwater systems.
- The provision of ICW systems on agricultural lands within the LPF can provide storage to agricultural runoff, slow runoff, create aquatic and riparian habitat and absorb and/or retain CO2, however incentives would possibly need to be in place for the general public to adopt such systems.
- Educating the general public on the potential negative impacts of such activities can also help mitigate this pressure.

4.3.4 Instream Works and Channel Modifications

The methodologies outlined above have been chosen as to be minimally invasive. However, as with the majority of urban watercourses in Ireland, some of the primary pressures within Clondalkin are the significant morphological alterations as a result of culverting, canalisation, and construction of flow regulation structures such as weirs. Key ecosystem services and habitat types cannot return to the urban catchments without some River Restoration measures being undertaken within the main river channel. Possible options include:

- De-culverting of Watercourses
- Introduction of Large Woody Debris,
- Establishment of in-stream vegetation,
- New meander in impounded river channel,
- Reconnecting a remnant meander,
- Improving sinuosity such as use of in-channel features like bars, or flow deflectors for a more engineered solution,
- Narrowing channel with lateral berms,
- Creating a sinuous low-flow channel in an already over-widened channel,
- Creation of on-line bays,
- Fixing whole trees into the riverbank for flow diversity,
- Gravel reworking to restore a low-flow channel,
- Weir removal
- Review of/reduction in channel maintenance.

The impact of these measures on the current channel morphology and maintenance practices varies significantly. Options such as introducing Large Woody Debris would likely have a minimal impact on flooding while providing substantial benefits in the form of flow heterogeneity and habitat creation.

4.4 Riparian Corridor Objectives:

1. To ensure that hydromorphological assessments are undertaken where proposed development is within lands which are partially or wholly within the Riparian Corridors identified as part of this Development Plan.

2. To require development proposals that are within riparian corridors to demonstrate how the integrity of the Riparian Corridor can be maintained and enhanced having regard to flood risk management, biodiversity, ecosystem service provision, water quality and hydromorphology.
3. To promote and protect native riparian vegetation along all watercourses and ensure that a minimum 10m vegetated riparian buffer from the top of the riverbank is maintained/reinstated along all watercourses within any development site.

4.5 Clondalkin LPF area - hydromorphological assessment

A hydromorphological assessment of the entire River Camac catchment was carried out by JBA in 2021 as part of the River Camac FAS. The River Camac as it flows through the LPF area was delineated as three reaches for the purposes of that assessment, as shown in Figure 4-2. Reach CA07 flows from Fonthill Road South, downstream to the culvert entrance underneath the Mill Shopping Centre car park. Reach CA06 is from this point, downstream through Clondalkin and the residential areas to the east, to the M50 culvert. From here the river flows east of the M50 (CA05), outside the LPF area. Another unnamed tributary (CA04-02), immediately north of the Grand Canal, is just outside of the LPF area to the north.

Refer to Table 4.1, Table 4.2, Table 4.3 and Table 4.4 for a detailed assessment of each reach.

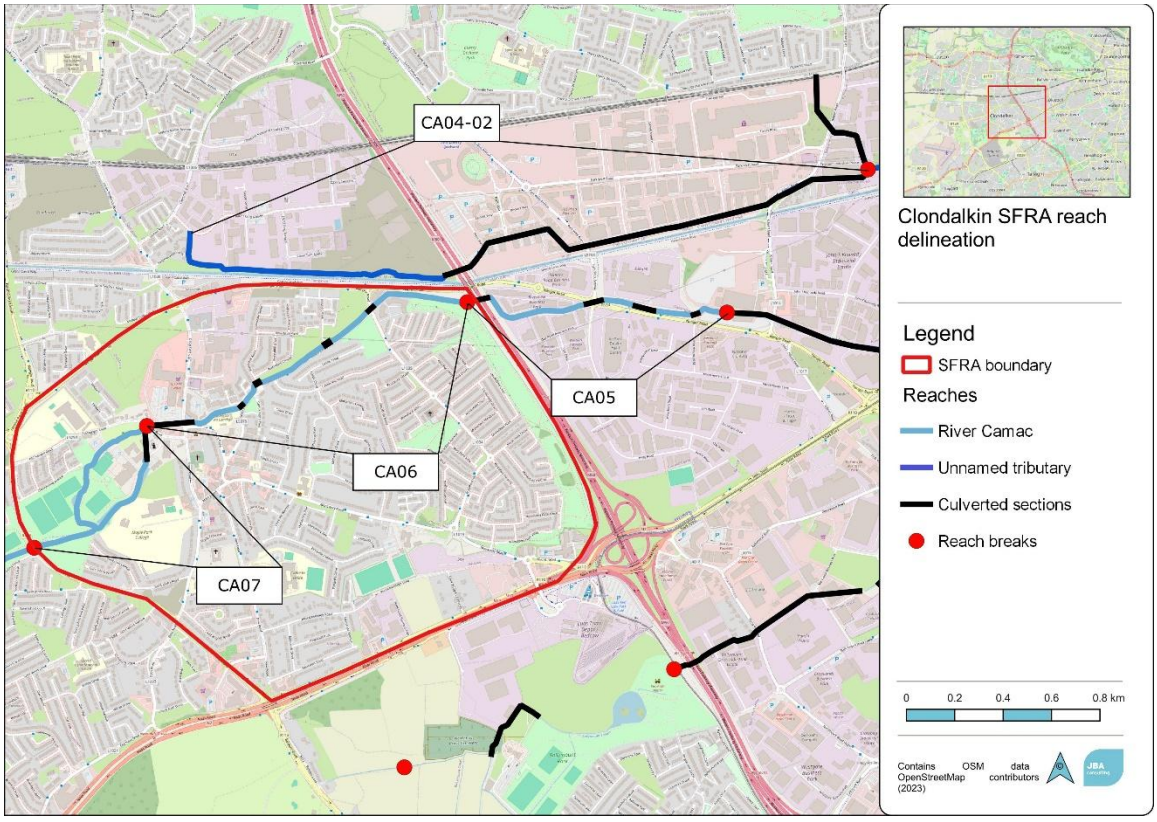
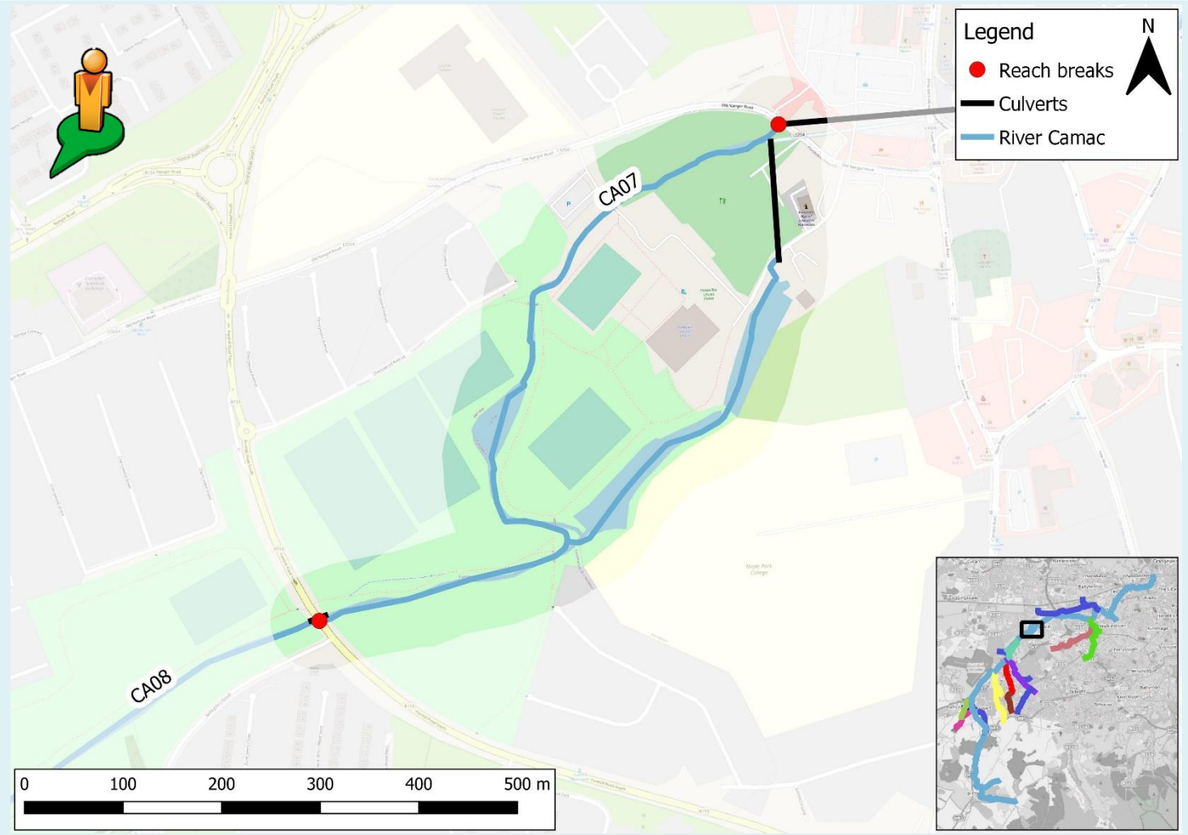


Figure 4-2: Reach delineation

Table 4.1: Reach CA07 Clondalkin Mill Ponds

River Camac – CA07 - Clondalkin Mill Ponds			
CA07 passes through several green areas (Clondalkin Leisure Centre and GAA pitches, Clondalkin pitch and putt). A disused mill race and pond form a second branch; the two streams join back up just before the reach break at the Old Nangor Road.			
Length: 1418m Average bankfull width: 10m Average bankfull depth: 1.5m		Gradient (approx): 0.4% WFD Status/Risk: Poor/At Risk	
Pressures Embankment (Adjacent) Over-widening Weirs	Hydromorphological impacts Armouring and incision of bed Impoundment upstream of weir Lack of flow and geomorphic diversity Poor lateral (floodplain) connectivity Poor longitudinal connectivity River-floodplain disconnection	Ecological impacts Poor habitat diversity/naturalness Poor riparian zone Siltation of bed substrate	
WFD class 0.3 (poor)	Habitat Modification 5 (severely modified)	Riparian Quality Index 3 (moderate)	River Habitat Quality V (very poor)
Notes There is a large weir at the top of the reach, which diverts some of the flow from the Camac through a sluice gate and into a series of mill ponds. The weir itself is approximately 2m in height and contains a large scour pool at the downstream end. There is a fish pass, which is perched above the scour pool, preventing fish from accessing it. Around the weir there are remnants of the old mill infrastructure. The hydraulic function of the mill ponds is unclear, as there are a number of concrete barriers which trap the water in sections, and the ponds appear to accumulate a large volume of fine sediment, organic debris, and algae. Downstream of the weir, the river meanders through the Clondalkin Leisure Centre Park. The land on the right bank appears to be raised, with a steep bank and no connection to the floodplain. There is some flow diversity through rapid/riffle formation, and a number of pools. The flow is confined in several areas due to the presence of 5 low weirs and remnants of old mill structures within the channel. The riparian zone is narrow, but provides shading to the channel. Downstream toward the pitch and putt course, the river is again over-deepened and straightened, with banks showing evidence of alteration and re-sectioning. The river then flows through a culvert under the Mill Shopping Centre. There is little to no active floodplain due to over-deepening of the channel.			



1) Historic weir (Reg. no. 11209042) associated with the Mill Race and pond. There is a large scour pool at the downstream end.

2) Looking US: Channel is realigned, with 2 weirs seen in the distance. The riparian zone is very narrow, with manicured grass on both banks.

3) Mill pond south of Clondalkin Leisure Centre, which now occupies the former mill race.

4) Looking DS: Redundant mill infrastructure remains in the channel, causing a barrier to flow and sediment transport.

Table 4.2: Reach CA06 Clondalkin to M50

Camac – CA06 - Clondalkin to M50

This reach runs from Clondalkin, where it is culverted beneath a car park before flowing through a mix of housing areas and green field sites. It ends just before the M50, which CA05 passes through a culvert. Land use is mostly residential.

Length: 1538m Average bankfull width: 4.5m Average bankfull depth: 0.35m	Gradient (approx): 0.5% WFD Status/Risk: Poor/At Risk

Pressures	Hydromorphological Impacts	Ecological impacts
Bank protection (concrete) Bed protection (concrete) Channel straightening/re-alignment Culverts Poaching (horses) Urban/commercial land use (road, park, urban developments)	Bank instability (slumping) Incision of the bed Poor hydromorphic diversity Poor lateral (floodplain) connectivity Poor longitudinal connectivity	Barrier to fish migration Poor riparian habitat Poor marginal bank habitats Siltation of bed substrate

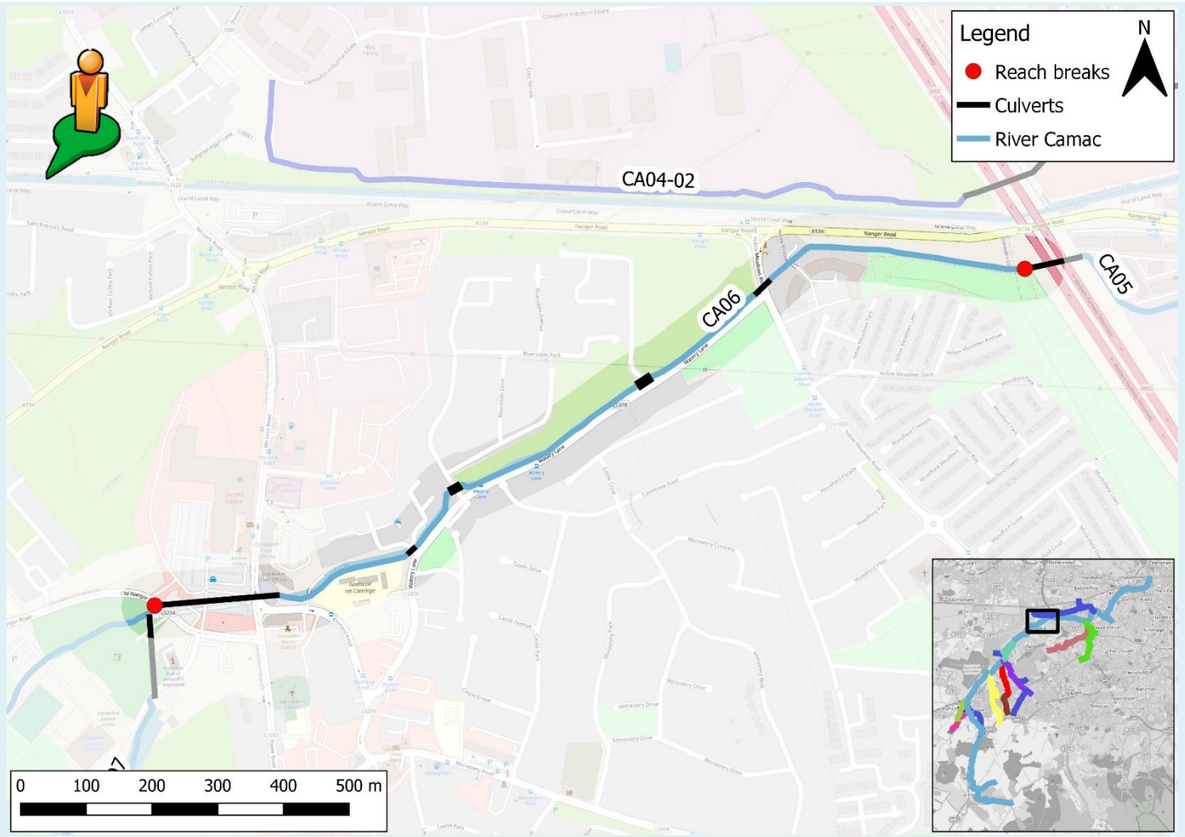
WFD Class	Habitat Modification	Riparian Quality Index	River Habitat Quality
0.297 (Poor)	5 (severely modified)	2 (high)	V (very poor)

Notes

Extending from the culvert under the Mill Shopping Centre, CA06 is extensively straightened and over-deepened through the more urban area of Clondalkin. There are a number of outfalls along the reach as it extends straight beside Orchard Road and Watery Lane. The channel bed is composed of gravel and cobble, and is moderately embedded with fine sediment. There is little flow diversity, with a homogenous bed of glides throughout the reach as it follows the road. The channel is again over-deepened through this area, with the floodplain extensively confined by residential development and road development on either side. There is a narrow riparian corridor providing shading to the channel.

