South West Hertfordshire Level 1 Strategic Flood Risk Assessment

Final Report

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Revision history

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2018s0161 SW Hertfordshire L1 SFRA v1.0 / 27/03/2018	Draft Report	Three Rivers District Council Dacorum Borough Council St. Albans City and District Council Watford Borough Council Hertfordshire County Council Thames Water Canal and River Trust
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	London Colney model outputs included	Dacorum Borough Council St. Albans City and District Council Watford Borough Council

Contract

This report describes work commissioned by Claire May, on behalf of Three Rivers District Council, by an email dated 31 January 2018. Nathan Chapman, Emily Jones and Fiona Hartland of JBA Consulting carried out this work.

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Purpose

This document has been prepared as a Final Report for Three Rivers District Council, Dacorum Borough Council, St. Albans City and District Council and Watford Borough Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Three Rivers District Council.

Acknowledgements

Many thanks to the following people for their involvement and input in the SFRA: Claire May, Lauren McCullagh and Marko Kalik from Three Rivers District Council; Rebecca Williams from Dacorum Borough Council; John Hoad from St. Albans City and District Council; Jack Green and Phil Dodshon from Watford Borough Council; Andy Hardstaff from Hertfordshire County Council; Chris Padley and Steve Cook from the Environment Agency and Mark Dickinson from Thames Water.

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Executive summary

Introduction

This Strategic Flood Risk Assessment (SFRA) 2018 document for South West Hertfordshire replaces the Level 1 Strategic Flood Risk Assessment originally published by Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council in August 2007. The purpose of this study is to provide a comprehensive and robust evidence base to support the production of Local Plans for the four Councils.

Strategic Flood Risk Assessment (SFRA) objectives

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

Level One: where flooding is not a major issue in relation to Strategic Housing Land Availability Assessment (SHLAA) sites and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.

Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the National Planning Policy Framework' (NPPF) Exception Test (detailed in the Planning Practice Guidance (PPG)). In these circumstances, the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

At this stage, a Level 1 SFRA has been prepared for South West Hertfordshire.

The key objectives of the Level 1 Strategic Flood Risk Assessment are:

1. To replace the Councils' existing Level 1 Strategic Flood Risk Assessment, taking into account most recent policy and legislation in the National Planning Policy Framework.
2. To collate and analyse the latest available information and data for current and future (i.e. climate change) flood risk from all sources and how these may be mitigated.
3. To inform decisions on the emerging Local Plan including the selection of development sites and planning policies.
4. To provide supporting evidence to support the Councils with the preparation of their Local Plans, allowing the application of the Sequential Test in the allocation of new development sites.
5. To provide a comprehensive set of maps presenting flood risk from all sources that can be used as an evidence base for use in the emerging Local Plans.
6. To provide advice for applicants carrying out site-specific flood risk assessments and outline specific measures or objectives that are required to manage flood risk to the appropriate standard.

SFRA outputs

- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, groundwater and sewer flooding.
- Updated review of historic flooding incidents
- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure
- An assessment of the potential increase in flood risk due to climate change.
- Areas at risk from other sources of flooding, for example surface water or reservoir.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.
- High level screening of sites against fluvial and surface water flood risk.

Summary of Level 1 Assessment

The SFRA has considered all sources of flooding including fluvial, surface water, groundwater, sewers and reservoir within the study area.

Fluvial flood risk is shown to generally be confined to the Main River floodplains such as the River Colne and River Lee catchments. Overall fluvial flood risk is in close proximity to watercourses, with few areas of extensive floodplain.

Surface water flooding is shown to correlate with watercourses throughout the South West Hertfordshire Study Area, with the higher proportion of surface water flooding in densely urbanised areas such as Hemel Hempstead, St. Albans, Rickmansworth and Watford. A heightened groundwater flood risk is present in the chalk valleys of the Rivers Bulbourne, Colne, Chess, Gade, Lee and Ver, however was shown to be low for over the rest of South West Hertfordshire.

Flooding from the Grand Union Canal, although largely a residual risk, was identified within recorded incidents of breach or overtopping, predominantly in Berkhamsted and Rickmansworth, where the canal interacts with the adjacent rivers.

The potential Local Plan sites within the study area were screened to identify the proportion of the sites shown to be within fluvial Flood Zones, historic flood outlines, as well as areas at risk of reservoir and surface water flooding.

Recommendations

Level 2 SFRA assessments should be undertaken at all sites which have been identified as 'at risk' and which may be carried forward in the Local Plan. The aim of the level

2 assessments is to consider the detailed nature of the flood characteristics within the Flood Zones for such sites in more detail (including depths, velocities, hazard etc.).

The Flood and Water Management Act (2010), the Localism Act (2011) and the NPPF all offer opportunities to approach planning for flood risk, sustainable drainage, green infrastructure, water quality, amenity, bio-diversity and habitat, and Water Framework Directive considerations in an integrated way.

Planning policies should focus on supporting the Lead Local Flood Authority (LLFA) in ensuring that all developments, even minor ones, build SuDS into their design and ensure that master planning integrates SuDS and making space for water into site design right from the concept stage.

Use of SFRA data

Level 1 Strategic Flood Risk Assessments are high-level strategic documents and, therefore do not go into detail on an individual site-specific basis. The primary purpose of this Strategic Flood Risk Assessment data is to provide an evidence base to inform the Local Plans of Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council, as well as any future flood risk policies.

This Strategic Flood Risk Assessment is intended to assist in application of the Sequential Test for site allocations and identify where the application of the Exception Test may be required within a Level 2 Strategic Flood Risk Assessment. The Strategic Flood Risk Assessment can also be used as a starting point for private developers, to help appraise the flood risk to a proposed development site.

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This SFRA should be a **'living document'** and as a result should be updated when new information becomes available. This may include catchment-scale flood modelling and mapping studies, flood risk assessment requirements, climate change allowances, or new planning guidance and legislation.

New information may be provided by the four Councils in South West Hertfordshire, Hertfordshire County Council (in its role as the Lead Local Flood Authority), the Canal and River Trust, Thames Water and the Environment Agency. In particular, the Environment Agency and Hertfordshire County Council should be consulted to ensure the latest flood risk guidance and data is used in decision-making.

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Definitions and Abbreviations

Term	Definition
AIMS	Asset Information Management System (Environment Agency GIS database of assets)
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CFMP	Catchment Flood Management Plan - A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
CSO	Combined sewer overflow
DBC	Dacorum Borough Council
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EU	European Union
FFL	Finished floor level
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRA	Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRMP	Flood Risk Management Plan
FWMA	Floods and Water Management Act - Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the

Term	Definition
	legislative framework for managing surface water flood risk in England.
Ha	Hectare
HELAA	Housing and Economic Land Availability Assessment
JBA	Jeremy Benn Associates Limited
LFRMS	Local Food Risk Management Strategy
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NPPF	National Planning Policy Framework
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity.
PPG	National Planning Practice Guidance
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average

Term	Definition
	recurrence interval over an extended period of time.
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water map. Environment Agency national map showing risk of flooding from surface water.
SA	Sustainability Appraisal
SACDC	St. Albans City and District Council
Sewer flooding	Flooding caused by a blockage or overflow in a sewer or urban drainage system.
SHLAA	Strategic Housing Land Availability Assessment - This is a technical piece of evidence to support local plans and their sites & policies . Its purpose is to demonstrate that there is a supply of housing land in the Borough/District which is suitable and deliverable.
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SPD	Supplementary Planning Document
STW	Sewage treatment works
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding from surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
TRDC	Three Rivers District Council
WBC	Watford Borough Council

Term	Definition
WCS	Water Cycle Study
WFD	Water Framework Directive

1 Introduction

1.1 Objectives

The key objectives for the 2018 South West Hertfordshire Strategic Flood Risk Assessment (SFRA) are:

1. To replace the Councils' existing Level 1 SFRA, taking into account the most recent policy and legislation in the National Planning Policy Framework (NPPF).
2. To collate and analyse the latest available information and data for current and future (i.e. climate change) flood risk from all sources and how these may be mitigated.
3. To inform decisions on the emerging Local Plans, including the selection of development sites and planning policies.
4. To provide supporting evidence to support the Councils with the preparation of their Local Plan, allowing the application of the Sequential Test in the allocation of new development sites.
5. To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the emerging Local Plan.
6. To provide advice for applicants carrying out site-specific flood risk assessments and outline specific measures or objectives that are required to manage flood risk to the appropriate standard.

1.2 Levels of SFRA

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1. **Level 1:** where flooding is not a major issue in relation to potential site allocations and where development pressures are low. The assessment should be of sufficient detail to enable application of the Sequential Test.
2. **Level 2:** where land outside Flood Zones 2 and 3 cannot appropriately accommodate all necessary development, creating the need to apply the NPPF Exception Test. In these circumstances, the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This update provides a Level 1 SFRA assessment. Should the Councils be unable to place development outside of flood zones, a Level 2 assessment may be required in the future.

1.3 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Identification of policy and technical updates.
- Identification of any strategic flooding issues which may have cross-boundary implications.
- Identification of any flood modelling and data gaps.
- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, sewers, groundwater, reservoirs and canals.
- Mapping showing distribution of flood risk across all flood zones from all sources of flooding including climate change allowances, including new and amended data sources.
- Review of historic flooding incidents.
- Reporting on the standard of protection provided by defences.
- Assessment of surface water management issues and Sustainable Drainage Systems guidance.
- Flood Risk Assessment guidance for developers.
- Sequential Test guidance and sequential approach to flood risk.
- Assessment of strategic flood risk solutions that can be implemented to reduce risks.

1.4 SFRA study area

The study area of South West Hertfordshire is located approximately 30km north west of the City of London, and incorporates the major conurbations of Hemel Hempstead, Rickmansworth, St. Albans and Watford (Figure 1-1).

South West Hertfordshire covers the administrative boundaries of four Local Planning Authorities: Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council. These four Councils are working closely together in the preparation of their Local Plan evidence bases. The term South West Hertfordshire is used herein as a short name to cover the administrative area of these four Councils.

Dacorum Borough Council

With an area of 212km^2 and estimated population of 152,400[1] people, Dacorum is both the largest and most populated of the four authorities. It covers the major settlements

[1] Nomis (2016) Dacorum: Resident Population (2016). Available at: https://www.nomisweb.co.uk/reports/lmp/la/1946157223/report.aspx

of Berkhamsted, Hemel Hempstead and Tring, as well as the western part of Kings Langley, which is shared with Three Rivers District. The Rivers Gade and Bulbourne, and the Grand Union Canal flow through the District, meeting at Hemel Hempstead.

St. Albans City and District Council

St. Albans City and District covers an area of 62km^3, and is crossed by the Rivers Lee, Ver, Colne and Ellen Brook. As well as the key city of St. Albans, which contains the majority of the 147,000[2] population, other large settlements within the District are Harpenden, Wheathampstead and Sandridge.

Three Rivers District Council

Named after the three watercourses of the River Colne, Chess and Gade, which reach a confluence in Rickmansworth, Three Rivers District covers an area 89km^2 and hosts a population of 92,700 people[3]. The key settlements of Rickmansworth, South Oxhey, Croxley Green, Abbots Langley, Chorleywood, Leavesden and Garston, and Mill Lane are located within the District.

Watford Borough Council

Centred around the town of Watford, the Borough covers a relatively small area of 21km^2. However, the Borough is densely urbanised, with a total population of 96,600 people[4]. The River Gade, Grand Union Canal and the River Colne form the western and eastern boundaries of Watford, respectively.

As many of the issues covered within the SFRA are relevant to all four Local Planning Authorities, the majority of the document covers South West Hertfordshire as a single entity. However, in the case of flood risk, where more specific information is applicable to a single authority, an overview of the key issues across the study area is provided within Section 6 of the main SFRA document, and more detailed information for each authority is provided in a separate appendix.

