Hertsmere Borough Council Level 1 Strategic Flood Risk Assessment

Hertsmere Borough Council

September 2023

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Quality information

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1.1 Background

1.1.1 The National Planning Policy Framework[1] (NPPF) and associated Planning Practice Guidance (PPG)[2] for Flood Risk and Coastal Change emphasise the active role Local Planning Authorities (LPA) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. The NPPF outlines that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and the LPA should use the findings to inform strategic land use planning.

1.1.2 A SFRA for Hertsmere Borough Council (HBC) was prepared by AECOM in 2018 and formed part of the evidence base for HBC's Core Strategy and Site Allocations and Development Management (SADM) Policies Plan[3].

1.1.3 The following changes have occurred since the previous SFRA (2018) was issued:

- Several strategic flood risk datasets have been updated for the study area.
- The NPPF was updated in July 2021[1].
- The Environment Agency published an updated guide on how to prepare an SFRA[4] in March 2022. This included updates in several areas including the governance arrangements for preparing SFRAs and further detail on the sequential test, among other advice.
- Guidance on how climate change allowances (for peak river flows, peak rainfall, and sea level rise) should be applied to flood risk assessments was updated in May 2022[5].
- In August 2022, significant changes were made to the to the PPG for Flood Risk and Coastal Change.

1.1.4 As a result of these changes, HBC has commissioned AECOM to review and update the Level 1 SFRA for its administrative area. This Report comprises the updated Level 1 SFRA Report.

1.1.5 The purpose of the Level 1 SFRA Update is to collate and analyse the most up to date readily available flood risk information for all sources of flooding, to provide an overview of flood risk issues across the Borough. This will be used by HBC to inform the preparation and examination of HBC's emerging Local Plan – Planning for Growth, including the application of the Sequential Test to future site allocations. It is also intended that the revised Level 1 SFRA deliverables will assist prudent decision-making on flood risk issues by Development Management Officers on a day-to-day basis. The SFRA will also help emergency planners to better understand the flood risk to existing and proposed communities.

1.1.6 Under the Flood and Water Management Act (FWMA)[6], HCC is designated as a Risk Management Authority (RMA) and its primary duty is to cooperate with the Lead Local Flood Authority (LLFA) and other RMAs to manage flooding from local sources across the Borough, specifically surface water, groundwater and ordinary watercourses. HBC's power as an RMA includes designation of flood risk and maintaining a register of structures and features that are likely to have a significant effect on flood risk. As well as powers of designation, HBC is the RMA holding the powers to manage flood risk from ordinary watercourses under S14A of the Land Drainage Act 1991. The Environment Agency retains responsibility for leading and coordinating the management of flood risk associated with Main Rivers.

[1] Department for Levelling Up, Housing and Communities. Updated July 2021. *National Planning Policy Framework*. https://www.gov.uk/government/publications/national-planning-policy-framework--2
[2] Department for Communities and Local Government and Ministry of Housing, Communities and Local Government. Updated August 2022. *Planning Practice Guidance: Flood Risk and Coastal Change.* http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
[3] Hertsmere Borough Council. Adopted November 2016. *Hertsmere Local Plan - Site Allocations and Development Management Policies Plan.* https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Plan/FINAL-ADOPTED-SADM-01-02-2017.pdf
[4] Environment Agency. Updated March 2022. *How to prepare a strategic flood risk assessment.* https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment#full-publication-update-history
[5] Environment Agency. *Flood risk assessments: climate change allowances*. Updated May 2022. Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)
[6] Flood and Water Management Act, 2010. https://www.legislation.gov.uk/ukpga/2010/29/contents

1.2 Approach to Flood Risk Management

1.2.1 The overall approach for the consideration of flood risk set out in the NPPF and paragraphs 3 and 4 of the PPG is summarised as follows:

1.2.2 This has implications for LPAs and developers as described below.

Assess flood risk

1.2.3 The NPPF outlines that Local Plans should be supported by a SFRA and LPAs should use the findings to inform strategic land use planning. Figure 1-1 illustrates how flood risk should be taken into account in the preparation of the Local Plan by HBC.

1.2.4 Where appropriate, for sites in areas at risk of flooding, developers must undertake a site-specific Flood Risk Assessment (FRA) to accompany planning applications (or prior approval for certain types of permitted development, or Technical Details Consent).

1.2.5 Assessments of flood risk should identify sources of uncertainty and how these are accounted for in a mitigation strategy.

Avoid flood risk

1.2.6 In plan-making, HBC should apply the sequential approach to site selection so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of climate change and the vulnerability of future users to flood risk. This involves applying the Sequential Test and, if needed, the Exception Test, as described in Figure 1-1.

1.2.7 In decision-taking this involves applying the Sequential Test and if necessary, the Exception Test for specific development proposals. Furthermore, *within* individual application sites, the most vulnerable aspects of development must be located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location.

1.2.8 Where the Sequential and Exception Tests have been applied as necessary and not met, development should not be allowed.

Control flood risk

1.2.9 HBC and developers can investigate measures to control the risk of flooding affecting the site. Early discussions with relevant flood risk management authorities, and reference to SFRAs and programmes of flood and coastal erosion risk management schemes will help to identify such opportunities.

1.2.10 HBC and developers should seek flood risk management opportunities (e.g. safeguarding land), and to reduce the causes and impacts of flooding (e.g. through the use of sustainable drainage systems).

Mitigate flood risk

1.2.11 After applying measures to avoid and control the risk of flooding, the next step is to mitigate the risk of flooding. HBC and developers must ensure that development is appropriately flood resilient and resistant. Passive flood resilience and resistance measures should be prioritised over active measures as they are likely to be more effective and more reliable.

Manage flood risk

1.2.12 HBC and developers should consider further management measures to deal with any residual risk remaining after avoidance, control and mitigation have been utilised. Residual risks will need to be safely managed to ensure people are not exposed to hazardous flooding. LPAs and developers should

provide safe access and escape routes and consider whether adequate flood warning would be available to people using the development.

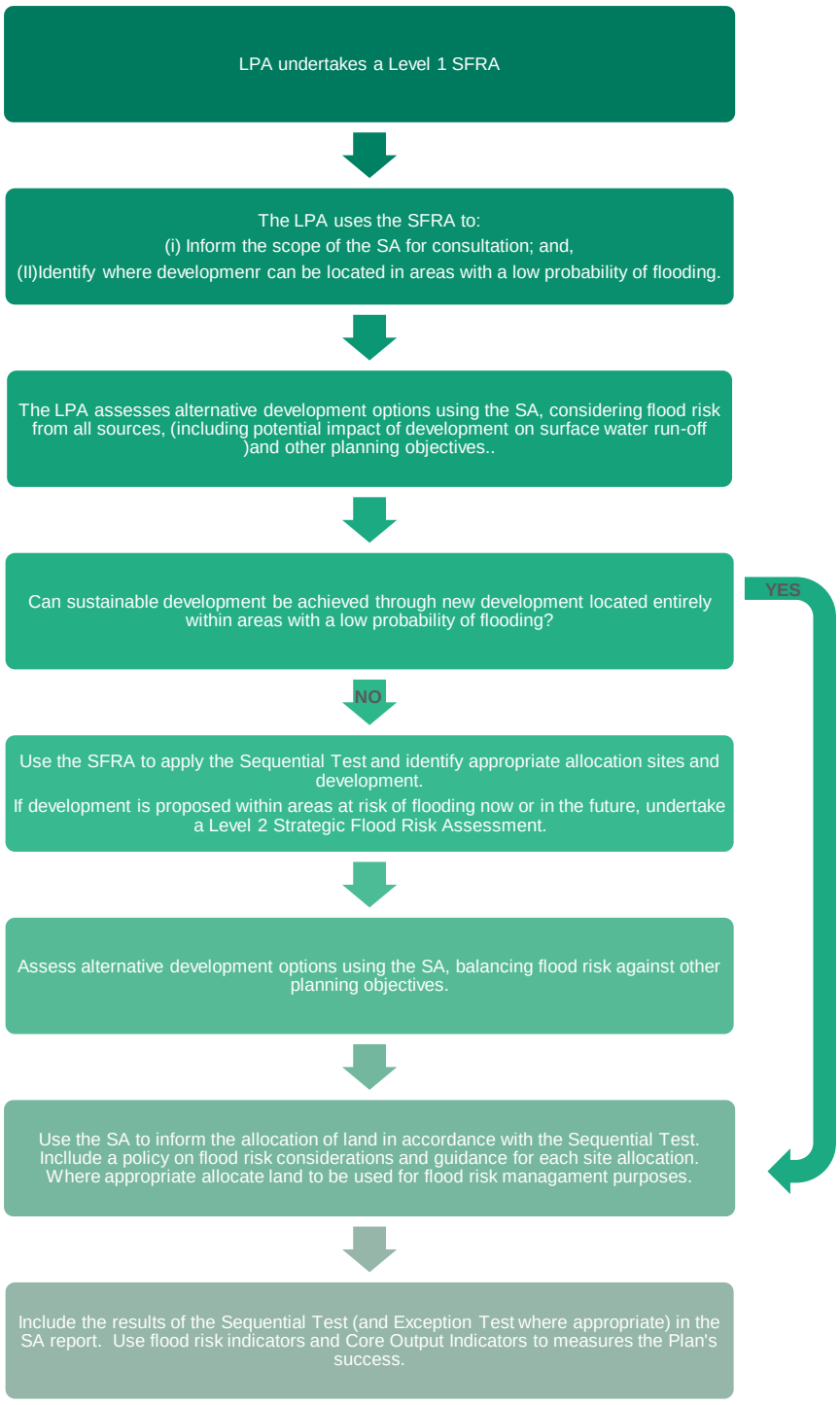

Figure 1-1 Taking flood risk into account in the preparation of strategic policies (Planning Practice Guidance for Flood Risk and Coastal Change Diagram 1)

1.3 Partner Organisations

1.3.1 Several organisations are involved in development and flood risk management across the study area, as described below.

1.3.2 **Hertsmere Borough Council** is the LPA for the study area, responsible for long term strategic planning of future development through the preparation of Local Plans, as well as for determining planning applications within the Borough. HBC should work with the LLFA to secure Local Plan policies compatible with the local flood risk management strategy. HBC is also the Land Drainage Authority for the study area. HBC published a set of Byelaws[7] under the Section 66 of the Land Drainage Act 1991, to secure the efficient working of the drainage system in their area, for preventing flooding or remedying or mitigating any damage caused by flooding. HBC have certain permissive powers to undertake flood defence works and powers of enforcement under the Land Drainage Act 1991 on watercourses which have not been designated as Main Rivers.

1.3.3 **Hertfordshire County Council** is designated as the LLFA under the FWMA and has a duty to lead and coordinate the management of local flood risk, which includes flood risk from surface water, groundwater, and ordinary watercourses. However, HBC has permissive powers to manage flood risk from surface runoff and groundwater under S14A the Land Drainage Act 1991.

1.3.4 The LLFA is a statutory consultee in planning for all major development in relation to the management of surface water drainage.

1.3.5 **Hertfordshire County Council (Highways Authority)** maintains the local road network which are highway maintainable at public expense which includes provision of highway drainage and several roadside ditches. The HCC Highways Authority also has permissive powers under the Highway Act 1980 to manage flooding of the highway. The Highways Authority must ensure that road projects do not increase flood risk.

1.3.6 **Environment Agency** has a strategic overview role for flood risk management associated with Main Rivers in the Borough and is a statutory consultee for any development proposed within Flood Zone 2 and 3 associated with these watercourses. The Environment Agency is continually improving and updating their flood map for Main Rivers and has permissive powers to carry out flood defence works, maintenance and operational activities for these Main Rivers. However, overall responsibility for maintenance lies with the riparian owner.

1.3.7 **Thames Water Utilities Limited** has the duty as a statutory body to provide wastewater services to the whole of the study area and is responsible for the management, maintenance, and operation of flood control structures. Water Companies are defined as an RMA within the FWMA and are responsible for flood risk management functions in accordance with the Water Resources Act 1991 and the Land Drainage Act 1991. Thames Water is responsible for surface water drainage from development via adopted sewers and for maintaining trunk sewers into which much of the highway drainage in the study area connects. To this extent, Thames Water Utilities Limited are required to adequately drain the upstream infrastructure.

1.3.8 **National Highways** has responsibilities (under the Highways Act 1980) for the effectual drainage of surface water from motorways and major A roads, including the slip roads to and from trunk roads, insofar as ensuring that drains, including kerbs, road gullies, ditches and the pipe network which connect to the sewers are maintained.

1.3.9 **Affinity Water** provide water to parts of the Borough, and this is provided from groundwater sources as well as surface water sources. These supply sources are taken from the River Thames as well as reservoirs throughout the region.

[7] Hertsmere Borough Council, *Land Drainage Byelaws*, 1998. https://www.hertsmere.gov.uk/Documents/04-Environment-Refuse--Recycling/Drainage/Land-Drainage-Bylaws.pdf

1.4 Level 1 SFRA Approach

1.4.1 The Level 1 SFRA is a desk-based study, using readily available existing information and datasets to enable the application of the Sequential Test and to identify where the Exception Test may be required. The main tasks in preparing the Level 1 SFRA are described below.

Gathering data and analysing it for suitability

1.4.2 Under Section 14 of NPPF, the risk of flooding from all sources must be considered as part of a Level 1 SFRA, including flooding from tidal sources, rivers (fluvial), land (overland flow and surface water), groundwater, sewers, and artificial sources.

1.4.3 An extensive set of datasets was requested from several organisations, including HBC, HCC (as the LLFA and Highways Authority), the Environment Agency, and Thames Water.

1.4.4 Datasets and information gathered as part of the preparation of the first and second iteration of the SFRA in 2008 and 2018 have been retained where appropriate. The datasets are described further in Section 3, including detail regarding appropriate uses and limitations, and how they have been used within the Level 1 SFRA.

Producing strategic flood risk maps, GIS deliverables and reporting

1.4.5 A series of GIS maps have been produced using the data gathered during the study. The mapping deliverables are summarised in Table 1-1 and presented in **Appendix A** and should be referred to when reading Section 3 'Assessing Flood Risk'.

Table 1-1 Strategic Flood Risk Maps

Figure No.	Figures Title and Content
Figure 01	Study Area *(administrative boundaries, watercourses, water bodies)*
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Figure 03	Superficial Geology
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Figure 15	Main Rivers Covered by Detailed Hydraulic Modelling
Figure 16	Chalk Streams
Figure 17.0 – 17.4	Working with Natural Processes

Providing guidance for specific purposes

1.4.6 The SFRA report is structured as follows:

- Section 2 provides a summary of the planning policy context.
- Section 3 ‘Assessing Flood Risk’ and the supporting mapping deliverables (**Appendix A**) provide a description of the risk of flooding across the Borough.
- Section 4 provides guidance on ‘Avoiding Flood Risk’ through the appropriate application of the Sequential Test by HBC when allocating future development sites as part of the plan-making process, as well as by developers promoting development on windfall sites.
- Sections 5 provides guidance on measures to ‘Control and Mitigate Flood Risk’ on future development sites.
- Section 6 provides guidance on the application of SuDS.
- Section 7 provides guidance on the preparation of site-specific FRAs.
- Section 8 outlines several flood risk management objectives and policy recommendations for consideration by HBC throughout the development of their strategic planning documents.
- Section 9 summarises the next steps for HBC.

2. Legislative and Planning Policy Context

2.1 Introduction

2.1.1 This Section provides an overview of the legislative, national, and local planning policy context specific to the Level 1 SFRA for HBC. The information presented in the SFRA should be used by HBC to establish robust policies in relation to flood risk as part of their emerging local plan.

2.2 Flood and Water Management Act

2.2.1 The FWMA[6], enacted by Government in response to the Pitt Review[8], designated county councils, such as HCC, as LLFAs. As such, HCC has responsibilities to lead and co-ordinate local flood risk management. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses).

2.2.2 The FWMA also formalises the flood risk management roles and responsibilities for other organisations including the Environment Agency, district councils, water companies and highway authorities. The responsibility to lead and co-ordinate the management of tidal and fluvial risk remains that of the Environment Agency.

National Strategy for Flood and Coastal Erosion Risk Management

2.2.3 In accordance with the FWMA, the Environment Agency has developed a National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England[9]. This strategy provides a framework for the work of all flood and coastal erosion risk management authorities. Hertsmere is not a coastal Borough; therefore, for this area the National FCERM Strategy sets out the other long-term objectives for managing all other sources of flood risk and the measures proposed to achieve them.

2.2.4 The strategy sets the context for, and informs the production of, local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It has a long-term vision for: **a nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100** and has 3 long-term ambitions, underpinned by evidence about future risk and investment needs. They are:

- **Climate resilient places:** working with partners to bolster resilience to flooding and coastal change across the nation, both now and in the face of climate change.
- **Today's growth and infrastructure resilient in tomorrow's climate:** making the right investment and planning decisions to secure sustainable growth and environmental improvements, as well as infrastructure resilient to flooding and coastal change.
- **A nation ready to respond and adapt to flooding and coastal change:** ensuring local people understand their risk to flooding and coastal change, know their responsibilities and how to take action.

2.2.5 The Environment Agency's 'Flood risk assessments: climate change allowances'[10] guidance is a supporting note for the National FCERM Strategy. The document reflects an assessment completed by the Environment Agency using UKCP18 data to produce more representative climate change allowances for river flood flows and extreme rainfall for each of the river basin districts in England. It is essential that land use planning decisions consider the impact of a changing climate where appropriate.

[8]Cabinet Office (2008) Sir Michael Pitt Report 'Learning lessons learned from the 2007 floods'. http://www.environment-agency.gov.uk/research/library/publications/33889.aspx
[9] Defra, Environment Agency (2021) The National Flood and Coastal Erosion Risk Management Strategy for England.
[10] Environment Agency. *Flood risk assessments: climate change allowances*. Updated May 2022. Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

Local Flood Risk Management Strategy

2.2.6 As LLFA, HCC has a statutory duty to develop, maintain, apply, and monitor a strategy for local flood risk management in the administrative area. HCC has prepared their Local Flood Risk Management Strategy 2 (LFRMS)[11] to enable flood risk across Hertfordshire to be managed more effectively and holistically.

2.2.7 The overall aim of the LFRMS is to "give an understanding of local flood risk in Hertfordshire and the actions that will be taken to manage it most appropriately within available resources". The LFRMS will seek to implement the following principles:

1. Take a risk-based approach to local flood risk management
2. Work in partnership to manage flood risk in the county
3. Improve the understanding of flood risk to better inform decision making
4. Support those at risk of flooding to manage that risk
5. Work to reduce the likelihood of flooding where possible
6. Ensure that flood risk arising from new development is managed

2.2.8 Alongside these 6 principles, the LFRMS have outlined 21 policies and a list of 11 actions. These 11 actions include short, medium, and long-term programmes and range from working with the community and other key stakeholders to providing additional regulation and funding.

2.3 Flood Risk Regulations

2.3.1 Under the UK Flood Risk Regulations[12] ('the Regulations'), LLFAs must prepare Preliminary Flood Risk Assessments (PFRAs) and where necessary, (in formally identified Flood Risk Areas where the risk of flooding from local sources is significant), Flood Risk Management Plans (FRMPs). The Environment Agency is required to prepare FRMPs for all of England covering flooding from Main Rivers, the sea, and reservoirs. These are described below.

Preliminary Flood Risk Assessment

2.3.2 A Preliminary Flood Risk Assessment (PFRA) report is a high-level screen exercise to identify areas of significant risks as 'Indicative Flood Risk Areas' across England where 30,000 people or more are at risk from flooding.

2.3.3 A PFRA was prepared for HCC in 2011[13]. A subsequent addendum was published on 3 April 2018[14]. The PFRA provides a high-level overview of flood risk from local flood sources and includes flooding from surface water (i.e., rainfall resulting overland runoff), groundwater, ordinary watercourses (smaller watercourses and ditches) and canals. It excludes flood risk from Main Rivers, the sea, and reservoirs as these are assessed nationally by the Environment Agency. The PFRA report looks at past flooding and where future flooding might occur across the area and the consequences it might have to people, properties, and the environment.

Thames RBD Flood Risk Management Plan

2.3.4 The Thames River Basin District Flood Risk Management Plan[15] was published by the Environment Agency and sets out the measures to manage flood risk in the Thames River Basin District from 2021 to 2027.