As the channel flows alongside the Riversdale estate, it is similarly confined by Watery Lane on the right bank, with a park on the left bank. The road extends to the top of bank on the left, as such the banks are protected in places to maintain the lateral position. The riparian zone is narrow but more diverse, with a mix of herbaceous plants and isolated/occasional trees. The bed through this section remains homogenous, lacking in riffle/pool diversity which would be common for this river type in an unmodified setting.

As it flows through the Yellow Meadows estate, there are further modifications to the channel banks. There is one area, spanning a length of approximately 150m where the banks have been reinforced with concrete into a trapezoidal shaped channel, with no riparian buffer. Immediately downstream, the banks are exposed and eroding. The bed in this area is composed of clean gravels, which are forming shoals and actively shifting on the bed. Aquatic vegetation (Ranunculus spp.) is present on the bed along the lower half of the reach, due to the presence of the clean gravel bed with minimal fine sediment.



1) Looking DS: Reach as it passes through Clondalkin village. A pole is in the centre of the river, and urban development has encroached on both banks.

2) Bank poaching from horses in green area at Watery Lane and L1035.

3) Looking US: Banks are lined with concrete on the right bank through Yellow Meadows, with bank erosion observed just downstream where unprotected.

4) The bed at the downstream end of the reach contains clean, shifting gravels, and a high presence of aquatic instream vegetation.

Table 4.3 Reach CA05 M50 to Fox & Geese (downstream of LPF area)

River Camac – CA05 - M50 to Fox & Geese

CA05 begins at the M50, where it emerges from a culvert to flow through a number of business parks. It flows parallel to the Nangor Road to CA04.

Length: 1128m Average bankfull width: 4.0m Average bankfull depth: 1.5m	Gradient (approx): 0.4% WFD Status/Risk: Poor/At Risk

Pressures	Hydromorphological impacts	Ecological impacts
Bank protection (concrete) Bed protection (concrete) Channel straightening/re-alignment Culverts Increased channel energy Over-deepening River-floodplain disconnection	Barrier to sediment migration Excess fine sediment deposition on beds Poor lateral (floodplain) connectivity	Barriers to fish migration Lack of natural habitats in upper reach Poor hydromorphic and habitat diversity Poor riparian habitat (poor shading in upper half of reach)

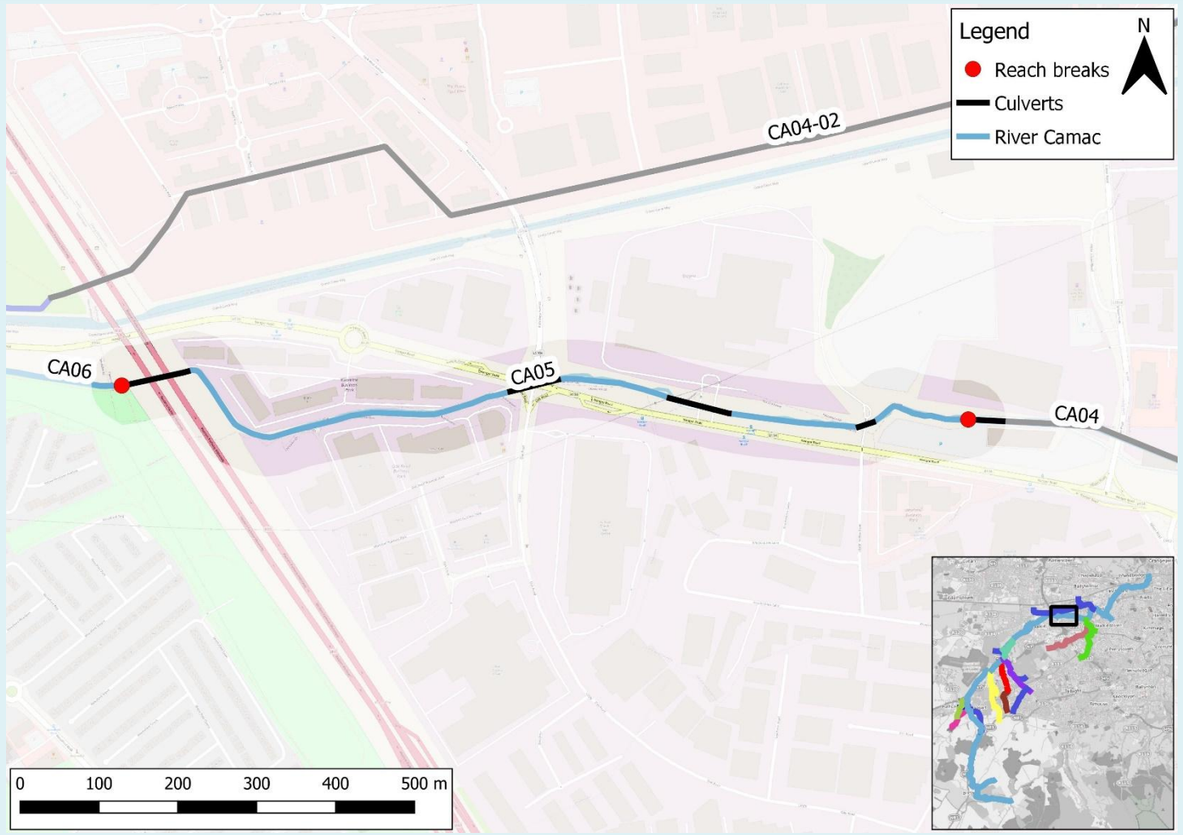
WFD Class	Habitat Modification	Riparian Quality Index	River Habitat Quality
Poor (expert opinion)	Significantly modified (expert opinion)	Low (expert opinion)	Poor (expert opinion)

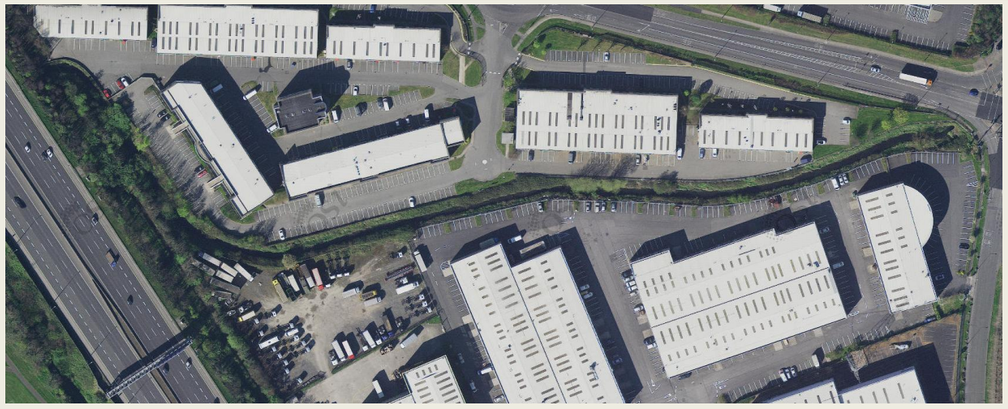
Notes

CA05 was inaccessible due to extensive commercial and industrial development within the floodplain, however, certain observations can be made using aerial photography and available mapping. This reach has been extensively straightened to accommodate commercial development, with a number of culverts are present from its beginning at the M50 and through Fox and Geese and the Western Industrial Estate. The river through this area is also over-deepened, causing similar issues to the upstream reaches including homogeneity of flow on the bed, a lack of geomorphological diversity, and poor riparian habitat.

Certain parts of the channel (within the Diageo estate) have a riparian buffer strip of mature trees, however overall artificial land cover has extended to the top of bank along much of this reach, restricting the channel in its ability to provide habitat diversity.

It was not possible to complete a full RHAT for this reach, so expert judgement has been used to inform the WFD and habitat indices.





1) Aerial image showing the reach between the M50 and Oak Rd. This section has been straightened, and industrial land use has encroached to the top of bank. There is a poor riparian buffer zone.

2) Aerial image showing the reach between Oak Rd and Willow Rd. The channel has been straightened through this section, and there is an extensive culvert, however there is a mature riparian buffer strip.

Table 4.4: Reach CA04-02 unnamed tributary (outside of LPF area)

Unnamed Tributary – CA04-02

This reach flows from Clondalkin Industrial Estate, along the northern edge of the Grand Canal, to the M50. Here it enters a culvert (1.9km in length), passing beneath the M50 and flowing through Park West Business Park to its confluence with CA04-03.

Length: 3112m Average bankfull width: 1.5m Average bankfull depth: 0.3m	Gradient (approx): 0.3% WFD Status: n/a

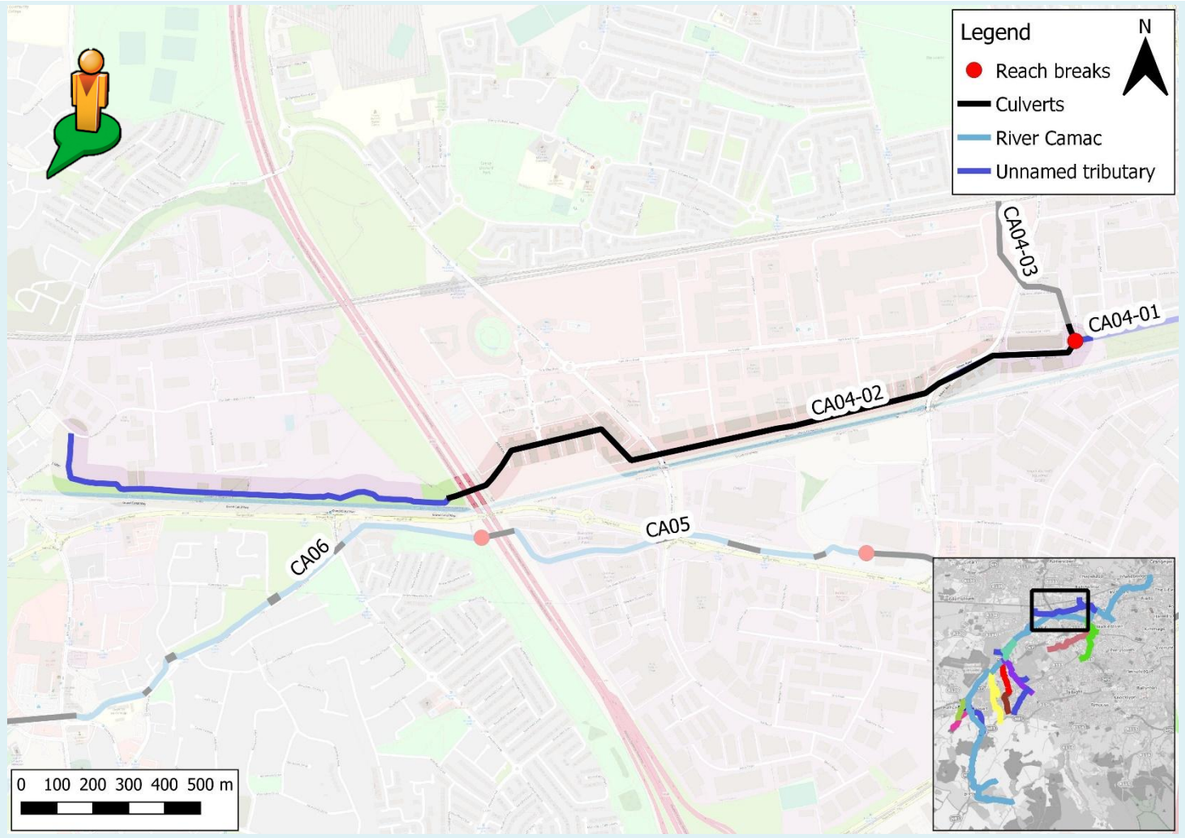
Pressures	Hydromorphological impacts	Ecological impacts
Channel straightening/ realignment Embankment Poor lateral (floodplain) connectivity Urban/commercial land use	Increased runoff entering channel Poor water quality	Poor floodplain habitats Nutrient enrichment /decreased oxygen Siltation of bed substrate

WFD Class	Habitat Modification	Riparian Quality Index	River Habitat Quality
0.203 (poor)	5 (severely modified)	2 (high)	V (very poor)

Notes

Around the Clondalkin Industrial Estate, CA04-02 is embanked on the north side between the channel and industrial estate, straightened and over-deepened. There is little perceptible flow, with the bed making up fine sediment and providing habitat for macrophytes. There is a well-established riparian buffer of trees, grasses, and shrubs. The remainder of the tributary is culverted.

The tributary is present on historical maps from the late 19th century, and appears to be constructed as part of historic Water Works infrastructure. The tributary now accepts industrial runoff from the Clondalkin Industrial estate, Park West Business Park, and Kylemore Industrial Estate. It is unclear whether the tributary is completely artificial or else significantly modified. The risks that is presents to the downstream catchment are poor water quality through industrial runoff, and unnatural inputs of fine sediment through industrial runoff and poaching.



1) Looking DS: Industrial land use to the north; the Grand Canal is to the south. Channel is over-deepened and embanked.

2) Outfall entering the channel from Clondalkin Industrial Estate.

3) Looking DS: Land corridor between the stream (left) and Grand Canal (right).

4) The bed substrate is primarily silt and mud, with a presence of reeds and other macrophytes.

5 Development Management and Flood Risk

5.1 Introduction

In order to guide both applicants and planning officials through the process of planning for and managing flood risk, the key features of a range of development scenarios have been identified (relating to the Flood Zone, development vulnerability and presence or absence of flood defences).

It is accepted that flood risk and its management is a complex and highly site-specific phenomenon so the specific requirements of the assessment should be agreed with SDCC prior to commencing work.

It should be noted that this section of the SFRA is for lands and sites where the Justification Test for Development Plans has been applied and passed, and therefore Part 1 of the Justification Test for development management can also be passed. In addition to the general recommendations in the following sections, Section 5 and Appendix A should be reviewed for specific recommendations for the watercourses within Clondalkin.

As detailed in Section 3 of this document, the Flood Zone maps have been developed using the most appropriate data available to SDCC at the time of preparing this LPF. The Flood Zone maps have been created specifically to inform the application of the Justification Test and to guide development policy within Clondalkin.

This means a Site-Specific Flood Risk Assessment may result in locally appropriate information which could show a greater or less level of risk than is included in the Flood Zone maps. This is to be expected and it will require discussion between the applicant/developer and the SDCC Planning and Engineering teams to ensure the assessment is appropriate and relevant to the site in question.