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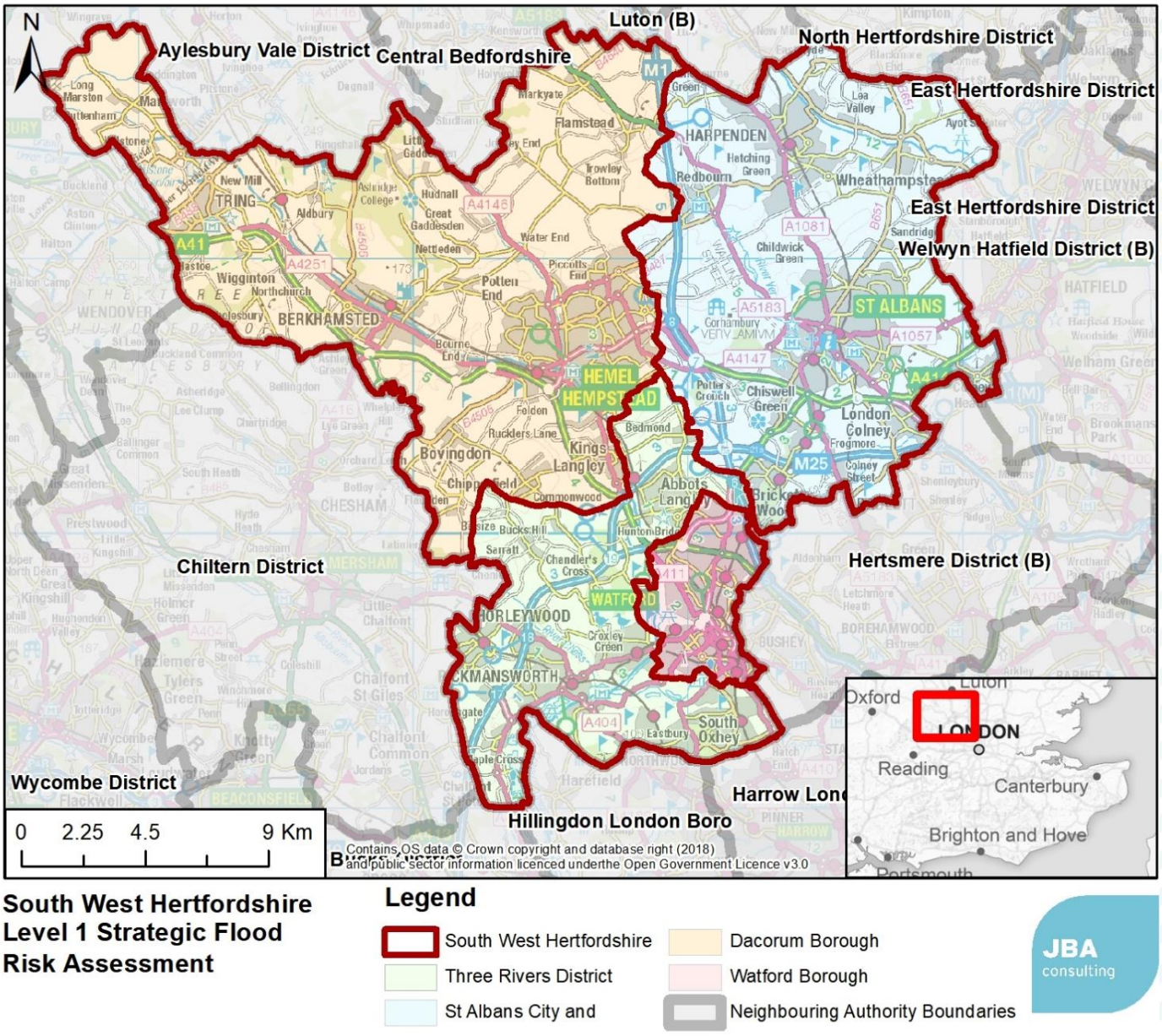
2 Nomis (2016) St. Albans: Resident Population (2016). Available at: https://www.nomisweb.co.uk/reports/lmp/la/1946157227/report.aspx.

3 Nomis (2016) Three Rivers: Resident Population (2016). Available at: https://www.nomisweb.co.uk/reports/lmp/la/1946157229/report.aspx#tabrespop.

4 Nomis (2016) Watford: Resident Population (2016). Available at: https://www.nomisweb.co.uk/reports/lmp/la/1946157230/report.aspx

Figure 1-1: Study area of the South West Hertfordshire SFRA



South West Hertfordshire Level 1 Strategic Flood Risk Assessment

Legend

- South West Hertfordshire
- Three Rivers District
- St Albans City and
- Dacorum Borough
- Watford Borough
- Neighbouring Authority Boundaries

1.5 Stakeholder engagement

The following parties (external to the Councils) have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Hertfordshire County Council (as Lead Local Flood Authority)
- Thames Water
- Canal and River Trust

1.6 SFRA User Guide

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
Level 1 Strategic Flood Risk Assessment	
3. **The sequential, risk-based approach**	Describes the Sequential approach and application of Sequential and Exception Tests. Describes the modelling and data used for the assessment. Outlines mapping that should be used for the Sequential and Exception Tests
4. **The impact of climate change**	Outlines climate change guidance published by the Environment Agency in February 2016.
5. How is flood risk assessed?	Provides an overview of flooding and risk, Flood Zones, and what they mean.
6. Understanding flood risk in South West Hertfordshire	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting the districts and boroughs.

Section	Contents
7. Flood defences and flood risk assets	Provides assessment of residual risk from flood defences, including current condition and standard of protection.
8. Cross-boundary considerations	Broad scale assessment of areas where the cumulative impact of development may be detrimental to flood risk.
9. Flood risk guidance for planners and developers	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the Lead Local Flood Authority (LLFA) that should be followed.
10. Water Framework Directive, Green Infrastructure and Natural Flood Management	The potential strategic flood risk and water quality solutions to be considered by the Councils and other flood management authority partners.
11. Guidance for planners and developers: Surface water runoff and drainage	Advice on managing surface water runoff and flooding.
12. Assessment of flood risk in potential development areas	Summary of flood risk to strategic sites and HELAA sites.
13. Local Plan Considerations	Outlines key considerations for Local Plan Policy.
Summary and recommendations	
14. Summary and conclusions	Reviews Level 1 SFRA and provides recommendations

2 The Planning Framework and Flood Risk Policy

2.1 Introduction

The overarching aim of development and flood risk planning policy in the UK is to ensure the potential risk of flooding from all sources is taken into account at every stage of the planning process.

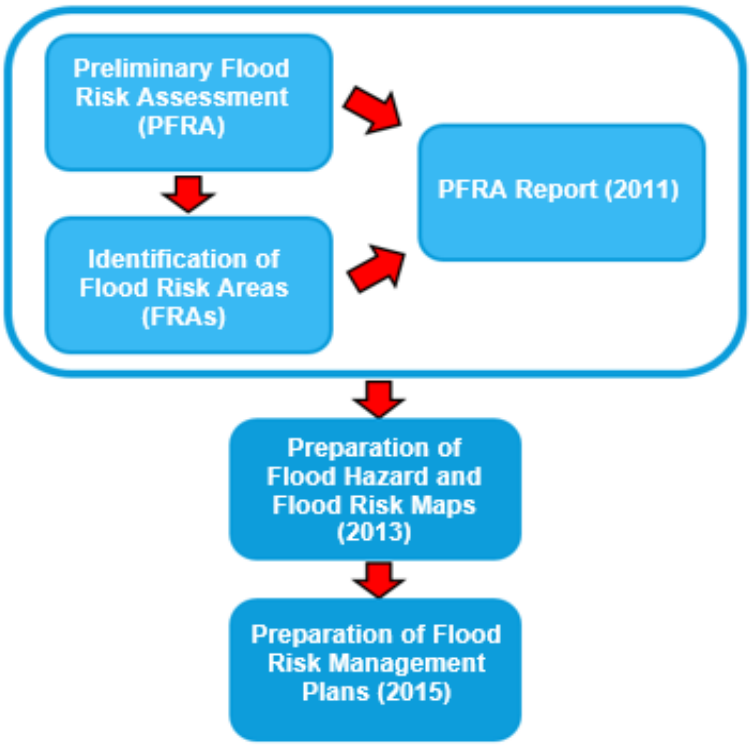
The following section provides an overview of the current planning framework, flood risk policy and flood risk management responsibilities, which inform the subsequent sections of this updated SFRA.

2.1.1 The Flood Risk Regulations

The Flood Risk Regulations (2009) translate the current EU Floods Directive into UK law and place responsibility upon Lead Local Flood Authorities (LLFAs) to manage local flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; and responsibility for local sources of flooding, from surface water, groundwater and ordinary watercourses, rests with LLFAs.

Figure 2-1 below illustrates the steps that have / are being taken to implement the requirements of the EU Directive in the UK via the Flood Risk Regulations.

Figure 2-1: Assessments implementing the Flood Risk Regulations



2.1.2 Hertfordshire Preliminary Flood Risk Assessment

In accordance with the Regulations, LLFAs are required to assess flood risk from local sources (surface water, groundwater and ordinary watercourses) over a six-

year cycle, beginning with the preparation of a Preliminary Flood Risk Assessment (PFRA) report.

PFRAs are a high-level screening exercise and consider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The Regulations require the LLFA to identify significant Flood Risk Areas through the process of the PFRA, using the Flood Risk Area threshold defined by Defra.

The Hertfordshire PFRA[5] was published in 2011, with an addendum report published in 2017[6], and provides information on significant historic and predicted local flood risk. No Nationally Significant Flood Risk Areas were identified, however the assessment estimated that 53,400 properties in Hertfordshire were potentially at risk of flooding from a 1 in 200-year flood event.

The number of properties identified as at risk within each district and borough of South West Hertfordshire were as follows:

- Dacorum: 8,700 properties
- St. Albans: 6,800 properties
- Three Rivers: 4,400 properties
- Watford: 4,300 properties

2.2 Flood Risk Management Plans

Flood Risk Management Plans (FRMPs) are required under the Flood Risk Regulations and highlight the hazards and risks of flooding from rivers, the sea, surface water, groundwater and reservoirs. FRMPs provide catchment scale flood risk planning, and set out how Risk Management Authorities (RMAs) work together with communities to manage flood risk.

The draft FRMPs were prepared by the Environment Agency in 2015, in partnership with LLFAs and other RMAs, and co-ordinated flood risk management planning with river basin management planning required under the Water Framework Directive. South West Hertfordshire is covered by the Thames River Basin District FRMP[7].

5 Hertfordshire County Council (2011) Preliminary Flood Risk Assessment. Available at: https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/flood-investigations/archive-consultations/hcc-preliminary-flood-risk-assessment.pdf

6 Hertfordshire County Council (2017) Preliminary Flood Risk Assessment Addendum. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698609/PFRA_Hertfordshire_County_Council_2017.pdf

7 Environment Agency (2015) Thames river basin district flood risk management plan. Available at: https://www.gov.uk/government/publications/thames-river-basin-district-flood-risk-management-plan.

2.3 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are high level policy documents covering large river basin catchments. They aim to set policies for sustainable flood risk management for the whole catchment covering the next 50 to 100 years.

South West Hertfordshire is covered by the Thames CFMP, and it is estimated that the following numbers of properties are at risk of fluvial flooding during a 1 in 100-year event:

- Dacorum: 500 – 1,000 properties
- St. Albans: 500 – 1,000 properties
- Three Rivers: 500 – 1,000 properties
- Watford: 100 – 250 properties

The Thames CFMP catchment is split into sub areas with similar flood risk management types, with one of six policies assigned to each sub area.

South West Hertfordshire covers two sub policy areas (Table 2-1), Sub Area 2, which covers the River Colne, including the settlements of Watford, Rickmansworth and London Colney; and Sub Area 4, covering tributaries of the River Colne, and the Upper Lee.

Objectives and potential actions within the two policy sub areas are provided in Table 2-1.