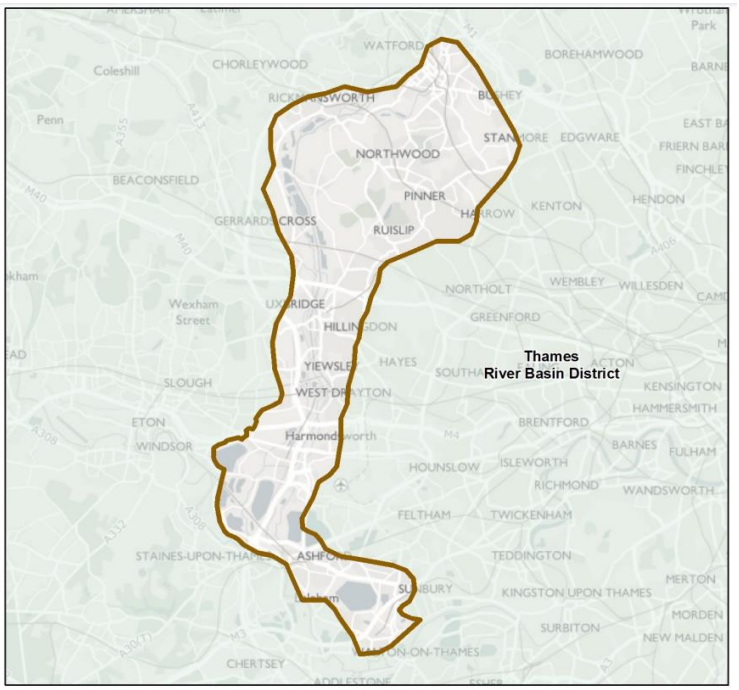
[11] Hertfordshire County Council (2019) *Local Flood Risk Management Strategy 2* (2019 – 2029). https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/flood-risk-management/lfrms-for-hertfordshire-full-report.pdf
[12] HSMO (2009) *The Flood Risk Regulations*. http://www.legislation.gov.uk/uksi/2009/3042/contents/made
[13] Hertfordshire County Council (2011) *Preliminary Flood Risk Assessment*. http://www.hertsdirect.org/docs/pdf/f/hccpfra.pdf
[14] Hertfordshire County Council (2017) *Preliminary Flood Risk Assessment Addendum*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/691054/Hertfordshire_County_Council_PFRA_updated_2017.pdf
[15] Environment Agency (December 2022) *Thames River Basin District Flood Risk Management Plan 2021-2027*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1120245/Thames-FRMP-2021-2027.pdf

2.3.5 The river basin management plans (RBMPs) aim to enhance nature and the natural water assets that are the foundation of everyone's wealth, health, and wellbeing. The plans summarise measures that will help nature to recover and adapt to future climate impacts.

2.3.6 The proposed updated RBMPs set out the environmental objectives for the water environment and a high-level summary of the measures needed to achieve those objectives. The plans summarise funding that will be invested in the water environment to 2027.

2.3.7 The updated Thames RBMP looks differently at the River Colne catchment than how the 2015-2021 report analysed it. The plan now focuses on the Colne Valley Strategic area as shown in Figure 2-1 which borders the southwest of the Borough. The report shows that 2,479 people are at a High Risk (>3.3%) of being flooded each year out of a total population of 338,422 within the Colne Valley Strategic Area.

Figure 2-1 The Colne Valley Rivers and Sea Strategic Area



Thames River Basin Management Plan

2.3.8 Alongside the Thames RBD Flood Risk Management Plan, the Thames River Basin Management Plan[16] was produced in October 2022 and last updated in December 2022. These two plans are aligned to "set strategic goals and approaches to managing water and flood risk within the RBD". The River Basin Management Plan sets out the foundation for delivering the government's 25 Year Environment Plan.

Thames Catchment Flood Management Plan

2.3.9 The Thames Catchment Flood Management Plan[17] provides an overview of the flood risk across the river catchment and recommended ways of managing the risk now and over the next 50 to 100 years. CFMPs are used to help the Environment Agency and partners to plan and agree the most effective way to manage flood risk in the future.

2.3.10 The Colne catchment is discussed within Sub-area 4 of the CFMP. The section states that the catchment is "generally managing flood risk effectively and the policy recognises the moderate level of flood risk in these areas". The proposed actions to be implemented are stated below:

[16] Environment Agency (December 2022) *Thames river basin district river basin management plan: updated 2022.* https://www.gov.uk/guidance/thames-river-basin-district-river-basin-management-plan-updated-2022

[17] Environment Agency (December 2009) *Thames: Catchment flood management plan.* https://www.gov.uk/government/publications/thames-catchment-flood-management-plan

- We want to maintain the existing capacity of the river systems in developed areas to reduce the risk of flooding from more frequent events. We will work with our partners to identify opportunities to make the existing systems more efficient (for example, where there are significant restrictions to flow from undersized culverts or bridges).
- We will work with Local Planning Authorities to retain the remaining floodplain for uses that are compatible with flood risk management and put in place polices that lead to long-term adaptation of urban environments in flood risk areas.
- We will continue to increase public awareness, including encouraging people to sign-up for the free Floodline Warnings Direct service.

2.4 National Planning Policy Framework

2.4.1 The NPPF is a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities. It was first published in 2012 and last updated in July 2021. The overall approach of the NPPF to flood risk is broadly summarised in Paragraph 159:

2.4.2 *"*Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."

2.4.3 The NPPF is supported by the Planning Practice Guidance: flood risk and coastal change, which advises how to take account of and address the risks associated with flooding and coastal change in the planning process."

NPPF Guidance SuDS Policy (April 2015)

2.4.4 SuDS are an approach to managing rainwater and surface water that replicates natural drainage, the key objectives being to manage flow rate and volume of runoff to reduce risk of flooding and water pollution. LPAs such as HBC are required to ensure that SuDS are implemented for all major developments where appropriate, and that by using planning conditions or planning obligations there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.4.5 As the LLFA, HCC is a statutory consultee for SuDS applications. HCC will need to be consulted on the drainage elements of planning applications for major development to ensure they conform to necessary national[18] and local SuDS standards.

2.4.6 The most up to date and comprehensive information on planning, designing, constructing, and maintaining SuDS can be found in CIRIA Report C753 – The Suds Manual[19].

2.5 Local Planning Policy

2.5.1 A new local plan for HBC is currently under development. The HBC Core Strategy[20] adopted in 2013 is a key statutory Development Plan Document (DPD), which sets out HBC's vision and strategy for the Borough between 2013 and 2027. The document seeks to strike a balance between the Borough's housing and economic development needs, social welfare, and protection of the environment. It sets the framework for more detailed planning policies and provides the foundation for decisions on planning applications and development proposals.

2.5.2 The Core Strategy aligns to the national guidance laid out in NPPF:

- The promotion of sustainable development to meet community development needs and the promotion of high-quality design.
- The continued presumption against inappropriate development in the Green Belt.

[18] Defra. March 2015. *Sustainable drainage systems: non-statutory technical standards.* https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards
[19] The SuDS Manual, CIRIA C753, 2015.
[20] Hertsmere Borough Council, January 2013 *Local Plan DPD Core Strategy*. https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Development-Framework/Core-Strategy-DPD-2013.pdf

- The identification of a 'rolling' five-year supply of housing sites.
- Identification of housing land for a further 10 years to enable 15 years total supply.
- Promotion of commercial activity within existing centres.

2.5.3 The following Core Strategy objectives would directly or indirectly contribute to reduction of flood risk within HBC:

- To address issues arising from climate change, and all types of flooding and to take advantage of water and other natural resources responsibly.
- To protect the Green Belt and its role in preventing urban sprawl and the coalescence of towns.
- To maintain an adequate supply of suitable land, focused on brownfield sites within the principal towns, to accommodate expected development needs and supporting community infrastructure.

2.5.4 The Core Strategy Policy CS16 – Environmental impact of development (see box below) is particularly relevant to the SFRA as it states any future development proposal needs take account of the policy recommendation of this SFRA.

CS16 Environmental impact of development

Council will work with key partners, including the Environment Agency and Natural England, to ensure that development proposals do not create an unacceptable level of risk to occupiers of a site, the local community, and the wider environment. Development proposals should take account of the policy recommendations of the Council's SFRA, and the guidance set out in the jointly produced guidance of the Hertfordshire Planning Authorities 'Building Futures' the Hertfordshire Guide to Promoting Sustainability in Development. Proposals will be required to incorporate sustainability principles, minimising their impact on the environment, and ensuring prudent use of natural resources by measures including:

i) avoiding development in the floodplain and close to river corridors unless the requirements of the sequential and exceptions tests have been met and flood prevention/mitigation measures are in place as required by the Environment Agency.

2.5.5 HBC adopted a Site Allocations and Development Management (SADM)[21] Policies Plan in November 2016 following an Examination in Public. This is now being given full weight in the determination of planning applications. One of the main purposes of SADM Policies Plan is to deliver the policies set out in the Hertsmere Core Strategy 2013. Several SADM policies directly relate to flood risk management and expands on the policy CS16. A summary of these policies is presented below, full policy text is available in SADM document found on the HBC website[21].

- Policy SADM13 – The Water Environment
  - watercourses and areas of water will be improved
  - New built development will normally be directed to lands with lowest flood risk
  - attenuation areas that help reduce flood risk downstream will be retained
- Policy SADM14 – Flood Risk
  - application of sequential and exception tests to actively manage and reduce flood risk within HBC area
  - requirement for site specific flood risk assessments for new development plans in a flood risk area to take into account the risk associated with all types of flooding
  - sets out a list of principles that future developments must satisfy
- Policy SADM15 – Sustainable Drainage Systems
  - design of new development should include sustainable drainage measures

[21] Hertsmere Borough Council, 2016. *Site Allocations and Development Management Policies Plan.* https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Plan/FINAL-ADOPTED-SADM-01-02-2017.pdf

- Policy SADM16 – Watercourses
  - developments on sites that contain a watercourse or are situated next to a watercourse need to comply with as set of principles to protect watercourses.

2.6 Wastewater Management Plans

2.6.1 There are several plans relevant to the HBC study area that consider water resource and wastewater infrastructure planning.

2.6.2 Thames Water completed a Drainage and Wastewater Management Plan 2025-2050[22] in May 2023. A Drainage and Wastewater Management Plan (DWMP) is a 'long-term strategic plan that will set out how wastewater systems, and the drainage networks that impact them, are to be extended, improved, and maintained to ensure they are robust and resilient to future pressures'. The plan is over 25 years, 2025 to 2050. The DWMP will be renewed on a 5- year cycle with cycle 1 published in May 2023. A Catchment Strategic Plan was included as part of this DWMP for Hertfordshire[23].

2.6.3 HBC undertook an Infrastructure Assessment[24] that concluded wastewater infrastructure will be an important delivery issue for growth in the Borough between 2011 and 2027. The evidence presented in the assessment highlighted that:

- Growth proposed in the Borough and adjoining areas would lead to a requirement for significant upgrades to either Maple Lodge WWTW or Blackbirds WWTW, or both. As of June 2022, Thames Water are undertaking an upgrade project at Maple Lodge.
- Significant upgrades would also be required at Rye Meads WWTW in Ware. This view was also supported in water cycle strategy review of Rye Meads[25].

2.6.4 Paragraph 8.40 from the Infrastructure Delivery Plan[26] (IDP) produced by HBC states: "A county wide strategic assessment of water infrastructure – the Water Cycle – was commissioned by Hertfordshire County Council in 2015." However, it does not appear that this report has been published with the IDP stating that "the draft does not suggest any insurmountable capacity issues for Hertsmere in the period to 2031."

2.6.5 In March 2017, Herefordshire County Council undertook a study[27] to help identify how future growth within the county is likely to affect water infrastructure systems. Regarding Hertsmere, the main outcomes from the evaluation were as follows:

- The evaluation indicates most growth areas remain relatively unconstrained (by the wastewater system), up to and including in 2031, with only localised network capacity likely requiring strategic intervention in Potters Bar.
- The potential impact of sewer discharges on watercourse quality in Borehamwood by 2051 could require the promotion of more sustainable construction solutions (for development sites) to ensure rainfall runoff is discharging to the environment (not the foul sewers).
- The evaluation indicates a large degree of uncertainty in 2051, with the high scenario demonstrating strategic intervention could be required across the district (mainly to improve sewer and STW capacity). This scale of intervention could require adaptation of local planning policies and / or construction methods to limit foul flows and promote largescale water recycling.

[22] Thames Water, May 2023. *Our Drainage and Wastewater Management Plan 2025-2050* https://www.thameswater.co.uk/media-library/home/about-us/regulation/drainage-and-wastewater/the-plan.pdf
[23] Thames Water, May 2023. *Hertfordshire Catchment Strategic Plan* https://www.thameswater.co.uk/media-library/home/about-us/regulation/drainage-and-wastewater/hertfordshire-catchment-strategic-plan.pdf
[24] Hertsmere Borough Council, February 2013. *Local Development Plan Infrastructure Assessment.* https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Planning-Publications/CD12-Hertsmere-Infrastructure-Assessment.pdf
[25] Stevenage Borough Council, September 2015, *Rye Meads Water Cycle Strategy Review.* https://www.north-herts.gov.uk/sites/default/files/TI11%20Rye%20Meads%20Water%20Cycle%20Strategy%20Review.pdf
[26] Hertsmere Borough Council, 2018, *Infrastructure Delivery Plan – Stage 1: Baseline Study*. https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Plan/IDP-Stage-1-Baseline-Study.pdf
[27] Hertfordshire County Council, March 2018. *Hertfordshire Water Study 2017*. https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Plan/Hertfordshire-Water-Study-2017-.pdf

3. Assessing Flood Risk

3.1 Introduction

3.1.1 This section provides a strategic assessment of flood risk across the Hertsmere study area from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historic incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read with reference to the maps in **Appendix A**.

3.2 Study Area

Location

3.2.1 The study area of HBC is shown in **Appendix A Figure 01**, together with the location of the principal watercourses and their catchments, and reservoirs. HBC forms part of the County of Hertfordshire, and is in South West Hertfordshire, immediately adjoining the London Boroughs of Barnet, Enfield and Harrow which lie to the south.

3.2.2 HBC covers an area of 100km^2 of which approximately 80% is Green Belt and lies entirely in the River Thames Basin District, River Colne catchment. The main settlements are Borehamwood & Elstree, Potters Bar, Bushey, Radlett, and Shenley. There are several other smaller rural villages, including Aldenham, Letchmore Heath, Patchetts Green, Ridge and South Mimms which remain largely residential in character and land use, relying on larger settlements nearby for employment and local services. Parts of the M25 and A1(M), including the South Mimms motorway service area, are located within the study area. HBC has no coastline and given its significant distance to the coast, tidal flooding is not an issue and therefore is not considered in this report.

3.2.3 The topography of the study area comprises deep river valleys and upland areas, as shown in **Appendix A Figure 02**. The lowest lying areas fall within the River Colne valley towards the west and north, which includes sparsely populated settlements and farmlands. Radlett and Borehamwood towns, in the Radlett Brook valley, are at a slightly higher elevation. Other major settlements are located on higher uplands.

Hydrogeology

3.2.4 Hydrogeology is the branch of geology that considers the distribution and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers). It is important to understand the hydrogeology as it affects the rate of surface runoff and indicates where there is risk of groundwater flooding. Substantial areas of impermeable surface rock are likely to induce rapid runoff, leading to surface water flooding in downstream locations. Furthermore, the presence of aquifers is likely to promote the risk of groundwater flooding and therefore it is important that they are identified and located.

3.2.5 The chalk outcrop which forms the Chiltern Hills to the west of Hertfordshire continues eastwards and then northwards into East Anglia. Hertsmere lies on the boundary between the chalk of Hertfordshire to the north and the London Clay and Reading Beds of the London Basin to the south (**Appendix A Figures 03, and 04)**. As a result of the generally impervious nature of the valley slopes the catchment has a relatively rapid runoff response meaning that surface water runoff in the area is frequent.

3.2.6 There is a marked contrast in soil types across the Borough. In the headwaters of the catchment (southern end of Borough) across Borehamwood, Bushey, and Potters Bar the soils are generally clays with low permeability, seasonally waterlogged, with medium to high runoff producing potential. The soils in the lower part of the catchment (northern end of the Borough) across Radlett and Shenley are generally well-drained, loamy sandy soils which are permeable and produce relatively low amounts of runoff.

3.3 Summary of Flood Sources

3.3.1 Table 3-1 summarizes the range of potential flood sources and pathways in the study area. Where relevant, each source is discussed in further detail below.

Table 3-1 Potential flood sources and pathways

Flood Source	Source	Pathway	Consider further
Rivers (Fluvial)	Hilfield Brook, Radlett Brook, Tykeswater and Mimmshall Brook	Floodplain ponding / conveyance / breach and overtopping	Yes
Surface Water (Pluvial)	Greenfield runoff Urban runoff	Flow paths merging from surrounding fields	Yes
Sewers	Urban runoff	Surcharged sewers or burst water mains (failure of infrastructure)	Yes
Sea (Tidal)	HBC has no coastline and is located a significant distance away from the sea, therefore there is no tidal flood risk	No coastline	No
Groundwater	Perched within alluvial deposits	Rising water level	Yes
Artificial Sources	Reservoir	Flow paths should a reservoir fail	Yes

3.4 Flooding from Rivers

Sources

3.4.1 The Environment Agency 'Detailed River Network' dataset has been used to identify watercourses in the study area and their designation (i.e., Main River or ordinary watercourse). However, the 'Detailed River Network' does not show all ordinary watercourses. An ordinary watercourse includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, and passages, other than those excluded by virtue of being a Main River or Public Sewer, through which water flows according to the Land Drainage Act 1991.

3.4.2 There are several designated Main Rivers in the study area, the locations of which are shown in **Appendix A Figure 05.0**. Main Rivers are watercourses shown on the statutory Main River maps held by the Environment Agency and the Department for Environment, Flood and Rural Affairs (Defra). The Environment Agency has permissive powers to carry out works necessary for flood defence purposes on these rivers. The overall responsibility for maintenance, however, lies with the riparian owner (Further information can be found at: https://www.gov.uk/guidance/owning-a-watercourse)

3.4.3 The Hertsmere study area falls within the catchment of the River Colne, a major tributary of the River Thames. The River Colne splits off into several separate branches on leaving Hertfordshire, a few of which re-join it, and flows into the River Thames on the reach above Penton Hook Lock at Staines-upon-Thames. The Colne catchment covers an area of 1014km^2 extending from southern Bedfordshire through western Hertfordshire, eastern Buckinghamshire, and Surrey where it joins the River Thames.

3.4.4 The River Colne flows from northeast to southwest through Hertsmere, from Colney Heath through to Watford. Within the study area, the northern-most boundary is near the confluence of the River Colne and Tyttenhanger Stream with the southern-most boundary at Bushey Heath at the upstream end of the Hartsbourne Stream. The main tributaries of the Colne along this reach are the Hilfield Brook, Radlett Brook, Tykeswater and Mimmshall Brook with numerous other drains, ditches, and brooks across the Borough.

3.4.5 Hilfield Brook flows east to west through North Bushey to its confluence with the Colne at Watford. The Radlett Brook, also known as Tykeswater, flows northwest to the confluence with the Colne near Colney Street. The Radlett Brook catchment is heavily urbanised, relatively steep with an average gradient of 4.84m/km and is approximately 4.7km^2 in area. The Mimmshall Brook drains northwards to the Water End Swallow Holes (near Potters Bar) where it later confluences with the River Colne at Colney Heath. The Mimmshall Brook[28] catchment is 53km^2 in area of which over 18% is urbanised (principally Potters Bar).

[28] A small diversion of the Mimshall Brook has been undertaken as part of works at Sky Studios, Rowley Lane. More information can be found on this under planning application 20/0315.

3.4.6 There are numerous other drains, ditches, and brooks across the Borough of which several are classified as 'Main River' and are the statutory responsibility of the Environment Agency. The catchment has extensive partially developed floodplain with development built up to the water's edge and narrow floodplains in the headwaters, with relatively few properties at risk of flooding. The main urban areas such as Borehamwood, Radlett and Potters Bar are at risk flooding from several sources and flooding mechanisms. These include overtopping of river banks, in-channel blockages with constrictions causing the back-up of water, overflow of surface water and sewerage drainage infrastructure, rapid surface water runoff from urban areas, breach or overtopping of flood storage areas /reservoirs, and groundwater flooding.

Structures

3.4.7 Throughout the river network there are hydraulic structures such as weirs, mills, bridges and culverts. These may elevate water level and hence exacerbate flood risk in the associated areas. Structures can promote debris dam formation which may reduce the capacity of the watercourse. Moreover, the existence of structures is likely to reduce watercourse capacity. The locations of some of these structures, as per the Environment Agency Asset Information Management System (AIMS) database, are shown in **Appendix A Figures 05.1 to 05.4**.

3.4.8 The ownership of culverts and other related structures along Main Rivers is spread across the Environment Agency, Local Authorities, and private companies/individuals who in turn are responsible for maintaining the assets. The asset owners should undertake regular inspection of their assets to identify their condition and need for maintenance and/or repair. This responsibility includes landowners with main rivers running within the boundary of their property.

Historic Records of River Flooding

3.4.9 The Environment Agency has provided an extract from the 'Recorded Flood Outlines' dataset for the study area[29] which details the following historic fluvial events in the Borough:

- River Colne: July 1987, October 1993, October 2000, December 2000, February 2009, February 2014.
- Radlett Brook: December 1979, September 1992.
- Mimmshall Brook: July 1987, September 1992, December 2000.

3.4.10 These are understood to be the most significant flood events to have occurred in the Borough since World War II. The total extent of historical flooding is shown in **Appendix A Figures 05.1 to 05.4** under 'Recorded Flood Outlines'. However, it should be emphasised that there could be unreported flooding incidents across the Borough.

3.4.11 Anecdotal evidence collated by HBC identifies areas with flood risk issues within Bushey in the River Colne floodplain, and in Potters Bar associated with the Potters Bar Brook.