5.2 Requirements for a Flood Risk Assessment

An appropriately detailed Flood Risk Assessment (FRA) will be required in support of any planning application (see section 5.2 of the accompanying Strategic Flood Risk Assessment (SFRA) document). For sites within Flood Zones A or B, a site-specific 'Stage 2 – Initial FRA' will be required and may need to be developed into a 'Stage 3 – Detailed FRA. The level of detail will vary depending on the risks identified and the proposed land-use. As a minimum, all proposed development, including that in Flood Zone C, must consider the impact of surface water flood risks on drainage design and demonstrate compliance with the minimum required finished floor levels, detailed in the following sections of this report. In addition, flood risk from sources other than fluvial and tidal should be reviewed, as should the impacts of climate change. Groundwater flood risk for each portion of a development below ground should be evaluated in the FRA.

For sites within Flood Zones A or B, a site-specific 'Stage 2 – Initial FRA' will be required and may need to be developed into a 'Stage 3 – Detailed FRA'. The Stage 3 FRA incorporates a site-specific hydraulic model to enable detailed analysis of flood risk. The extents of Flood Zones A and B are delineated through this SFRA. However, future studies may refine the extents (either to reduce or enlarge them) so a comprehensive review of available data should be undertaken once an FRA has been triggered.

The FRA may be relatively straight forward, with qualitative appraisal of risks accompanying the drainage design. Alternatively, the findings of the Eastern CFRAM study, CAMAC FAS, CFRMP and the various other studies that have been carried out in Clondalkin may be drawn upon to inform finished floor levels and provide details on flood depth, velocity and impacts of defence breach. This information will all be essential in understanding residual flood risks and in developing emergency plans. In other circumstances, a detailed modelling study and flood risk assessment may need to be undertaken.

Any proposal that is considered acceptable in principle shall demonstrate the use of the sequential approach in terms of the site layout and design and, in satisfying the Justification Test (where required), and the proposal will demonstrate that appropriate mitigation and management measures are put in place.

To ensure that flood risk assessments demonstrate the use of the sequential approach as set out in the Flood Risk Guidelines, in terms of the site layout and design and satisfies the Justification Test (where required), demonstrating that appropriate mitigation and management measures are put in place before any proposal can be considered acceptable in principle

Specific requirements for an FRA in varying circumstances are detailed in the following sections.

5.3 Development in Flood Zone C

Where a site is within Flood Zone C, but adjoining or in close proximity to Flood Zone A or B there could be a risk of flooding associated with factors such as the event of failure of a defence, blocking of a bridge or culvert. Risk from sources other than fluvial and coastal must also be addressed for all development in Flood Zone C. Where a site is located on a 'dry island' (i.e., is fully surrounded by Flood Zone A or B), it is particularly important that flood risks are fully investigated and particular consideration is given to emergency response and evacuation routes; it should not be assumed that development on a 'dry island' is appropriate.

As a minimum, an FRA should be undertaken which will screen out possible indirect sources of flood risk and where they cannot be screened out it should present mitigation measures. The most likely mitigation measure will involve setting finished floor levels to a height that is above the 1 in 100 year fluvial, with an allowance for climate change (HEFS) and freeboard. Design elements such as channel maintenance or trash screens may also be required. Evacuation routes in the event of inundation of surrounding land should also be detailed.

The impacts of climate change (HEFS) should be considered for all proposed developments. Considerations should be proportionate to the type of development, including design life and future adaptability, but may include raising finished floor levels.

It may also be appropriate to consider residual risks arising from culvert/ structure blockage, particularly where it is identified that the site in question forms part of a flow route. Identification of flow routes across the site will not necessarily prohibit development but should be incorporated into the landscaping and design of the development. This will prevent ingress of water to the development itself and ensure risks to neighbouring sites are unchanged.

5.4 Development in Flood Zone A and B

Within Flood Zone A and B, potential development has been classed as either minor (typically extensions and changes of use) or major new development, which may be less or highly vulnerable to flooding. Each scenario is discussed below.

On lands where the Justification Test for Plan Making has been passed and where a small proportion of the land is at risk of flooding, the sequential approach to development will be applied, and development within Flood Zones A and B will be limited to Minor Development (see below and Section 5.28 of the Planning System and Flood Risk Management Guidelines). There will be a presumption against the granting of permission for highly or less vulnerable development which encroaches onto or results in the loss of the flood plain. Water compatible development only will be considered in such areas at risk of flooding.

5.4.1 Minor Development

Section 5.28 of The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009 identifies certain types of development as being 'minor works' and, therefore, exempt from the Justification Test for development management. Such development relates to works associated with existing developments, such as extensions, renovations and rebuilding of existing development, small scale infill and changes of use.

Despite the 'sequential approach' and 'Justification Test' not applying, as they relate to existing buildings, an assessment of the risks of flooding should accompany such applications. This must demonstrate that the development would not increase flood risks, by introducing significant numbers of additional people into the flood plain and/or putting additional pressure on emergency services or existing flood management infrastructure. The development must not have adverse impacts or impede access to a watercourse, floodplain or flood protection and management facilities. Where possible, the design of built elements in these applications should demonstrate principles of flood resilient design. (See: The Planning System and Flood Risk Management Guidelines for Planning Authorities Technical Appendices, 2009, Section 4 – Designing for Residual Flood Risk).

Generally, the approach to deal with flood protection would involve raising the ground floor levels above the level of extreme high tides. However, in some parts of the plan area, which are already developed, ground floor levels for flood protection could lead to floor levels being much higher than adjacent streets, thus creating a hostile streetscape for pedestrians. This would cause problems for infill development sites if floor levels were required to be significantly higher than those of

neighbouring properties. In this regard, for the key development sites in the plan area it has been recognised that ground floor levels below predicted flood levels could be allowed, in limited circumstances, on a site-by-site basis, for commercial and business developments. However, if this is the case, then these would be required to be of flood resistant construction using water resistant materials and electrical fittings placed at higher levels. For high risk areas it would also be necessary to impose planning restrictions in these areas. Residential uses would not be permitted at ground flood levels in high risk zones.

It should be noted that for residential buildings within Flood Zone A or B, bedroom accommodation shall not be permitted at basement or ground floor.

For commercial operations, business continuity must be considered, and steps taken to ensure operability during and recovery after a flood event for both residential and commercial developments. Emergency access must be considered as in many cases flood resilience will not be easily achieved in the existing built environment.

The requirement for providing compensatory storage for minor developments has been reviewed and can generally be relaxed, even where finished floor levels have been raised. This is because the development concerns land which has previously been developed and would already have limited capacity to mitigate flooding. However, a commentary to this effect must be substantiated in the FRA.

5.4.2 Highly Vulnerable Development

Two broad classes of major development have been identified for the purposes of this assessment. The first is new development which is located in 'greenfield' (currently undeveloped). The second is brownfield and larger scale infill and regeneration, which, given the urban nature of the area, will form the majority of major development proposals.

Highly vulnerable development in Flood Zones A or B needs to have passed both the Plan Making Justification Test and the Justification Test for Development Management. Development which is highly vulnerable to flooding, as defined in The Planning System and Flood Risk Management Guidelines for Planning Authorities and Technical Appendices, 2009, includes (but is not limited to): dwelling houses, hospitals, emergency services and caravan parks, and requires a particularly rigorous consideration of flood risks and robust flood management measures.

5.4.2.1 New Development

It is not appropriate for new, highly vulnerable development to be located on greenfield land in Flood Zone A or B, whether it is highly or less vulnerable. In the main, such areas are parks and public open space within the wider built environment which provide flood storage and reduce risks to existing development. There would be little or no opportunity to compensate for the loss of such storage areas, and development within them would be contrary to a number of the policies and objectives within this Plan. Such proposals do not pass the Justification Test. Instead, a less vulnerable use should be considered.

5.4.2.2 Regeneration

Regeneration of areas within Flood Zones A and B has, in the main, been justified and the approach for managing risks to such development is provided below.

The DECLG Circular Letter PL2/2014 states that 'notwithstanding the need for future development to avoid areas at risk of flooding, it is recognised that the existing urban structure of the country contains many well established cities and urban centres which will continue to be at risk of flooding'.

In cases where development has passed the Justification Test for Plan Making, the outline requirements for a site-specific FRA have been detailed in this SFRA in both the following sections, the Area Assessments in Section 8 and the Justification Tests in Appendix A. Of prime importance is the requirement to manage risk to the development site and not to increase flood risk elsewhere. This should give due consideration to safe evacuation routes and access for emergency services during a flood event.

5.4.3 Less Vulnerable Development

This section applies to less vulnerable development in Flood Zone A which has passed the Justification test for Development Plans, and less vulnerable development in Flood Zone B, where this form of development is appropriate, and the Justification Test is not required.

Less vulnerable development includes retail, leisure, and warehousing etc. This category includes less vulnerable development in all forms, including refurbishment or infill development, and new development both in defended and undefended situations.

The design and assessment of less vulnerable development should be the 1% AEP fluvial or 0.5% AEP tidal events as standard, with climate change and a suitable freeboard included in the setting of finished floor levels.

The presence or absence of flood defences informs the level of flood mitigation recommended for less vulnerable developments in areas at risk of flooding. In contrast with highly vulnerable development, there is greater scope for the developer of less vulnerable uses to accept flood risks and build to a lower standard of protection, which is still high enough to manage risks for the development in question. However, any deviation from the design standard of 1% AEP, plus climate change, plus freeboard, needs to be fully justified within the FRA.

5.4.4 Flood Mitigation Measures at Site Design

For any development proposal in an area at moderate or high risk of flooding that is considered acceptable in principle (i.e. has passed the Plan Making Justification Test), the site-specific FRA must demonstrate that appropriate mitigation measures can be put in place and that residual risks can be managed to acceptable levels. This may include the use of flood-resistant construction measures that are aimed at preventing water from entering a building and that mitigate the damage floodwater causes to buildings. Alternatively, designs for flood resilient construction may be adopted where it can be demonstrated that entry of floodwater into buildings is preferable to limit damage caused by floodwater and allow relatively quick recovery.

Various mitigation measures are outlined below and further detail on flood resilience and flood resistance are included in the Technical Appendices of the Planning Guidelines, The Planning System and Flood Risk Management.

It should be emphasised that measures such as those highlighted below should only be considered once it has been deemed 'appropriate', to allow development in a given location or the Justification Test for Development Plans has been passed. The Planning Guidelines do not advocate an approach of engineering solutions in order to justify the development which would otherwise be inappropriate.

6 Stormwater Management Strategy and SuDS Retrofit

6.1 SUDS Overview

6.1.1 Introduction

The SuDS philosophy is to mimic the natural hydrological cycle by promoting; infiltration, evaporation, evapotranspiration, the harvesting of rainwater at source and the temporary storage of water (ponding), through the construction of a combination or series of components to form a 'management train'. Whilst there is no internationally agreed definition for SuDS – as the understanding of the SuDS philosophy correlates to the extent to which it is embedded in policy and practice over time, the three 'pillars' of sustainable stormwater management practice are generally accepted as;

1. Reducing the rate and quantity of stormwater discharge,
2. Improve the quality of stormwater discharges and receiving water bodies and
3. Provide amenity and biodiversity value. Consideration of the sensitivity of the surrounding environment and downstream water quality is fundamental to the successful implementation of SUDS systems, particularly as we face into the uncertainties of a changing climate.

Urban development generally results in a high proportion of impervious surfaces, pavements, roadways, roofs etc. Adopting traditional methods of storm water runoff disposal can result in quantities of contaminated surface water run-off entering the drainage network of sewers, culverts, streams, and rivers which can cause both flooding and pollution in downstream catchments. An alternative to this is to use sustainable urban drainage systems.

6.1.2 Surface Water Assessment and Management

As per requirement for surface water management plans for all development proposals a surface water assessment shall be carried out for all sites and reported either in a standalone report, including drainage design drawings and supporting calculations, or it may form part of a more detailed flood risk assessment, which will also consider other flood risks.

A specific requirement of the EU Water Framework Directive is that surface water discharge is controlled and managed so that any impact on its receiving environment is mitigated. This can be achieved through the use of Sustainable Drainage Systems (SuDS). SuDS can reduce the rate of run-off through a combination of infiltration, storage and conveyance (slowing down the movement of water). Sustainable drainage can be achieved through the use of green infrastructure such as green roofs and pervious pavements, rainwater harvesting, soakaways, swales and detention basins, ponds and wetlands.

In order to reduce flooding and improve water quality, all developments in the Council's administrative area are required to implement the policies of the Council's Design Guidance Document for Implementing SuDS Solutions (2021) as summarised in Section 4.3 of the Draft CDP 2022 - 2028, in relation to surface-water and flood risk management. This is done by ensuring new development does not obstruct existing flow routes and by limiting the run-off from new development to green-field rates.

It is noted that the GDSDS requires consideration of a 10% increase in rainfall intensity to take into account the possible impacts of climate change. However, the OPW Climate Change Sectoral Adaptation Plan contains more recent recommendations in this regard. Drainage and surface water design should, therefore, take into account climate change in the same way as fluvial or tidal risk assessments. Guidance on the application of climate change allowances is provided in Section 3.2.7..

6.1.3 Sustainable Drainage Systems

The use of SuDS is a way of managing rainfall that mimics natural drainage processes and reduces the impact of development on communities and the environment. Conventional drainage seeks to convey runoff from the catchment to the downstream receptor as quickly as possible. In contrast, SuDS slow the flow and store water in both hard and soft landscape areas, thereby reducing the peak flow from the catchment, limiting the impact on the downstream boundary.

SuDS also use components individually and in series to trap silt and heavy pollution “at source”. Many contaminants are broken down naturally as runoff passes from one SuDS component to the next. Multi-functional SuDS components that manage water at or near the surface can bring significant community benefits, adapting their function to the weather. The loss of aquatic habitat is reversed when using the SuDS approach. It allows flora and fauna to flourish and to connect with existing habitats.

Where SuDS are designed as an integral part of the urban fabric, they will help mitigate the contribution to flooding and the impact that development has on the natural landscape. They are also able to rehabilitate the hydrology of the urban environment through sustainable re-development and SuDS retrofit.

There are four key pillars that SUDS design should aim to incorporate. These are presented in Figure 6-1 below.

Figure 6-1: SUDS Pillars

6.1.4 Nature Based Solutions / Green Infrastructure Design

Nature-based measures can be adopted in river environments that aim to retain water on the landscape during periods of high rainfall and flood by mimicking the functioning of a natural landscape, thereby reducing the magnitude of flood events and providing complimentary ecosystem services. In general, nature-based measures aim to:

- Reduce the rate of run-off during periods of high rainfall;
- Provide flood storage in upper catchment areas; and
- Use natural materials and “soft” engineering techniques to managing flooding in place of “hard” engineering in river corridors.

Nature-based and green infrastructure measures to control flooding typically focus on the use of porous surfaces in developments (Sustainable Urban Drainage Systems or SuDS), planting of native vegetation communities/ assemblages that are tolerant of both wet and dry conditions, and reversing the impacts of over-engineered river corridors (river restoration) to reduce the peak of flood events by mimicking the function of a natural catchment landscape. In addition to providing flood relief benefits, nature-based solutions can provide an array of ecosystem services including silt and pollution control for run-off entering the river system, improved riparian and in-river habitats, localised temperature reduction during periods of extreme heat, reduced maintenance requirements in engineered systems, groundwater recharge, and carbon sequestration.