Table 2-1: Policy Sub Areas of the Thames CFMP covering South West Hertfordshire

CFMP	Sub Area	Coverage	Policy	Proposed actions
Thames	2 – Towns and villages in open floodplain (central)	River Colne	Policy 4 – Areas of low, moderate or high flood risk where flood risk is already being effectively managed, but where further actions may be needed to keep pace with climate change.	Maintain the Lower Colne defences and investigate opportunities for new defence schemes (London Colney, Watford).
				Review efficiency of maintenance regime in maintaining channel capacity.
				Promote safe and sustainable development which reduces flood risk. Ensure SFRAs and Local Development Framework policies manage longer term flood risk.
				Raise greater awareness of flood risk, further developing flood warning and emergency response.

CFMP	Sub Area	Coverage	Policy	Proposed actions
	4 – Chalk & downland catchments	Colne Tributaries Upper Lee	Policy 3 - Areas of low to moderate flood risk where existing flood risk is generally being managed effectively.	Maintain existing capacity of river systems in developed areas, working with partners to make existing systems more efficient.
				Work with Local Planning Authorities (LPAs) to retain the floodplain for uses compatible with flood risk management and instate policies which lead to adaptation of urban environments in flood risk areas.
				Increasing public awareness, including encouraging people to sign up for the free flood warning service.

2.3.1 Flood and Water Management Act

The Flood and Water Management Act (FWMA) (2010) aimed to create a simpler and more effective means of managing both flood risk and coastal erosion and implement Sir Michael Pitt's recommendations following his review of the 2007 floods. The FWMA received Royal Assent in April 2010.

The FWMA established LLFAs, which for the study area is Hertfordshire County Council. Duties for LLFAs set out in the FWMA 2010 include:

Local Flood Risk Management Strategy: LLFAs must develop, maintain, apply and monitor an LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most. The Hertfordshire County Council LFRMS was published in 2013, and updated in 2018.

Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations). Further details on the criteria for undertaking a formal flood investigation under Section 19, can be found on Hertfordshire Council Council's website. At the time of preparing this SFRA, there were four Section 19 Flood Investigation Reports covering the study area, which assessed communities in Long Marston, Harpenden, Redbourn and Chorleywood.

Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area. A Flood Asset Register

has been prepared for Hertfordshire, and identifies assets in Three Rivers and St. Albans (see Section 7.5).

Designation of Features: LLFAs may exercise powers to designate structures and features that effect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.

Consenting: When appropriate LLFAs will perform consenting of works on Ordinary Watercourses.

2.3.2 Hertfordshire Local Flood Risk Management Strategy

Under the Flood and Water Management Act (2010), Lead Local Flood Authorities are required to produce a Local Flood Risk Management Strategy (LFRMS). This document provides a framework for managing flood risk within the county, setting policies and outlining a plan of deliverable actions.

The Hertfordshire LFRMS was produced in 2013[8], and was updated in 2018[9]. The revised strategy reflects the evolution of the LLFA role since the commencement of the 2010 Flood and Water Management Act, as well as the growth in knowledge and experience of flood risk in Hertfordshire. Key changes include policies on development, including Sustainable Drainage Systems (SuDS) and culverting of ordinary watercourses, details of flood risk management scheme investment, proposals for partnership working, and criteria for investigating flooding incidents.

The policies and action plan of the LFRMS follow six principles:

1. *Taking a risk-based approach to local flood risk management.*
2. *Working in partnership to manage flood risk in the county.*
3. *Improving our understanding of flood risk to better inform decision making.*
4. *Supporting those at risk of flooding to manage that risk.*
5. *Working to reduce the likelihood of flooding where possible.*
6. *Ensuring that flood risk arising from new development is managed appropriately.*

2.3.3 Reservoirs

The FWMA also updates the Reservoirs Act 1975, applicable to reservoirs of 25,000m^3 or greater. Phase 1 has been implemented in 2013 requiring large raised reservoirs to be registered to allow the Environment Agency to categorise whether they are 'high risk' or 'not high risk'. However, the level and standard of inspection and maintenance required under the Acts means that the risk of

8 Hertfordshire County Council (2013) Local Flood Risk Management Strategy for Hertfordshire 2013 – 2016. Available at: https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/managing-flood-risks.aspx

9 Hertfordshire County Council (2018) Local Flood Risk Management Strategy: A Strategy for the Management of Local Sources of Flood Risk – Consultation Version. Available at: https://www.hertfordshire.gov.uk/about-the-council/consultations/environment/local-flood-risk-management-strategy-2018.aspx

flooding from reservoirs is relatively low. The risk of inundation to South West Hertfordshire as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Reservoir Inundation Mapping (NRIM) study.

2.3.4 Ministerial Statement from Secretary of State for DCLG

On 18 December 2014, a Written Ministerial Statement laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply to major development from 6 April 2015. In considering planning applications, planning authorities should consult the LLFA on the management of surface water, and ensure, through use of planning conditions or obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

In March 2015, the LLFA was made a statutory consultee to the planning system, which came into effect on 15 April 2015. As a result, Hertfordshire County Council are required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as:

- Residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known.
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square meters or larger or, where the floor area is not yet known, a site area of 1 hectare or larger.

2.4 Planning Policy and Evidence Documents

2.4.1 National Planning Policy Framework

The revised National Planning Policy Framework (NPPF)[10] was issued on 24 July 2018, and replaced the 2012 NPPF, as well as the previously issued Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs).

The NPPF is supported by the Planning Practice Guidance (PPG). The NPPF is a source of guidance for LPAs to assist in preparation of Local Plans, as well as for applicants preparing planning submissions.

Paragraphs 155 - 156 of the NPPF state that: *"Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood*

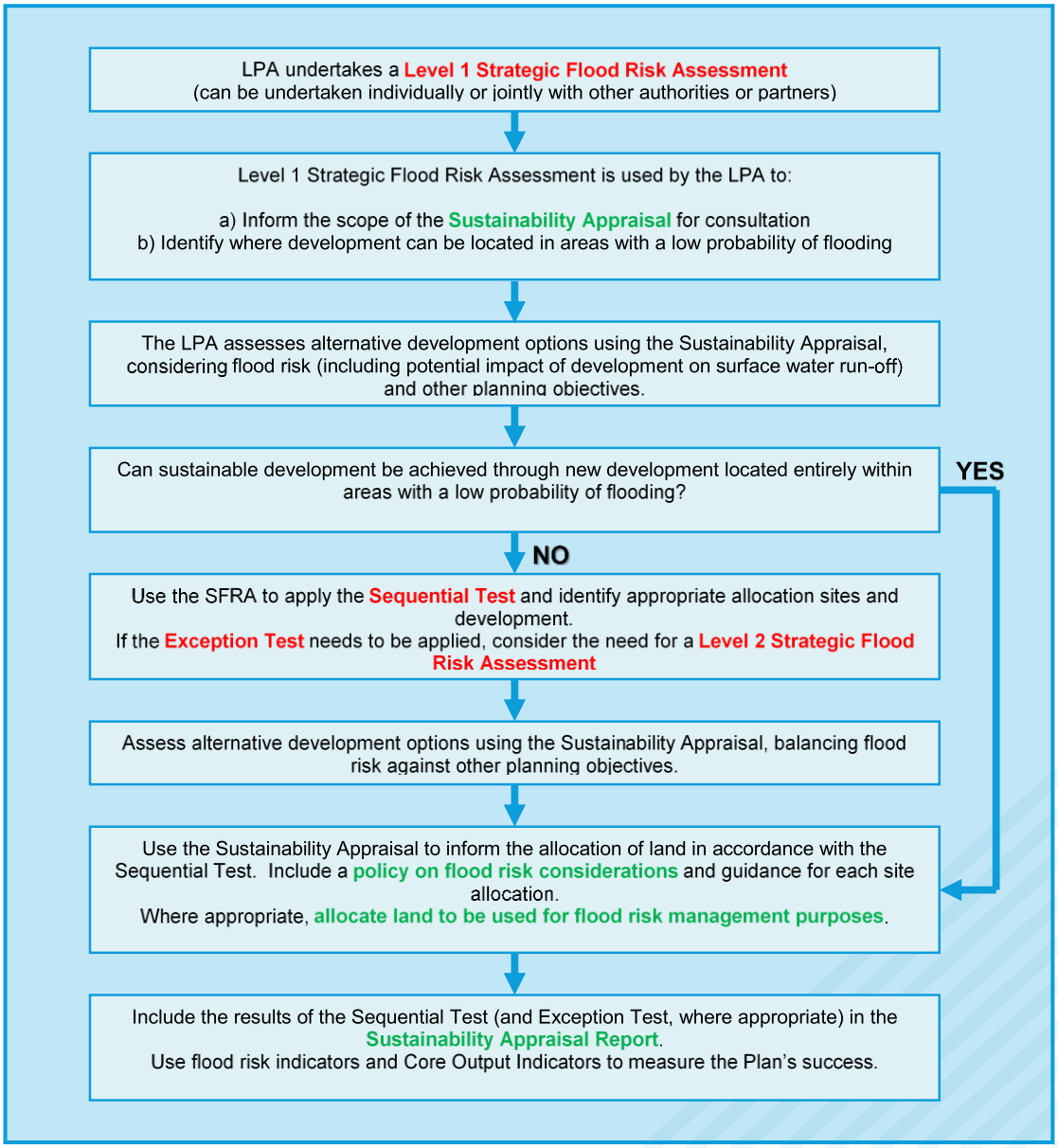
10 Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework. Accessed online at: https://www.gov.uk/government/publications/national-planning-policy-framework--2.

authorities and internal drainage boards. All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. ".

The web-based Planning Practice Guidance on Flood Risk and Coastal Change[11] (henceforth referred to as 'the Planning Practice Guidance') was published alongside the NPPF and was most recently updated in November 2016. The guidance sets out how the policy should be implemented. A flow chart of how flood risk should be taken into account in the preparation of Local Plans is shown in Figure 2-2 below.

11 Planning Practice Guidance: Flood Risk and Coastal Change, Department for Communities and Local Government (2015), Accessed online at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change.

Figure 2-2: The process of flood risk consideration in the preparation of a Local Plan



Based on Diagram 1 of the Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-021-20140306).

2.4.2 Key changes to the NPPF (2018)

The NPPF was revised to implement the 2017 planning and housing market reforms introduced within the Housing White Paper[12]. Central to the reforms is the concept of 'planning for the right homes in the right places'. The key amendments with regards to development and flood risk, are as follows:

[12] Department for Communities and Local Government (2017) *Fixing our broken housing market*. Available at: https://www.gov.uk/government/publications/fixing-our-broken-housing-market.

Clarification of the Exception Test (Para. 159-161)

- Land should not be allocated for development within Local Plans where the requirements of the Exception Test are not capable of being met.
- The Exception Test still needs to be met for planning applications (other than minor development and changes of use) on allocated sites which have undergone the Sequential Test.
- For the Exception Test to be passed, both of the following elements should be satisfied:
  a) 'the development would provide wider sustainability benefits to the community that outweigh the flood risk; and
  b) 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"

Minor Development and Changes of Use (Para. 164)

- Minor development and change of use must still follow Paragraph 163 of the NPPF, excluding the Sequential and Exception Tests, relating to the provision of a site-specific flood risk assessment, and ensuring that flood risk is not increased elsewhere.

Cumulative impacts on flood risk (Para. 156)

- Local Plans must be supported by a SFRA, and provide policies for managing all sources of flood risk.
- Planning policy on flood risk should address the cumulative flood risks associated with separate new developments which are located within, or affect, areas susceptible to flooding.

Impacts of Climate Change (Para. 157)

- The impacts of climate change in increasing flood risk should be taken into account, and where it may cause development to become unsustainable in the long-term, opportunities should be taken to '*relocate development, including housing, to more sustainable locations*'.

2.4.3 Localism Act

The Localism Act (2011) provides local communities with greater control in local decision-making, such as deciding the location of new homes and businesses, through the preparation of neighbourhood development plans. It requires local authorities to "engage constructively, actively and on an ongoing basis in any process by means of which development plan documents are prepared so far as relating to a strategic matter"[13].

13 Localism Act 2011: Section 110, Department for Communities and Local Government (2011), Accessed online at: http://www.legislation.gov.uk/ukpga/2011/20/section/110.