Existing Hydraulic models

3.4.12 A comprehensive hydrological and hydraulic model for the Upper Colne and its tributaries was undertaken by Halcrow for the Environment Agency in December 2010[30]. The model covers key sections of the Upper Colne catchment where the Hertsmere area falls. This catchment can be split into three areas: the 'Colne', the 'Eastern Tributaries' and the 'Western Tributaries'. The 'Colne' and some of the 'Eastern Tributaries' flow within the Borough boundaries including Mimmshall Brook, Salisbury Hall Brook (upstream portion only), Radlett Brook (Tykes Water) and Hillfield Brook. The modelled flood maps from this study are presented in **Appendix A Figure 06.1 to 06.4.**

3.4.13 The Upper Colne hydraulic model is currently being updated as part of the Environment Agency programme of works. It is anticipated that this updated model will be available in 2023 and therefore it is recommended that the SFRA is updated following the release of this information to ensure it includes the most up to date understanding of flood risk across Hertsmere.

[29] The 'Recorded Flood Outlines' dataset identifies the flood extents associated with specific flood events. The 'Historic Flood Map' shows greatest extent of past flooding and does not identify individual flood events.
[30] Halcrow Group Limited (December 2010), Upper Colne SFRM Study (TH013 and TH031), Hydraulic Modelling and Mapping Final Technical Report.

3.4.14 In 2018, a hydraulic modelling study was undertaken of the Potters Bar Brook. This modelling formed part of the Potters Bar Golf course Flood Risk Assessment[31] and focussed on the watercourse from the railway embankment to the west of the golf course to the aqueduct to the south of Potters Bar as shown in **Appendix A Figure 15.** Whilst this model has been approved by the Environment Agency, it has not formally been adopted within the Flood Map for Planning.

NPPF Flood Zones

3.4.15 The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The Planning Practice Guidance categorises areas within the fluvial floodplain into zones based on the probability of flooding from rivers, as defined in Table 3-2.

3.4.16 The 'Flood Map for Planning (Rivers and Sea)'[32] is the main reference for planning purposes as it contains Flood Zones 1, 2 and 3a, as defined in the PPG and presented in Table 3-2[33]. The 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain.

3.4.17 The 'Flood Map for Planning (Rivers and Sea)' was first developed in 2004 using national generalised modelling and is now routinely updated and revised using the results from the Environment Agency's programme of catchment studies, entailing topographic surveys and hydrological and/or hydraulic modelling as well as previous flood events.

Table 3-2 Fluvial Flood Zones (PPG Table 1)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)	Low
Flood Zone 2	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)	Medium
Flood Zone 3a	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.(Land shown in dark blue on the Flood Map)	High
Flood Zone 3b	Land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise of: • Land having an annual probability of 1 in 30 (greater than 3.3% AEP) of flooding, with existing flood risk management features and structures operating effectively, • Land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). LPAs should define Flood Zone 3b within their SFRA in agreement with the Environment Agency. It is not separately distinguished from Flood Zone 3a on the Flood Map for Planning (Rivers and Sea).	Functional Floodplain

3.4.18 Most of the Borough is defined as Flood Zone 1, low probability of flooding from fluvial sources. Flood Zones 2 and 3 are situated most heavily alongside the River Colne, Radlett Brook, Mimmshall Brook and Watery Lane. **Appendix A Figure 05.1 to 05.4** presents the Flood Zones.

3.4.19 It should be noted that the scope of modelling studies typically covers flooding associated with Main Rivers and watercourses with a catchment of greater than 3km². In HBC, ordinary watercourses that form tributaries to the Main Rivers have not been included in the model. Modelling of ordinary watercourses available on the 'Flood Map for Planning (Rivers and Sea)' within HBC, are the result of the national generalised modelling carried out by the Environment Agency and needs to be refined when

[31] Westwood Services (August 2018) *Potters Bar Golf Course – Flood Risk Assessment.*
[32] *Flood Map for Planning (Rivers and Sea).* https://flood-map-for-planning.service.gov.uk/
[33] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities and Local Government. Updated August 2022. *Planning Practice Guidance: Flood Risk and Coastal Change Table 1 Flood Zones* https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-1-Flood-Zones

determining the probability of flooding for an individual site and preparing a site-specific FRA. Further detail regarding the scope of site specific FRAs is provided in Section 7.

3.4.20 It is noted that a separate map is available on the Environment Agency website which is referred to as 'Risk of Flooding from Rivers and Sea'[34]. This map considers the presence of flood defences and so describes the actual risk of flooding, rather than the residual risk if there were no defences present. This mapping has been made available by the Environment Agency as the primary method of communicating flood risk to members of the public, however, for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated Flood Zones remains the primary source of information.

Residual Risk

3.4.21 It is important to recognise that the risk of flooding from the rivers in Hertsmere can never be fully mitigated, and there will always be a residual risk of flooding that will remain after measures have been implemented to protect an area or a particular site from flooding. This residual risk is associated with several potential risk factors including (but not limited to):

- A flooding event that exceeds that for which the flood risk management measures have been designed e.g., flood levels above the designed finished floor levels,
- The structural deterioration of flood defence structures (including informal structures acting as a flood defence) over time, and/or,
- General uncertainties inherent in the prediction of flooding.

3.4.22 The modelling of flood flows and flood levels is not an exact science; therefore, there are inherent uncertainties in the prediction of flood levels used in the assessment of flood risk. Whilst the Flood Zones provide a relatively robust depiction of flood risk for specific conditions; all modelling requires the making of core assumptions and the use of empirical estimations relating to (for example) rainfall distribution and catchment response.

3.4.23 Steps should be taken to manage these residual risks using flood warning and evacuation procedures, as described in Section 5.13.

Functional Floodplain Flood Zone 3b

3.4.24 The Functional Floodplain is defined in the NPPF as 'land where water has to flow or be stored in times of flood'. The Functional Floodplain (also referred to as Flood Zone 3b), is not separately distinguished from Flood Zone 3a on the Flood Map for Planning (Rivers and Sea). Rather the SFRA is the place where LPAs should identify areas of Functional Floodplain in discussion with the Environment Agency.

3.4.25 The PPG states that the identification of Functional Floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, it should include the normal form of the river channel and land that would flood with an annual probability of 1 in 30 (greater than 3.3% AEP), with existing flood risk management features and structures operating effectively. Flood Zone 3b is also defined in the PPG as land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

3.4.26 Specific to Hertsmere, this would be defined by the 2% annual probability defended flood extents as provided by the latest Environment Agency hydraulic modelling study of the Upper Colne catchment[30] and a recent review[35] of the model in the vicinity of Newberries car park in Radlett, as shown in **Appendix A Figures 05.1 to 05.4**. Further guidance on the Functional Floodplain Flood Zone 3b is provided in Section 8.3.1.

Climate Change

3.4.27 A considerable amount of research is being carried out worldwide in an endeavour to quantify the impacts that climate change is likely to have on flooding in future years. The Intergovernmental Panel on Climate Change (IPCC) reports are showing that climate change is resulting in increased peak rainfall intensity and river flow, which would result in more frequent and severe flood events. Climate change is perceived to represent an increasing risk to low lying areas of England, and it is anticipated that the

[34] *Long Term Flood Risk Map 'Risk of Flooding from Rivers and Sea'*. https://www.gov.uk/check-long-term-flood-risk
[35] Royal HaskoningDHV. October 2017. *Newberries Car Park, Radlett – Hydrology and Modelling Refinements*.

frequency and severity of flooding will change measurably within our lifetime. Appendix A Figure 18 has been produced to provide a representation of the likely impact of climate change across the Borough. This figure uses 1 in 100 year + 20% climate change allowance as a proxy for the 1 in 100 year plus 21% climate change flood event.

3.4.28 In 2022 the Environment Agency published revised guidance on climate change allowances based upon UKCP18 data[36]. The 'peak river flow climate change allowances by management catchment' table and map within the guidance identify the appropriate climate change allowances to use based upon the management catchment. Hertsmere Borough falls within the Colne management catchment and the London management catchment as seen in Figure 3-1 and the recommended climate change values are set out in Table 3-3 and Table 3-4.

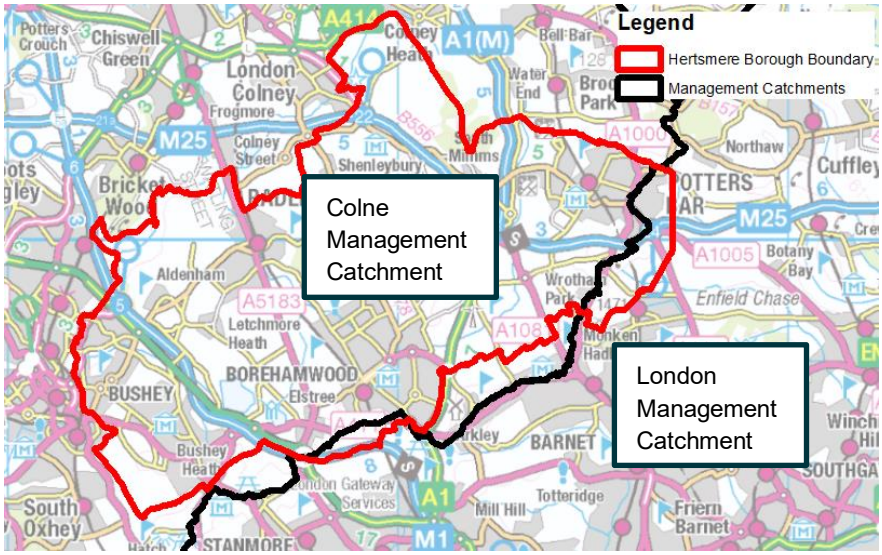


Figure 3-1 River Management Catchments

Table 3-3 Peak River flow climate change allowances for the Colne Management Catchment

	Central	Higher	Upper
Total potential change anticipated for '2020s' (2015-39)	10%	16%	30%
Total potential change anticipated for '2050s' (2040-2069)	8%	16%	38%
Total potential change anticipated for the '2080s' (2070-2115)	21%	35%	72%

Table 3-4 Peak River flow climate change allowances for London Management Catchment

	Central	Higher	Upper
Total potential change anticipated for '2020s' (2015-39)	10%	14%	26%
Total potential change anticipated for '2050s' (2040-2069)	7%	14%	30%
Total potential change anticipated for the '2080s' (2070-2115)	17%	27%	54%

Applying Peak River Flow Climate Change Allowances

3.4.29 To understand if a land use allocation is appropriate in the context of likely future flood risk, the climate change allowance guidance[36] states that Table 3-5 should be used to determine the appropriate allowance according to current flood zone and flood risk vulnerability.

[36] Environment Agency. *Flood risk assessments: climate change allowances*. Updated May 2022. Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

Table 3-5 Peak River flow allowances for flood risk assessments

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	**Highly vulnerable**	**More vulnerable**	**Less vulnerable**	**Water compatible**
Zone 2	Higher central	Central	Central	Central	Central
Zone 3a	Higher Central	X	Central	Central	Central
Zone 3b	Higher Central	X	X	X	Central
X – development should not be permitted					

3.4.30 For the allowances identified in Table 3-3 and Table 3-4, the site should be assessed as to whether it will move from FZ1 to FZ2 or FZ2 to FZ3. If the flood zone changes, the site should be checked once more against the flood risk vulnerability and flood zone compatibility table (PPG Tables 2 and 3) to establish if the development is still appropriate, or if the Exception Test is required.

3.4.31 If the development is still appropriate in Flood Zones 2 and/or 3, assessment of future flood risk will be needed for planning applications for the type of development allocated in site specific policies. This will be done through a suitable site specific flood risk assessment (FRA).

3.4.32 If the Exception Test is required, it is expected that site specific policies will advise the development and development proposals will include a detailed FRA using the appropriate climate change allowances. However, it may be that once the climate change allowances have been applied, a particular development may now not be suitable in a particular area, and accordingly the land allocations may need to be re-considered.

3.4.33 Where sites are only partially within Flood Zone 3a, a nuanced approach to flood risk may be appropriate. For these sites, it may be simpler to demonstrate satisfaction of the Exception Test and the risk of flooding may in fact be lower than other sites where a greater proportion is within Flood Zone 3a.

Existing Hydraulic Models and the Impact of Climate Change

3.4.34 The Upper River Colne modelling study (2010) predated the latest climate change guidance and did not include the revised climate change allowance values. The Upper Colne hydraulic model is currently being updated as part of the Environment Agency programme of works but in the meantime the existing modelling study from 2010 should be used to inform fluvial flood risk.

3.4.35 In the 2010 model, the 1:100 year return period scenario was run with flows increased by 20% to analyse the effects of climate change on the flood extents/depths. The results indicate that the Upper Colne Model is sensitive to climate change with an increase in maximum water levels of 225mm and significant changes to the flood extents.

3.4.36 Whilst the allowance used in the modelling study is lower than the latest recommended values for climate change allowances, the Environment Agency has advised that the existing 20% climate change results are the best representation of the 21% climate change allowance. Therefore, the flood map of this event (**Appendix A Figure 07**) could be taken as an indication of the climate change scenario. Updated climate change allowances need to be estimated by way of detailed hydraulic / hydrological analysis as part of strategic hydraulic modelling by the Environment Agency or site-specific FRAs for future development proposals. As the Upper Colne hydraulic model is currently being updated, developers should request latest modelling from the Environment Agency in advance of any new development proposals or associated modelling work.

Flood Risk Management Measures

3.4.37 Flood risk management measures can consist of bunds, walls and other structures that manage flow in times of flooding and therefore reduce the risk of water from entering property. They generally fall into one of two categories: ‘formal’ or ‘informal’.

3.4.38 A ‘formal’ flood risk management asset has been specifically built to control floodwater. It is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In

accordance with the FWMA, the Environment Agency has discretionary powers to construct and maintain defences to help protect against flooding.

3.4.39 An 'informal' flood risk management asset has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

3.4.40 A study of informal flood risk management assets has not been made as part of this assessment. Should any changes be planned in the vicinity of road or railway crossings over rivers in the study area it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal flood defences should be identified as part of site specific FRAs and the residual risk of their failure assessed.

3.4.41 In accordance with the scope of a Level 1 SFRA, a high-level review of formal flood defences has been carried out using data from the Environment Agency Asset Information Management System (AIMS). This dataset contains details of flood defence assets associated with Main Rivers and provides a good starting point for identifying significant local defences and potential areas benefiting from defences, but the quantity and quality of information provided differs considerably between structures. The AIMS is intended to provide a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would need to be undertaken as part of a site specific FRA where the need arises). Flood defences in the study area are presented in **Appendix A Figures 05.1 to 05.4.**

3.4.42 The main flood defences in the Borough consist of culverts, weirs, and natural banks. These can be seen along all the Main Rivers as indicated through information provided by the Environment Agency. Furthermore, the Flood Storage Reservoir along Radlett Brook provides an additional, more sophisticated flood defence measure.

3.4.43 Any works in, over, under or within 8 metres of a designated Main River or flood defence requires a Flood Risk Activity Permit, prior to the works commencing, from the Environment Agency under the Environmental Permitting Regulations.

3.4.44 Any works that could affect the flow of an ordinary watercourse (i.e. not designated as a Main River) require consent from the LLFA (HCC in the study area) prior to the commencement of works. This includes culverting, diverting, and can include outfalls and bridges depending on the likely affect to the flow of the watercourse. In addition, any work within 9m of any watercourse will need prior consent from HBC (HBC Byelaws no. 9).

Flood Warning Areas

3.4.45 The Environment Agency provides a free Flood Warning Service[37] for many areas at risk of flooding from rivers and the sea. In some parts of England, the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency has provided a GIS layer of Flood Warning Areas in the study area which are presented in **Appendix A Figure 08.** There are four Environment Agency Flood Warning Areas in the Borough, namely:

1. The Radlett and Borehamwood Brooks at Borehamwood
2. The Mimmshall Brook at Warrengate Road including Water End
3. The Radlett Brook at Radlett
4. The River Colne near Bushey Hill Farm

3.5 Flooding from Surface Water

3.5.1 Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. Overland flow of this nature has a short response time and results in localised flooding, particularly in urban areas. This has the potential to occur in Hertsmere as it is a largely urban catchment. The NPPF states that an SFRA

[37] Environment Agency Flood Warning Service. https://check-for-flooding.service.gov.uk/

should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well other available information.

3.5.2 For practical purposes, flooding from drains and ditches has been considered in the same category as surface water flooding. Where ordinary watercourses are culverted, trash screens and culverts have the potential to become blocked by items such as plant debris and rubbish. Blockages can restrict the natural flow of water, increasing the chance of water flowing out of bank and causing local flooding due to the reduced conveyance potential of the associated watercourse. This may apply to some upper sections of the Hertsmere Brook, which is in effect a culverted watercourse.

3.5.3 The pathways of surface water will be defined by the local topography. Natural or unnatural features may influence the route that floodwater will take. In urban areas roads form a common pathway for surface water, helping dictate the area that will be affected by flooding. This is further exemplified where there are steep gradients in the hillslopes. On a site specific scale, the risk from this flood source should be identified in a FRA.

3.5.4 Development of new sites could increase the risk of flooding from surface water if the runoff from rainfall is not controlled. This might also occur from developments outside the boundaries of HBC where the development catchment drains into the Borough.

Historic Records

3.5.5 Records of flooding from surface water, drains, ditches, and ordinary watercourses have been provided from several sources. Reports and datasets included in the previous iterations of the SFRA report have been retained to provide a consistent record. Records of flooding which are georeferenced are presented in **Appendix A Figure 09.** These records have been provided by HBC, HCC, and National Highways. Due to the topography, most of these are concentrated in the southern half of Hertsmere.

HBC Records

3.5.6 HBC provided a flooding database (2002 – 2021) with records categorised by source of flooding, including surface water sewers, foul sewers and land drainage. An additional record of flooding from July 2021 has also been provided. A summary of this information is shown in Table 3-6 and presented in **Appendix A Figure 09**.

3.5.7 The HBC flooding database shows different properties flooding during storm events in 2002, 2010, 2011, 2012, 2014, 2015 and 2021 and the actions taken after each event. The affected areas are located across the Borough; however, the most frequently affected areas are in the localities of Potters Bar, Bushey, and Borehamwood.

3.5.8 HBC collected anecdotal evidence from residents and business owners, which highlighted flooding of areas around Little Bushey Lane, Spring Croft, Finch Lane, and the south side of Potters Bar.

Table 3-6 Hertsmere Borough Council Flood Records

Town	Source of flooding																
	L	S	P	H	F	MR	L/H	H/L	?	S/L	H/S	S/H	L/S	H/F	H	L/H/MR	Total
Barnet	5			3													8
Borehamwood	305	185	4	36	17	6	27	12			2		3				597
Bushey	237	195	2	71	59	97	1		2		4	1	3			2	674
Bushey Heath	26	6	1	13	2												48
Elstree	46	10	1	10	1		2				1		1				72
London Colney	1			1													2
Potters bar	494	133	4	54	51	4	1		21	2	6			1			771
Radlett	39	7	3	33	27	3	1								1		114
Shenley	14	2	1	9													26
South Mimms	3	1		8	1	9		2	1								25
St Albans	1																1
Watford	5			7	1				1								14
Total	**1176**	**539**	**16**	**245**	**159**	**119**	**32**	**14**	**25**	**2**	**13**	**1**	**7**	**1**	**1**	**2**	**2352**

Key to Source
F: Foul sewer L: Land drainage S: Surface water sewer H: Highway drainage P: Private drainage
MR: Main River ?: Unknown

HCC Records

3.5.9 HCC has a role as LLFA to co-ordinate management of local flood risk in the county. As a LLFA, it is required to carry out Section 19 Flood Investigations as defined in the FWMA. Flood investigation reports for HCC are available through the county website[38]. Flooding records from HCC database[3] are shown in **Appendix A Figure 09.**

National Highways Records

3.5.10 National Highways keeps a record of flood incidents along the highways operated by them. National Highways has provided records of flood events from 2009-2016 within the HBC area, which are also shown in **Appendix A Figure 09.**

Risk of Flooding from Surface Water

3.5.11 The Environment Agency along with HCC LLFA undertake modelling of surface water flood risk at a national and local scale and produced mapping to identify those areas at risk of surface water flooding during three annual probability events: 1 in 30 year (3.33% annual probability), 1 in 100 year (1% annual probability) and 1 in 1,000 year (0.1% annual probability). The latest version of the mapping is referred to as the 'map of Risk of Flooding from Surface Water' (RoFSW) and the extents have been made available for the Level 1 SFRA as GIS layers. This dataset is also available on the Environment Agency website and is referred to as 'Risk of Flooding from Surface Water'.

3.5.12 The RoFSW provides all relevant stakeholders, such as the Environment Agency, LPAs, and the public, access to information on surface water flood risk which is consistent across England and Wales[39]. The modelling helps the Environment Agency take a strategic overview of flooding and assists LLFAs in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within the study area which may have a surface water flood risk. However, it should be noted that this national mapping has the following limitations:

[38] Hertfordshire County Council, *Webpage for Flood Investigations*. https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/flood-investigations.aspx#
[39] Environment Agency, 2019. *What is the 'Risk of Flooding from Surface Water' Map?*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842485/What-is-the-Risk-of-Flooding-from-Surface-Water-Map.pdf

- Use of a single drainage rate for all urban areas,
- It does not show the susceptibility of individual properties to surface water flooding,
- The mapping has significant limitations for use in flat catchments,
- No explicit modelling of the interaction between the surface water network, the sewer systems, and watercourses,
- In several areas, modelling has not been validated due to a lack of surface water flood records, and
- As with all models, the RoFSW is affected by a lack of, or inaccuracies in, available data.