These measures can be implemented across an array of scales, for instance across a catchment as part of a wider flood relief scheme, or on a site-specific basis as part of a landscaping or green

infrastructure plan. Nature-based solutions can provide flood mitigation benefits and ecosystem services across all scales if given adequate planning and should be considered during the site layout and design stages of a development. The Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas – Best Practice Interim Guidance Document (2022) provides guidance in making appropriate planning and design decisions to incorporate nature based solutions and climate change adaptation to urban spatial planning (see also policies SI10, SI11, SI12, SI22, GI3, GI24, GI29, GI34, and GI35 in the CDP 2022-2028).

6.1.4.1 Interception

Interception is the prevention of run-off (and the associated pollution load) for the majority of small (frequent) rainfall events (or for the initial depth of rainfall for larger events). From a hydraulic perspective, interception is required to mimic greenfield hydraulic response characteristics where small rainfall events do not generally produce any runoff and thus to protect the morphology and ecology of the receiving watercourse, and the hydrological soil water balances in the catchment.

Interception provides both water quantity and water quality benefits and suggested examples are provided in Figure 5 1below. Each of these is expanded on further in the following section.

6.1.4.2 Rain Gardens

Bioretention systems including rain gardens collect run-off, allowing it to pond temporarily on the surface encouraging evaporation before filtering the remaining runoff through vegetation and underlying soils. Small scale rain gardens can be situated at street intersections, traffic islands and kerb extensions to create parking bays or traffic calming measures. Rain gardens are an excellent example of how SuDS can be integrated into a streetscape with limited impact on the primary purpose of an urban space.

6.1.4.3 Permeable Paving

Permeable paving provides a pavement suitable for pedestrian and / or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored beneath the overlying surface before infiltration to the ground, or controlled discharge downstream. Permeable pavements, together with their associated substructures, are an efficient means of managing surface water run-off close to its source, intercepting run-off, reducing the volume and frequency of run-off, and providing a treatment medium. Treatment processes that occur within the surface structure, the subsurface matrix and the geotextile layers include:

- Filtration
- Adsorption
- Biodegradation
- Sedimentation

6.1.5 Bioretention Tree Pits

Trees can help protect and enhance the urban environment by contributing to effective surface water management strategies and adding beauty and character to the urban landscape. Trees and their planting structures provide benefits to surface water management in the following ways:

- Transpiration
- Interception
- Increased Infiltration
- Phytoremediation

Trees can be planted within a range of infiltration SuDS components (e.g., bioretention systems, detention basins, swales) to improve their performance, or they can be used as standalone features within soil-filled tree pits, tree planters or structural soils.

6.1.6 Swales

Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat, and often attenuate surface water run-off. When incorporated into site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are often used to drain roads, paths, or car parks, where it is convenient to collect distributed inflows of run-off, or as a means of

conveying run-off on the surface while enhancing access corridors or other open spaces. Swales can have a variety of profiles, can be uniform or non-uniform, and can incorporate a range of different planting strategies, depending upon the site characteristics and system objectives. Swales can replace conventional pipework as a means of conveying run-off, and the use of adjacent filter strips and / or flow spreaders can also remove the need for kerbs and gullies.

6.1.7 Attenuation

The following section details the measures that should be considered for providing surface attenuation within any proposed development.

Whilst green roofs provide significant interception as well as amenity benefits, they have been included here as attenuation measures. Similarly, detention basins and wetlands within each developed site will provide both interception and treatment benefits.

6.1.8 Attenuation Hierarchy

The graphic below details the hierarchy of attenuation measures that should be considered as part of any development. Justification for the dismissal of any of the storage measures needs to be clearly presented in any submission. This is detailed further in Section 6. The following sections detail the benefits and limitations of each of the attenuation measures referenced in Figure 6-2.

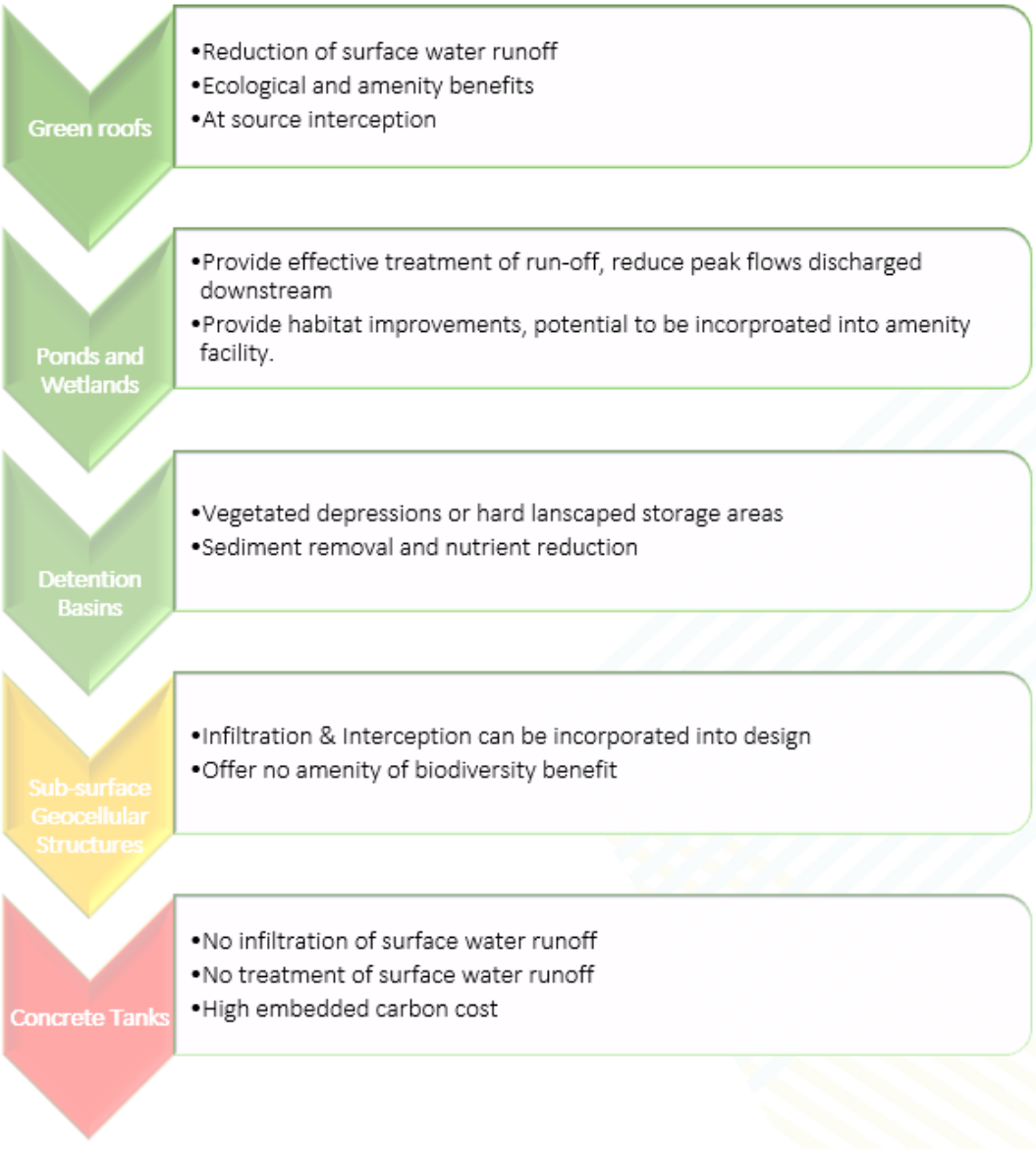


Figure 6-2 Hierarchy of measures

6.1.9 Surface Attenuation Measures

6.1.9.1 Green/Blue Roofs

Green roofs are areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water run-off. Types of green roof can be divided into two main categories, extensive and intensive, depending on substrate depth. The incorporation of green roofs directly aligns with SDCC Policy G15 Objective 7.7

Blue roofs are roof design that is explicitly intended to store water and can include open water surfaces, storage within or beneath a porous medium or below a raised decking surface or impermeable cover. Green roofs can be used together with rainwater harvesting systems although the yield from the roof will be significantly lower than a conventional roof.

6.1.9.2 Detention Basins

Detention basins are landscaped depressions that are normally dry except during and immediately following storm events. They can be on-line components where surface run-off from regular events is routed through the basin. When flows rise, because the outlet is restricted, the basin fills and provides storage of run-off and flow attenuation. Detention basins can also be off-line components into which run-off is diverted once flows reach a specified threshold. Detention basins can be vegetated depressions or hard landscaped storage areas. Where the basin is vegetated, the soil surface can absorb some run-off, so can be used to support interception. The principal water quality benefits of vegetated detention basins are associated with the removal of sediment and buoyant materials, but levels of nutrients, heavy metals, toxic materials, and oxygen demanding materials may also be significantly reduced. Water quality benefits of a vegetated detention basin increase as the detention time for an event extends. Where designed appropriately, some or all of the basin area can also be used as a recreational or other amenity facility.

6.1.9.3 Sub-surface Attenuation Measures

The above-surface measures should be prioritised, but where these are not suitable sub-surface attenuation solutions may be considered. Proprietary products that encourage SuDS like processes should be considered. Reinforced concrete tanks are not permitted unless agreed in advance with WCC and justification outlining how all other options have been exhausted must be provided.

6.1.10 Factors Influencing the Design of SuDS

There is no unique solution and each situation must be evaluated on its own merits and suitable SuDS solutions applied, although the means to achieving these objectives are many and varied. Factors such as site suitability, available space, cost, maintenance regimes and community acceptance must be considered to ensure successful implementation. The various SuDS features can generally be categorised as ‘hard’ SuDS and ‘soft’ SuDS. Soft SuDS resemble natural features and include techniques such as swales, ponds and wetlands. Hard SuDS are more similar to traditional drainage methods but incorporate SUDS principles. Examples of these are permeable pavements and proprietary SUDS features such as filtration systems and vortex separators.

6.1.11 The Management Train

The SuDS philosophy, and effective stormwater management in general, requires a series of SuDS features, linked together, to form a stormwater management system to treat and attenuate surface water runoff as close to the source of runoff as possible, before being conveyed downstream for further treatment and storage.

6.2 SuDS Objectives

6.2.1 Quantity Control Processes

Several techniques can be implemented to control the quantity of runoff from a development. Each technique presents different opportunities for stormwater control, flood risk management, water conservation and groundwater recharge.

1. Infiltration
    a. Soaking of water into the ground

   b. Most desirable solution to runoff management as it restores the natural hydrologic process
   c. Impacted by groundwater vulnerability and infiltration ability of subsoil
2. Detention / Attenuation
   a. Slows down surface water flows before their transfer downstream
   b. Usually achieved through use of a storage volume and constrained outlet
   c. Should be above ground
   d. Reduces peak flow rate but total volume of runoff remains the same
3. Conveyance
   a. Transfer of surface runoff from one place to another
   b. Through grassed channels/trenches and pipes
   c. Transfer essential for managing flows and linking SuDS components
   d. Uncontrolled conveyance to a point of discharge in the environment not considered sustainable
4. Water Harvesting
   a. Direct capture and use of runoff on site for domestic or irrigation, overflowing/discharging to adjoining SuDS component(s)
   b. Contributes to Flood Risk Management

6.2.2 Quality Control Processes

A number of natural water quality treatment processes can be exploited within SuDS design. Different processes will predominate for each SuDS technique and will be present at different stages in the treatment train.

1. Sedimentation – reducing flow velocities to a level at which the sediment particles fall out of suspension;
2. Filtration & Biofiltration – trapping pollutants within the soil or aggregate matrix, on plants or on geotextile layers;
3. Adsorption – pollutants attach or bind to the surface of soil or aggregate particles;
4. Biodegradation – Microbial communities in the ground degrade organic pollutants such as oils and grease;
5. Volatilisation – transfer of a compound from solution in water to the soil atmosphere and then to the general atmosphere;
6. Precipitation – transform dissolved constituents to form a suspension of particles of insoluble precipitates;
7. Plant Uptake – removal of nutrients from water by plants in ponds and wetland;
8. Nitrification – Ammonia and ammonium ions can be oxidised by bacteria in the ground to form nitrate which can be readily used as a nutrient by plants;
9. Photolysis – The breakdown of organic pollutants by exposure to ultraviolet light.

6.2.3 Water Quality

The implementation of SuDS as part of future development within the SDCC CDP lands should ensure that the quality of discharge from future development to the surrounding watercourses, through the removal of sediments and contaminants, will not negatively impact the existing condition of the watercourses. The quantity of discharge from future developments to surrounding watercourses will also not negatively impact the existing condition of the watercourses, as discharge rates will be limited to an approximate greenfield rate. Moreover, the adoption of SuDS systems in all new developments and the protection of existing floodplains shall assist in the attainment of our objectives under the Water Framework Directive as downstream watercourse conditions will be improved as a result of a better quality and quantity of discharge from upstream developments.

6.2.4 Effects of Climate Change

The effects of climate change need to be considered when designing and preparing maintenance regimes for SuDS features. Sedimentation is one of the primary removal mechanisms in SuDS. As discussed above, this is achieved through the reduction in flow velocities to a level at which particles

fall out of suspension. However, care must be taken through design and appropriate maintenance regimes to ensure the risk of re-suspension is minimised during extreme rainfall events. The level of biodegradation activity that occurs within SuDS features will be affected by environmental conditions such as temperature and the supply of oxygen and nutrients. It is also depending on the physical conditions within the ground such as the suitability of the materials for colonisation.

6.3 Quantity and Quality Performance

In selecting suitable SuDS components for a SuDS management train, the quantity of runoff and quality performance for various SuDS techniques should be assessed:

1. Source Control techniques are most effective in reducing run off volume.
2. Open Channels and Detention Basins provide the best hydraulic control for large flows (1% AEP), and water quality benefits.
3. Permeable paving, Infiltration and Filtration techniques (filter strips, swales, grassed channels) are most effective for water quality treatment.
4. Subsurface storage systems offer limited potential for water treatment.

6.4 Community, Environmental and Amenity Performance

Community and environmental factors for various SuDS techniques include Maintenance Regime, Community Acceptability, Construction and Maintenance Costs and Habitat Creation Potential.

Detention Basins and Swales (particularly Conveyance Swales) typically provide the most cost-effective SuDS solution while also incorporating the potential for habitat creation.

The implementation of wetlands will typically promote habitat creation and are generally accepted by communities as they provide valuable open space for visual and recreational enjoyment, however capital and maintenance costs can be relatively high.

There may be some public safety concerns associated with SuDS techniques involving open water, however good design and education can help minimise these concerns. This can be achieved through ‘demonstration projects’ and initiatives to educate local residents of the benefits of SuDS systems and natural floodplain management approaches as a means to tackle flood risk, particularly in response to climate change and the adverse environmental effects of uncontrolled contaminated stormwater runoff from urban developments. It is also recommended that developers make the proposals and advantages clear to future prospective buyers of the lands at the time of sale. The SuDS approach also offers benefits to the health and wellbeing of citizens.

6.5 SuDS Retrofitting

There are opportunities for SuDS retrofitting throughout the CDP lands, however, this would be difficult to implement on existing private development. This is due to a lack of knowledge on the societal benefits of SuDS (economic, ecological, health and wellbeing, amenity etc.) by the general public. SuDS measures that could be implemented on existing private development include permeable paving on driveways, installation of rainwater harvesting systems and the provision of vegetated systems such as swales and bioretention areas within private gardens.