Neighbourhood Plans are the vehicle through which local communities are able to contribute to making decisions about the location and type of development, and the supporting infrastructure required to enable sustainable development within their areas. A Neighbourhood Plan is written by local people, and "made" or adopted by the LPA, becoming part of the development plan for that LPA. Neighbourhood Plans should take national guidance into account, and should be in general conformity with the LPA's planning policy.

2.5 Local Plans

All four Councils in South West Hertfordshire, Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council, are currently preparing new Local Plans. The Plans will shape the growth of housing, employment, infrastructure and service provision over the coming years.

The following sections identify the key existing Local Plan Policies within each of the four Local Planning Authorities in South West Hertfordshire, and draft New Local Plan policies, where available, which relate to development and flood risk.

An overview of the current Strategic Housing Land Availability Assessment (SHLAA) for each Local Planning Authority (where available) is also provided, to identify the key areas of growth across South West Hertfordshire. The SHLAA provides a review of the land within a District or Borough which is available for housing development, however it does not determine whether a site should be allocated for development.

2.5.1 Dacorum Borough Council

The Local Plan 1991 – 2011 is currently in place in Dacorum. A new Local Plan is currently being prepared to cover the period up to 2036, and will address the key considerations within the Borough, including household projections, the role and function of the Green Belt, and establishing inter-Local Planning Authority partnerships for delivering housing requirements in Dacorum.

The Core Strategy for Dacorum was adopted in September 2013, and is being reviewed following completion of the Site Allocations Development Planning Document (DPD). Existing *Policy CS31: Water Management* centres on the sequential allocation of development, outside Flood Zones 2 and 3 where possible. It seeks to limit surface water runoff, while securing opportunities to manage surface water flooding, and conserve water quality in Groundwater Source Protection Zones. A further aim is to maintain the flow of water into river systems and the Grand Union Canal. Further details of implementing sustainable surface water drainage in Dacorum is outline in the 2015 Policy Statement[14]. Particular

14 Dacorum Borough Council (2015) Policy Statement: Sustainable Drainage. Available at: http://www.dacorum.gov.uk/docs/default-source/strategic-planning/ot2-sustainable-drainage-advice-note-feb-201567554a4551156b7f9bc7ff00000246a4.pdf?sfvrsn=0.

attention is paid to the maintenance arrangements for sustainable drainage systems (SuDS), with the Council not adopting SuDS either directly, or through the use of commuted sums.

In addition, a wastewater advice note has been produced in consultation with Thames Water, to identify sites within the Site Allocations DPD requiring preparation of a Wastewater Drainage Strategy as part of a planning application submission[15].

The 2016 SHLAA for Dacorum[16] provided an assessment of land supply in the Borough between 1 April 2015 and 2036. A total of 990 sites were assessed within the SHLAA, of which 103 were found to be deliverable or developable for housing. Taking into account sites with planning permission and windfall sites, which have historically formed part of the housing supply in Dacorum, the total housing capacity over the 15-year period is estimated to be 15,521 dwellings.

The following settlements were identified as the areas for future growth within the Site Allocations Development Plan Document (DPD), which was adopted in July 2017:

- Kings Langley
- Tring
- Berkhamsted
- Markyate
- Hemel Hempstead
- Bovingdon

These six settlements are the three main towns and three larger villages within Dacorum.

The Grovehill Neighbourhood Plan is 'made' (adopted) and forms part of the Dacorum Local Plan (this is currently the only neighbourhood plan being progressed within Dacorum).

The Council is currently in the early stages of preparing a New Local Plan, which seeks to update existing policies to support sustainable growth in the District up to 2036. This document is proposed to replace the 2004 Local Plan, the Core Strategy and Site Allocations DPD.

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[15] Dacorum Borough Council (2015) Advice Note: Planning Requirements for Waste Water Infrastructure Issues in Dacorum. Available at: www.dacorum.gov.uk/docs/default-source/strategic-planning/ot4-planning-requirements-for-waste-water-infrs-issues-feb2015.pdf?sfvrsn=0.

[16] Dacorum Borough Council (2016) Strategic Housing Land Availability Assessment (SHLAA) 2016. Volume 2: Site Schedules. Available at: http://www.dacorum.gov.uk/home/planning-development/planning-strategic-planning/new-single-local-plan/technical-work-for-the-early-partial-review

The sites within SHLAA, received as part of the 'Call for Sites' processes, the Borough's brownfield register, the adopted and emerging Local Plan allocations (or sites which our emerging evidence has identified) have been assessed as part of the South West Hertfordshire Level 1 SFRA.

2.5.2 St. Albans City and District Council

St. Albans is currently covered by The District Local Plan Review 1994. The Local Plan is in the process of being revised and replaced with the St. Albans City and District Local Plan 2020 – 2036, to provide an overview of development in the City and District up to 2036.

The new Local Plan identifies the current issues facing St. Albans, including population growth, adequate provision of affordable and social housing and protecting the Green Belt from urban sprawl.

Policy L29: Green and Blue Infrastructure, Countryside, Landscape and Trees of the Emerging New Local Plan[17] sets out the Council's commitment to avoid development in areas flood risk, and encourage the use of SuDS, flood storage areas and river restoration (including the removal of culverts) in the management of flood risk and enhancing biodiversity in new developments.

A series of Neighbourhood Plans are currently being developed in Colney Heath, Redbourn, Sandridge, St. Stephen, Wheathampstead and Harpenden. Once approved and adopted, these plans will form part of the Development Plan.

The SHLAA Update 2016[18] was undertaken to form a comprehensive evidence base of site availability to support the new Local Plan. It provides an update to the original 2009 SHLAA Assessment[19], to include sites subsequently submitted both informally and via the April 2016 'Call for Sites' consultation.

The following settlement areas have been identified for growth within the SHLAA Assessment:

- Bricket Wood and Surrounds
- Chiswell Green, Colney Street, How Wood, Park Street and Surrounds
- Colney Heath, Sleaphyde, Smallford and Surrounds
- Harpenden and Surrounds
- London Colney, Harperbury Hospital and Surrounds
- Redbourn and Surrounds

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17 St. Albans City ad District Local Plan 2020 – 36: Initial Officer Working Draft (September 2018). Available at http://stalbans.moderngov.co.uk/documents/s50035163/PPC%20May%202018%20-%20Draft%20Local%20Plan%20-%20Appendix%201%20-%20Draft%20Local%20Plan.pdf:

18 St. Albans City and District Council (2016) Strategic Housing Land Availability Assessment Update. Available at: https://www.stalbans.gov.uk/Images/SP_SLP_SHLAA001SHLAAUpdate2016OctoberIntroduction_tcm15-56141.pdf

19 St. Albans City and District Council (2009) Strategic Housing Land Availability Assessment. Available at: https://www.stalbans.gov.uk/Images/SP_SHLAA_2009_tcm15-12325.pdf

- Sandridge and Surrounds
- St Albans and Surrounds
- West of District
- Wheathampstead and Surrounds

All sites submitted as part of the 2009 SHLAA, interim 2009 – 2016 period, and SHLAA Update 2016, have been assessed as part of the South Hertfordshire Level 1 SFRA.

2.5.3 Three Rivers District Council

The Three Rivers Local Plan 2011 – 2026 consists of three documents: the Core Strategy (2011), Development Management Policies Local Development Document (2013) and Site Allocations Local Development Document (2014).

The 2011 Core Strategy[20] sets out the Strategic Objective (S3) of the Council to allocate and approve development in areas of lower flood risk, and to consider the impacts of climate change on decision-making: '*reduce impacts on the environment by…promoting the…conservation of water resources and …designing development to take into account future changes to the climate'*.

The Council is currently in the early stages of preparing a New Local Plan, which seeks to update existing policies to support sustainable growth in the District up to 2032.

The Council undertook a public consultation on the Local Plan issues and options, as well as a Call for Sites Public Consultation between July and September 2017. The sites submitted as part of this consultation have been assessed as part of the South West Hertfordshire SFRA.

An update of the Three Rivers 2008 SHLAA[21] was undertaken in 2010[22]. A total of 532 potential sites were assessed within the District, of which 109 sites were considered to be suitable for further assessment. These sites had the capacity to deliver 3,661 new dwellings, with 1,236 in urban areas and 2,425 on greenfield land.

The Core Strategy sets the intention to focus future major development around the Principal Town of Rickmansworth and the Key Centres of South Oxhey, Croxley Green, Abbots Langley, Chorleywood, Leavesden and Garston and Mill End.

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20 Three Rivers District Council (2011) Local Plan Core Strategy. Available at: http://www.threerivers.gov.uk/egcl-page/core-strategy.

21 Three Rivers District Council (2008) Strategic Housing Land Availability Assessment. Available at: https://www.threerivers.gov.uk/egcl-page/evidence-base

22 Three Rivers District Council (2010) Three Rivers Strategic Housing Land Availability Assessment Update. Available at: https://www.threerivers.gov.uk/egcl-page/evidence-base

A series of Neighbourhood Plans are currently being developed in Croxley Green, Chorleywood and Abbots Langley. Once approved and adopted, these plans will form part of the Development Plan.

2.5.4 Watford Borough Council

Local Plan

The existing Local Plan 2006 – 2031[23] for Watford was adopted in January 2013. Policy SD2: *Water and Wastewater* aims to manage surface water runoff and all forms of flooding sources, including non-fluvial sources, as well as water quality and consumption.

The Residential Design Guide SPD provides advice on water consumption, drainage and managing water through the use of Sustainable Drainage Systems (SuDS).

A Local Plan Part 2[24] was partially developed, detailing potential development sites and more detailed Development Management policies, which was made available for public consultation in Autumn 2016.

Policy SD8*: Managing Flood Risk and the Water Environment* of the Local Plan Part 2 follows the requirements of the NPPF in its requirements for flood risk assessments, following the Sequential and Exception Tests, and incorporate the Hertfordshire County Council guidance for Sustainable Drainage Systems in Hertfordshire.

However, a decision was made by Watford BC in October 2017 to not progress Part 2, and instead focus on the preparation of a new Local Plan. The existing Core Strategy will be replaced by the new Local Plan, which will cover the period of 2016 to 2036.

Future growth within Watford is focused in the following six Special Policy Areas (SPAs):

- SPA1: Town Centre
- SPA2: Watford Junction
- SPA3: Riverwell (formerly referred to as the Health Campus)
- SPA4: Lower High Street
- SPA5: Dome Roundabout
- SPA6: Western Gateway

These strategic sites, and the Borough's brownfield register, have been assessed as part of the South West Hertfordshire Level 1 SFRA.

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23 Watford Borough Council (2013) Watford's Local Plan Part 1 – Core Strategy 2006 - 2031. Available at: https://www.watford.gov.uk/downloads/file/114/watford_local_plan_core_strategy_2006-31_adopted_30_january_2013

24 Watford Borough Council (2016) Local Plan Part 2: Site Allocations and Development Management Policies. Available at: https://www.watford.gov.uk/info/20012/planning_and_building_control/135/planning_policy/1.

However, a significant amount of windfall development is also expected to arise on brownfield sites within Watford, due to the high housing demand.

At the time of producing this SFRA, there were no neighbourhood plans proposed within Watford Borough.

2.6 Water Cycle Studies

Future changes in climate and increases in new development can be expected to exert greater pressure on the existing waste water supply and infrastructure within a settlement. A large number of new homes, for instance, may cause the existing water supply infrastructure to become overwhelmed, which would result in adverse effects on the environment both locally and in wider catchments. Planning for water management therefore needs to take these potential challenges into account.

Water Cycle Studies (WCS) assist local authorities in selecting and developing sustainable development allocations, so that there is minimal impact on the environment, water quality, water resources, infrastructure and flood risk. In areas where there may be conflict between any proposed development and environmental requirements, this can be achieved through the recommendation of potential sustainable solutions.