3.5.13 The RoFSW shows that surface water flooding largely follows the fluvial pathways, yet is much more extensive, often originating upstream of the tributaries. There are also multiple localised surface water flood areas that follow some of the main streets of Hertsmere from north to south. The RoFSW for the study area is presented in **Appendix A Figures 10.0 to 10.4**.

Climate Change

3.5.14 Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This will lead to an increased volume of water entering land and urban drainage systems, consequently resulting in surface water flooding.

3.5.15 The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However, as an indicative dataset the 0.1% AEP is a reasonable proxy for 1% AEP plus climate change. This can be found within **Appendix A Figure 07.**

3.5.16 If additional surface water modelling is to be undertaken, then climate change allowances for rainfall should be applied as show in Table 3-7 and Table 3-8. Depending on the design life of the development an allowance for climate change of between 20% and 40% on top of 1% AEP of surface water flooding would be expected. Further guidance on the application of the climate change requirements can be found through the HCC LLFA webpage[40] and on GOV.UK[36].

Table 3-7 Colne Management Catchment peak rainfall allowances[36]

3.3% annual exceedance rainfall event		
Epoch	**Central allowance**	**Upper end allowance**
2050s	20%	35%
2070s	25%	35%

1% annual exceedance rainfall event		
Epoch	**Central allowance**	**Upper end allowance**
2050s	20%	40%
2070s	25%	40%

Table 3-8 London Management Catchment peak rainfall allowances[36]

3.3% annual exceedance rainfall event		
Epoch	**Central allowance**	**Upper end allowance**
2050s	20%	35%
2070s	20%	35%

[40] Hertfordshire County Council. *Webpage on Surface Water Drainage*. https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/surface-water-drainage

1% annual exceedance rainfall event		
Epoch	**Central allowance**	**Upper end allowance**
2050s	20%	40%
2070s	25%	40%

3.6 Flooding from Groundwater

3.6.1 Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

Areas Susceptible to Groundwater Flooding

3.6.2 Despite groundwater flooding generally posing a low risk within HBC, an assessment is required as part of the SFRA. A quantified assessment of risk from groundwater flooding is difficult to undertake, especially on a strategic scale. This is due to a lack of groundwater level records, the variability in geological conditions and the lack of predictive tools (such as modelling) that can be used to make assessments of groundwater flow and risk of groundwater flooding following rainfall events.

3.6.3 The British Geological Survey (BGS) 'Susceptibility to Groundwater Flooding' dataset is a strategic scale map that can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come close to the ground surface based on geological and hydrogeological conditions. This dataset is presented in **Appendix A Figure 11** comprises three classes as follows:

- A: Limited potential for groundwater flooding to occur
- B: Potential for groundwater flooding of property situated below ground level
- C: Potential for groundwater flooding to occur at surface

3.6.4 The remaining areas are not considered to be prone to groundwater flooding. The 'Susceptibility to Groundwater Flooding' should be used, in conjunction with other relevant information, to establish the relative risk of groundwater flooding, and is most suitable for informing land-use planning decisions at the strategic scale. The dataset should not be employed in isolation to inform land-use planning decisions at any scale and should not be utilised for this purpose at the site scale.

3.6.5 The dataset highlights that most of the Borough has a limited potential for groundwater flooding. However, there are some areas in the north-west, north-east and centre where potential groundwater flooding might occur although there are no records of this type of flooding within the Borough.

3.7 Flooding from Sewers

3.7.1 Sewerage infrastructure in HBC is a separate surface and foul water system owned and operated by Thames Water Utilities Limited (TWUL). However, some surface water runoff will inevitably find its way into foul sewers during heavy rainfall. Though the volume of this runoff will be small, it should also be regarded as a possible source of flooding along the route of the sewer network.

3.7.2 During heavy rainfall, flooding from the sewer system may occur if:

(1) The rainfall event exceeds the capacity of the sewer system/drainage system:

New sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While the potential impact of extreme rainfall events is recognised, it is not cost beneficial to construct sewers that could accommodate every extreme rainfall event. However, many of the sewer systems in England date back to Victorian times, where the capacity could be significantly less than the 1:30 year. This could result in sewer flooding occurring much more frequently in these older systems.

(2) The system becomes blocked by debris or sediment:

Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

(3) The system surcharges due to high water levels in receiving watercourses:

Within the study area there is potential for surface water outlets to become submerged due to high river levels. When this happens, water is unable to pass downstream. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers (i.e. containing both foul and storm water), if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance, floodwaters will contain untreated sewage.

3.7.3 This flooding mechanism is likely to become more common in the future due to climate change and an increase in the number and intensity of convective storms. It is now a widely accepted phenomenon that one of the main effects of climate change in the southeast of England will be higher intensity rainfall events and more frequent winter storms, all of which will increase the risk of flooding from all sources.

3.7.4 Approximately 80% of Hertsmere drains to the Maple Lodge Sewage Treatment Works (STW) and the remainder drains to Blackbirds STW. Thames Water have stated that the Maple Lodge catchment is subject to high infiltration of surface water into the foul sewer network, which places increased pressure on the capacity of the sewer network. Thames Water are currently developing a strategy to reduce groundwater entering the network.

Historic Records of Sewer Flooding

3.7.5 All water companies responsible for operating sewerage systems in England and Wales, are required to record all instances of internal flooding to properties. TWUL has provided an extract from their flooding register for the study area. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within 4-digit postcode areas that have experienced flooding either internally or externally within the last 10 years **(Appendix A Figure 12)**.

3.7.6 It should be noted that the records only appear on the flooding register where they have been reported to TWUL, and as such they may not include all instances of sewer flooding. Furthermore, given that TWUL target these areas for maintenance and improvements, locations that experienced flooding in the past may no longer be at significant risk of flooding in the future.

3.8 Reservoirs, Canals, and Other Artificial Sources

3.8.1 **Appendix A Figure 13** identifies the Large Reservoirs and Flood Storage Reservoirs (FSRs) present in the HBC area.

Table 3-9 Reservoirs in HBC

Name	FSR/Large	OS Grid
Hillfield	Large	TQ 1572 9595
Bowmans	Large	TL18875 04575
Aldenham	Large	TQ 1694 9543
Radlett	FSR	TQ 1705 9914
Bushey*	Large	TQ 15234 94046

*This reservoir is covered. However, this should still be treated as per any other reservoir flood risk.

3.8.2 Table 3-10 identifies reservoirs outside HBC but that could pose a risk of flooding to the HBC study area.

Table 3-10 Reservoirs outside of HBC

Name	FSR/Large Reservoir	OS Grid
Arkley Nos. 3	Large Reservoir	TQ 22100 95800

3.8.3 The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPF encourages LPAs to identify any at risk reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

3.8.4 Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected, and essential safety work is carried out. These reservoirs therefore present a managed risk. HBC is responsible for working with members of the Local Resilience Forum (LRF) to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

3.8.5 The Environment Agency dataset 'Risk of Flooding from Reservoirs' available online identifies areas that could be flooded if a large[41] reservoir was to fail and release the water it holds. The mapping shows areas at risk of flooding downstream of the Hillfield Park Reservoir, Bowmans Lake, and Aldenham Reservoir which are classified as large reservoirs. It should be noted that reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925 and all large reservoirs must be regularly inspected and supervised by reservoir panel engineers.

3.8.6 The Risk of Flooding from Reservoir mapping has been updated since the 2018 SFRA and it is noticed that the flood extent to the east of Bushey has reduced. The Environment Agency were contacted regarding this update in mapping and stated that these changes were due to the updated methodology and data used to produce the maps. A non-technical summary of how the maps were produced can be found at: https://www.gov.uk/guidance/reservoir-flood-maps-when-and-how-to-use-them

3.8.7 Regarding Aldenham Reservoir, a report and letter were filed in 2019 by the Dam Supervisor with the Environment Agency advising that it would be prudent to lower the water level by a metre to reduce pressure on the dam, avoiding its collapse. Subsequently, approval has been gained by the Aldenham Reservoir site owners to carry out dam repairs, and Outline consent for enabling works in the form of an employment area in mid 2023.

[41] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

4. Avoiding Flood Risk – Applying the Sequential Test

4.1 Sequential Approach

4.1.1 This Section guides the application of the Sequential Test and, if required, the Exception Test in the Plan-making and planning application processes. Not all development will be required to undergo these tests, as described below, but may still be required to undertake a site-specific FRA, guidance about which is included in Section 7.

4.1.2 The sequential approach is a decision-making tool designed to select sites so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of climate change and the vulnerability of future users to flood risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test, where required, will ensure that new development in areas of flood risk will only occur where flood risk is clearly outweighed by other sustainability benefits and the development can be made safe without increasing flood risk elsewhere and where possible reducing the level of flood risk overall.

4.1.3 The sequential approach can be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments (except Water Compatible) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

4.2 Applying the Sequential Test – Plan-Making

4.2.1 Figure 4-1 illustrates the approach for applying the Sequential Test that HBC should adopt in the allocation of sites as part of the preparation of the Local Plan. The Sequential Test should be undertaken by HBC and accurately documented to ensure decision processes are consistent and transparent.

4.2.2 The Sequential Test needs to be applied to potential development sites across the whole LPA area to increase the possibilities of delivering development not exposed to flood risk, both now and in the future. When preparing a Local Plan, the LPA should demonstrate that a range of site allocations have been considered, using the SFRA to apply the Sequential and Exception Tests where necessary.

4.2.3 When considering the risk of flooding to each site, it is important to assess **the proportion of the site at risk of flooding and the intended location of development within the site**. For example, a large strategic site may have a small area of high risk of flooding, but when considered as a whole, it offers a large area at low risk of flooding.

4.2.4 It is also important to assess **the risk of flooding along the access/egress routes to the site**. There are occasions when development sites at low risk of flooding are located on ‘dry islands’ surrounded by areas at greater risk of flooding. This should be captured within the site assessments and used to inform the sequential testing of sites by HBC.

4.2.5 Where it is not possible to locate development in low-risk areas, the Sequential Test should go on to compare sites within medium risk areas and only where there are no sites in low and medium risk areas, within high-risk areas.

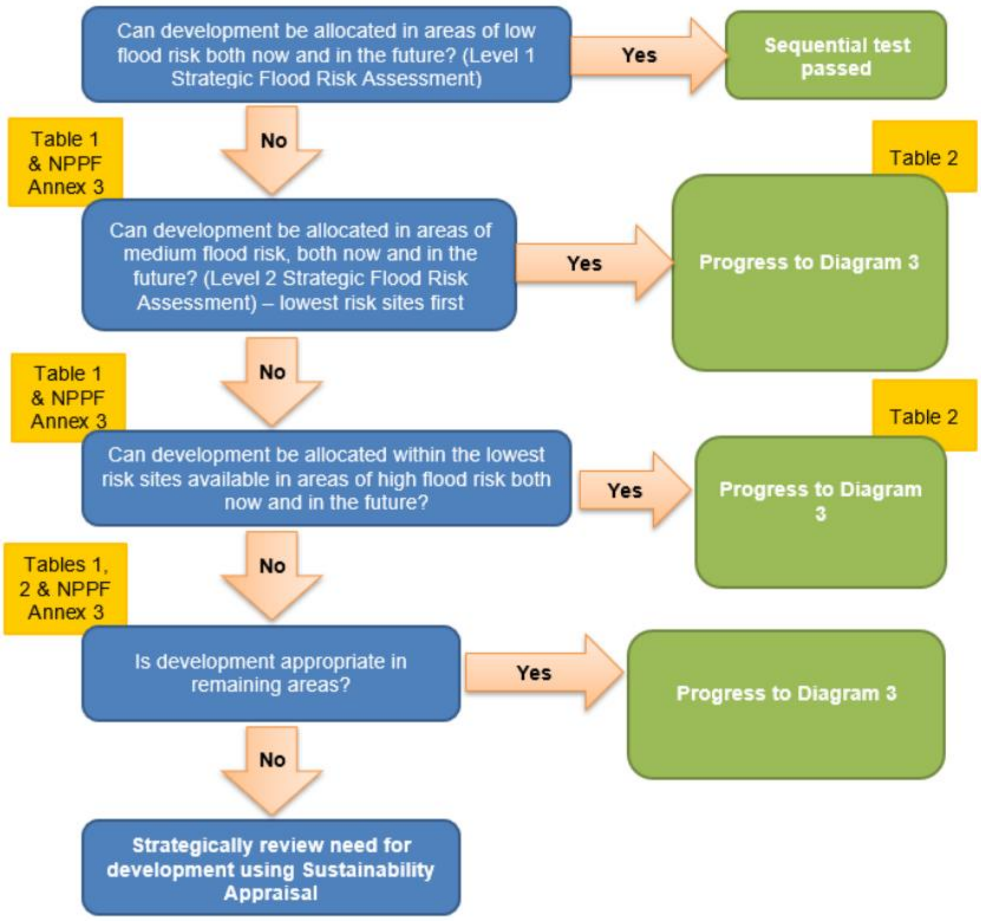


Figure 4-1 Applying the sequential test in the preparation of a Local Plan (PPG Diagram 2)

4.2.6 The Sequential Test requires an understanding of the risk of flooding from all sources in the study area and the vulnerability classification of the proposed developments. Flood Zone definitions are provided in Table 3-2 and mapped in the figures in Appendix A (and the Flood Map for Planning (Rivers and Sea) on the Environment Agency website). Flood risk vulnerability classifications, as defined in the PPG are presented in Table 4-1.

4.2.7 The NPPF acknowledges that some areas will (also) be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including flooding from land or surface water runoff; groundwater; sewers; and artificial sources.

4.2.8 If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

Table 4-1 Flood Risk Vulnerability Classification (NPPF Annex 3)

Vulnerability Classification	Development Uses
Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood. Wind turbines. Solar farms.
Highly Vulnerable	Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	Hospitals. Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. Non–residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	Police, ambulance and fire stations which are not required to be operational during flooding. Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment works which do not need to remain operational during times of flood. Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). Car parks.
Water-Compatible Development	Flood control infrastructure. Water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel working. Docks, marinas and wharves. Navigation facilities. MOD defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

4.2.9 The NPPF indicates suitability of a development based on its vulnerability and location within a fluvial flood zone as set out in Table 4-2. However, the vulnerability classification of types of development is still relevant in considering flood risk from other sources. For example, a basement dwelling will still be more vulnerable to surface water flooding than an office development.

Table 4-2 Flood Risk Vulnerability and Flood Zone 'Incompatibility' (PPG Table 2)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	**1**	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3a †	Exception Test Required †	✓	×	Exception Test Required	✓
	3b *	Exception Test Required *	✓*	×	×	×

✓ – Exception Test is not required × – Development should not be permitted

† – In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* – In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood
- result in no net loss of floodplain storage
- not impede water flows and not increase flood risk elsewhere

Recommended Stages for LPA Application of the Sequential Test

4.2.10 The recommended steps in undertaking the Sequential Test are detailed below. The information required to address many of these steps is provided in the accompanying maps presented in Appendix A. When preparing a Local Plan, a database of the potential allocation sites across Hertsmere should be generated and information for each site populated using the GIS layers presented in the maps. This database can be used by HBC when applying the steps below.

1. Identify all potential development sites across the Local Plan area.
2. Assign a unique site reference to each site.
3. Identify the range of potential uses that could be considered on each site and the associated Vulnerability Classifications.
4. Identify the design life of the development with respect to climate change:
   - 100 years of residential developments: and
   - 75 years for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.
5. Use the flood risk datasets and information in the Level 1 SFRA to analyse the flood risk to the sites from all sources of flooding, now and in the future. For example, analysis could include:
   - Site area (ha)
   - % of site within Flood Zones 1, 2, 3a and 3b.
   - % of site within modelled 1% AEP plus climate change flood extents
   - Presence of a watercourse (main river or ordinary watercourse) within the site boundary, or within 20m of the site boundary.
   - % of site within 'Risk of Flooding from Surface Water' Modelled Extents for the 3.3% AEP, 1% AEP and 0.1% AEP scenarios.
   - Recorded flooding incidents or investigations within 500m of the site.
   - Within areas of notable surface water flood risk as identified by the Lead Local Flood Authority.
   - Susceptibility to Groundwater Flooding of the area local to the site, based on the BGS 'Susceptibility to Groundwater' Flooding dataset.

- % of site within 'Risk of Flooding from Reservoirs' flood extents.

6. Based on the results of the analysis undertaken in Step 5, develop a matrix to rank the sites from least to greatest risk of flooding considering all sources of flooding. Further guidance on this can be found in A Good Practice Guide[42].This will enable the Council to take account of the size of the site, the scale and type of development and the scale of any risks. (For example, a large site with a small area of Flood Zone 3a may be considered preferable to a small site entirely at risk of surface water flooding).
7. Use a sequential approach to allocate those sites with greater vulnerability (e.g., Highly Vulnerable) towards those areas at lowest risk of flooding. If these cannot be delivered in lowest flood risk areas, because the identified sites are unsuitable or there are insufficient sites in low flood risk areas, sites in areas of greater flood risk may need to be identified to accommodate development or opportunities sought to locate the development outside the Borough.
8. Follow the same approach with More Vulnerable and then Less Vulnerable uses, steering development towards lowest flood risk sites first. Should additional sites still be required to meet the identified need, consider those sites at slightly greater risk and so on. This will demonstrate that sites are only selected where there are 'no reasonably available alternative sites at lower risk of flooding'.
9. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however, it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies. In Flood Zone 3b Water Compatible infrastructure should be designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage and not impede water flows and not increase flood risk elsewhere.
10. HBC should record this decision making process within a Sequential Test Statement, or similar document, which will form part of the Local Plan evidence base.
11. Consideration may need to be given to the risks posed to a site within a Flood Zone in more detail in a Level 2 SFRA. This more detailed study should consider the detailed nature of flood hazard to allow a sequential approach to site allocation within a Flood Zone. Consideration of flood hazard within a flood zone would include:
    - Flood risk management measures,
    - The rate of flooding,
    - Flood water depth,
    - Flood water velocity.

4.2.11 Where the development is Highly Vulnerable, More Vulnerable, Less Vulnerable or Essential Infrastructure and a site is found to be impacted by a recurrent flood source (other than tidal or fluvial), the site and flood sources should be investigated further regardless of any requirement of the Exception Test.

Windfall Sites

4.2.12 Windfall sites are those which have not been specifically identified as available in the Local Plan process. They typically comprise of previously developed sites that have unexpectedly become available. In cases where development cannot be fully met through the provision of site allocations, LPAs are expected to make a realistic allowance for windfall development, based on past trends and expected future trends. It is recommended that the acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

[42] AECOM, 2021. Strategic flood risk assessments – A Good Practice Guide. https://www.adeptnet.org.uk/strategic-flood-risk-assessment-good-practice-guide

4.3 Applying the Sequential Test for Planning Applications

4.3.1 The Sequential Test should be applied to 'Major' and 'Non-major development' proposed in areas at risk of flooding. The Environment Agency publication 'Demonstrating the flood risk Sequential Test for Planning Applications[43]' sets out the procedure for applying the sequential test to individual applications as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the Borough area (or beyond the borough area if the site is near a borough boundary), or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area). For individual planning applications subject to the Sequential Test, the area to apply the test will be defined by local circumstances relating to the catchment area for the type of development proposed. For nationally or regionally important infrastructure the area of search to which the Sequential Test could be applied will be wider than the local planning authority boundary.
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan. The definition of 'reasonably available sites' is included within the PPG as sites in a suitable location for the type of development with a reasonable prospect that the site is available to be developed at the point in time envisaged for the development.
- State the method used for comparing flood risk between sites; for example the Flood Map for Planning (Rivers and Sea), the SFRA mapping for all sources of flooding, site-specific FRAs if appropriate, other mapping of flood sources. Default preferred source is the Flood Map for Planning, the latest version of which is presented in **Appendix A Figures 05.0 to 05.4**. The online version needs to be checked for updates regularly. A site specific FRA will provide more detail at site level and any discrepancy with Environment Agency or SFRA maps will have to be explained in the FRA.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 4-2, apply the Exception Test.
- Apply the Sequential approach to locating development within the site (as described in Section 5.2).

4.3.2 It should be noted that it is for LPAs, (and in the case of surface water management arrangements and local flood risk for major planning applications the LLFA), both taking advice from the Environment Agency as appropriate, to consider the extent to which Sequential Test considerations have been satisfied, considering the circumstances in any given case.

4.3.3 The developer should justify with evidence to the LPA and the LLFA, as appropriate, what area of search has been used when making the application. Ultimately HBC and HCC (as LLFA), as appropriate, need to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere.

4.3.4 **Recommendation:** It is recommended that HBC keep an up-to-date register of 'reasonably available' sites, clearly ranked in flood risk preference, and prepare guidance on the appropriate area of search for common development types.

Sequential Test Exemptions

4.3.5 It should be noted that the Sequential Test does not need to be applied in the following circumstances:

[43] Environment Agency and Defra, February 2017. *Flood risk assessment: the sequential test for applicants.* https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants

- The site has been allocated for development and subject to the test at the plan making stage (provided the proposed development is consistent with the use for which the site was allocated and provided there have been no significant changes to the known level of flood risk to the site, now or in the future which would have affected the outcome of the test).
- The site is in an area at low risk from all sources of flooding, unless the Strategic Flood Risk Assessment, or other information, indicates there may be a risk of flooding in the future.
- The application is for a development type that is exempt from the test, as specified in footnote 56 of the NPPF. This includes:
  - Householder development,
  - Small non-residential extensions (with a footprint of less than 250m^2),
  - Changes of use; except for changes of use to a caravan, camping or chalet site, or to a mobile home or park home site, where the Sequential and Exception tests should be applied as appropriate.