6.6 Recommendations

1. New surface water drainage networks will be required as part of development within the plan lands. These networks should be designed in accordance with South Dublin County Council’s Sustainable Drainage Systems (SuDS) Explanatory, Design and Evaluation Guide and current Health & Safety Legislation. Where the Local Authority is to take-in-charge SuDS features within developments, the Safety File will be required.
2. Protect existing floodplains and ensure no development occurs on flood-plains along the existing watercourses that flow through the lands. These flood-plains shall accommodate flood waters during extreme flooding events through the provision of Riparian Corridors.
3. A Management Train should be incorporated during the design stage whereby surface water should be managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment.

4. Management trains for new developments should facilitate the construction of future SuDS components – to mitigate the risk of flooding caused by more extreme rainfall events and risk of pollution due to lower baseflow in receiving waters.

7 Flood Risk Management Policies/Objectives

7.1 Flood Risk Management Policy

The Planning Guidelines recommend a sequential approach to spatial planning, promoting avoidance rather than justification and subsequent mitigation of risk. The implementation of the Planning Guidelines on a settlement basis is achieved through the application of the policies and objectives contained within Chapter 6 of the South Dublin CDP 2022-2028.

The use and application of the policies and guidelines constitute the formal plan for flood risk management in Clondalkin. This approach has been achieved in the development plan making process in the settlements contained within the plan and covered in this SFRA.

7.2 Flood Risk Management

Section 11.3 of the CDP outlines the approach to Flood Risk Management. SDCC will require compliance with best practice guidance for the collection, reuse, treatment and disposal of surface waters for all future development proposals.

Section 11.3.1 of the CDP also emphases the importance of riparian corridors, which are now regarded as essential for ecosystem service provision. The benefits of Riparian Corridors are addressed in detail in Chapter 4: Green Infrastructure, Section 4.2.2 Sustainable Water Management, relevant policy and objectives are also set out in that section.

SDCC policy and objectives are outlined in Table 7-1 and Table 7-2.

Table 7-1 Policy IE4: Flood Risk Management

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.**
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.**
IE4 Objective 3: **To continue to support and co-operate with the Office of Public Works in measures set out in the relevant Flood Risk Management Plan.**
IE4 Objective 3: **To support and facilitate the delivery of flood alleviation schemes in South Dublin County, including the schemes listed, in as environmentally sensitive a way as possible and to ensure that zoning or development proposals do not impede or prevent the progression of these measures:** • **Poddle Flood Alleviation Scheme;** • **Camac Flood Alleviation Scheme;** • **Whitechurch Flood Alleviation Scheme;** • **Lucan to Chapelizod Flood Alleviation Scheme.**
IE4 SLO 1: **To require the preparation of a site and catchment specific Flood Risk Assessment and Mitigation Strategy, prepared by a qualified person(s), to be submitted with any proposal**

for development on the 'EE' zoned lands at Moneenalion Commons Upper, Baldonnell (See Development Plan Map).

Table 7-2 Policy IE3: Surface Water and Groundwater

Policy IE3: Surface Water and Groundwater
Manage surface water and protect and enhance ground and surface water quality to meet the requirements of the EU Water Framework Directive.
IE3 Objective 1: To maintain, improve and enhance the environmental and ecological quality of our surface waters and groundwater by implementing the relevant programme of measures set out in the River Basin Management Plans.
IE3 Objective 2: To maintain and enhance existing surface water drainage systems in the County and to require Sustainable Drainage Systems (SuDS) in new development in accordance with objectives set out in section 4.2.2 of this Plan including, where feasible, integrated constructed wetlands, at a local, district and County level, to control surface water outfall and protect water quality.
IE3 Objective 3: To protect the regionally and locally important aquifers within the County from risk of pollution.
IE3 Objective 4: To continue efforts to improve water quality under the Local Government (Water Pollution) Act 1977, as amended and by implementing the measures outlined under the Nitrates Directive (91 / 676 / EEC) and the current National Nitrates Action Programme (NAP) and all other relevant legislation.
IE3 Objective 5: To generally prohibit development within restricted areas identified on the Bohernabreena / Glenasmole Reservoir Restricted Areas Map contained in Appendix 5.
IE3 Objective 6: To protect salmonid water courses, such as the Liffey and Dodder River catchments (including Bohernabreena Reservoir), which are recognised to be exceptional in supporting salmonid fish species.
IE3 Objective 7: To protect surface water quality by continuing to assess the impact of domestic and industrial misconnections to the drainage network in the County and the associated impact on surface water quality, and by implementing measures to address same, and to diagnose and repair any misconnections in Council housing stock as part of the re-letting process.
IE3 Objective 8: **Integrate Surface Water and Groundwater systems as an essential component of all new developments, in accordance with the requirements set out in Chapter 12: Implementation and Monitoring and the policies and objectives of this chapter.**

8 Settlement Zoning Review

The purpose of land use zoning objectives is to indicate to property owners and members of the public the types of development the Planning Authority considers most appropriate in each land use category. Zoning is designed to reduce conflicting uses within areas, to protect resources and, in association with phasing, to ensure that land suitable for development is used to the best advantage of the community as a whole.

This section of the SFRA will:

- Outline the strategic approach to flood risk management.
- Consider the land use zoning objectives utilised within Clondalkin and assess their potential vulnerability to flooding.
- Based on the associated vulnerability of the particular use, a clarification on the requirement of the application of the Justification Test is provided.
- The consideration of the specific land use zoning objectives and flood risk will be presented for the settlements. Comment will be provided on the use of the sequential approach and Justification Test. Conclusions will be drawn on how flood risk is proposed to be managed in the settlement.

8.1 A Strategic Approach to Flood Risk Management

A strategic approach to the management of flood risk is important in Clondalkin as the risks are varied, with scales of risk and vulnerability varying across the settlement.

Following the Planning Guidelines, development should always be located in areas of lowest flood risk first, and only when it has been established that there are no suitable alternative options should development (of the lowest vulnerability) proceed. Consideration may then be given to factors which moderate risks, such as defences, and finally consideration of suitable flood risk mitigation and site management measures is necessary.

It is important to note that whilst it may be technically feasible to mitigate or manage flood risk at site level, strategically it may not be a sustainable approach.

A summary of flood risks associated with each of the zoning objectives has been provided in the following settlement reviews. The Flood Risk commentary indicates whether a certain land zoning, in Flood Zone A or B, will need to have the Plan Making Justification Test (JT) applied and passed.

When carrying out a site-specific FRA, or when planning applications are being considered, it is important to remember that not all uses will be appropriate on flood risk grounds, hence the need to work through the Justification Test for Development Management on a site by site. For example, a Town Centre zoning objective can include for an integrated mix of residential, commercial, community and social uses which have varying vulnerabilities and would not be equally permissible within Flood Zone A and B.

Figure 8-1 provides the Land Use Zonings (LUZ) and the Flood Zone A & B flood extents.

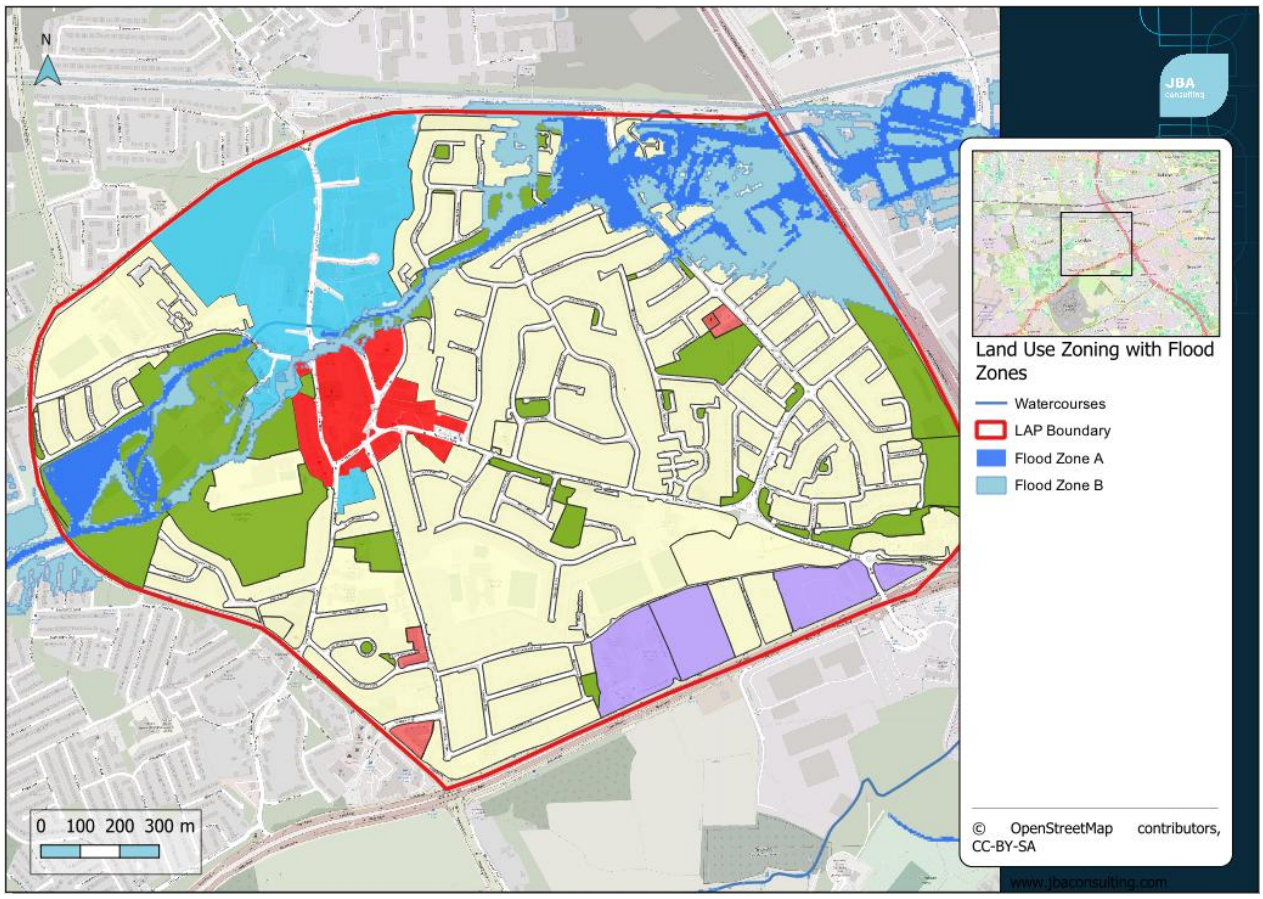


Figure 8-1 LUZ with Flood Zone A & B Extents

The following sections review the land use zoning objectives for each settlement area within the plan and provide a comprehensive summary of flood risk and justification where necessary.

8.2 Review of Opportunity Sites

The Justification Test is required for all opportunity sites and areas for potential development within a flood zone, whether located behind defences or not.

Due to the current absence of the Camac FRS flood extents and the related uncertainty in flood extents within the Clondalkin area, it is necessary to proceed to assess the opportunity sites based on the HEFS flood extents.

The HEFS extents provide valuable information to inform zoning decisions, particularly where development is proposed in areas that may be vulnerable under more extreme climate scenarios. Therefore, the HEFS flood extents have been used as part of the Justification Test appraisal of the opportunity sites undertaken in Appendix A. This approach aligns with the National Planning Framework (NPF), which identifies flood risk management and climate adaptation as key components of sustainable spatial planning. The NPF Strategic Flood Risk Assessment emphasises that flood risk should be a core consideration in land use planning, that the sequential approach should guide zoning decisions and that climate resilience must be embedded in all plan-making processes.

The baseline Flood Zone A & B extents and the opportunity sites are provided in Figure 8-2.

Figure 8-3 provides the HEFS flood extents with the opportunity sites that have been used as part of the Justification Test undertaken in Appendix A.