A Water Cycle Study Scoping Report for South West Hertfordshire[25] was undertaken in 2010 to support the existing Local Plans, and recommended that water consumption is reduced to 105 litres per person per day (l/p/d) across the study area. The WCS also highlighted the restrictions in the capacity of Maple Lodge and Blackbirds Wastewater Treatment Works in accommodating the proposed levels of growth in Dacorum, St. Albans, Three Rivers and Watford. Upgrading of the sewerage infrastructure across South West Hertfordshire was also identified as a requirement.

In addition, the Hertfordshire Water Study is currently being undertaken, to provide a county-wide assessment of water supply, wastewater treatment and infrastructure needs up to 2050. The study will assess the immediate, medium and long-term impacts of water planning in Hertfordshire, with a view to water resource use beyond the boundaries and lifetimes of the current emerging local plans. Once finished, this will replace the Water Cycle Study Scoping Report for South West Hertfordshire.

2.7 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline surface water issues in a given location, and the preferred options for managing the flood risk. SWMPs are undertaken, when required, by LLFAs in consultation with key local partners who

25 Hyder Consulting (2010) Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council, Welwyn Hatfield Borough Council Water Cycle Study: Scoping Study.

are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water, and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

SWMPs covering Dacorum, St. Albans and Watford have been produced, and a SWMP is currently being developed for the Three Rivers District.

A phase I district-wide review of surface water flood history and modelled flood risk identified six "hot-spot" areas in Three Rivers, which will be investigated further at phase II. The final outputs are expected in Autumn 2018.

2.8 Association of British Insurers Guidance

The Association of British Insurers (ABI) and the National Flood Forum have published guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England to assist local authorities in England in producing Local Plans and reviewing planning applications in flood risk areas. The guidance complements the National Planning Policy Framework, and provides the following key recommendations:

- Ensure strong relationships with technical experts on flood risk.
- Consider flooding from all sources, taking account of climate change.
- Take potential impacts on drainage infrastructure seriously.
- Ensure that flood risk is mitigated to acceptable levels for proposed developments.
- Make sure Local Plans take account of all relevant costs, and are regularly reviewed.

The government and insurance companies have been working together to develop a new flood re-insurance scheme known as FloodRe. It was launched in April 2016, and is designed to:

- Enable flood cover to be affordable for those households at highest risk of flooding.
- Increase availability and choice of insurers for customers.
- Allow time for government, local authorities, insurers and communities to become better prepared for flooding.
- Create a 'level playing field' for new entrants and existing insurers in the UK home insurance market.

Further details are available on the FloodRe website at www.floodre.co.uk.

2.9 The Water Framework Directive

The EU Water Framework Directive (WFD) seeks to integrate and enhance the way in which water bodies are managed throughout Europe by the preservation,

restoration and improvement of the water environment. On 23 October 2000 the European Commission established the WFD requiring each Member State of the European Union to satisfy the environmental objectives set by the Directive and implement the legislation. This was transposed into law in England and Wales in 2003. In England, the Environment Agency has overall responsible for the delivery of the WFD objectives, but local authorities must consider WFD and other environmental legislation when exercising their land drainage consenting powers on Ordinary Watercourses[26].

The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Ecological Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date. Further information on the ecological status of waterbodies in the study area is available on the Environment Agency's Catchment Data Explorer.

It is important that developments aim to take positive measures to conform to the WFD, which can be impacted as a result of development, for example in terms of 'deterioration' in ecological status or potential.

2.10 Roles and responsibilities in South West Hertfordshire

Flood risk management responsibilities under the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009 are summarised in Table 2-2.

26 Environment Agency (2012) Advice Note: Ordinary Watercourse Regulation – Consenting. Accessed online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297398/geho0112bvyf-e-e.pdf on 26/03/2018.

Table 2-2: Roles and responsibilities in South West Hertfordshire.

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	• National Statutory Strategy • Reporting and supervision (overview role)	• Main Rivers, reservoirs • Designating authority for assets linked to the Main River network • Identify Significant Flood Risk Area • Flood Risk and Hazard Maps • Flood Risk Management Plan • Warn and inform during flood events • Enforcement authority for Reservoirs Act 1975
Lead Local Flood Authority (Hertfordshire County Council)	• Input to national strategy • Formulate and implement local flood risk management strategy	• Ordinary Watercourses • Enforce and consent works (as Land Drainage Authority) • Surface water, groundwater, other sources of flooding • Prepare and publish a PFRA • Identify Flood Risk Areas, where areas of nationally significant flood risk exist • Produce flood hazard mapping and Flood Risk Management Plans in Flood Risk Areas • Maintain a register of 'significant' flood risk assets • Designating authority for essential flood infrastructure • Statutory consultee for surface water drainage proposals on large scale developments
Lower Tier Authorities (Dacorum Borough Council, St. Albans City and District Council, Three Rivers District	• Input to National and Local Authority Plans and Strategy	• Maintenance of Ordinary Watercourses (where riparian owners) • General drainage powers (under the Land Drainage Act) to manage flood risk from Ordinary Watercourses • Designating authority for essential

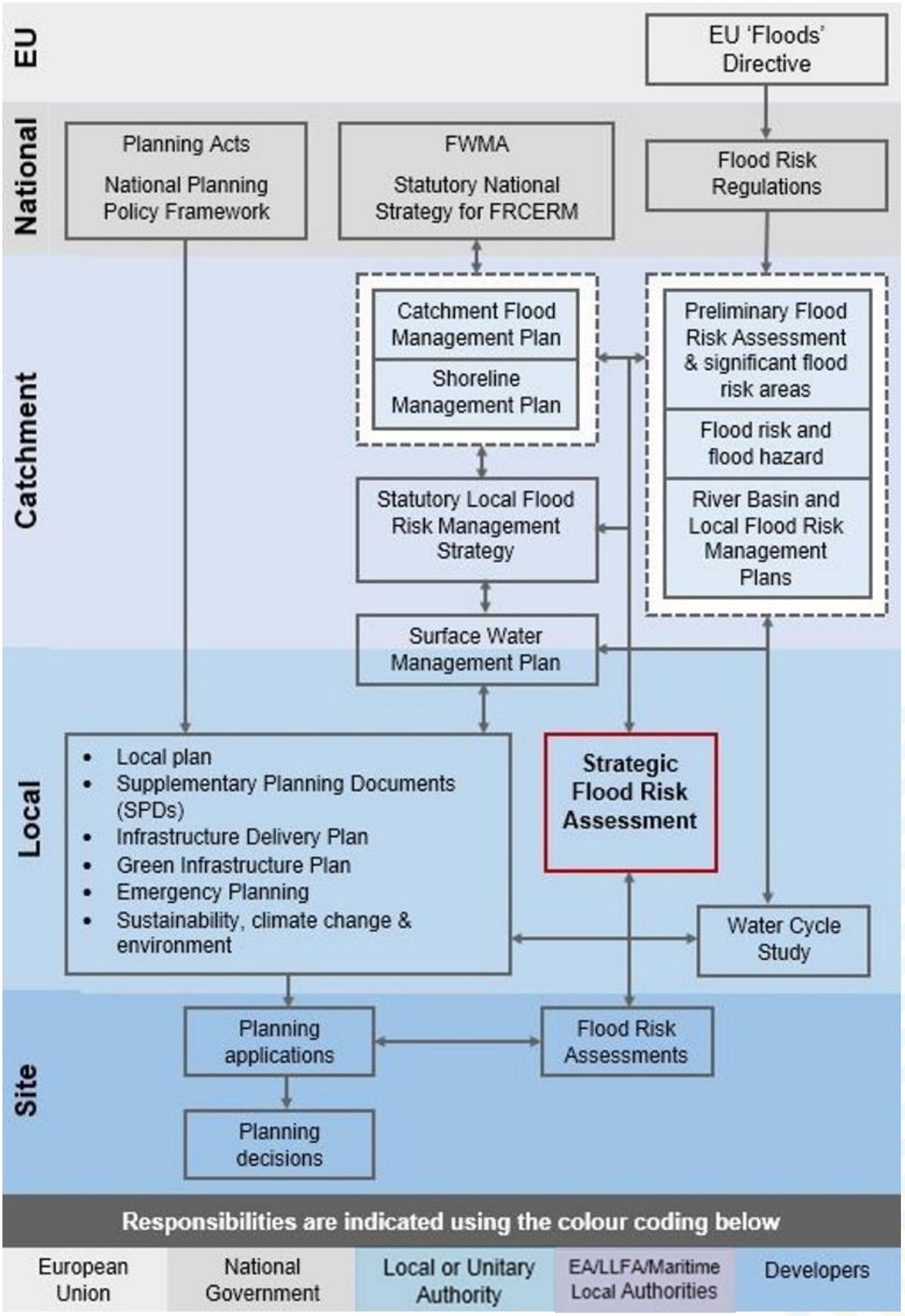
Council, Watford Borough Council)		flood infrastructure, where linked to Ordinary Watercourses • Duty to act consistently with, and have due regard for, local and national Flood Risk Management strategy when conducting their functions (e.g. planning)

Figure 2-3 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and the Flood and Water Management Act, in conjunction with the Localism Act "duty to cooperate", introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of Catchment Flood Management Plans (CFMPs), Surface Water Management Plans (SWMPs) and Water Cycle Studies (WCSs).

Figure 2-3: Strategic planning links and key documents for flood risk.

† See Table 2-2 for roles and responsibilities for the preparation of information



3 The sequential risk-based approach to development

3.1 Flood Zones

The NPPF sets out a Sequential Test to steer new development to areas with the lowest probability of flooding. This is initially based on the Flood Map for Planning (Rivers and Sea), as provided by the Environment Agency, but should be refined by the SFRA to take into account the probability of flooding, other sources of flooding and the impact of climate change.

The Flood Map for Planning (Rivers and Sea) is made up of a suite of map layers, including Flood Zone 2 and 3a, Defences, Areas Benefiting from Defences, and Flood Storage Areas.

The Flood Zones describe the land that would flood from rivers if there were no defences present. They are based on broad scale modelling that has been refined with detailed hydraulic models in areas of higher risk. Areas Benefiting from Defences can be identified using the accompanying layers.

Where outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on National Generalised Modelling, which provides a simplified representation of river processes and channel structures. Whilst the generalised modelling is mostly accurate on a large, catchment scale, it is not intended for specific sites or provided at locations where the catchment area of the watercourse falls below 3km².

As a result, the resolution of the Flood Map for Planning varies, and it is not suitable for a site-specific application evidence for sites with watercourses on, or adjacent to the site. Accordingly, it may be necessary to undertake more detailed analysis or hydraulic modelling at the planning application stage. The suitability of the existing Flood Zones will need to be determined in consultation with the Environment Agency and Lead Local Authority on a case-by-case basis.

The most up to date version of the Flood Map for Planning (Rivers and Sea) should always be used, and can be viewed on the Environment Agency's website[27].

For planning purposes under the NPPF, a more detailed breakdown of risk within the Flood Zones is required and the SFRA is required to define Flood Zone 3b (also known as a Functional Floodplain) and Flood Zone 3a with climate change, using more detailed data from hydraulic models where available. This information is included in the detailed mapping which accompanies this report and encompasses all the local authority's currently identified sites.

A concept diagram showing the classification of NPPF Flood Zones is included in Figure 3-1.

27 Flood Map for Planning (Rivers and Sea), Environment Agency (2017), Accessed online at: https://flood-map-for-planning.service.gov.uk/

Table 3-1 includes a description of the Flood Zones and discussion of appropriate development within each zone. A fuller discussion of Flood Zones and their relation to planning policy can be found in the NPPF and the Planning Policy Guidance.