4.4 Exception Test

4.4.1 Following the application of the Sequential Test it may be concluded that there are no reasonable available alternative sites in areas of lower risk, and in some cases the Exception Test may be required. Figure 4-2 shows the decision making process and Table 4-1 identifies when the Exception Test is required, based on the flood zone and the vulnerability classification of the proposed development. The Exception Test should only be applied as set out in Figure 4-2 i.e., only if the Sequential Test has shown that there are no reasonably available, lower-risk sites, suitable for the proposed development, to which the development could be steered.

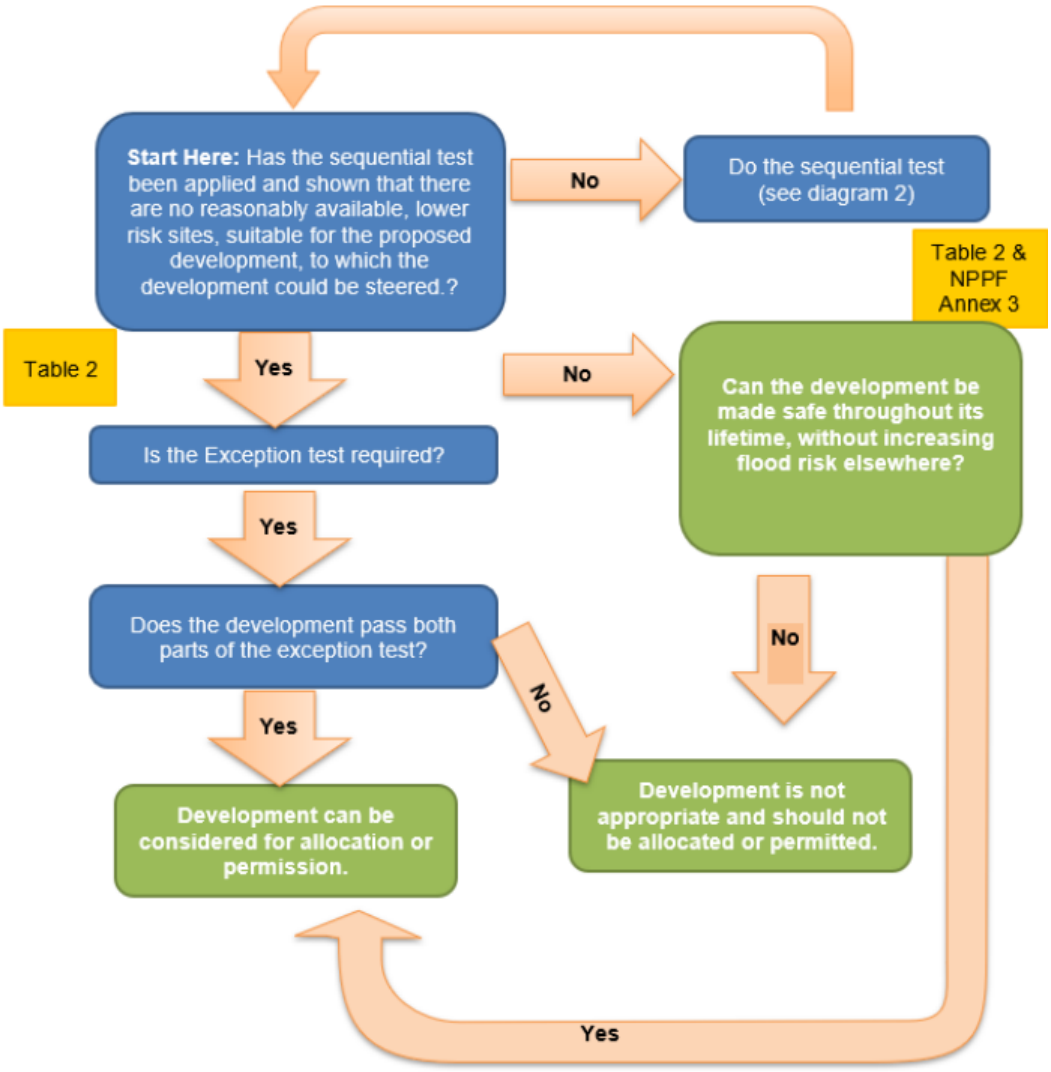


Figure 4-2 Application of the Exception Test in the preparation of a Local Plan (PPG Diagram 3)

4.4.2 For the Exception Test to be passed:

- Part 1 - It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and
- Part 2 - A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

4.4.3 Both elements of the test will have to be passed for development to be allocated or permitted.

4.4.4 To satisfy Part 1) of the Exception Test, the objectives of the Sustainability Appraisal (SA) can be used to assess each potential development site. The Hertsmere BC SA[44] includes a series of sustainability objectives which enable an appraisal of the sustainable development of a potential development site.

4.4.5 As noted in the PPG (paragraph 036), examples of wider sustainability benefits to the community could include:

- The re-use of suitable brownfield land as part of a local regeneration scheme.
- An overall reduction in flood risk to the wider community through the provision of, or financial contribution to, flood risk management infrastructure.
- The provision of multifunctional Sustainable Drainage Systems that integrate with green infrastructure, significantly exceeding National Planning Policy Framework policy requirements for Sustainable Drainage Systems.

4.4.6 Identified sustainability benefits need to be balanced against any associated flood risks, informed by the site-specific flood risk assessment. The impacts of flood risk on social, economic, and environmental factors should be considered. Where wider sustainability benefits are absent or where they are outweighed by flood risk, the Exception Test has not been satisfied and the site allocation in the plan should not be made or planning permission should be refused.

4.4.7 With respect to Part 2) of the Exception Test, there are several ways a new development can be made safe:

- Avoiding flood risk by not developing in areas at risk of flooding.
- Substituting higher vulnerability land uses for lower vulnerability uses in higher flood risk locations and locating higher vulnerability uses in areas of lower risk on a strategic scale, or on a site basis.
- Providing adequate flood risk management infrastructure which will be maintained for the lifetime of the development.
- Mitigating the potential impacts of flooding through design and resilient construction.
- Managing the remaining residual risk through flood warning and emergency planning measures.

4.4.8 Consideration must also be made to ensure that the risk of flooding elsewhere is not increased and where possible is reduced.

4.4.9 Further guidance on how development could satisfy Part 2) of the Exception Test is provided in Sections 5 and 6.

[44] Hertsmere Borough Council, October 2021. *Sustainability Appraisal of the Hertsmere Draft Local Plan.* https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Plan/Draft-Local-Plan-Sustainability-Appraisal-Report-PDF-4.78Mb.pdf

5. Measures to Control and Mitigate Flood Risk

5.1 Overview

5.1.1 The NPPF acknowledges that it may not always be possible to avoid locating development in areas at risk of flooding. This Section provides guidance and policy recommendations on the range of measures that could be considered to control and mitigate flood risk. These measures should be considered when preparing a site-specific FRA as described in Section 7.

5.1.2 As noted in Section 3, it is essential that the development management process influencing the design of future development within the Borough carefully mitigates the potential impact that climate change may have upon the risk of flooding. As a result, mitigation measures should be designed with an allowance for climate change over the lifetime of the proposed development as follows:

- 100 years for residential developments; and
- 75 years for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.

5.2 Development Layout and Sequential Approach

Policy Recommendation 1 A sequential approach to site planning should be applied within new development sites.

5.2.1 Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas (considering all sources of flooding) e.g. residential (or other more vulnerable) elements should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding. Table 2 in the PPG provides a compatibility matrix and determines which types of development are appropriate in areas of flood risk.

5.3 Riverside Development (Main Rivers and Ordinary Watercourses)

Policy Recommendation 2 Retain a 10m wide undeveloped buffer strip alongside Main Rivers and explore opportunities for riverside restoration. New development within 8m of a Main River will require consent from the Environment Agency.

5.3.1 The Environment Agency is likely to seek a 10 metre wide undeveloped buffer strip alongside main fluvial rivers for maintenance purposes and would also ask developers to explore opportunities for riverside restoration as part of any development. This buffer zone must be from the top of the riverbank/edge or defence/edge of the culvert. Whilst HCC will work with developers to improve the functioning of ordinary watercourses where possible, there is no specific requirement for a buffer strip.

5.3.2 As of 6th April 2016, the Water Resources Act 1991 and associated land drainage byelaws have been amended and flood defence consents will now fall under the Environmental Permitting (England and Wales) Regulations 2016.

5.3.3 The Environmental Permitting (England and Wales) Regulations 2016 require a permit to be obtained for any activities which will take place:

- on or within 8 metres of a main river

- on or within 8 metres of a flood defence structure or culvert
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert
- in a floodplain more than 8 metres from the riverbank, culvert or flood defence structure and you do not already have planning permission.

5.3.4 Further details and guidance are available on the GOV.UK website: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits. The Environment Agency can be consulted regarding permission to do work on or near a river, river or sea flood defence by contacting enquiries@environment-agency.gov.uk. In addition, any work within 9 metres of any watercourse will need prior consent from HBC (HBC Byelaws no. 9).

5.3.5 HCC, as the LLFA, and the Environment Agency will be minded to reject applications for culverting in areas identified as being in Flood Zone 2 or 3a/3b and/or in an area of surface water flooding identified within the Environment Agency Flood Map for Surface Water (**Appendix A Figures 10.0 to 10.4**), due to the potential of proposed works increasing flood risk. Exceptions to this policy will only be considered if the applicant is able to demonstrate that, all alternative options have been explored and are proven to be unachievable and on the balance of probabilities, the proposed development would not increase flood risk. The Environment Agency strongly encourages deculverting of watercourses due to the associated benefits including lower flood risk, improved biodiversity, and landscape connectivity.

5.3.6 The Environment Agency also is unlikely to permit building on/in the proximity to a culvert due to concerns about the potential impacts on the structural integrity of the culvert, which can lead to an increase in flood risk. In addition, the Environment Agency encourages developers to seek options to open up existing culverts.

5.3.7 Where HBC and/or HCC are made aware of breaches to legislation then they have a duty to make the relevant organisation aware of this.

5.4 Floodplain Compensation Storage

Policy Recommendation 3 All new development must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.

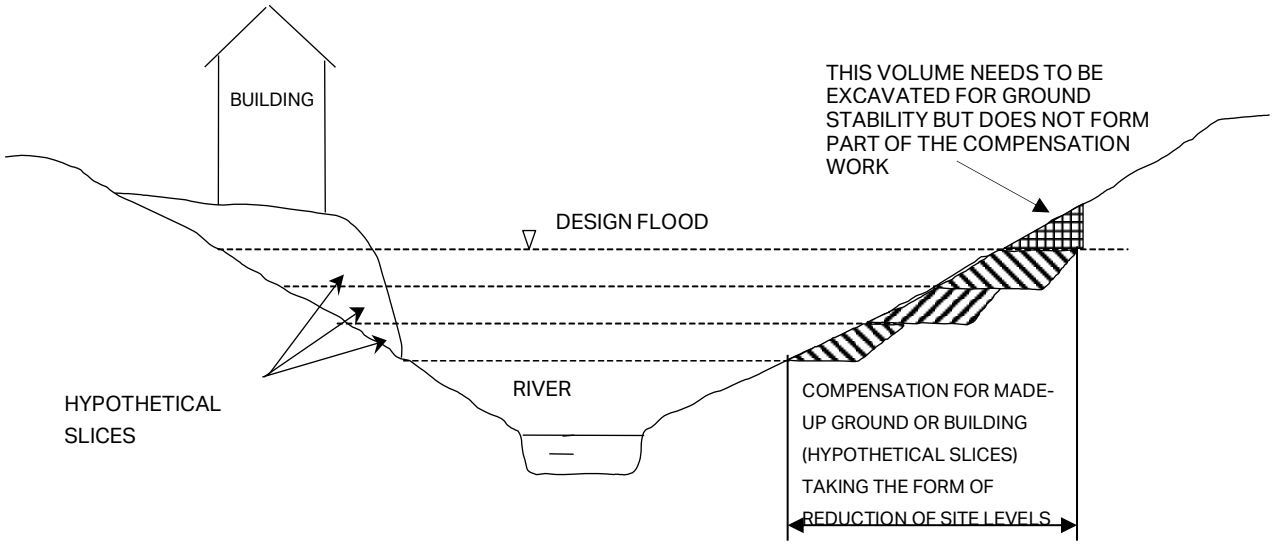
5.4.1 Where proposed development results in a change in building footprint, the developer must ensure that it does not impact upon the ability of the floodplain to store water and should seek opportunities to provide betterment with respect to floodplain storage. There may be particular opportunities for floodplain storage for sites on the edge of settlements.

5.4.2 Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

5.4.3 As depicted in Figure 5-1, floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it should be in the immediate vicinity, in the applicant's ownership and linked to the site. Floodplain compensation must be considered in the context of the 1% annual probability (1 in 100 year) flood level including the appropriate allowance for climate change. When designing a scheme flood water must be able to flow in and out and must not pond. An FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[45].

[45] CIRIA, January 2004, *CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry.*

Figure 5-1 Example of Floodplain Compensation Storage (Environment Agency 2009)



5.4.4 The requirement for no loss of floodplain storage means that it is not possible to modify ground levels on sites which lie completely within the floodplain (when viewed in isolation), as there is no land available for lowering to bring it into the floodplain. It is possible to provide off-site compensation within the local area e.g. on a neighbouring or adjacent site, or indirect compensation, by lowering land already within the floodplain, however, this would be subject to detailed investigations and agreement with the Environment Agency to demonstrate (using an appropriate flood model where necessary) that the proposals would improve and not worsen the existing flooding situation or could be used in combination with other measures to limit the impact on floodplain storage.

5.4.5 The Environment Agency recommends within the Flood Risk and Coastal Change guidance that stilts and voids below buildings is not an acceptable method of providing floodplain compensation. This is recommended as voids often do not allow water to pass freely through them due to silting up, trash screens being blocked, limited capacity and other materials ended up being stored within them.

5.5 Green Infrastructure

5.5.1 Green Infrastructure (GI) is a strategically planned and managed network of natural and semi-natural green (land) and blue (water) spaces that intersperse and connect urban centres, suburbs and rural fringe, consisting of:

- Open spaces e.g. parks, woodland, nature reserves and lakes,
- Linkages e.g. river corridors, canals, pathways, cycle routes and greenways,
- Networks of 'urban green' e.g. private gardens, street trees, verges and green roofs.

5.5.2 The identification and planning of GI is critical to sustainable growth and flood risk management. GI can provide a wide range of ecosystem services, including climate mitigation and adaptation, and is central to climate change action. GI also provides additional green spaces for storm flows, freeing up water storage capacity in existing infrastructure and reducing the risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. Additionally, GI can improve accessibility to waterways and water quality, supporting regeneration and improving opportunity for leisure, economic activity, and biodiversity.

5.6 Natural Flood Management

5.6.1 Natural flood management involves techniques that aim to work with natural hydrological and morphological processes, features, and characteristics to manage the sources and pathways of flood waters. Techniques include the restoration, enhancement and alteration of natural features and characteristics, but exclude traditional flood defence engineering that works against or disrupts these natural processes.

5.6.2 The contribution natural flood management techniques can make to reduce the causes and impacts of flooding will vary greatly from case to case. In some cases, they may be capable of comprehensively addressing flood risk to a site on their own, but in many cases, they will need to be used in a complementary way alongside more conventional flood risk management techniques such as engineered defences. Natural flood management techniques can also contribute to the delivery of biodiversity and environmental net gains and support the implementation of river basin management plans and the public body duty to have regard to them.

5.6.3 There are a number of opportunities available to reduce the causes and impacts of flooding through Working with Natural Processes (WWNP)[46]. This involves implementing measures that help to protect, restore, and emulate the natural functions of catchments, floodplains, rivers, and the coast. WWNP takes many forms and can be applied in urban and rural areas, and on rivers, estuaries, and coasts.

5.6.4 As part of a research project undertaken by the Environment Agency and Flood and Coastal risk Management Research and Development Programme, a series of spatial datasets have been generated for these natural processes[47], identifying their best estimate of locations in the country where the methods can be applied.

Table 5-1 Description of WWNP datasets

Natural Process	Benefits	Most Effective Conditions	Notes
Floodplain Woodland Planting Potential	Slows floodwaters and increases water depth on the floodplain. Reduces flood peaks, delays flood peak timing and desynchronises flood peaks. Enhances sediment deposition on the floodplain.	Middle and lower river reaches of middle to large catchments.	Based upon Flood Zone 2. Information is largely based on modelled data and open constraints data and is indicative rather than specific.
Riparian Woodland Planting Potential (woodlands on land immediately adjoining a watercourse)	Slows flood flows. Reduces sediment delivery to the watercourse. Reduces bankside erosion. Creates below ground storage.	At the reach scale in middle and upper catchments.	Based upon a 50m buffer of available OS Open Data river networks. Information is largely based on open data and is indicative rather than specific.
Wider Catchment Woodland	Intercepts, slows, stores and filters water. Reduces flood peaks, flood flows and frequency.	Small events on small catchments – extent of reduction decreases as flood magnitude increases.	Based upon the 1:50k BGS geology survey and relies upon identifying drift and bedrock geologies that are characteristic of slowly permeable soils. Information is largely based on the 100m gridded version of BGS data and open constraints data and is indicative rather than specific.
Floodplain Reconnection Potential (reconnecting watercourses and floodplains)	Encourages more regular floodplain inundation and flood water storage Decreases the magnitude of flood peaks and reduces downstream flood depths.	High frequency, low return period floods.	Designed to support signposting of areas where there is currently poor connectivity such that flood waters are constrained to the channel and flood waves may therefore propagate downstream rapidly Based upon the Risk of Flooding from Rivers and Seas probability maps and identifies areas of low and very low probability that are close to a watercourse, but do not contain residential property or key services (may contain non-residential property – important to consider).
Runoff Attenuation Features (3.3% and 1% AEP)	Delays and flattens the hydrograph and reduces peak flow locally for small flood events.	A cluster of features working as a network throughout the landscape.	Based upon the Risk of Flooding from Surface Water datasets and identifies areas of high flow accumulations for the 1% and 3.3% AEP surface water maps.

[46] Environment Agency and Flood and Coastal Risk Management R&D Programme, 2021. *Working with Natural Processes to Reduce Flood Risk.* https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk?web=1&wdLOR=c56AD7DAC-BB7B-471B-94B4-B5C5B91DEEE4

[47] Defra Data Services Platform. *Working with Natural Processes datasets* https://environment.data.gov.uk/searchresults;query=wwnp;searchtype=All;page=1;pagesize=20;orderby=Relevancy

(includes swales, ponds and sediments traps)	The areas of ponding or accumulation are between 100 and 5000 metres squared and have been tagged where they fall on an area of slope steeper than 6% as gully blocking opportunities

5.6.5 Defra have produced a Woodland Constraints dataset which refines potential locations for WWNP, taking into account roads, rail, urban areas, existing woodland, peat, and water bodies.

5.6.6 The WWNP data does not provide information on design, which may need to consider issues such as drain-down between flood events. It is important to note that land ownership and change to flood risk have not been considered. Locations identified may have more recent building or land use than available data indicates.

5.6.7 **Appendix A Figure 17** provides information from the Environment Agency's 'Working with Natural Processes – Evidence Directory' about where these measures could be applied. This map shows that although there are a lot of existing woodland constraints within Hertsmere Borough, there are also a wide range of opportunities to implement natural processes to alleviate flooding. There are potential opportunities for floodplain woodland planting and riparian woodland planting towards the south of the administrative area between the River Ash and River Thames. Towards the north west of the administrative area, some wider catchment woodland opportunities, riparian woodland planting potential and floodplain reconnection potential are presented in the map. Riparian woodland planting also holds the potential to confer environmental benefits such as improved water quality, Biodiversity Net Gain, wildlife corridors, and carbon sequestration, in unison with natural flood management.

Policy Recommendation 4 Extend and enhance existing Green Infrastructure in the Borough including the implementation of floodplain and riparian woodland planting schemes. Land that is likely to be needed for natural flood management should be safeguarded. Consideration should also be given to any necessary access to that land, and any additional land which may be needed temporarily during construction.

5.6.8 The mapping in Appendix A Figure 17 should be used by HBC to support future blue and green infrastructure planning.

5.6.9 In early 2023, HBC undertook a "Call for Sites" process to find suitable sites for Natural Flood Management and blue infrastructure. A number of sites were received through this process however, there is not yet enough information on the nature or extent of the sites to determine their suitability. It may be that some of the Biodiversity Net Gain (BNG) sites may be utilised for water related habitat restoration which would represent a dual function.

5.7 Finished Floor Levels

Policy Recommendation 5 More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.

5.7.1 Where developing in Flood Zones 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly Vulnerable land uses, is to ensure internal floor levels are raised a freeboard level above the design flood level.

5.7.2 In certain situations (e.g., for proposed extensions to buildings with a lower floor level; conversion of existing historical structures with limited existing ceiling levels; or requirements for accessible and adaptable dwellings), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the Environment Agency and/or HBC should be approached to discuss options for a reduction in the minimum internal ground floor levels provided flood resistance measures are implemented up to an agreed level. There are also circumstances where flood resilience measures should be considered first. These are described further below. For Less and More Vulnerable developments where internal access to higher floors is required, the associated plans showing the access routes and floor levels should be included within any site-specific FRA.