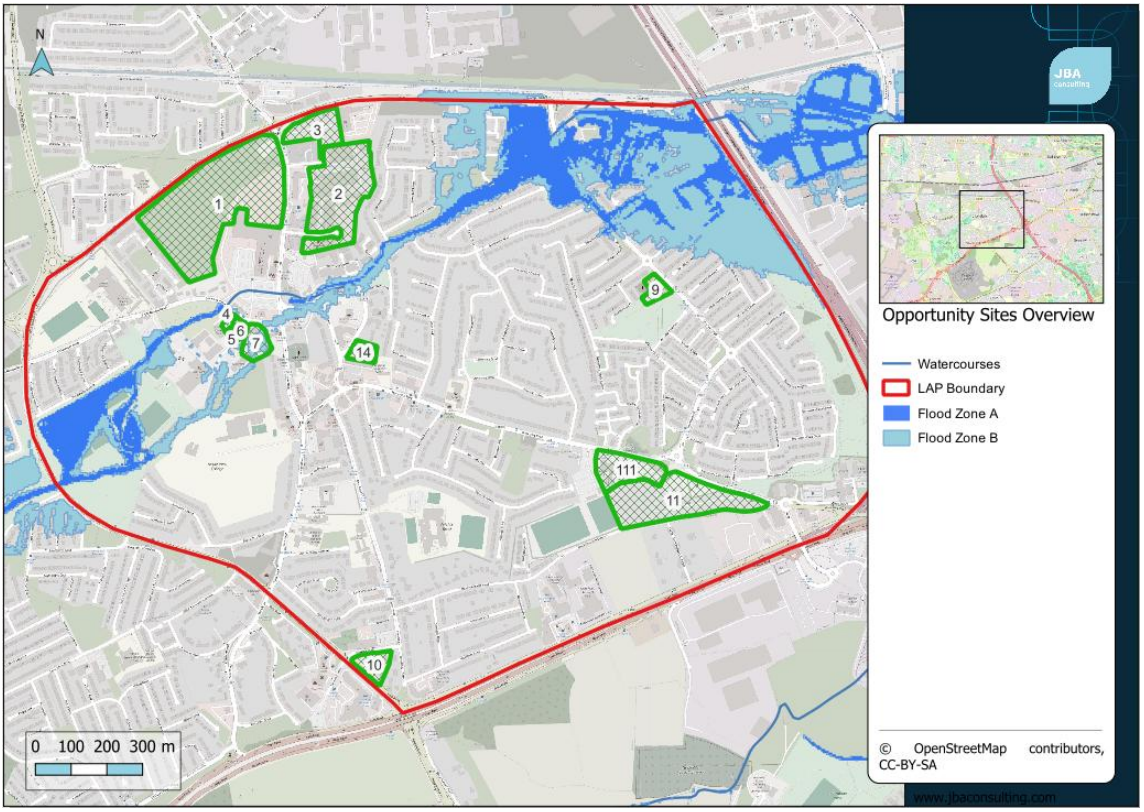


Figure 8-2 Opportunity Sites, Clondalkin - Flood Zone A & B

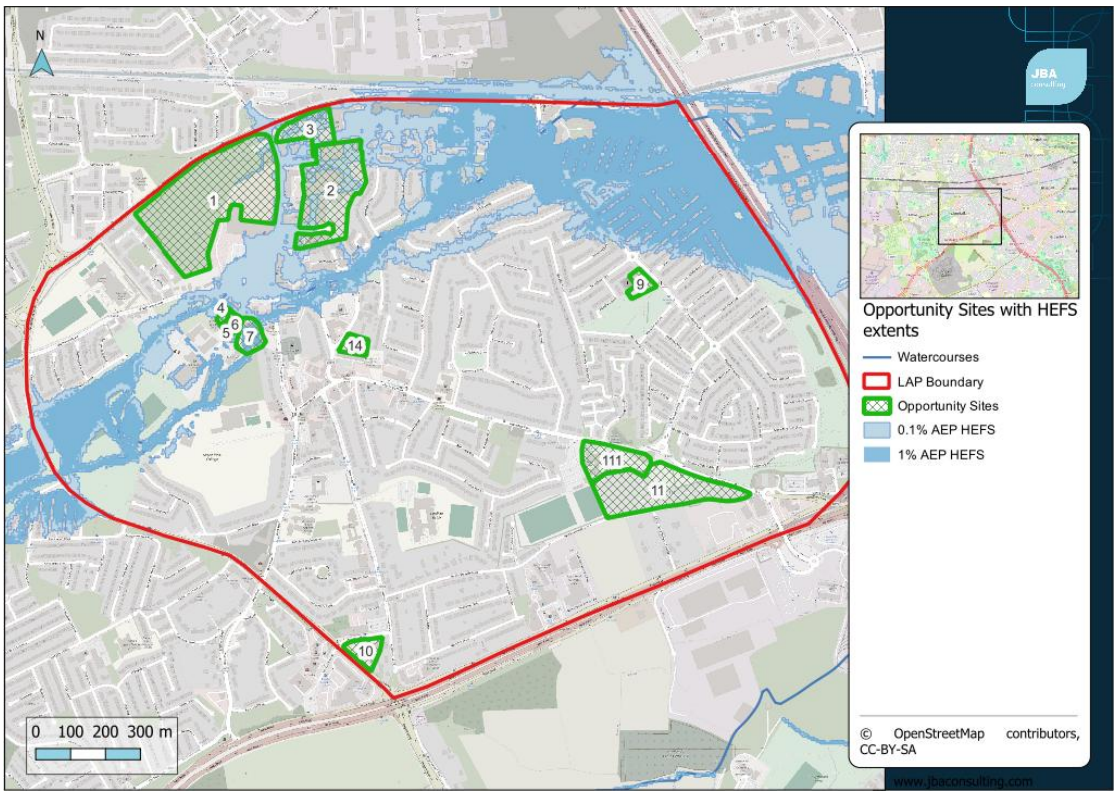


Figure 8-3 Opportunity Sites, Clondalkin - HEFS Flood Extents

8.3 Review of Flood Risk in Clondalkin

The River Camac poses a significant flood risk in Clondalkin and downstream urban areas like Inchicore and Kilmainham. Historically, the river has suffered serious flooding events, notably in

2011 and 2021, which inundated residential areas including the Old Nangor Road and Cherrywood. The catchment is highly urbanised and extensively culverted, meaning traditional flow routes are constrained and debris blockage in culverts has led to flooding in the past.

There is extensive overlap with the Town Centre zoning and 0.1% AEP HEFS flood extent, while the northern boundary of the Village Centre Zoning overlaps with both 1% AEP HEFS and 0.1% AEP HEFS flood extents. The remainder of the settlement shows significant overlap with existing residential and 1% AEP HEFS and 0.1% AEP HEFS flood extents in the northern half of the settlement originating from the River Camac. There should be careful consideration given to infill development and bedrooms should only be located in the upstairs of two-story buildings when extending existing residential property in these Flood Zones. Climate change is accounted for as the base Flood Zones used by SDCC include a climate change allowance of 30% increase in flows.

Clondalkin will have some level of protection in the future after on completion of the Camac Flood Alleviation Scheme with options including new flood storage ponds, reinforced floodwalls and embankments, culvert upgrades, and channel capacity improvements to defend against a 1% annual exceedance event while accounting for climate-change.

9 Review

9.1 Triggers for Review

An update to the SFRA will be triggered by the six-year review cycle that applies to local authority Development Plans. In addition, there are a number of other potential triggers for an SFRA review and these are listed in Table 9.1 (subject to change).

There are a number of key outputs from possible future studies and datasets, which should be incorporated into any update of the SFRA as availability allows. Not all future sources of information should trigger an immediate full update of the SFRA; however, new information should be collected and kept alongside the SFRA until it is updated.

Additional information will arise from the OPW and SDCC flood relief schemes over the period of this Development Plan, not only will these studies revisit the CFRAM assessment, but once schemes are in place the definition of risk will change significantly for existing development, and possibly also for undeveloped lands.

Any updates of the CFRAM Studies arising from future iterations and extensions of the CFRAM should be incorporated into SFRA updates.

Detailed, site specific FRAs may be submitted to support planning applications. Whilst these reports will not trigger a review of the Flood Zone maps or SFRA, they should be retained and reviewed as part of the next Development Plan cycle.

Table 9.1: SFRA Review Triggers

Trigger	Source	Possible Timescale
Catchment Flood Risk Assessment and Management (CFRAM) Cycle 2	OPW	At least xx
OPW Flood Relief Scheme outputs	OPW	Unknown
CAMACFAS	OPW/SDCC/DCC	Unknown
Flood maps of other sources, such as drainage networks	Various	Unknown
Significant flood events	Various	Unknown
Changes to Planning and / or Flood Management Policy	DoEHLG / OPW	Unknown
Construction / completion of flood relief schemes	OPW / DLRCC	Unknown

9.2 Conclusion

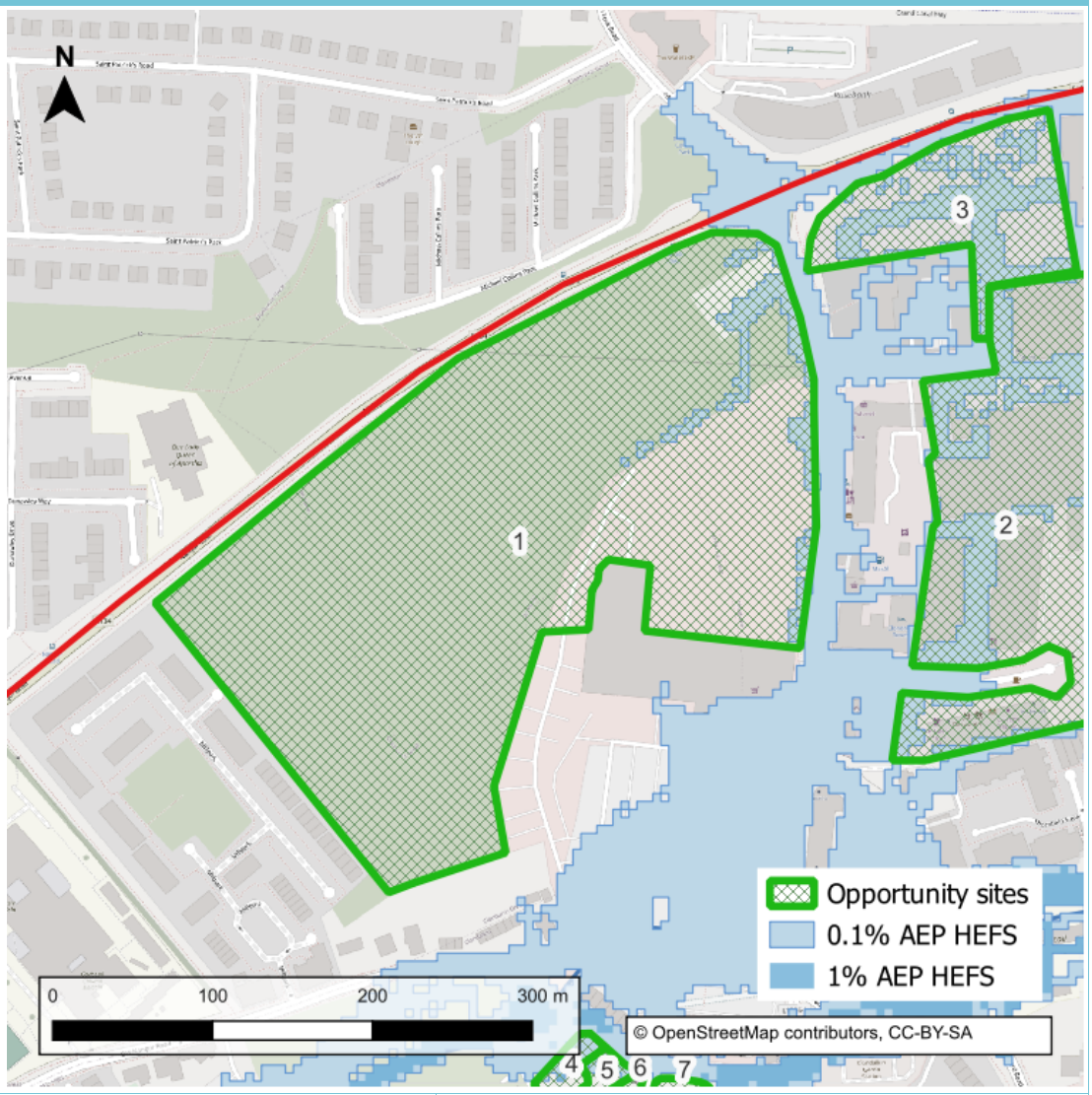
This SFRA has been developed to inform the preparation of policies and objectives for the Clondalkin LPF, which have been reviewed against the recommendations set out in The Planning System and Flood Risk Management Guidelines for Planning Authorities and Technical Appendices, 2009. The land-use zoning allocations aim to avoid areas of high flood risk and where this is not achieved, but the land-use zoning has passed parts 1 and 2 of the Justification Test, recommendations have been made in part 3 of the Justification Test, relating to flood risk (see Appendices A). It is noted the Flood Zones are based on best currently available data, but that a more detailed, site specific, flood risk assessment may produce locally varying flood outlines. There are a number of triggers which may prompt a review of the SFRA or will require a slight change in specification for site specific flood risk assessments, including the completion of various ongoing schemes.

Appendices

A Justification Tests

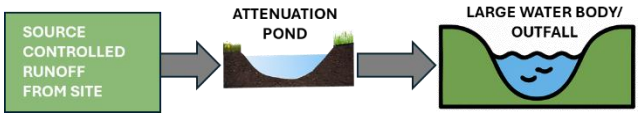
A.1 Opportunity Sites

A.1.1 Opp site 1 - Town Centre (TC)

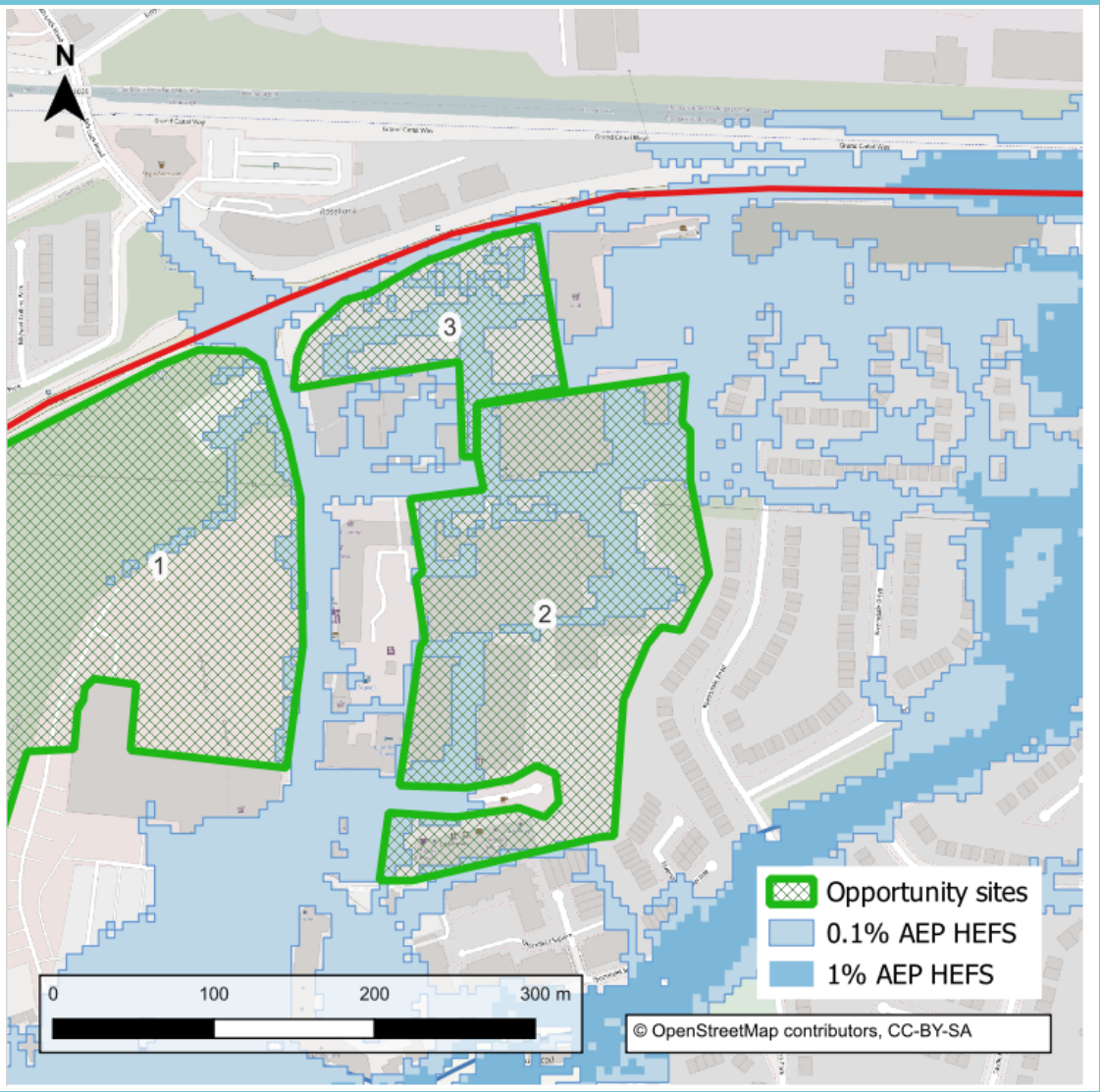


1. The urban settlement is targeted for growth under the National Planning Framework, Regional Spatial and Economic Strategy (RSES), statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.	Yes. Clondalkin Village is identified as a Level 1 settlement in South County Dublin Development Plan 2022 – 2028 settlement hierarchy. Key Towns are defined as International business core with a highly concentrated and diversified employment base and higher order retail, arts, culture and leisure offer. Acts as national transport hub with strong inter and intra-regional connections and an extensive commuter catchment.
2. The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and in particular:	Yes. Town centre use zoning in the town is required to achieve the proper planning and sustainable development of the urban settlement.
I. Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement	Yes. The zoning is essential to facilitate regeneration and vitality of the settlement

ii. Comprises significant previously developed and/or underutilised lands,	Yes. The lands are previously developed and contain Town Centre uses.
iii. Is within or adjoining the core of an established or designated urban settlement,	Yes. The Town Centre lands are situated within the Town Centre of Clondalkin.
iv. Will be essential in achieving compact and sustainable urban growth, and	Yes. Development of site will contribute significantly to achieving compact growth in town centre.
v. There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.	There are no suitable alternative lands.
3. A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere. N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment	Opportunity Site 1 is partially within the 0.1% AEP HEFS extents. Parts 1 & 2 of the test found that it is considered appropriate to retain the existing zoning. • Considering that the 0.1% AEP extent is largely limited to the eastern boundary, development in this area is feasible once appropriate mitigation measures can be applied, i.e. compensatory flood storage, appropriate setting of FFL. • To enable development within the site a masterplan Stage 3 FRA (including hydraulic model) is required. The model will confirm the effectiveness of any mitigation measure while also ensuring no increase in flood risk elsewhere • Consideration should also be given to the potential surcharging of the local stormwater system and associated impact on the development site. • FRA should address climate change scenarios in relation to FFLs and potential mitigation measures; • Finished floor levels should be above the 1% AEP level plus climate change and freeboard, or 0.1 AEP climate change event, whichever is higher; • Bedrooms should only be located in the upstairs of two-story buildings when extending existing residential property in Flood Zone B, if the ground floor can't be raised above the 0.1% AEP HEFS flood level; • Flood resilient construction materials and fittings should be considered if in Flood Zone A/B, if the ground floor can't be raised above the 0.1% AEP HEFS flood level; • Proposals should not impede existing flow paths or cause flood risk impacts to the surrounding areas, and; • Emergency evacuation plan and defined access / egress routes should be developed for extreme flood events. • Any development shall also be required to be built in accordance with SDCC SuDS Policy including consideration of nature-based surface water management in line with the DHLGH Best Practise Interim Guidance Document; Nature-Based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas.