Figure 3-1: Definition of the Flood Zones

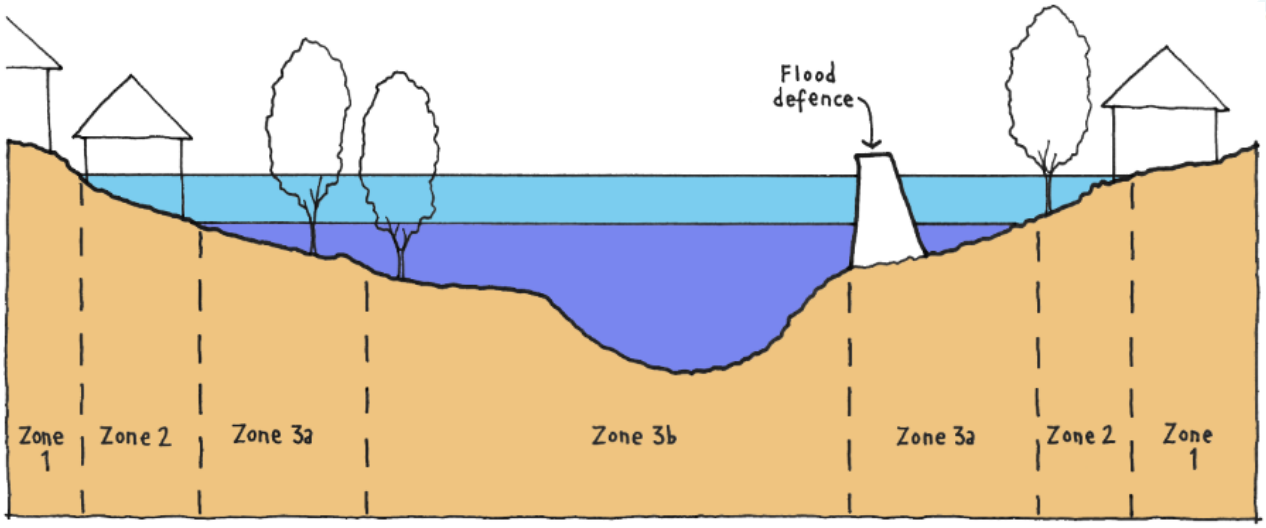


Table 3-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites greater than 1Ha, or with critical drainage problems (as identified by the EA), a Flood Risk Assessment (FRA) considering the vulnerability of the site to flooding from other sources (surface water, groundwater, ordinary watercourses and sewers) must be provided. The FRA should be prepared in line with Hertfordshire County Council guidance on flood risk and drainage, and must consider the potential to increase flood risk elsewhere, and the effect of new development on surface water runoff.
		Sites smaller than 1Ha are still required to carry out an appropriate level of assessment, relative to the scale of development and flood risk to the site.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as

Zone	Probability	Description
		appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year. Developers and the local authorities should seek to reduce the overall level flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere.
		All developments in this zone require an FRA.

3.2 The sequential, risk-based approach

The sequential, risk-based approach outlined in the NPPF and the Planning Practice Guidance is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3), and that within Flood Zone 1, development is situated away from areas at risk from all other sources of flooding, including Ordinary Watercourses, surface water, reservoirs, groundwater and sewer flooding.

The flood risk management hierarchy underpins the risk-based approach and is the basis for making all decisions involving development and flood risk. When using the hierarchy, account should be taken of:

- The nature of the flood risk (the source of the flooding).
- The spatial distribution of the flood risk (the pathways and areas affected by flooding).
- Climate change impacts.

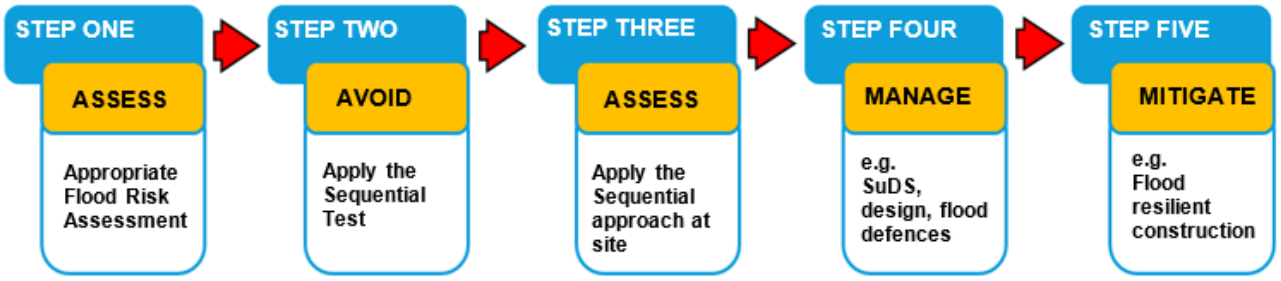
- The degree of vulnerability of different types of development (the receptors).

Developments should reflect the application of the Sequential Test using the maps produced for this SFRA. The information in this SFRA should be used as evidence and, where necessary, reference should also be made to relevant evidence in other documents referenced in this report. The Flood Zone maps and flood risk information on other sources of flooding contained in this SFRA should be used where appropriate to apply the Sequential Test.

Where other sustainability criteria outweigh flood risk issues, the decision-making process should be transparent. Information from this SFRA should be used to justify decisions to allocate land in areas at high risk of flooding.

The flood risk management hierarchy is summarised in Figure 3-2.

Figure 3-2: Flood Risk Management hierarchy



3.3 Applying the Sequential Test and Exception Test in preparation of a Local Plan

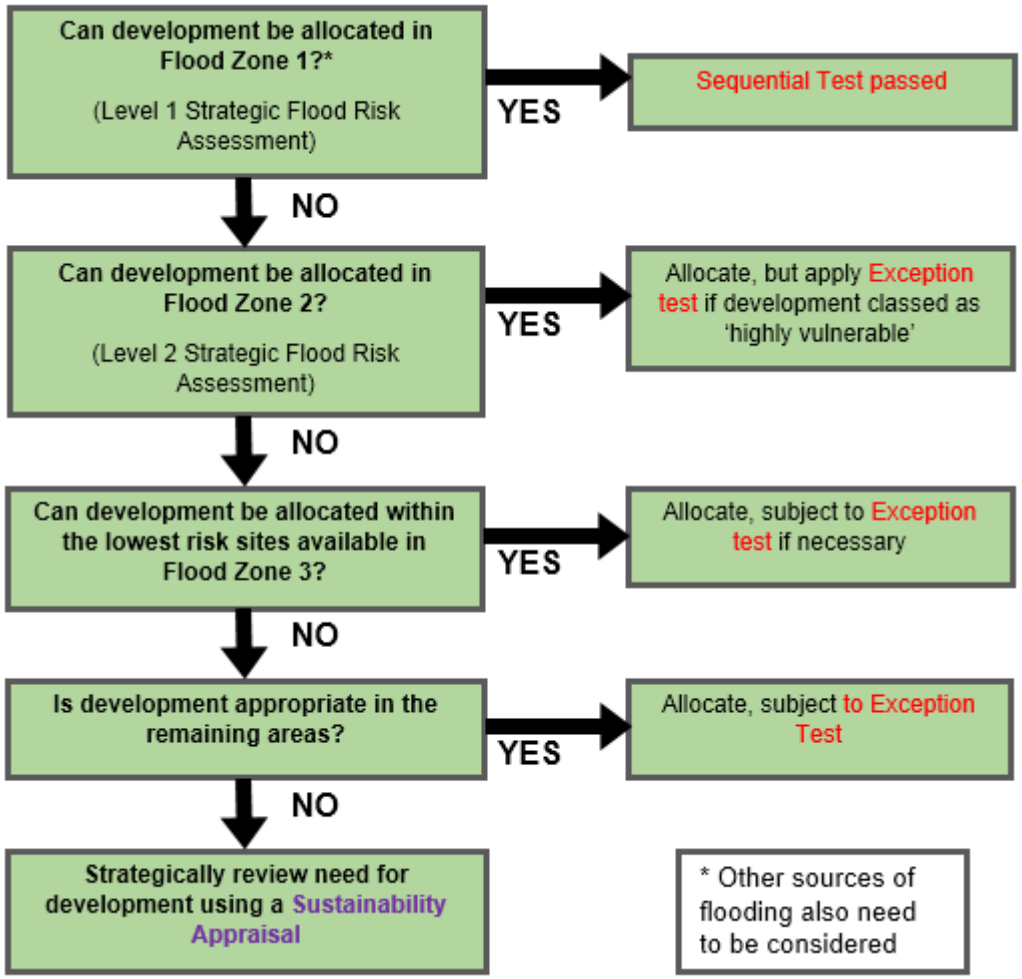
When preparing a Local Plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using Strategic Flood Risk Assessments to apply the Sequential and Exception Tests where necessary.

3.3.1 Sequential Test

The Sequential Test should be applied to the whole LPA area to increase the opportunities to allocate development in areas not at risk of flooding. The Planning Practice Guidance 'Applying the Sequential Test in the preparation of a Local Plan' describes the process.

Dacorum Borough Council, Three Rivers District Council, St. Albans City and District Council and Watford Borough Council will carry out the Sequential Test, as appropriate, for all sites that have come forward through the Local Plan process, taking into account all sources of flooding, and an appropriate allowance for climate change. The climate change allowances have been considered in the modelling of this study.

Figure 3-3: Applying the Sequential Test in preparation of a Local Plan



The first stage of the Sequential Test will identify all potential sites located within Flood Zone 1, and at low risk of flooding from all other sources, in order for them to be taken forward for consideration for inclusion in the Local Plan.

For a site to be considered at low risk of flooding in South West Hertfordshire, it must meet the following conditions:

- Site is within Flood Zone 1.
- Site is not within Flood Zone 3a plus climate change.
- Site is <10% at risk from surface water flooding in the 1 in 1,000-year event.
- Site is <10% within highest risk category in JBA Groundwater map (groundwater is <0.025m below the surface in the 1 in 100-year event).
- Site is not within the Historic Flood Map.
- Site is not at risk of reservoir flooding.
- Site is not at risk of breach from canal flooding.
- Site does not contain an Ordinary Watercourse.

The above criteria take into account the potential to mitigate low levels of surface water and groundwater risk through appropriate design, and therefore are not likely to represent a significant constraint to development.

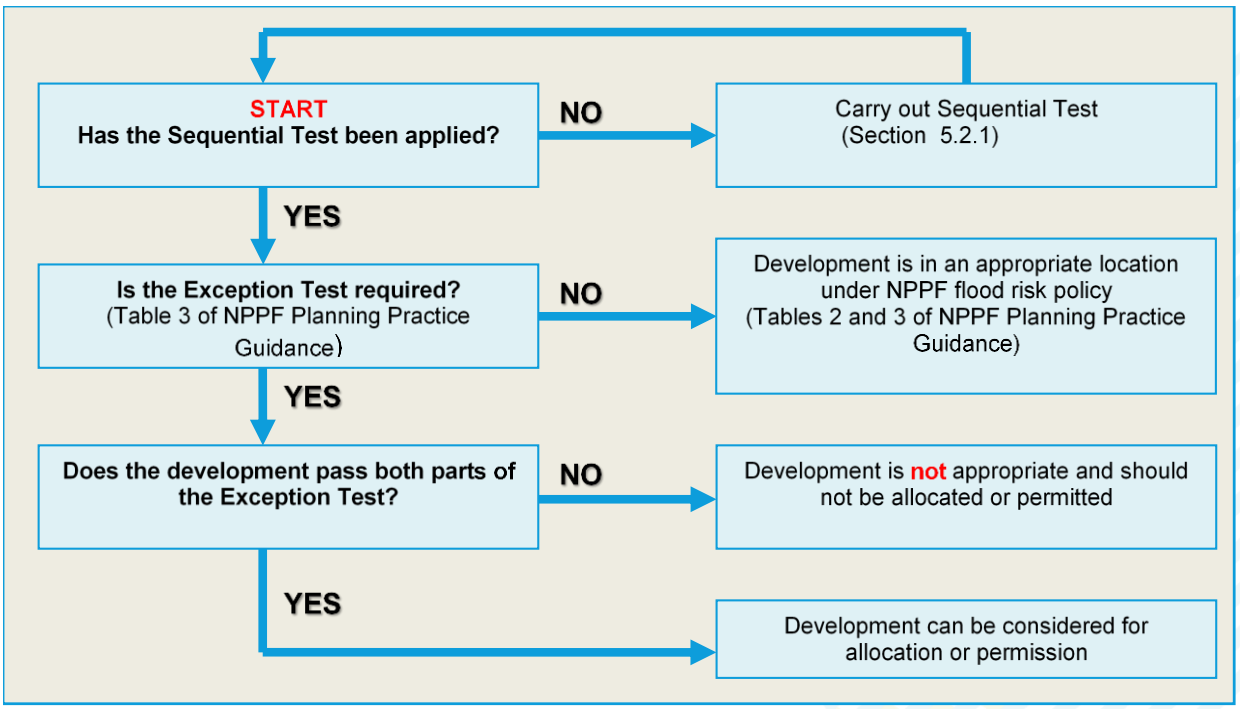
It is possible that all the necessary development required over the plan period cannot be accommodated by sites identified above as low risk from all sources (noting that the SA process may discount some low risk sites on SA grounds), and additional sites may be required to enable delivery of the level of development set out in the Local Plan.