5.8 Flood resilience measures

Policy Recommendation 6 Where development or redevelopment is proposed in areas at risk of flooding, flood resilience measures should be implemented.

5.8.1 'Property Flood Resilience' is an approach to building design which aims to reduce flood damage and speed recovery and reoccupation following a flood. It uses a combination of flood resistance and recovery measures and is described in the industry-developed CIRIA Property Flood Resilience Code of Practice[48], which provides advice for both new-build and retrofit. It includes specific guidance for local authority planners.

5.8.2 Resistance and recovery measures are unlikely to be suitable as the only mitigation measure to manage flood risk, but they may be suitable in some circumstances, such as:

- Water Compatible and Less Vulnerable uses where temporary disruption is acceptable, and the development remains safe.
- Where the use of an existing building is to be changed and it can be demonstrated that the avoidance measures are not practicable, and the development remains safe.
- As a measure to manage residual flood risk from flood risk management infrastructure when avoidance measures have been exhausted.

5.8.3 Flood resistance and recovery measures cannot be used to justify development in inappropriate locations.

5.8.4 Where historic buildings are involved, early consultation with Historic England should be undertaken and their guide[49] on flood resilience for historic properties provides additional information.

Flood Resistance 'Water Exclusion Strategy'

5.8.5 Flood resistant construction can prevent entry of water or minimise the amount that may enter a building where there is short duration flooding with water depth up to approximately 0.6 metres, depending on the building's characteristics. Where measures to exclude water in this way are proposed above this level, advice should be sought from a suitably qualified building surveyor, architect, or structural engineer.

5.8.6 There is a range of flood resistance and resilience construction techniques that can be implemented in new developments to mitigate potential flood damage. Flood resistance measures, or dry-proofing, stops water entering a building up to a safe structural limit. Resistance measures can be passive, such as flood doors which are normally closed; or active, such as air brick covers or removable flood barriers. Passive measures are to be prioritised over active measures.

5.8.7 This form of construction needs to be used with caution and accompanied by measures that will speed-up flood recovery, as effective flood resistance can be difficult to achieve. Hydrostatic pressures exerted by floodwater can cause long-term structural damage, undermine the foundations of a building or cause leakage through the walls, floor, or sub-floor, unless the building is specifically designed to withstand such stresses. In addition, temporary and demountable defences are not appropriate for new-build developments.

5.8.8 There is a range of property flood protection devices available on the market, designed specifically to resist the passage of floodwater. These include removable flood barriers and gates designed to fit openings, vent covers, and stoppers designed to fit WCs. These measures can be appropriate for preventing water entry associated with fluvial flooding as well as surface water and sewer flooding. The efficacy of such devices relies on their being deployed before a flood event occurs. It should also be

[48] Kelly, D, Barker, M, Lamond, J, McKeown, S, Blundell, E and Suttie, E (2020) *Guidance on the code of practice for property flood resilience*, C790B, CIRIA, London (ISBN: 978-0-86017-895-8) https://www.ciria.org/CIRIA/Resources/Free_publications/CoP_for_PFR_resource.aspx

[49] Historic England, April 2015, *Flooding and Historic Buildings*. https://historicengland.org.uk/images-books/publications/flooding-and-historic-buildings-2ednrev/

borne in mind that devices such as air vent covers, if left in place by occupants as a precautionary measure, may compromise safe ventilation of the building in accordance with Building Regulations.

Flood Recovery 'Water Entry Strategy'

5.8.9 Flood recoverability measures (or wet-proofing), accept that water will enter the building, but through careful design and changes to the construction will minimise damage and allow faster cleaning, drying, repairing and re-occupancy of the building after a flood. Measures are preferably passive, such as the use of resilient building materials, or active such as moving sensitive equipment or belongings to upper floors when flooding is expected.

5.8.10 Materials should be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Recovery measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

5.8.11 A variety of flood recovery tools can be implemented, such as:

- Using materials with either, good drying and cleaning properties or, sacrificial materials that can easily be replaced post-flood.
- Design for water to drain away after flooding.
- Design access to all spaces to permit drying and cleaning.
- Raise the level of electrical wiring, appliances, and utility metres.

5.8.12 Structures such as bus, bike shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground and designed in such a way as to prevent entrainment of debris which in turn could increase flood risk and/or breakaway posing a danger to life during high flows.

5.9 Safe Access and Egress

Policy Recommendation 7 For developments located in areas at risk of fluvial flooding, safe access / egress must be provided for new development as follows in order of preference:

- Dry route for people and vehicles.
- Dry route for people.
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people.
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However, the public should not drive vehicles in floodwater.

In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.

5.9.1 A safe access and egress route is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

5.9.2 A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area (e.g. within Flood Zone 1) using public rights of way without the intervention of emergency services or others during design flood conditions, including climate change allowances. This is of particular importance when contemplating development on sites located on dry islands. Access considerations should include the voluntary and free movement of people during the

design flood (1% AEP including climate change), as well as the potential for evacuation before a more extreme flood, considering the effects of climate change for the lifetime of the development.

5.9.3 Guidance prepared by the Environment Agency[50] uses a calculation of flood hazard to determine safety in relation to flood risk. Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain along with a suitable debris factor to account for the hazard posed by any material entrained by the floodwater. The derivation of flood hazard is based on the methodology in Flood Risks to People FD2320, the use of which for the purpose of planning and development control is clarified in the abovementioned publication. The FD2320 document should be used by developers as it includes information for calculating flood hazard for access and egress planning.

5.9.4 With respect to other sources of flooding, consideration should be made of likely surface water ponding. As recommended in the CIRIA 635 Designing for Exceedance in Urban Drainage – Good Practice (Table 12.3), provision should be made to ensure that flood depths do not exceed 100mm to keep water within a kerb height and to reduce the likelihood of bow waves from vehicles driving through water affecting others, for example housing to the side of a car park.

Table 5-2 Hazard to People Rating (HR=d x (v +0.5) + DF) (Table 13.1 FD2320/TR2)

Flood Hazard	Hazard Rating	Description
Low	Less than 0.75	Very low hazard – Caution
Moderate	0.75 to 1.25	Dangerous for some – includes children, the elderly and the infirm
Significant	1.25 to 2.0	Dangerous for most – includes the general public
Extreme	More than 2.0	Dangerous for all – includes the emergency services

5.10 Place of safety

5.10.1 In exceptional circumstances, safe access above the 1% annual probability (1 in 100 year) flood level including climate change may not be achievable. In these circumstances the Environment Agency and HBC should be consulted to ensure that the safety of the site occupants can be satisfactorily managed. This will be informed by the type of development, the number of occupants and their vulnerability and the flood hazard along the proposed egress route. A suggested definition of a place of safety is a dry, habitable space, internally accessible and accessible at all times. For example, this may entail the designation of a place of safety on an upper floor of a building, from which the occupants can await the flood levels to subside or be rescued by emergency services.

5.10.2 It should be noted that sole reliance on a place of safety is a last resort, and all other possible means to evacuate the site should be considered first. Provision of a place of safety will not guarantee that an application will be granted.

5.11 Car Parks

5.11.1 Where car parks are specified as areas for the temporary storage of surface water and fluvial floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent the vehicles from floating out of the car park. Signs should be in place to notify drivers of the susceptibility of flooding and flood warning should be available to provide sufficient time for car owners to move their vehicles if necessary.

[50] Environment Agency (2008) *Supplementary note on Flood hazard ratings and thresholds for development planning and control purpose*. Clarification of Table 13.1 FD2320/TR2 and Figure 3.2 FD2321/TR1.

5.12Flood Routing

Policy Recommendation 8 All new development, whether in Flood Zones 2 and 3 at risk of fluvial flooding, at risk of surface water flooding or at risk of groundwater flooding at the surface, should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water and therefore reduced flood risk elsewhere, such as:

- Maintain or improve existing flow paths in greenfield areas within the new development.
- Removing boundary walls or replacing with other boundary treatments such as hedges or fencing with gaps (for example post-and-rail or hit-and-miss).
- Considering alternatives to solid wooden gates or ensuring that there is a gap beneath the gates to allow the passage of floodwater.
- Consider reducing ground floor footprint
- Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.

5.12.1 To demonstrate that 'flood risk is not increased elsewhere', development in areas at risk of flooding will need to prove that flood routing is not adversely affected by the development, for example giving rise to backwater affects or diverting floodwaters onto other properties.

5.12.2 Potential overland flow paths should be determined, and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere. Flow paths in greenfield areas should be maintained. Where this is not the case, developers should assess the increased risk of flooding through the change in flow path, i.e. through the consideration of change in surface roughness resulting in increased velocity of floodwater and increase in the hazard rating associated with the potential flooded area.

5.12.3 Careful consideration should be given to the use of fences and landscaping walls to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

5.12.4 It will also be necessary to consider how these areas or features will be maintained over the lifetime of the development, which may require the removal of permitted development rights in certain locations.

5.13Emergency plans

Policy Recommendation 9 For developments proposed in Flood Zone 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population.

The Environment Agency has a tool on their website to create a Personal Flood Plan. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.

Flood Warning and Evacuation Plans should also be prepared for sites located next to surface water flow, or where there is another source of flood risk affecting the site.

5.13.1 **Evacuation** is where flood alerts and warnings, such as those provided by the Environment Agency associated with fluvial flooding, enable timely actions by residents or occupants to allow them to get to safety unaided, i.e. without the deployment of trained personnel to help people from their homes, businesses and other premises. **Rescue** by the emergency services is likely to be required where flooding has occurred, and prior evacuation has not been possible.

5.13.2 Emergency Plans should include:

How flood warning is to be provided, such as:

- availability of existing flood warning systems (refer **Appendix A Figure 08**);
- where available, rate of onset of flooding and available flood warning time; and
- how flood warning is given.

What will be done to protect the development and contents, such as:

- How easily damaged items (including parked cars) or valuable items (important documents) will be relocated;
- How services can be switched off (gas, electricity, water supplies);
- The use of flood protection products (e.g. flood boards, airbrick covers);
- The availability of staff/occupants/users to respond to a flood warning, including preparing for evacuation, deploying flood barriers across doors etc.; and
- The time taken to respond to a flood warning.

Ensuring safe occupancy and access to and from the development, such as:

- Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate;
- Safe access route to and from the development;
- If necessary, the ability to maintain key services during an event;
- Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
- Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.)

5.13.3 There is no statutory requirement for the Environment Agency or the emergency services to approve emergency plans. HBC is accountable via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with emergency planning staff to ensure that the development proposals include safe access and egress.

5.14Chalk Streams

5.14.1 A number of the watercourses in Hertsmere are chalk streams, as shown in **Appendix A Figure 16**. This includes the sections of the River Colne, Hillfield Brook, The Radlett Brook and Catharine Bourne.

5.14.2 As described in the Chalk Stream Restoration Strategy (CSRS) 2021[51] from Catchment Based Approach (CaBA), chalk streams are a special type of spring-fed river unique to England and north-west Europe. They derive most of their flow from underground chalk aquifers and create a distinctive landscape.

5.14.3 The Chalk Stream Restoration Strategy identifies the multiple pressures on chalk streams, stating *"we extract water from them, we pollute them with treated and not-so-treated sewage, and we have re-shaped them again and again over the centuries, through deforestation, milling, canalisation, dredging. All this has combined to create what has been called the 'chalk-stream crisis': a collapse in ecological condition which in the worst places means that rivers are hardly rivers (the headwaters of the Beane, the Misbourne and other rivers near London either do not flow at all or flow rarely) and which elsewhere leads to low flows, eutrophication, excessive siltation and denuded, de-natured physical habitat".*

5.14.4 It is recommended that HBC strengthen their policy to protect these sensitive environments. This will involve a range of measures including reducing water abstraction, preventing polluted runoff or sediment

[51] Catchment Based Approach, 2021. *Chalk Stream Restoration Strategy 2021 Main Report*. https://catchmentbasedapproach.org/wp-content/uploads/2021/10/CaBA-CSRG-Strategy-MAIN-REPORT-FINAL-12.10.21-Low-Res.pdf?_gl=1*stvu97*_ga*MTg2NzEzMzA1OS4xNjc3NTk0NDIx*_up*MQ..

laden runoff from discharging to the watercourses as well as returning the floodplains to their natural state.

Policy Recommendation 10 In accordance with the CaBA CSRS, HBC should apply the following rules to development near chalk streams:

- Appraise the implications of for water resources and sewerage systems of major housing developments in their Local Plan and when reviewing proposals for major housing developments.
- Planning approval must be contingent on the pre-existence of or parallel investment in more than adequate supply and treatment infrastructure with no additional burden on chalk aquifer abstraction. Developers should make water-company developer contributions to help cover the costs of addressing such impacts.
- Where there is a need for groundwater abstraction, sustainable groundwater abstraction should be undertaken. This should see a maximum reduction of natural flows of 10% at Q95.
- HBC should delineate a minimum of 10m buffer zone to protect the riparian corridor or chalk streams from encroaching development.
- Works within the watercourse require a Water Framework Directive (WFD) risk assessment.
- SuDS (sustainable drainage systems) should be implemented on all new, large-scale developments (housing, roads, car parks) in chalk catchments.
- The highest standards of water efficiency should be implemented for new development in 'water-stressed' chalk catchments. More ambitious than the current optional standard of 110 l/h/d, a minimum of 90 l/h/d is recommended.

5.14.5 The 10m buffer zone will allow access to the channel for maintenance and improvement works, along with acting as a natural buffer during periods of heavy rainfall or flooding. They can absorb and store excess water, reducing the impact of floods downstream and preventing soil erosion. These zones function as natural floodplains, which not only protect adjacent areas from flooding but also create valuable wetland habitats that support a wide array of species. Along with being beneficial for the area from a flood risk perspective, implementing such a buffer zone also has the following benefits to chalk streams:

i. Habitat Diversity: Buffer zones provide space for diverse habitats that are essential for various plant and animal species and provide numerous additional ecosystem services. These areas offer a range of environmental conditions, from wet to dry, which allows a wide variety of flora and fauna to thrive.

ii. River Corridor Connectivity: Ensuring that buffer zones are maintained will protect connectivity between chalk streams and riparian habitats, which is vital for establishing a healthy river corridor. This corridor serves as a natural wildlife passage, allowing species to move freely between different locations and habitats, access essential resources, along with preventing species isolation. This enhances overall biodiversity and ecological resilience within the chalk stream ecosystem. Preserving this connectivity will contribute to the long-term sustainability of chalk streams and safeguard the intricate web of life they support.

iii. Water Quality: The presence of buffer zones helps improve water quality in chalk streams. The vegetation in these areas filters out pollutants and excess nutrients, acting as a natural purification system. As the water flows through these zones, it undergoes a process of filtration, ensuring that the chalk stream remains pristine and supports healthy aquatic life.

iv. Climate Resilience: Chalk streams connected to healthy buffer zones are more resilient to the impacts of climate change. During periods of drought, the presence of wetted marginal areas helps maintain base flows in the stream, ensuring the survival of aquatic species even in challenging conditions. Additionally, the increased vegetation in these zones' aids in carbon sequestration, contributing to mitigating climate change effects.

v. Erosion Control: Marginal vegetation and root systems play a vital role in stabilising the banks of chalk streams. Buffer zones allow this marginal vegetation to grow. They help prevent erosion and protect the stream from excessive sedimentation, which can be detrimental to aquatic habitats and fish spawning grounds.

5.14.6 The benefits of preserving the buffer zone will not only have the aforementioned benefits, but also will help achieve the vision of the CaBA CSRS which is for “ecologically vibrant chalk streams, all flowing with a healthy flush of clean water through meandering channels over bright gravel; streams full of wildlife, streams which are a pleasure to spend time beside and which could and should be a credit to the stewardship of our generation”.

6. Guidance for the Application of Sustainable Drainage Systems (SuDS)

6.1 What are SuDS?

Policy Recommendation 11 Suitable surface water management measures should be incorporated into new development designs to reduce and manage surface water runoff to the greenfield runoff rate. This should be achieved by incorporating Sustainable Drainage Systems (SuDS). Developers should preferentially incorporate at least 2 types of SuDS which provide multiple benefits (water quantity, water quality, amenity, biodiversity). Rainwater should be seen as a resource, and rainwater harvesting included within development design.

Developers should engage with the LLFA and water company (Thames Water) early in the scheme design process (through pre-application liaison) to appropriately consider the impact on the receiving watercourse or sewer system.

This policy should be updated when Schedule 3 of the Flood and Water Management Act 2010 is implemented, at which point SuDS will become mandatory as part of new developments.

6.1.1 SuDS are surface water drainage solutions designed to manage surface water runoff and mitigate the adverse effects of urban storm water runoff by reducing flood risk and controlling pollution[52]. SuDS techniques allow surface water runoff from development to be controlled in ways that imitate natural drainage by controlling the rate of discharge to a receiving watercourse, surface water sewer or point of infiltration. SuDS may also provide valuable habitat and amenity value when carefully planned for in development.

6.1.2 The SuDS Manual[19] states that SuDS design should be based on the following to maximise benefits:

- Use surface water runoff as a resource
- Manage rainwater close to where it falls (at source)
- Manage runoff on the surface (above ground)
- Allow rainwater to soak into the ground (infiltration)
- Promote evapotranspiration
- Slow and store runoff to mimic natural runoff rates and volumes
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

6.1.3 The SuDS Manual identifies six specific functions provided by SuDS components. These functions are not independent of each other, and a SuDS component can often be used to provide two or more functions. These processes include:

1. Rainwater harvesting systems – components that capture rainwater and facilitate its use within the building or local environment.
2. Pervious surfacing systems – structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system, e.g. green roofs, pervious paving. Many of these systems also include some subsurface storage and treatment.

[52] Defra, Environment Agency. March 2015. *Cost Estimation for SuDS – Summary of Evidence*. https://assets.publishing.service.gov.uk/media/6034ee6c8fa8f54334a5a6a9/Cost_estimation_for_SUDS.pdf

3. Infiltration systems – components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil. A high-level indication of suitability of infiltration SuDS techniques across HBC area is shown in Appendix A Figure 14; however, developers should undertake a more detailed assessment to determine site-specific suitability.
4. Conveyance systems – components that convey flows to downstream storage systems. Where possible, these systems also provide flow and volume control and treatment, e.g. swales.
5. Storage systems – components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff, e.g. ponds, wetlands and detention basins.
6. Treatment systems – components that remove or facilitate the degradation of contaminants present in the runoff.

6.1.4 As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development. Table 6-1 has been reproduced from the SuDS Manual, CIRIA C753 and outlines typical SuDS techniques.

Table 6-1 Typical SuDS Components

Component type	Description
Rainwater harvesting systems	Rainwater is collected from the roof of a building or from other paved surfaces in an over-ground or underground tank for use on site. Depending on its intended use, the system may include treatment elements. The system should include specific storage provision if it is to be used to manage runoff to a design standard.
Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation. Blue roofs store water at roof level, without the use of vegetation.
Infiltration systems	These systems collect and store runoff allowing it to infiltrate into the ground. Overlying vegetation and underlying unsaturated soils can offer protection to groundwater from pollution risks.
Proprietary treatment systems	These subsurface and surface structures are designed to provide treatment of water through the removal of contaminants.
Filter strips	Runoff from an impermeable area is allowed to flow across a grassed or otherwise densely planted area to promote sedimentation and filtration.
Filter drains	Runoff is temporarily stored below the surface in a shallow trench filled with stone/gravel, providing attenuation, conveyance, and treatment (via filtration).
Swales	A vegetated channel is used to convey and treat runoff (via filtration). These can be “wet”, where water is designed to remain permanently at the base of the swale, or “dry” where water is only present in the channel after rainfall events. It can be lined, or unlined to allow infiltration.
Bioretention systems	A shallow landscaped depression allows runoff to pond temporarily on the surface before filtering through vegetation and underlying soils prior to collection or infiltration. In its simplest form it is often referred to as a rain garden. Engineered soils (gravel and sand layers) and enhanced vegetation can be used to improve treatment performance.
Trees	Trees can be planted within a range of infiltration SuDS components to improve their performance, as root growth and decomposition increase soil infiltration capacity. Alternatively, they can be used as standalone features within soil-filled tree pits, tree planters or structural soils, collecting and storing runoff and providing treatment (via filtration and phytoremediation).
Pervious pavements	Runoff is allowed to soak through structural paving. This can be paving blocks with gaps between solid blocks, or porous paving where water filters through the block itself. Water can be stored in the sub-base and potentially allowed to infiltrate into the ground
Attenuation storage tanks	Large, below-ground voided spaces can be used to temporarily store runoff before infiltration, controlled release, or use. The storage structure is often constructed using geocellular or other modular storage systems, concrete tanks, or oversized pipes.
Detention basins	During a rainfall event, runoff drains to a landscaped depression with an outlet that restricts flows, so that the basin fills and provides attenuation. Generally, basins are dry, except during and immediately following the rainfall event. If vegetated, runoff will be treated as it is conveyed and filtered across the base of the basin.
Ponds and wetlands	Features with a permanent pool of water can be used to provide both attenuation and treatment of runoff, where outflows are controlled, and water levels are allowed to increase following rainfall. They can support emergent and submerged vegetation along their shoreline and in shallow, marshy zones, which enhances treatment processes and biodiversity.

6.1.5 The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution, amenity, and biodiversity benefits. In addition, SuDS can be employed on a strategic scale, for example with several sites contributing to large scale jointly funded and managed SuDS. It should be noted that each development site must offset its own increase in runoff and attenuation cannot be "traded" between developments.