4. Stormwater Management	The site is predominantly greenfield and relatively large, providing excellent scope to implement an integrated and sustainable stormwater management strategy. Given its size, the area lends itself well to a masterplan-based SuDS design, where runoff from different development parcels can be managed collectively rather than through separate, site-by-site systems. A stormwater attenuation basin could be strategically located along the southern boundary near River Camac if the topography allows. This basin would serve as the main control feature, temporarily storing surface water before releasing it at a restricted rate—kept to the greenfield runoff equivalent or a practical minimum of 2 L/s in accordance with CIRIA guidance. A typical schematic for such site is illustrated below:  Additionally, source control SuDS measures such as swales, rain gardens, and permeable paving should be incorporated within individual plots to slow, treat, and retain runoff close to where it falls. These measures will contribute to the overall network, reducing reliance on hard-engineered solutions and enhancing biodiversity and amenity. Exact location of attenuation site will depend on topographical and hydraulic assessment during later design stages.

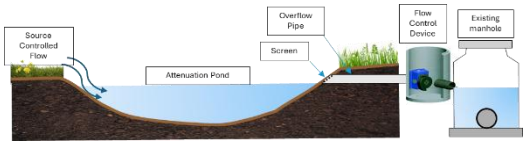
A.1.2 Opp sites 2, 3 - Town Centre (TC)



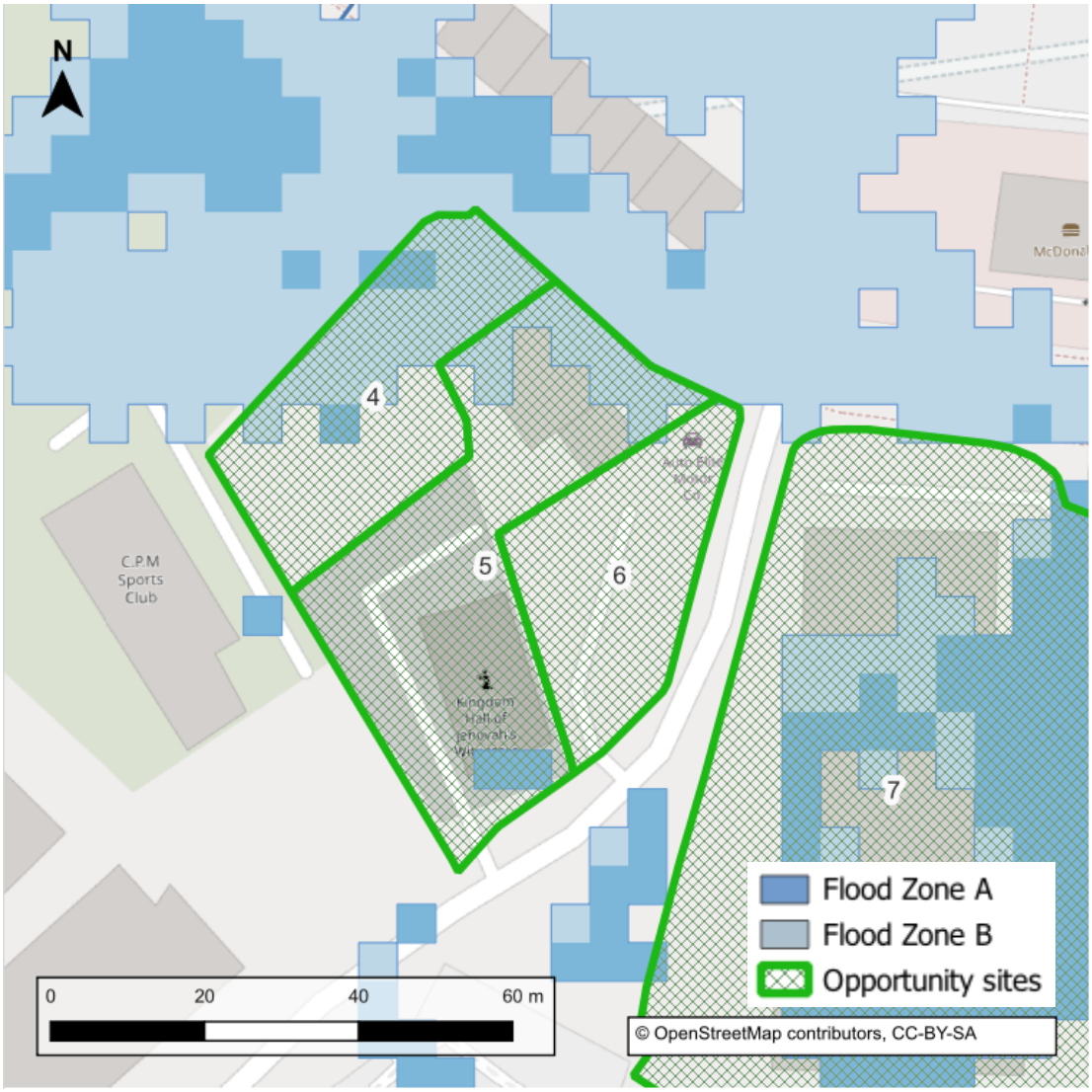
1. The urban settlement is targeted for growth under the National Planning Framework, Regional Spatial and Economic Strategy (RSES), statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.	Yes. Clondalkin Village is identified as a Level 1 settlement in South County Dublin Development Plan 2022 – 2028 settlement hierarchy. Key Towns are defined as international business core with a highly concentrated and diversified employment base and higher order retail, arts, culture and leisure offer. Acts as national transport hub with strong inter and intra-regional connections and an extensive commuter catchment.
2. The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and in particular:	Yes. Town centre use zoning in the town is required to achieve the proper planning and sustainable development of the urban settlement.
I. Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement	Yes. The zoning is essential to facilitate regeneration and vitality of the settlement
ii. Comprises significant previously developed and/or underutilised lands,	Yes. The lands are previously developed and contain Town Centre uses.
iii. Is within or adjoining the core of an established or designated urban	Yes. The Town Centre lands are situated within the Town Centre of Clondalkin.

settlement,	
iv. Will be essential in achieving compact and sustainable urban growth, and	Yes. Development of site will contribute significantly to achieving compact growth in town centre.
v. There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.	There are no suitable alternative lands.
3. A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere. N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment	Opportunity sites 2 and 3 are within the 0.1% HEFS extents. Parts 1 & 2 of the test found that it is considered appropriate to retain the existing zoning. Opportunity site 1 is within Flood Zone B. Parts 1 & 2 of the test found that it is considered appropriate to retain the existing zoning. • To enable development within the site a masterplan Stage 3 FRA (including hydraulic model) is required. The model will confirm the effectiveness of any mitigation measure while also ensuring no increase in flood risk elsewhere • Both Opp Sites 2 & 3, function as a flood conveyance pathway with floodwaters flowing in a general west - east direction. It is critical that this flow path is maintained as part of any development. • The masterplan will be developed for each opportunity site to ensure that the flow path is appropriated managed. The aim is to ensure that flood risk is not increased upstream or downstream of the site and the development is protected from inundation. • Therefore, careful consideration needs to be taken regarding gradients which could impact on flood depths through the development and should allow a freeboard of 300mm above the predicted 0.1% AEP HEFS flood level. • Consideration should also be given to the potential surcharging of the local stormwater system and associated impact on the development site. • FRA should address climate change scenarios in relation to FFLs and potential mitigation measures; • Finished floor levels should be above the 1% AEP level plus climate change and freeboard, or 0.1 AEP climate change event, whichever is higher; • Bedrooms should only be located in the upstairs of two-story buildings when extending existing residential property in Flood Zone B, if the ground floor can't be raised above the 0.1% AEP HEFS flood level; • Flood resilient construction materials and fittings should be considered if in Flood Zone A/B, if the ground floor can't be raised above the 0.1% AEP HEFS flood level; • Proposals should not impede existing flow

	paths or cause flood risk impacts to the surrounding areas, and; • Emergency evacuation plan and defined access / egress routes should be developed for extreme flood events. • Any development shall also be required to be built in accordance with SDCC SuDS Policy including consideration of nature-based surface water management in line with the DHLGH Best Practise Interim Guidance Document; Nature-Based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas.

4. Stormwater Management	Site 2 primarily comprises existing commercial and warehouse developments that are already connected to a stormwater drainage network. In the event of redevelopment or future expansion, it is recommended to incorporate blue/green SuDS measures to improve runoff management, water quality, and site resilience. Suitable measures may include green roofs, tree-pit infiltration, and permeable paving to promote local infiltration and reduce surface runoff. Where sufficient space exists, swales or landscaped attenuation features can be added to enhance on-site storage and reduce peak flows. As a final measure, to minimise pressure on the public drainage network, underground storage tanks may be installed to control discharge at a rate equivalent to the greenfield runoff or 2 L/s, whichever is greater, thereby mitigating the risk of downstream flooding. Site 3 is predominantly greenfield, providing significant flexibility for the implementation of an integrated SuDS strategy within a coordinated masterplan framework. The site's undeveloped nature allows for a holistic green approach that manages surface water runoff at source, promotes infiltration, and enhances amenity and biodiversity. A stormwater attenuation basin can be strategically located within the site, aligned with the natural topography to collect and temporarily store runoff from surrounding development parcels. The stored water can then be discharged in a controlled manner to the external stormwater network, as illustrated in the schematic below.  This controlled release, managed through a flow control chamber ensures that discharge rates do not exceed the greenfield runoff equivalent, or a minimum of 2 L/s, in accordance with CIRIA guidance. The exact location, geometry, and outlet configuration of the basin will be determined following a detailed topographical and drainage connectivity assessment. Where possible, the basin should be integrated with landscaped areas or public open space, creating opportunities for biodiversity enhancement and visual amenity, while contributing to the overall stormwater management capacity.

A.1.3 Opp sites 4, 5, 6 - Town Centre (TC)

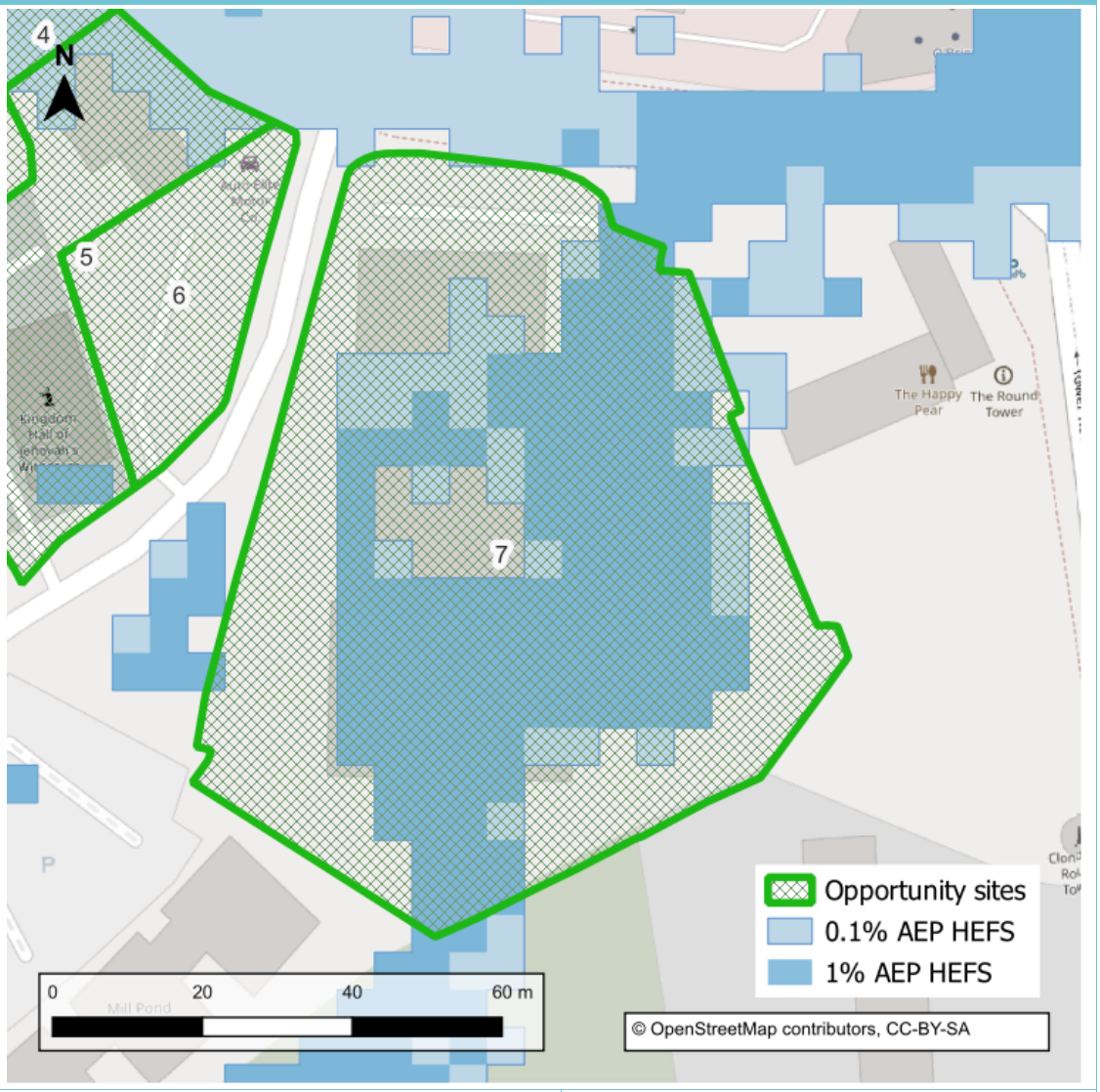


1. The urban settlement is targeted for growth under the National Planning Framework, Regional Spatial and Economic Strategy (RSES), statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.	Yes. Clondalkin Village is identified as a Level 1 settlement in South County Dublin Development Plan 2022 – 2028 settlement hierarchy. Key Towns are defined as International business core with a highly concentrated and diversified employment base and higher order retail, arts, culture and leisure offer. Acts as national transport hub with strong inter and intra-regional connections and an extensive commuter catchment.
2. The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and in particular:	Yes. Town centre use zoning in the town is required to achieve the proper planning and sustainable development of the urban settlement.
I. Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement	Yes. The zoning is essential to facilitate regeneration and vitality of the settlement
ii. Comprises significant previously developed and/or underutilised lands,	Yes. The lands are previously developed and contain Town Centre uses.
iii. Is within or adjoining the core of an established or designated urban settlement,	Yes. The Town Centre lands are situated within the Town Centre of Clondalkin.
iv. Will be essential in achieving compact and sustainable urban growth, and	Yes. Development of site will contribute significantly to achieving compact growth in town centre.
v. There are no suitable alternative lands for the particular use or development type,	There are no suitable alternative lands.