3.3.2 Exception Test

If, following an application of the Sequential Test, it is not possible for the development to be located in areas with a lower probability of flooding, the Exception Test must then be applied if required.

The guidance also explains how the Exception Test should be applied in the preparation of a Local Plan (Figure 3-4), as shown in Diagram 3 of the Planning Practice Guidance.

Figure 3-4: Applying the Exception Test in the preparation of a Local Plan



The requirements for the Exception Test depend on the proposed type/vulnerability of the development and the Flood Zone, as set out in Table 3 of the Planning Practice Guidance[28].

28 Ministry of Housing, Communities and Local Government (2014) Diagram 3 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 028, Reference ID: 7-021-20140306) March 2014. Available at:

NPPF vulnerability classifications for different type of development are given in Table 2 of the Planning Practice Guidance and summarised in Table 4-2The majority of the allocations in South West Hertfordshire are residential ('More Vulnerable', but 'Highly Vulnerable' for basement dwellings), with some employment ('Less Vulnerable'). Some developments may contain different elements of vulnerability and therefore in these instances the highest vulnerability category should be used, unless the development is considered in its component parts. Definitions of the flood vulnerability classifications are provided in Table 4-2.

It should be noted that at present, Table 3 of the Planning Practice Guidance does not suggest that the Exception Test is required to avoid flood risk from other sources. In the context of South West Hertfordshire, it is important that the risks from other sources, particularly surface water and groundwater, are addressed.

The Exception Test should only be applied following the application of the Sequential Test. For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk (informed by the evidence in the SFRA).
- 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.

Where required, Dacorum Borough Council, Three Rivers District Council, St. Albans City and District Council and Watford Borough Council will carry out the Exception Test for potential allocation sites. The Sequential Test and the Exception Test, if required, will be iterative in nature and inform the site selection process within the Local Plan.

3.4 Applying the Sequential Test and the Exception Test to planning applications

In addition to those sites allocated in Local Plans, other sites may become available or received as a 'speculative application'. Local Plans will need to be flexible enough to ensure that where sites are put forward for development outside of the allocation process (i.e. as a speculative application), that they can contribute to the sustainable development of South West Hertfordshire.

In these circumstances, the Local Plans should contain policies which set out how sites not identified in the Local Plan will require the Sequential Test to be applied on an individual site basis. The evidence presented within the SFRA Level 1 is intended to support the decision-making process.

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https://www.gov.uk/guidance/flood-risk-and-coastal-change

Developers should use evidence provided in this SFRA to apply the Sequential Test, as well as provide evidence to show that they have adequately considered other reasonably available sites. This should include other sites allocated within the Local Plan as suitable for the proposed development.

When assessing sites not identified in the Local Plan, the following procedure should be followed:

1 Identify whether the Sequential Test is required. It is not needed for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site), development sites which have been allocated through the Local Plan or for sites in Flood Zone 1 at low risk from flooding from other sources identified in the SFRA mapping.

2 If the Sequential Test is required, the LPA should agree the area of search with the applicant. This should be guided by the requirement for the proposed development in a particular area.

3 Determine whether there are any other 'reasonably available' sites within Flood Zone 1 and away from other sources of flood risk, or whether the sequential approach can be used to move all of the development within the site boundary to Flood Zone 1 and away from other sources of flood risk.

4 If there are found to be other reasonably available sites at a lower risk of flooding, then the development has failed the Sequential Test and planning permission should be refused. If there are no other reasonably available sites, then the development can be deemed as passing the Sequential Test and the Exception Test may be required as set out in Table 3 of the PPG.

Planning Applications should use, and be assessed against, the latest flood risk data and guidance available. These include the Flood Zone mapping, flood risk assessment requirements and climate change allowances made available by the Environment Agency, as well as flood risk management policies and guidance from Hertfordshire County Council, as Lead Local Flood Authority. The Environment Agency and Hertfordshire County Council should be consulted to ensure the latest guidance and data is used in applying the Sequential and Exception Tests.

3.5 Actual and residual flood risk

3.5.1 Actual flood risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- Residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) in any year.
- Residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed.
- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change will erode the present-day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

3.5.2 Residual flood risk

Residual risk refers to the risks that remain in circumstances after measures have been taken to manage flood risk. It is important that these risks are quantified to confirm that the consequences can be safely managed.

The residual risk can be:

- The effects of a flood or rainfall event with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow, rainfall intensity exceeding the capacity of drainage systems, or failure of pumping systems to cope with the incoming discharges.
- Failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of reservoir or canal embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.
- Flood risk from other sources, in an area benefiting from defence against a single source of flooding. For example, surface water flooding can occur behind the flood defences of a river.

The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency. In this instance, attention should be paid to the characteristics of flood emergencies and the roles and responsibilities during such events. Additionally, in the cases of breach or overtopping events, consideration should be given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

Further details of residual risk in South West Hertfordshire is discussed in Section 7.6.

4 The impact of climate change

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050.

4.1 Revised Climate Change Guidance

The Environment Agency published updated climate change guidance on 19 February 2016, which must now be considered in all new developments and planning applications. The Environment Agency for the Hertfordshire and North London Area have provided local guidance on the level of climate change assessment required for a development, which is available on request.

The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice. The LLFA should be contacted for advice on flood risk from ordinary watercourses, surface or groundwater.

4.2 Peak River Flows

The peak river flow allowances show the anticipated changes to peak flow by river basin district which the subject watercourse resides. Once this is determined, guidance on uplift in peak flows are assigned for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it resides.

These allowances (increases) are provided for three climate change 'epochs' or time periods:

- Total potential change anticipated for '2020s' (2015 to 2039).
- Total potential change anticipated for '2050s' (2040 to 2069).
- Total potential change anticipated for '2080s' (2070 to 2115).

One or two of the percentiles are provided for each combination of vulnerability and flood zone, which in the latter case provides a 'range' of allowances. The peak river flow allowances show the anticipated changes to peak flow by river basin district, for three future epochs and percentiles, as shown in Table 4-1.

Table 4-1: Peak river flow allowances by river basin district

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

4.2.1 High++ allowances

'High++' allowances are those which only apply to developments which are very sensitive to flood risk, and that have lifetimes beyond the end of the century. Further information is provided in the Environment Agency publication, Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.

4.2.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan.

Table 4-2 defines the five flood risk vulnerability classifications and provides examples of development and land use types within each classification.

Table 4-2: Flood risk vulnerability classifications of development and land uses

Flood risk vulnerability classification	Examples of development and land 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 electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable development	• Police and ambulance stations; fire stations and command centres; 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 development	• 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 development	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways;

Flood risk vulnerability classification	Examples of development and land uses
	offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; 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.
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. • Ministry of Defence 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.

Source: Table 2: Flood risk vulnerability classification, Paragraph 66, PPG.

Environment Agency guidance recommends use of the following peak river flow climate change allowances for each flood zone:

Table 4-3: Peak river flow allowances recommended for Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

Table 4-4: Peak river flow allowances recommended for Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Table 4-5: Peak river flow allowances recommended for Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

4.3 Peak rainfall intensity allowance

Increased rainfall affects river levels and land and urban drainage systems. Table 4-6 shows anticipated changes in extreme rainfall intensity in small and urban catchments.

For Flood Risk Assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Table 4-6: Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039 ('2020s')	Total potential change anticipated for 2040 to 2059 ('2050s')	Total potential change anticipated for 2060 to 2115 ('2080s')
Upper end	10%	20%	40%
Central	5%	10%	20%

4.4 Using climate change allowances

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for a development or development plan allocation, the following should be considered:

- Likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s).
- The design life of the proposed development. For residential development, a 100-year design life is applied, whereas for economic sites a 50-year design life is normally assumed.
- Vulnerability of the proposed development types or land use allocations to flooding.
- 'Built in' resilience measures used, for example, raised floor levels.
- Capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

4.5 The impact of climate change in South West Hertfordshire

In future years, South West Hertfordshire is likely to experience milder, wetter winters and short yet high intensity summer storms.

In assessing the impact on flood risk, the effect of climate change tends to be an increase in the mapped flood extent. Several watercourses in the study area, such as the River Ver, are in areas of steep chalk upland, where the floodplains are well

defined. In these cases, increases in flow are unlikely to result in a significant increase in flood extent.

It is important to remember that even where flood extent may not significantly increase, flooding is likely to become more frequent under a climate change scenario. For example, what is currently an event with a 2% probability of occurring in any one year, may increase to say a 5% probability under climate change.

The impact of climate change on surface water flood risk has been assessed by applying a 40% uplift ('Upper End' for 2060 to 2115) to the 1 in 100-year Risk of Flooding from Surface Water mapping. The climate change uplift extended and connected existing surface water flow paths generated during a 1 in 100-year event, and expanded areas of surface water ponding on low-lying ground, particularly against railway embankments and on the fluvial floodplain.

The effect of climate change on groundwater flooding, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. Milder, wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible. Groundwater flooding which occurs in permeable surface deposits (e.g. in river floodplain gravels) is predicted to become more frequent, in response to increases in fluvial flooding, whereas the future response of 'clearwater' groundwater flooding from chalk aquifers is less well understood[29]. The anticipated warmer climate and forecasted population increase may counteract this effect, with increased abstraction and evapotranspiration leading to the drying up of groundwater aquifers and chalk-fed streams.

[29] Sayers and Partners Ltd. (2015) UK Climate Change Risk Assessment 2017: Projections of future flood risk (Main Report). Available at: https://www.theccc.org.uk/wp-content/uploads/2015/10/CCRA-Future-Flooding-Main-Report-Final-06Oct2015.pdf.pdf

5 How is flood risk assessed?

5.1 Data used to inform the SFRA

Source of flood risk	Data used to inform the assessment	Data Supplied By
Historic (all sources)	Historic Flood Map and Recorded Flood Outlines Hydraulic Modelling Reports	Environment Agency
	2007 SFRA	Dacorum Borough Council St. Albans City and District Council Three Rivers District Council Watford Borough Council
	2011, 2017 PFRAs Section 19 Flood Investigation Reports Historic Flood Incident Records	Hertfordshire County Council
	Historic flood incidents / records Post-flood reports	Dacorum Borough Council Environment Agency
	Sewer Flooding Register	Thames Water
Fluvial (including climate change)	Upper Colne at London Colney (Capita-AECOM, 2018) River Gade and Bulbourne (JBA Consulting, 2016) Upper River Lee (Halcrow, 2010) Upper River Colne, including River Chess (Halcrow, 2010) Flood Zone Mapping	Environment Agency
Surface water	Risk of Flooding from Surface Water	Environment Agency (Data.gov)
	Reported flood incident data	
Groundwater	5m resolution Groundwater Flood Map	JBA Consulting
Sewer	Sewer Flooding Register	Thames Water
Reservoir	National Inundation Reservoir Mapping	Dacorum Borough Council
	Flood and Reservoir Inundation Plan for Hertfordshire	Dacorum Borough Council
Canal	Canal embankments	Canal and River Trust (Data.gov)

5.2 Updating the Flood Zone Mapping

The Environment Agency's Flood Zone 3a and 2 are updated quarterly with any new detailed hydraulic modelling information, and planners and developers should always refer to the most up to date issue. These data sets are now freely available on the Government open data website.