6.1.6 Other measures may also be required in relation to water and sewerage infrastructure that might include pipes and below ground storage required as part of a wider strategic scheme, to deal with surface water flood risk. Options may include:

- Increasing capacity in drainage systems.
- Separation of foul and surface water sewers.
- Improved drainage maintenance regimes.
- Managing overland flows.

6.2 Management Train

6.2.1 The concept used in the development of drainage systems is the surface water 'management train'[53] whereby different techniques can be used in series to change the flow and quality characteristics of runoff in stages that attempt to mimic natural drainage. The hierarchy of techniques that should be considered in developing the management train are:

1. **Prevention –** the use of good site design and site housekeeping measures to prevent runoff and pollution (e.g., sweeping to remove surface dust and detritus from car parks), and rain water reuse/harvesting. Prevention policies should generally be included within the site management plan.
2. **Source controls –** control of runoff at or very near its source (e.g., soakaways, other infiltration methods, green roofs, pervious pavements).
3. **Site controls –** management of water in a local area or site (e.g., routing water from building roofs and car parks to a large soakaway, infiltration, or detention basin.)
4. **Regional controls –** management of runoff from a site or several sites, typically in a balancing pond or wetland.

6.2.2 Generally, the aim should be to discharge surface water run-off as high up the following hierarchy of drainage options as reasonably practicable:

- Use rainwater as a resource through rainwater harvesting
- Into the ground (shallow infiltration)
- To a surface water body
- To a surface water sewer, highway drain, or another drainage system
- To a combined sewer

6.2.3 Where possible, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas. The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at the source should always be considered before site or regional controls. However, where upstream control opportunities are restricted, several lower hierarchy options should be used in series. Water should only be conveyed elsewhere if it cannot be dealt with at the site.

6.2.4 The passage of water between stages of the management train should be considered through the use of natural conveyance systems (e.g., swales and filter trenches) wherever possible. Pipework and sub-surface proprietary produce may still be required, especially where space is limited. Pre-treatment (i.e. the removal of silt and sediment loads) and maintenance is vital to ensure the long-term effectiveness of SuDS. Overland flow routes will also be required to convey and control floodwaters safely and effectively during extreme flood events. Generally, the greater the number of techniques used in a series the better the performance is likely to be and the lower the risk of overall system failure.

[53] https://www.susdrain.org/delivering-suds/using-suds/suds-principles/management-train.html

6.2.5 The Simple Index Approach set out in the CIRIA SuDS Manual should be utilised to design a SuDS treatment train that is able to treat surface water runoff appropriately depending on the pollution hazard of various land uses.

6.2.6 SuDS can be applied in all development situations, although individual site constraints may limit the potential of some sites achieving full benefits for all functions. The variety of SuDS available allows planners and designers to make full potential of the local land and consider the needs of local people when implementing the drainage design. The wishes of all the relevant stakeholders needs to be balanced in addition to the risk associated with each design option.

6.3 SuDS Costs

Whole Life Costs

6.3.1 Identifying whole life costs associated with SuDS is a complex process and involves consideration of the following: Procurement and design costs; Capital construction costs; Operation and maintenance costs; Monitoring costs; and Replacement or decommissioning costs. If the incorporation of SuDS is considered early in the design, as part of the wider landscaping and site planning phase, there is greater potential to manage the costs of SuDS effectively.

6.3.2 Information on typical capital costs and maintenance costs are provided below. For further detail, reference can be made to industry guidance such as the Defra and Environment Agency publication 'Cost Estimation for SuDS- Summary of Evidence'[52] and The CIRIA SuDS Manual.

Capital Costs

6.3.3 The Defra and the Environment Agency publication contains unit costs for SuDS components based on several industry references. It is noted that these costs are based on actual costs from several projects from within the UK and from a wider literature review. If used for cost estimating purposes these costs should be increased to allow for inflation to present day values.

6.3.4 The document provides a range of costs for each type and a relative assessment between SuDS features. The costs associated with any specific site will depend on several factors as follows:

- Scale and size of development
- Hydraulic design criteria (design event, volume of storage required and impermeable catchment area)
- Inlet/outlet infrastructure design (volume and velocity of anticipated flows and the capacity of drainage system beyond site boundary)
- Water quality design criteria
- Soil types (permeability and depth of water table), porosity and load bearing capacity
- Materials availability
- Density of planting
- Specific Utilities requirements
- Proximity to receiving watercourse
- Amenity / public education / safety requirements.

Operation and Maintenance Costs

6.3.5 As with any other flood risk management structure, SuDS require ongoing maintenance to ensure the system remains in good working order and the design life of the system is extended. The requirement for future maintenance should be addressed as part of planning conditions and s106 agreements. Operation and maintenance activities will include the following:

- Monitoring and post-construction inspection.
- Regular, planned maintenance (annual or more frequent).
- Intermittent, refurbishment, repair/remedial maintenance.

6.3.6 Additional costs may include the allocation of resources and materials because of maintenance activities.

6.3.7 The operation and maintenance of the proposed SuDS should include a provision to monitor the safety aspects of the SuDS infrastructure. This may include areas where there is the potential for public access around attenuation basins or swales.

6.3.8 The long-term maintenance costs associated with SuDS are relatively unknown as they are usually absorbed by operators responsible for maintaining the infrastructure as part of their wider asset base.

6.3.9 Whilst the construction of SuDS (e.g., attenuation ponds) and wetlands are relatively straightforward to calculate, maintenance costs are slightly more difficult to estimate due to the lack of information regarding who is responsible for this ongoing maintenance. The key factors that will influence maintenance costs include:

- Type and frequency of maintenance required (e.g., sediment removal, inlet/outlet maintenance, landscaping, and litter removal).
- The costs of maintenance (materials, labour, and equipment costs).
- The availability and source of materials and disposal costs.
- The responsibility for maintenance (e.g., LPA, highways authorities, residents, developer).

6.3.10 The Defra/Environment Agency SuDS costs document outlines some generic SuDS costs based on review of literature and some UK case studies undertaken by HR Wallingford (2004). If used for cost estimating purposes these costs should be increased to allow for inflation to present day values.

6.4 Infiltration SuDS Specific to Hertsmere

6.4.1 Across Hertsmere, the nature of the soil, subsoil and underlying strata makes the disposal of runoff to groundwater by means of SuDS incorporating soil infiltration processes a desirable and potentially feasible option. However, HCC (LLFA) have found that infiltration SuDS suitability is highly variable and location specific. Therefore, site-specific infiltration testing is required to identify the potential and detailed location within a site for infiltration SuDS features. Variability of ground conditions across large sites means that the infiltration potential cannot be assumed across the whole site. Specific areas for infiltration SuDS need to be identified early in the site planning and design process so that they can be integrated to best effect.

6.4.2 Developers should be made aware of the presence of several groundwater source protection zones[54] in the area and it is essential that the chemical and bacteriological quality of the runoff disposed of by infiltration is fully considered.

6.4.3 As part of this SFRA, an assessment of the suitability of using infiltration SuDS techniques across the Borough has been undertaken. The BGS infiltration SuDS suitability map shown on **Appendix A Figure 14** is largely based on the BGS infiltration SuDS suitability dataset. It is understood from the BGS guidance notes that the dataset is derived from the following data:

- Infiltration constraints summary level.
- Superficial deposits permeability.
- Superficial deposits thickness.
- Bedrock permeability.
- Depth to groundwater level.
- Geological indicators of flooding.

6.4.4 Four categories have been identified by the BGS for suitability for infiltration SuDS:

- Highly compatible for infiltration SuDS: The subsurface is likely to be suitable for free-draining infiltration SuDS.

[54] Groundwater Source Protection Maps. MAGIC Website: https://magic.defra.gov.uk/MagicMap.aspx

- Probably compatible for infiltration SuDS: The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions.
- Opportunities for bespoke infiltration SuDS: The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions.
- Very significant constraints are indicated: There is a very significant potential for one or more geohazards associated with infiltration.

6.4.5 Most areas inside the Borough have been designated as 'Probably compatible for infiltration SuDS' in the eastern half and 'Opportunities for bespoke infiltration SuDS in the west. 'Very significant constraints' are shown in approximately 11% of the Borough and the percentage of land identified as 'Highly compatible for infiltration SuDS' is 16%. A range of other types of SuDS measures (Table 6-1) can be adopted in sites where infiltration SuDS are not particularly suitable.

6.5 What is the role of the HCC?

6.5.1 HCC is a statutory consultee for surface water drainage as part of their role as LLFA. All major development should include provision for SuDS and a Sustainable Drainage Strategy will need to be completed and signed by a competent drainage engineer to verify that the proposals conform to the Government's 'Sustainable Drainage Systems: Non-Statutory Technical Standards[55].'

6.5.2 The following sections provide an overview of the Technical Standards and items which applicants should include when preparing a Sustainable Drainage Strategy for submission to HCC. Further information and guidance is available on the HCC website:

https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/surface-water-drainage/surface-water-drainage.aspx#

6.5.3 The SuDS information and policies are part of the adopted LFRMS for Hertfordshire.

What are the Technical Standards?

6.5.4 A set of non-statutory Technical Standards have been published, which set the requirements for the design, construction, maintenance, and operation of SuDS. The Technical Standards that are of chief concern in relation to the consideration of flood risk to and from development relating to peak flow control and volume control are presented below. These Technical Standards shall be used to support the Local Plan SuDS policies in consultation with the HCC LLFA.

6.5.5 ASA is the Association of SuDS Authorities which is a professional association of local authority officers that have involvement in SuDS. ASA (formerly Local Authority SuDS Officer Organisation) are the owners and writers of a Practice Guidance document which sits alongside the Non-Statutory Technical Standards for SuDS.

6.5.6 It should be noted that the Non-Statutory Technical Standards for SuDS provide national minimum requirements, but local requirements can be more stringent.

[55] Defra, March 2015. *Sustainable Drainage Systems*. https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

Non-statutory technical standards for sustainable drainage systems, March 2015

Flood risk outside the development

S1 Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or large estuary) the peak flow control standards (S2 and S3 below) and volume control standards (S4 and S6 below) need not apply.

Peak flow control

S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

S4 Where reasonably practicable, for Greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the Greenfield runoff volume for the same event.

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood risk within the development

S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

All major developments and other development should not result in an increase in surface water runoff, and where possible, should demonstrate betterment in terms of rate and volumes of surface water runoff.

Sustainable Drainage Systems (SuDS) should be used to reduce and manage surface water run-off to and from proposed developments as near to source as possible in accordance with the requirements of the Technical Standards and supporting guidance published by DCLG and Defra.

What should a Sustainable Drainage Strategy include?

6.5.7 The following provides an indication of the type of information that would be required as part of a Sustainable Drainage Strategy. These requirements are not exhaustive and are subject to change. The requirements should be checked against the most up to date requirements as published by the LLFA[56].

[56] *SuDS Design Guidance for Hertfordshire*. https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/guidance-for-developers.pdf

- A plan of the existing site.
- A topographical level survey of the area to metres Above Ordnance Datum (mAOD).
- Demonstration of a clear understanding of how surface water flows across the site and surrounding area. This could use the topographic survey and the information presented on the 'Flood Map for Surface Water' on the Environment Agency website.
- Plans and drawings of the proposed site layout identifying the footprint of the area being drained (including all buildings, access roads and car parks).
- Calculations of:
  - Changes in permeable and impermeable coverage across the site.
  - The existing and proposed controlled discharge rate for a 1 in 1 year event, 1 in 30 year and a 1 in 100 year event (with an allowance for climate change), which should be based on the estimated greenfield runoff rate.
  - Proposed storage volume (attenuation) including the water storage capacity of the proposed drainage features, with demonstration that they meet the requirements of the Technical Standards.
- Plans, drawings, and specification of proposed SuDS measures. This should include detail of hard construction, soft landscaping, and planting. A drainage design can incorporate a range of SuDS techniques.
- A design statement describing how the proposed measures manage surface water as close to its source as possible and follow the drainage hierarchy described in Section 6.2.
- Site specific geological information including borehole logs, depth to water table and/or infiltration test results in accordance with BRE365 for shallow infiltration (where depths are less than 3m below ground level). Where infiltration is proposed at a depth greater than 3m, falling head tests are required.
- Details of overland flow routes for exceedance events.
- Details of any offsite works required, together with necessary consents (where relevant). This consent may include an agreement in principle from Thames Water at the planning application stage to prove their discharge mechanism is viable.
- A management plan for future maintenance and adoption of drainage system for the lifetime of the development.

6.5.8 Applicants are encouraged to discuss their proposals with HCC (LLFA) and the water company (Thames Water) at the pre-application stage. Details on the charging schedule are presented on the relevant websites:

- HCC: https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/new-t003-surfwateradvice-request-form-v2-201705.docx / https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/surface-water-drainage/surface-water-drainage.aspx
- Thames Water: https://www.thameswater.co.uk/developers/larger-scale-developments/planning-your-development/water-and-wastewater-capacity

7. Guidance for preparing site-specific FRAs

7.1 What is a Flood Risk Assessment?

7.1.1 A site-specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development. The FRA must demonstrate how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with paragraph 164 of the NPPF and supporting PPG. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users. An FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow HBC to satisfy itself that the requirements have been met.

7.2 When is a Flood Risk Assessment required?

The NPPF states that a site-specific FRA is required in the following circumstances:

- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Proposals in an area within Flood Zone 1, which was identified in a SFRA as being at increased flood risk in future.
- Proposals of 1 hectare or greater in Flood Zone 1.
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

7.2.1 In addition to the above it should be noted that when determining whether an FRA is required, HBC should be consulted to determine whether there are any specific criteria they wish to apply in the assessment.

7.3 How detailed should a FRA be?

7.3.1 The PPG states that site-specific FRAs need to be credible, fit for purpose, and proportionate to the anticipated degree of flood risk. Site-specific FRAs need to make optimum use of information already available, including information in Hertsmere BC's Strategic Flood Risk Assessment, and the Environment Agency's Flood Map and surface water flood risk information, although in some cases additional modelling or detailed calculations will need to be undertaken. Flood risk assessments need to include the information set out in the flood risk assessment checklist in the PPG.

7.3.2 A flood risk assessment needs to be appropriate to the scale, nature and location of the development. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, Hertsmere BC would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater Hertsmere BC may require a more detailed assessment, for example, the preparation of site-specific hydraulic modelling to determine the flood risk to and from the site pre and post-development, and the effectiveness of any management and mitigation measures incorporated within the design.

7.3.3 As a result, the scope of each site-specific FRA will vary considerably. Table 7-1 presents the different levels of site-specific FRA as defined in the CIRIA publication C624[57] and identifies typical sources of information that can be used. Sufficient information must be included to enable the Council and where

[57] CIRIA (2004) Development and flood risk – guidance for the construction industry C624.

appropriate, consultees, to determine that the proposal will be safe for its lifetime, not increase flood risk elsewhere and where possible, reduce flood risk overall. Failure to provide sufficient information will result in applications being refused.

Table 7-1 Levels of Site-Specific Flood Risk Assessment

Description
Level 1 Screening study to identify whether there is any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information. The screening study will ascertain whether a FRA Level 2 or 3 is required. Typical sources of information include: • HBC SFRA • Flood Map for Planning (Rivers and Sea) • Environment Agency Standing Advice • NPPF Tables 1, 2 and 3
Level 2 Scoping study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased run-off. This study should confirm the sources of flooding which may affect the site. The study should include: • An appraisal of the availability and adequacy of existing information, • A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and • An appraisal of the scope of possible measures to reduce flood risk to acceptable levels. The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development. Typical sources of information include those listed above, plus: • Local policy statements or guidance. • CFMP. • HCC PFRA and LFRMS. • Data request from the Environment Agency to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth, and velocity. • Consultation with Environment Agency/HCC/sewerage undertakers and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding. • Historic maps. • Interviews with local people and community groups. • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition. • Site survey to determine general ground levels across the site, levels of any formal or informal flood defences.
Level 3 Detailed study to be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include: • Quantitative appraisal of the potential flood risk to the development, • Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; and • Quantitative demonstration of the effectiveness of any proposed mitigations measures. Typical sources of information include those listed above, plus: • Detailed topographical survey. • Detailed hydrographic survey. • Site-specific hydrological and hydraulic modelling studies which should include the effects of the proposed development. • Monitoring to assist with model calibration/verification. • Continued consultation with the HBC, Environment Agency, and other flood risk consultees.

Environment Agency Data Requests

7.3.4 The Environment Agency offers a series of 'products' for obtaining flood risk information suitable for informing the preparation of site-specific FRAs as described on their website https://www.gov.uk/planning-applications-assessing-flood-risk.

- **Products 1 – 4** contain maps of modelling outputs including flood level and flood depth information and the presence of flood defences local to the proposed development site.
- **Product 5** is the hydraulic modelling report.
- **Product 6** is the model output data, so the applicant can interrogate the data to inform the FRA.
- **Product 7** is the hydraulic model itself.

7.3.5 Hydraulic models of watercourses are regularly being produced and/or updated. For example, the Upper Colne hydraulic model is currently being updated as part of the Environment Agency works programme.

Developers should therefore request the most up to date information from the Environment Agency prior to undertaking an assessment of fluvial flood risk.

7.3.6 This can be requested via either their National Customer Contact Centre via enquiries@environment-agency.gov.uk, the Hertfordshire and North London Customer and Engagement Team via HNL.Enquiries@environment-agency.gov.uk or the Sustainable Places team via HNLSustainablePlaces@environment-agency.gov.uk.

Modelling of Ordinary Watercourses

7.3.7 It should be noted that the scope of modelling studies undertaken by the Environment Agency typically cover flooding associated with Main Rivers, and therefore Ordinary Watercourses that form tributaries to the Main Rivers may not always be included in the model. Where a proposed development site is near an Ordinary Watercourse and either no modelling exists, or the available modelling is considered to provide very conservative estimates of flood extents (due to the use of national generalised JFLOW modelling), applicants may need to prepare a hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site-specific FRA. This should be carried out in line with industry standards and in agreement with the Environment Agency and HCC (as the LLFA).

7.4 What needs to be addressed in a Flood Risk Assessment?

7.4.1 The PPG states that the objectives of a site-specific flood risk assessment are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source,
- whether it will increase flood risk elsewhere,
- whether the measures proposed to deal with these effects and risks are appropriate,
- the evidence for HBC to apply (if necessary) the Sequential Test, and
- whether the development will be safe and pass the Exception Test, if applicable.

7.5 Flood Risk Assessment Checklist

7.5.1 There is a checklist for Flood Risk Assessments within paragraph 80 of the PPG which should be followed: https://www.gov.uk/guidance/flood-risk-and-coastal-change#para80

7.5.2 **Appendix B** also provides a checklist for site-specific FRAs and Drainage Strategies developed by HCC (as LLFA) including the likely information that will need to be provided along with references to sources of relevant information. This information can also be found at: https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/guidance-for-developers.pdf As described in Section 7.3, the exact level of detail required under each heading will vary according to the scale of development and the nature of the flood risk.

7.6 Pre-application Advice

7.6.1 At all stages, HBC, and where necessary the Environment Agency, HCC and/or the Statutory Water Undertaker may need to be consulted to ensure the FRA provides the necessary information to fulfil the requirements for planning applications.

7.6.2 The Environment Agency, HCC, and HBC each offer pre-application advice services which should be used to discuss requirements for specific applications.

- **HBC** offer pre-application advice. Enquiries can be submitted by completing the relevant form available online at https://www.hertsmere.gov.uk/Planning--Building-Control/Planning-Advice/Pre-application-advice.aspx
- **Environment Agency** https://www.gov.uk/government/publications/planning-and-marine-licence-advice-standard-terms-for-our-charges The following government guidance sets out

when LPAs should consult with the Environment Agency on planning applications https://www.gov.uk/flood-risk-assessment-local-planning-authorities. Local guidance for Hertfordshire from the Environment Agency can be found here - https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/planning/planning-applications-decisions/environment-agency-%E2%80%93-pre-application-and-post-permission-advice-august-16.pdf

- **HCC** offer pre-application advice to developers on a chargeable basis. Details on the charging schedule are presented in the pre-application guide and the HCC LLFA webpage - https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/managing-flood-risks.aspx

8. Flood Risk Management Policy Considerations

8.1 Overview

8.1.1 To encourage a holistic approach to flood risk management and ensure that flooding is considered at all stages of the planning process, this section builds on the findings of the SFRA to set out key recommendations for consideration by HBC in relation to flood risk planning policy and with respect to development management decisions on a day-to-day basis.

8.2 Policy Considerations

8.2.1 It is recommended that the following flood risk objectives are considered by HBC during the policy making process. Guidance on how these objectives can be met throughout the development management process for individual development sites is included within Section 5.

Seeking Flood Risk Reduction through Spatial Planning and Site Design

- Use the Sequential Test to locate new development in areas of lowest risk, giving highest priority to areas within Flood Zone 1. Locating new development away from the most vulnerable flood risk areas would minimise the cost of installing and maintaining new flood defences and land drainage measures.
- Use the sequential approach within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.
- Avoid development immediately downstream of reservoirs which will be at high hazard areas in the event of failure.
- Seek opportunities for new development to achieve reductions to wider flood risk issues where possible, e.g., larger developments may be able to make provisions for flow balancing within new attenuation SuDS features.
- Identify long-term opportunities to remove development from the floodplain through land swapping.
- Build resilience into the design of a site (e.g., flood resilient design, raised floor levels).
- Safe access route to and from development.