in areas at lower risk of flooding within or adjoining the core of the urban settlement.	
3. A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere. N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment	Opportunity sites 4, 5 and 6 are partially within Flood Zone B, while Opportunity sites 4 and 5 are partially within the 1% AEP HEFS extent. Parts 1 & 2 of the test found that it is considered appropriate to retain the existing zoning. This is on the basis that; • Within Flood Zone A/B development is limited to extensions, renovations and change of use. • Infill highly vulnerable development and demolition and reconstruction can only take place in Flood Zone C. Any future development should be subject to an FRA which should follow the general guidance provided in Section 7 of the SFRA and must specifically address the following: • The sequential approach should be applied and highly vulnerable infill and redevelopment shall not be permitted in Flood Zone A or B; • FRA should address climate change scenarios in relation to FFLs and potential mitigation measures; • Finished floor levels should be above the 1% AEP level plus climate change and freeboard; • Bedrooms should only be located in the upstairs of two-story buildings when extending existing residential property in Flood Zone A/B; • Flood resilient construction materials and fittings should be considered if in Flood Zone A/B; • Proposals should not impede existing flow paths or cause flood risk impacts to the surrounding areas, and; • Emergency evacuation plan and defined access / egress routes should be developed for extreme flood events. • Masterplan development can be considered premature until the completion of the River Camac FAS due to the uncertainty of the flood extents in the area.
4. Stormwater Management	At present, Sites 5 and 6 are characterised as compact urban plots, largely occupied by existing buildings. While, Site 4 remains greenfield, offering more flexibility for surface water management interventions. If these three sites are developed collectively under a coordinated masterplan, Site 4 could function as a green infrastructure site. This would allow runoff from Sites 5 and 6 to be conveyed to Site 4, where stormwater attenuation could be achieved. Flow control devices could then regulate discharge to the public stormwater network, ensuring compliance with the greenfield runoff rate or a minimum of 2 L/s, in line with CIRIA SuDS design guidance. However, if the sites are developed individually on a piecemeal basis and Town Centre development is anticipated at these sites. Therefore, limited green opportunities will be available. In this scenario, surface water management should focus on

	building-integrated SuDS measures, including green roofs, tree infiltration pits, bioretention planters, and permeable paving to promote interception, filtration, and local storage of runoff. Given the limited space, underground storage tanks will be essential to provide adequate attenuation capacity. These tanks should be designed to restrict outflow to the equivalent greenfield runoff rate, preventing surcharging of the downstream public drainage network and reducing the risk of localised flooding.

A.1.4 Opp site 7 - Town Centre (TC)



1. The urban settlement is targeted for growth under the National Planning Framework, Regional Spatial and Economic Strategy (RSES), statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.	Yes. Clondalkin Village is identified as a Level 1 settlement in South County Dublin Development Plan 2022 – 2028 settlement hierarchy. Key Towns are defined as International business core with a highly concentrated and diversified employment base and higher order retail, arts, culture and leisure offer. Acts as national transport hub with strong inter and intra-regional connections and an extensive commuter catchment.
2. The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and in particular:	Yes. Town centre use zoning in the town is required to achieve the proper planning and sustainable development of the urban settlement.
I. Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement	Yes. The zoning is essential to facilitate regeneration and vitality of the settlement
ii. Comprises significant previously developed and/or underutilised lands,	Yes. The lands are previously developed and contain Town Centre uses.

iii. Is within or adjoining the core of an established or designated urban settlement,	Yes. The Town Centre lands are situated within the Town Centre of Clondalkin.
iv. Will be essential in achieving compact and sustainable urban growth, and	Yes. Development of site will contribute significantly to achieving compact growth in town centre.
v. There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.	There are no suitable alternative lands.
3. A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere. N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment	Opportunity site 7 is predominantly within Flood Zone B and is also within the 1% AEP HEFS extent. Parts 1 & 2 of the test found that it is considered appropriate to retain the existing zoning. This is on the basis that; • Within Flood Zone A/B development is limited to extensions, renovations and change of use. • Infill highly vulnerable development and demolition and reconstruction can only take place in Flood Zone C. Any future development should be subject to an FRA which should follow the general guidance provided in Section 7 of the SFRA and must specifically address the following: • The sequential approach should be applied and highly vulnerable infill and redevelopment shall not be permitted in Flood Zone A or B, without a full Stage 3 assessment; • FRA should address climate change scenarios in relation to FFLs and potential mitigation measures; • Finished floor levels should be above the 1% AEP level plus climate change and freeboard, or the 0.1% AEP HEFS event whichever is higher; • Bedrooms should only be located in the upstairs of two-story buildings when extending existing residential property in Flood Zone A/B; • New developments may have bedroom space on the ground floor once appropriate freeboards can be achieved and residual risk have been assessed. • Flood resilient construction materials and fittings should be considered if in Flood Zone A/B; • Proposals should not impede existing flow paths or cause flood risk impacts to the surrounding areas, and; • Emergency evacuation plan and defined access / egress routes should be developed for extreme flood events. • Masterplan development can be considered premature until the completion of the River Camac FAS due to the uncertainty of the flood extents in the area.

4. Stormwater Management	Given the anticipated use as Town Center with high-density redevelopment, the incorporation of surface-based attenuation features such as swales or attenuation ponds may be constrained. Nevertheless, a strong emphasis should be placed on decentralised SuDS measures that can effectively manage runoff close to source. These may include green roofs and podium planting to reduce rainfall impact, tree-pit infiltration systems to promote local infiltration, and permeable paving for car parks or access areas to attenuate flows and improve water quality. Where feasible, landscaped zones or setback areas along the site's perimeter could accommodate bioretention planters or shallow rain gardens, contributing to both hydraulic control and visual amenity. Nevertheless, underground attenuation storage should be provided to capture excess runoff, with flow-controlled devices before connecting to the existing public stormwater network. Discharge from the site should be limited to the greenfield runoff equivalent or a minimum of 2 L/s, in line with CIRIA guidance.

A.2 Objectives

Policy GI3: 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 1: To ensure that hydromorphical assessments are undertaken where proposed development is within lands which are partially or wholly within the Riparian Corridors identified as part of this Development Plan
GI3 Objective 2: To require development proposals that are within riparian corridors to demonstrate how the integrity of the riparian corridor can be maintained and enhanced having regard to flood risk management, biodiversity, ecosystem service provision, water quality and hydromorphology
GI3 Objective 3: To promote and protect native riparian vegetation along all watercourses and ensure that a minimum 10m vegetated riparian buffer from the top of the riverbank is maintained / reinstated along all watercourses within any development site
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

Policy GI4: 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 1: To limit surface water run-off from new developments through the use of Sustainable Drainage Systems (SuDS) using surface water and nature-based solutions and ensure that SuDS is integrated into all new development in the County and designed in accordance with South Dublin County Council's Sustainable Drainage Explanatory Design and Evaluation Guide, 2022.
GI4 Objective 2: To incorporate a SuDS management train during the design stage whereby surface water is managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment.
GI4 Objective 3: To require multifunctional open space provision within new developments to include provision for ecology and sustainable water management.
GI4 Objective 4: To require that all SuDS measures are completed to a taking in charge standard.
GI4 Objective 5: To promote SuDS features as part of the greening of urban and rural streets to restrict or delay runoff from streets entering the storm drainage network.
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

B HEFS Mapping

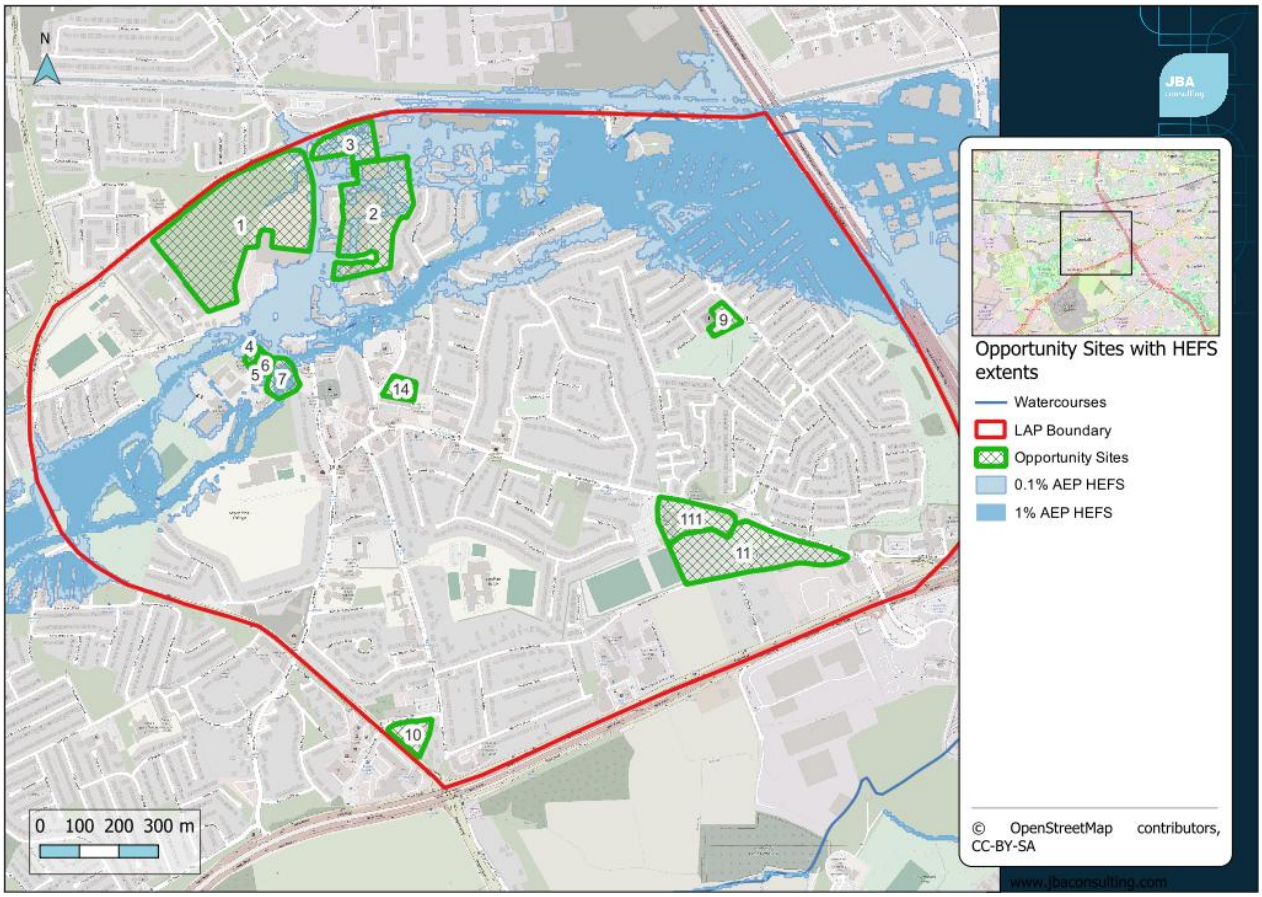


Figure 9-1 Opportunity Sites with HEFS CFRAM mapping

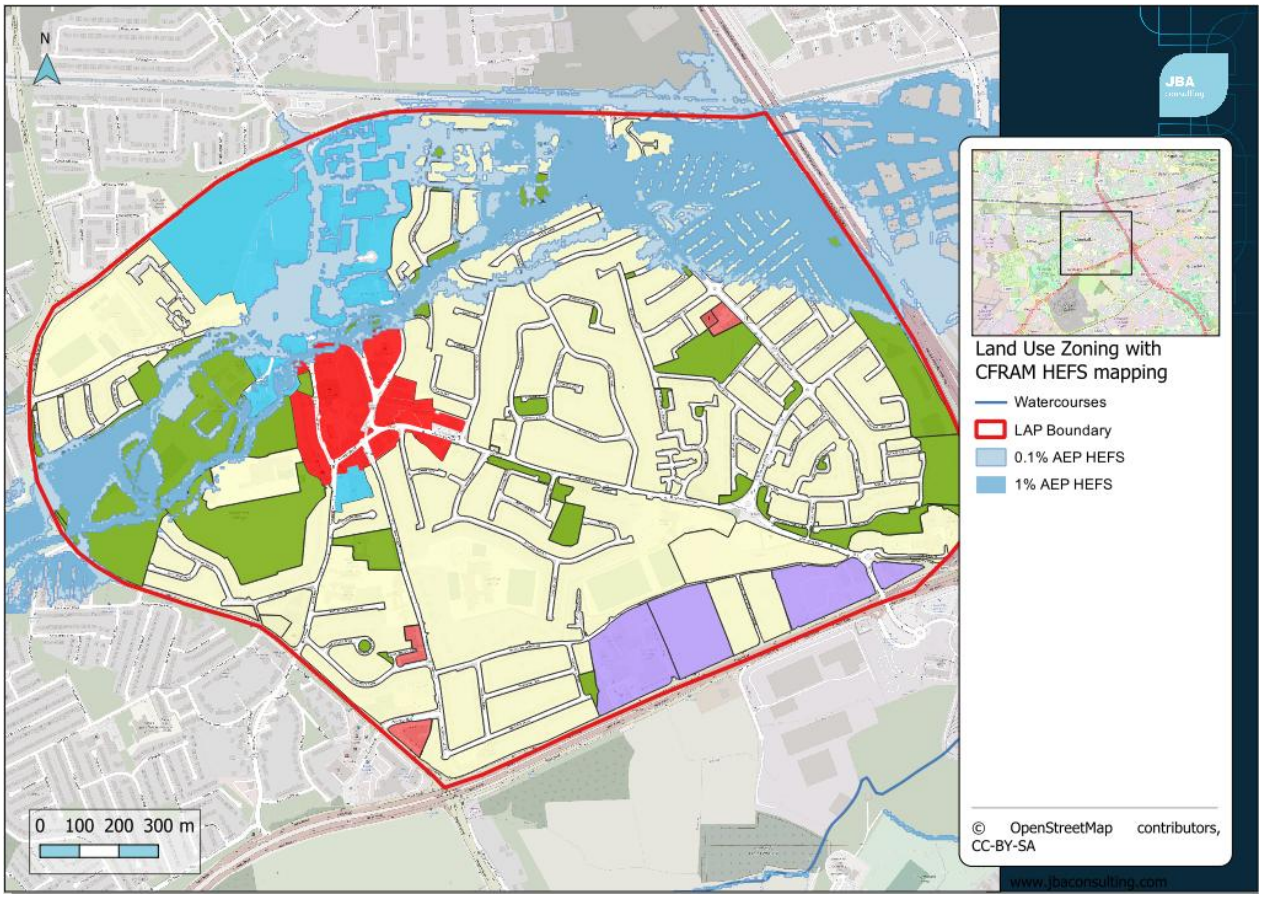


Figure 9-2 Land Use Zoning with HEFS Scenario Mapping