Reducing Surface Water Runoff from New Developments

- All development should seek to reduce surface water runoff from new developments to the greenfield runoff rate.
- All sites require the following:
  - Use of SuDS (where possible use of strategic SuDS should be made).
  - Discharge rates should be restricted to greenfield runoff rates.
  - 1 in 100 year attenuation of surface water, including the appropriate allowance for climate change.
- Rainwater should be seen as a resource within developments, with rainwater harvesting schemes included unless robust justification is provided as to why they are not feasible.
- Space should be specifically set aside for SuDS and used to inform the overall layout of development sites.
- SuDS with multiple benefits (water quantity, water quality, amenity, biodiversity) should be incorporated preferentially to SuDS with fewer benefits.

- Developments should incorporate permeable surfaces where possible, minimising the inclusion of hard standing unless it can be demonstrated that these are unavoidable.
- Surface water drainage proposals should have a clear plan for the long-term maintenance and adoption of the systems, prior to approval of any planning permission in line with national planning policy.
- Large potential development areas with several new allocation sites will be required to develop a strategy for providing a joint SuDS scheme. This will need to be on an integrated and strategic scale and where necessary will require the collaboration of all developers involved in implementing a specific expansion area or site.
- Careful assessment of the potential impact of surface water drainage from new developments will be necessary in areas with constrained drainage networks, particularly those networks that are dependent upon sewers and culverted watercourses with limited capacity. Consultation with the water company (Thames Water) should be undertaken early, through pre-planning application advice.
- Further work is necessary to understand the full extent of risk from surface water flooding in Hertsmere, including the preparation of SWMPs.
- Reducing the potential impacts of sewer flooding may require the installation of SuDS in both new and existing developments. The risk of foul sewer flooding that result from the misconnection of surface water drainage to the foul sewer network could be addressed if opportunities to disconnect surface water from foul sewers are taken.
- Consideration may need to be given to further use of rural SuDS to reduce both the risk of flooding and the risk of rivers drying out (smoothing out the peaks and troughs of local rainfall).

Enhancing and Restoring the River Corridor (Main Rivers and Ordinary Watercourses)

- An assessment of the condition of existing assets (e.g., bridges, culverts, river walls) should be made by developers in consultation with asset owners. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g., de-culverting, the use of bio-engineered river walls, raising bridge soffits to take into account climate change).
- Avoid further culverting and building over culverts. Where practical, all new developments with culverts running through their site should seek to de-culvert Main Rivers and ordinary watercourses for flood risk management and biodiversity benefit. Any culverting or works affecting the flow of a watercourse requires the prior written consent of either the Environment Agency (for Main Rivers), or HCC (for ordinary watercourses) under the terms of the Land Drainage/Water Resources Act 1991 and Flood and Water Management Act 2010. These regulatory bodies seek to avoid culverting, and their consent for such works will not normally be granted except as a means of access.
- Set development back from rivers, seeking a 10 metre wide undeveloped buffer strip for development from Main Rivers, and 9m from Ordinary Watercourses, including those where the Flood Zone or Surface Water flood extent does not exist. Under the terms of the Water Resources Act 1991 and the Land Drainage Byelaws, any works in, over, under or within 8 metres of a designated Main River or flood defence requires formal written consent from the Environment Agency prior to the works commencing. This includes the construction of any buildings, culverts, bridges, footways, and outfalls. In addition, any works that could affect the flow of an ordinary watercourse (i.e., not designated as a Main River) require consent from the LLFA (HCC) prior to the commencement of works. This includes culverting, diverting, and can include outfalls and bridges depending on the likely affect to the flow of the watercourse. In addition, any work within 9m of any watercourse will need prior consent from HBC (HBC Byelaws no. 9).

Protecting and Promoting Areas for Future Flood Alleviation Schemes

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset) and reinstate areas of functional floodplain which have been developed (e.g., reduce building footprints or relocate to lower flood risk zones).
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

Improving Flood Resilience and Emergency Planning

8.2.2 Due to the high level of flood risk affecting numerous properties it is recommended that funding is invested in flood mitigation infrastructure, especially those that reduce the risk of surface water flooding. Where funding is not viable for flood-related purposes, it is necessary to consider flood resilience measures, including:

- Seek to improve the emergency planning process using the outputs from the SFRA and through consultation with local emergency planners.
- Encourage all those within existing Flood Zone 3a and 3b (residential and commercial occupiers) to sign up to Flood Warning Service operated by the Environment Agency.
- Consider PFR schemes for existing properties at risk of flooding.
- Ensure robust emergency (evacuation) plans are implemented for new developments.

8.3 Development Management Considerations

Flood Zone 3b Functional Floodplain

8.3.1 The Functional Floodplain comprises undeveloped land within the 3.33% annual probability (1 in 30 year) flood extent. These areas should be safeguarded from any development. Where Water Compatible or Essential Infrastructure cannot be located elsewhere, it must:

- Remain operational and safe for users in times of flood,
- Result in no net loss of flood storage,
- Not impede water flows, and
- Not increase flood risk elsewhere.

8.3.2 Within the outline of the 3.3% annual probability (1 in 30 year) flood outline, there could be areas of existing development which are prevented from flooding by the presence of existing infrastructure or solid buildings. In these developed areas, existing building footprints, where it can be demonstrated that they exclude floodwater, will not be defined as Functional Floodplain and the planning requirements associated with Flood Zone 3b will not apply.

8.3.3 Where redevelopment is proposed in developed areas, schemes should not increase the vulnerability classification of the site. All schemes must result in a net reduction in flood risk and ensure that floodplain storage and flow routes are not affected. This can be achieved through a combination of on and off-site measures including, but not limited to:

- Reducing the development vulnerability.
- Increasing floodplain storage capacity and creating space for flooding to occur by restoring functional floodplain.
- Reducing impedance to floodwater flow and restoring flood flow paths.
- Incorporating flood resilient and/or resistance measures.
- Ensuring development remains safe for users in time of flood (this may refer to the timely evacuation of properties prior to the onset of flooding in accordance with an individual Emergency Plan for the site).

8.3.4 Proposals for the change of use or conversion to a use with a higher vulnerability classification will not be permitted.

8.3.5 Basement, basement extensions or conversions of basements to a higher vulnerability classification will not be permitted.

8.3.6 Where minor development is proposed, schemes should not affect floodplain storage or flow routes.

Approach to un-modelled Main Rivers and Ordinary Watercourses

8.3.7 Hydraulic modelling data (used to delineate Flood Zones) is not available from the Environment Agency for all Main Rivers and ordinary watercourses within the study area and in some cases the Environment Agency have modelling data, but only for the lower return periods and not for the 1 in 30 year (3.33% AEP) flood event. The extent of modelled Main Rivers and ordinary watercourses within Hertsmere are shown in **Appendix A Figure 15**.

8.3.8 The Environment Agency 2010 modelled Main Rivers and ordinary watercourses were chosen based on their assessed flood risk, level of urbanisation, proposed/potential future development, presence of slow structures which have significant impacts on the conveyance of flood flows and availability of data at the time of the study. As such, the following Main Rivers and ordinary watercourses were modelled by the Environment Agency in the 2010 Hydraulic Study:

- Mimmshall Brook
- Salisbury Hall Brook (upstream portion only)
- Radlett Brook (updated and subsequent update[35])
- Hilfield Brook.

8.3.9 The Environment Agency's current programme of works includes updating the Upper Colne hydraulic model. It should be noted there may be subsequent updates to the Environment Agency model resulting in the addition of modelled reaches and/or watercourses in response to future development demands.

8.3.10 *Main Rivers and Ordinary Watercourses where modelling data for the 3.33% (1 in 30 year) is not available –* Development within 20m of any un-modelled Main River and ordinary watercourses would be permissible if the developer is able to demonstrate, subject to the approval of HBC and meeting other Development Plan Document (DPD) policy considerations, that the proposed development lies outside the 1 in 30 year flood extents where the land is greenfield or complies with the requirements stated above where the land is in brownfield.

8.3.11 The prospective developer may need to develop a hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site-specific FRA. This should be carried out in line with industry standards and in agreement with the HBC, Environment Agency, and HCC (as the LLFA).

8.3.12 Schemes proposed in brownfield Flood Zone 3b sites will be subject to the completion of both the Sequential and Exception Tests as per Environment Agency and NPPF guidance.

8.3.13 The considerations related to Flood Zone 3b are summarised in Figure 8-1.

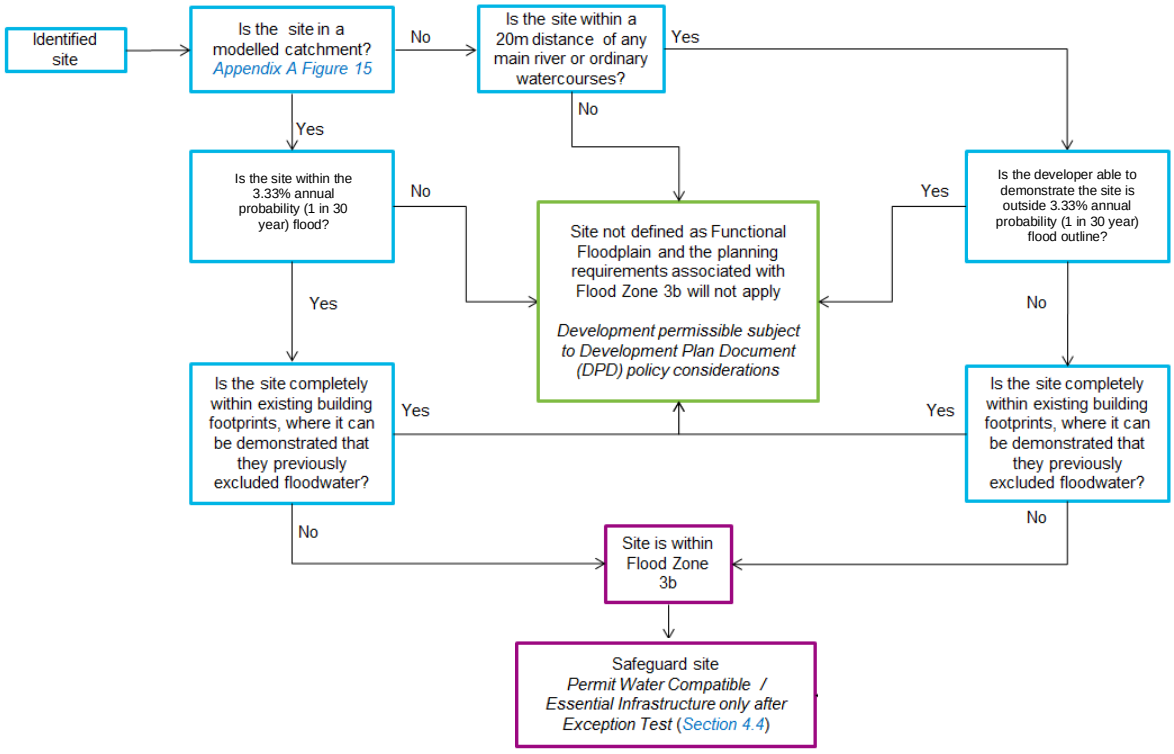


Figure 8-1 Development Management Considerations for Flood Zone 3b

Flood Zone 3a High Probability

8.3.14 Flood Zone 3a High Probability comprises land having a 1% (1 in 100 year) annual probability or greater risk of flooding from Main Rivers and ordinary watercourses. Water Compatible and Less Vulnerable developments are permitted in Flood Zone 3a; Essential Infrastructure and More Vulnerable developments require the Exception Test and Highly Vulnerable development is not permitted in this flood zone (see Table 4-2). Where development is proposed, opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding,
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques,
- Ensure it remains safe for users in times of flood; and
- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

Flood Zone 2 Medium Probability

8.3.15 Flood Zone 2 Medium Probability comprises land having between a 1% (1 in 100 year) and 0.1% (1 in 1000) annual probability of flooding from Main Rivers and ordinary watercourses. Water Compatible, Essential Infrastructure, Less Vulnerable and More Vulnerable developments are permitted in the Flood Zone 2 and Highly Vulnerable development requires the Exception Test (see section 4.4). Where development is proposed in areas of Flood Zone 2, the planning policy approach is similar to Flood Zone 3a. Opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding,
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques,
- Ensure it remains safe for users in times of flood, and
- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

Flood Zone 1 Low Probability

8.3.16 Flood Zone 1 Low Probability comprises land having a less than 0.1% (1 in 1000 year) annual probability of flooding from Main Rivers and ordinary watercourses. All development vulnerability classifications are permitted in Flood Zone 1. Where development over 1ha is proposed or there is evidence of flooding from another localised source in areas of Flood Zone 1, opportunities should be sought to:

- Ensure that the management of surface water runoff from the site is considered early in the site planning and design process; and
- Ensure that proposals achieve an overall reduction in the level of flood risk to the surrounding area, through the appropriate application of sustainable drainage techniques.

Climate Change Consideration

8.3.17 As explained in section 3.4.12, the existing Upper Colne model (2010) predates and therefore does not include the latest Environment Agency climate change guidance (2021). The model is currently being updated by the Environment Agency. Prior to its publication, the recommended process for the Development Management or site allocation purposes is set out below.

1. Sites along ***Mimmshall Brook, Hillfield Brook*** or ***Radlett Brook*** downstream of Radlett FSA – The 1 in 1000 year flood event provides a proxy to cover all climate change scenarios. Therefore, sites outside the flood map for this event (**Appendix A Figure 07**) can be allocated in the following way -
    - More Vulnerable or Highly Vulnerable non-residential properties – sites can be allocated with the condition that site-specific Sequential Test and FRA to be carried out to assess climate change impact for consideration during planning application.
    - other types of properties – no additional condition for climate change impact assessment – site-specific FRA may still be needed as per NPPF depending on type or size of the development (refer to Section 7.2)
2. For other locations, a site can be allocated in the Local Plan for future development if the following conditions are met:
    - it is defined as Less Vulnerable development.
    - it is not at risk of flooding during the 1 in 1000 year flood event (**Appendix A Figure 07**).
    - it is at low risk of flooding from all sources.
    - it is 100m away from a Main River or ordinary watercourse.

    Site-specific FRA may still be needed as per NPPF depending on type or size of the development.
3. For sites not covered above, an SFRA Level 2 or site-specific FRA needs to be undertaken ***before*** site allocation.

Changes of Use

8.3.18 Where a development undergoes a change of use and the vulnerability classification of the development changes, there may be an increase in flood risk. For example, changing from industrial use to residential use will increase the vulnerability classification from Less to More Vulnerable (Table 4-1).

8.3.19 For change of use applications in Flood Zone 2 and 3, applicants must submit an FRA with their application. This should demonstrate how the flood risks to the development will be managed so that it remains safe through its lifetime including provision of safe access and egress and preparation of Emergency Plans where necessary.

8.3.20 As changes of use are not subject to the Sequential or Exception Tests, HBC could consider when formulating policy what changes of use will be acceptable, having regard to paragraph 48 of the NPPF and taking into account the findings of this SFRA. This is likely to depend on whether developments can be designed to be safe and that there is safe access and egress.

8.4 Summary of Policy Recommendations

Policy Recommendation	Description
Policy Recommendation 1	A sequential approach to site planning should be applied within new development sites.
Policy Recommendation 2	Retain a 10m wide undeveloped buffer strip alongside Main Rivers and explore opportunities for riverside restoration. New development within 8m of a Main River will require consent from the Environment Agency.
Policy Recommendation 3	All new development must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.
Policy Recommendation 4	Extend and enhance existing Green Infrastructure in the Borough including the implementation of floodplain and riparian woodland planting schemes. Land that is likely to be needed for natural flood management should be safeguarded. Consideration should also be given to any necessary access to that land, and any additional land which may be needed temporarily during construction.
Policy Recommendation 5	More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.
Policy Recommendation 6	Where development or redevelopment is proposed in areas at risk of flooding, flood resilience measures should be implemented.
Policy Recommendation 7	For developments located in areas at risk of fluvial flooding, safe access / egress must be provided for new development as follows in order of preference: Dry route for people and vehicles. Dry route for people. If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people. If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However, the public should not drive vehicles in floodwater. In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.
Policy Recommendation 8	All new development, whether in Flood Zones 2 and 3 at risk of fluvial flooding, at risk of surface water flooding or at risk of groundwater flooding at the surface, should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water and therefore reduced flood risk elsewhere, such as: Maintain or improve existing flow paths in greenfield areas within the new development. Removing boundary walls or replacing with other boundary treatments such as hedges or fencing with gaps (for example post-and-rail or hit-and-miss). Considering alternatives to solid wooden gates or ensuring that there is a gap beneath the gates to allow the passage of floodwater. Consider reducing ground floor footprint Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.
Policy Recommendation 9	For developments proposed in Flood Zone 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population. The Environment Agency has a tool on their website to create a Personal Flood Plan. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate. Flood Warning and Evacuation Plans should also be prepared for sites located next to surface water flow, or where there is another source of flood risk affecting the site.

Policy Recommendation	Description
Policy Recommendation 10	In accordance with the CaBA CSRS, HBC should apply the following rules to development near chalk streams: Appraise the implications of for water resources and sewerage systems of major housing developments in their Local Plan and when reviewing proposals for major housing developments. Planning approval must be contingent on the pre-existence of or parallel investment in more than adequate supply and treatment infrastructure with no additional burden on chalk aquifer abstraction. Developers should make water-company developer contributions to help cover the costs of addressing such impacts. Where there is a need for groundwater abstraction, sustainable groundwater abstraction should be undertaken. This should see a maximum reduction of natural flows of 10% at Q95. HBC should delineate a minimum of 10m buffer zone to protect the riparian corridor or chalk streams from encroaching development. Works within the watercourse require a Water Framework Directive (WFD) risk assessment. SuDS (sustainable drainage systems) should be implemented on all new, large-scale developments (housing, roads, car parks) in chalk catchments. The highest standards of water efficiency should be implemented for new development in 'water-stressed' chalk catchments. More ambitious than the current optional standard of 110 l/h/d, a minimum of 90 l/h/d is recommended.
Policy Recommendation 11	Suitable surface water management measures should be incorporated into new development designs to reduce and manage surface water runoff to the greenfield runoff rate. This should be achieved by incorporating Sustainable Drainage Systems (SuDS). Developers should preferentially incorporate at least 2 types of SuDS which provide multiple benefits (water quantity, water quality, amenity, biodiversity). Rainwater should be seen as a resource, and rainwater harvesting included within development design. Developers should engage with the LLFA and water company (Thames Water) early in the scheme design process (through pre-application liaison) to appropriately consider the impact on the receiving watercourse or sewer system. *This policy should be updated when Schedule 3 of the Flood and Water Management Act 2010 is implemented, at which point SuDS will become mandatory as part of new developments.*

9. Next Steps

9.1 Next steps

9.1.1 Hertsmere BC should use this SFRA and associated mapping to:

- Develop their Local Plan and associated strategic policies,
- Safeguard land for flood risk management and green infrastructure,
- Carry out the sequential test for potential allocation sites and steer development towards those areas at lowest risk of flooding, before consideration of sites at greater risk,
- Carry out the sequential test for individual planning applications,
- Make decisions about individual planning applications,
- Decide whether a development can be made safe without increasing flood risk elsewhere,
- Identify the need for local design guidance or codes,
- Aid discussions with emergency planning teams.

9.1.2 Where development must be allocated in areas at risk of flooding further assessment of the risk of flooding may be required, for example through the preparation of a Level 2 SFRA.

9.2 Future Updates to the SFRA

9.2.1 This SFRA has been updated building upon existing knowledge and newly available datasets with respect to flood risk within HBC, made available by partner organisations including HCC, Thames Water, and the Environment Agency. In the future, new modelling studies or new information may influence future development management decisions within HBC. Therefore, it is important that the SFRA is adopted as a 'living' document and is reviewed regularly considering emerging policy directives, flood risk datasets and an improving understanding of flood risk within HBC.

9.2.2 The Upper Colne hydraulic model is currently being updated as part of the Environment Agency programme of works. It is anticipated that this updated model will be available in 2023 and therefore it is recommended that the SFRA is updated at the earliest possible opportunity following the release of this information to ensure it includes the most up to date understanding of flood risk across Hertsmere.

Appendix A - Maps

Figure No.	Figures Title and Content
Figure 01	Study Area *(administrative boundaries, watercourses, water bodies)*
Figure 02	Topography
Figure 03	Superficial Geology
Figure 04	Bedrock Geology
Figure 05.0 – 05.4	Flooding from Rivers (Flood Zone Map)
Figure 06.1 – 06.4	Modelled Fluvial Flood Risk
Figure 07	Fluvial and Surface Water Climate Change Outlines
Figure 08	Flood Warning Areas
Figure 09	Historic Flood Records
Figure 10.0 – 10.4	Map of Risk of Flooding from Surface Water (RoFSW)
Figure 11	Susceptibility to Groundwater Flooding
Figure 12	Sewer Flooding
Figure 13	Artificial Sources
Figure 14	British Geographic Survey (BGS) Infiltration Suds Suitability Mapping
Figure 15	Main Rivers Covered by Detailed Hydraulic Modelling
Figure 16	Chalk Streams
Figure 17.0 – 17.4	Working with Natural Processes

Appendix B - LLFA Summary Guidance for Developers