The Flood Zone 3b and 3a plus climate change provided by the SFRA will not be automatically updated. However, users should be aware that if Flood Zone 3a and 2 have changed, this is an indication that new modelled information is also available which could be used to refine Flood Zone 3b and 3a plus climate change.

5.2.1 Hydraulic Modelling

Flood risk within the districts has been assessed using results from hydraulic computer models supplied by the Environment Agency and existing Environment Agency Flood Zone mapping.

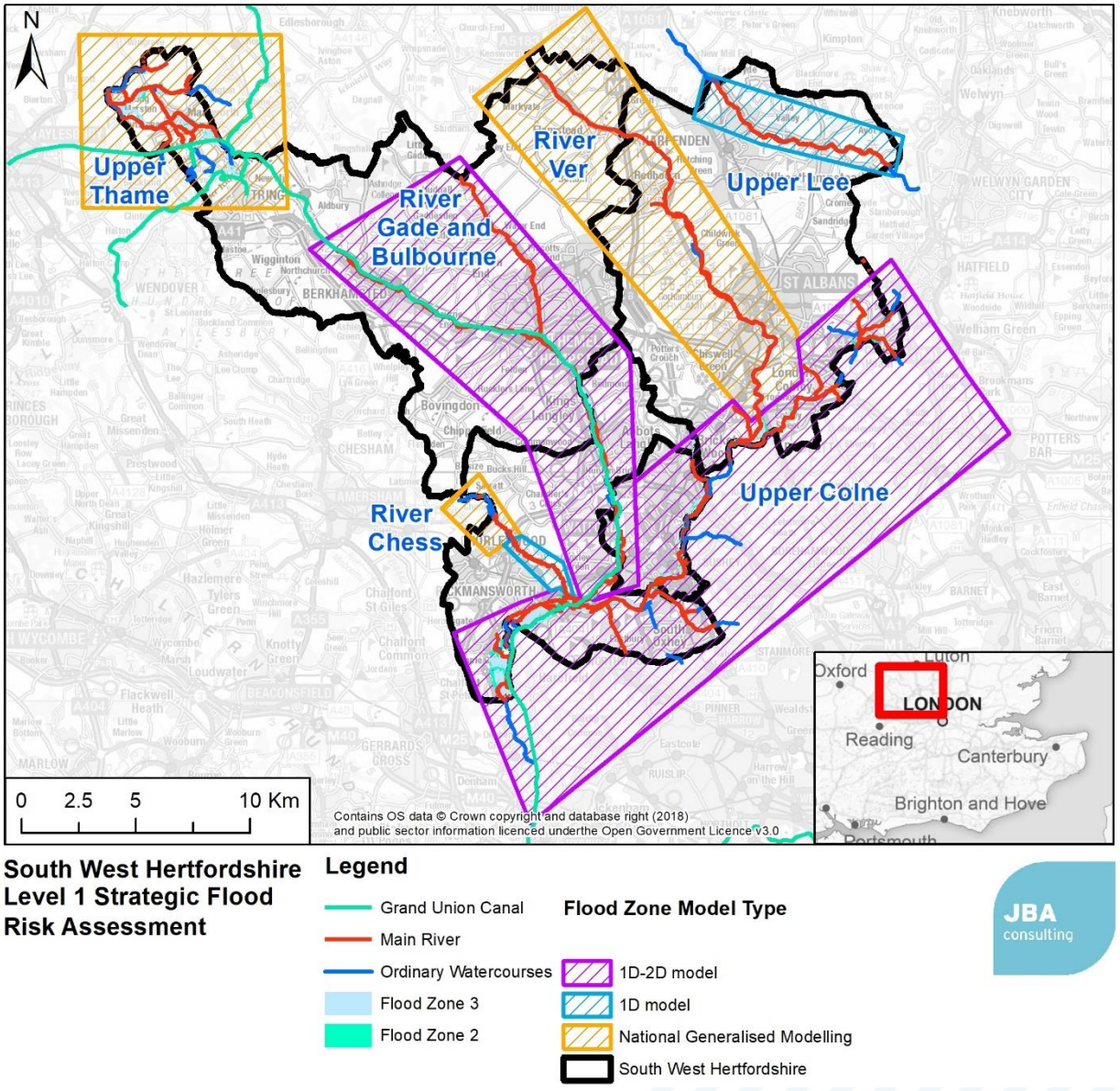
Table 5-1 lists the models provided by the Environment Agency for analysis within the South West Hertfordshire Level 1 SFRA. The extent of model also displayed in Figure 5-1.

Table 5-1: Summary of Environment Agency models used within the SFRA

Model	Year created	Model Type	Data source used in Flood Zone 3b	Data source used in Flood Zone 3a + CC	Comments	Confidence in modelled results
River Chess (Three Rivers)	2010	1D only	1 in 20 modelled outline	Flood Zone 2	Re-run for 100-year + 35% and +70% climate change allowances, but no flood extent produced as 1D-only model.	Moderate – lower confidence in results extrapolated onto the floodplain
Upper Colne (St. Albans, Three Rivers, Watford)		1D-2D	1 in 20 modelled outline	Flood Zone 2	Model was unstable during re-runs for larger climate change allowances. Results not used and FZ2 to act as conservative replacement.	Moderate – both channel and floodplain represented. Higher confidence in lower return periods, but unstable at higher flows

Model	Year created	Model Type	Data source used in Flood Zone 3b	Data source used in Flood Zone 3a + CC	Comments	Confidence in modelled results
Upper Lee (St. Albans)	2010	1D only	1 in 20 modelled outline	Flood Zone 2	Re-run for 100-year + 35% and +70% climate change allowances, but no flood extent produced as 1D-only model.	Moderate – lower confidence in results extrapolated onto the floodplain
River Gade (Dacorum, Three Rivers, Watford)	2016	1D-2D	1 in 20 modelled outline	1 in 100 + 70% modelled outline	Flood extents include the Grand Union Canal. Flood walls at Nash Mill represented.	Higher – recent model with both channel and floodplain represented
River Bulbourne (Dacorum)						
River Ver (Dacorum, St. Albans)	No hydraulic model currently available (detailed hydraulic model being developed for the EA at the time of this SFRA). In the interim period, the existing Flood Zones, based on National Generalised Modelling, have been used.					
Upper Thame (Dacorum)	No hydraulic model currently available, so existing Flood Zones based on National Generalised Modelling used. As a conservative estimate within this Level 1 SFRA, existing Flood Zone 3a (1 in 100-year) used to represent Flood Zone 3b (1 in 20-year), and Flood Zone 2 (1 in 1,000-year) used to represent Flood Zone 3a + CC (1 in 100-year + 70%CC).					

Figure 5-1: Extent and types of models used to inform the Flood Zones in South West Hertfordshire.



In the case of the River Chess and River Lee, the river channel and floodplain are represented as one-dimensional (1D) cross-sections. Whilst this method can provide reasonable confidence on water levels in or immediately adjacent to the channel, it does not allow the full complexities of flow within the floodplain to be modelled. This is particularly the case in urban areas where floodplain flows can be significantly influenced by buildings, roads, walls etc. Here, the models were re-run for the 1 in 100-year event with 35% and 70% climate change (CC) allowances, and the peak water levels were extracted in a tabular format. However, it was not feasible to extrapolate these levels across the floodplain, as changes in available ground models since 2010 would not have been conducive

to representative flood levels. Therefore, there was no update to flood risk mapping for the Rivers Chess or Lee for climate change, and the existing Flood Zones were used as an indication.

The models of the Upper Colne, Gade and Bulbourne combined 1D in-channel with two-dimensional (2D) modelling of the floodplains.

The Environment Agency's Upper Colne hydraulic model was re-run for the 35% and 70% climate change allowances as part of a series of Environment Agency model updates. However, the model became unstable and failed at longer duration storm events and higher climate change allowances, and therefore will require further upgrades to run successfully. The available 1 in 100-year + 70% CC model result was compared against the Flood Zone 2 results, to identify whether the extent and peak flows were greater the existing Flood Zone 2 and 1 in 1,000-year modelled results. The Flood Zone 2 extent and peak flow was greater, and therefore used as a conservative extent for Flood Zone 3a + CC.

No detailed hydraulic models were available for the River Ver or Upper Thame. Instead, the existing Flood Zone extents were used. These extents were originally defined using National Generalised Modelling, which assesses flood risk at a broader-scale, using simplified hydraulic processes and channel structures. At the time of preparation of this SFRA, the River Ver hydraulic model and updates to the River Gade and Bulbourne model were being developed.

The Level 1 SFRA was completed with the best information available during the timescale of the SFRA. Future updates to the SFRA should seek to incorporate any newly available model results. Should a Level 2 SFRA be required, it is recommended that the most recent model data available is reviewed and incorporated where possible.

5.2.2 Functional Floodplain (Flood Zone 3b)

The 'functional floodplain' is defined as an area of land where water flows or is stored in times of flood. This forms Flood Zone 3b within the NPPF. Following discussion between the four Local Planning Authorities and consultation with the Environment Agency, the following definition of the functional floodplain was agreed:

- Use the 1 in 20-year defended modelled flood extent wherever suitable hydraulic models are available.
- Elsewhere, take a precautionary approach and assume that Flood Zone 3a (1 in 100-year flood extent) represents the functional floodplain.

5.2.3 Surface Water

Mapping of surface water flood risk in South West Hertfordshire has been taken from the Risk of Flooding from Surface Water (RoFSW) map published by the Environment Agency. This information is based on a national scale map

identifying those areas where surface water flooding poses a risk. Surface water flood risk is subdivided into the following four categories:

- High: An area has a change of flooding greater than the 1 in 30 (3.3%) each year.
- Medium: An area has a chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%) each year.
- Low: An area has a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%) each year.
- Very Low: An area has a chance of flooding of less than 1 in 1000 (0.1%) each year.

The RoFSW shows the flooding that takes place from the 'surface runoff' generated by rainwater which:

a) is on the surface of the ground, and

b) has not yet entered a watercourse, drainage system or public sewer.

The RoFSW predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas.

It should be noted that because of the broad scale nature of the surface water flood risk mapping, wherever possible, these mapped outlines should be used in conjunction with other sources of local flooding information to confirm the presence of a surface water risk.

The impact of climate change on surface water flood risk has been assessed as part of the SFRA. The RoFfSW model has been re-run for the 1 in 100-year rainfall event, with the 'upper end' allowance of 40% for climate change. This has identified the surface water flood risk to all housing sites for the lifetime of the development (up to 2070 - 2115), based on current climate change predictions. For sites with short to medium-term design lives, such as economic sites, the '2050s' epoch (or time period) (2040 to 2069) 'central' allowance of 20% should be applied.

5.2.4 Ordinary Watercourses (not included in Flood Zone maps)

The location of small ordinary watercourses, which may not be included in the Environment Agency's Flood Zones if they have a catchment area of less than 3km², can be found using the OS MasterMap Water Network Layer or OS Open Rivers layer. The OS Open Rivers layer has been used in this assessment.

A good indication of potential flood risk from these watercourses can be gained from the RoFSW map. However, where development is proposed in the vicinity of an ordinary watercourse, the risk of flooding should be quantified within a Level 2 SFRA or a site-specific Flood Risk Assessment.

5.2.5 Groundwater

The JBA Groundwater Flood Map (Appendix A) provides a detailed assessment of the risk of groundwater emergence in a 1 in 100-year event at a 5m resolution. The risk is scaled between 0 and 4, with 0 indicating no risk and 4 identifying groundwater levels either at or very near (within 0.025m of) the ground surface. The groundwater levels are compared against ground surface levels to determine the head difference in metres; with 0m suggesting artesian discharge of groundwater at the surface.

The JBA Groundwater Flood Map should be used in combination with other information, such as local data or historic data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. The data can however help to identify areas for further assessment at a local scale, where finer resolution datasets may exist or more data could be gathered.

5.2.6 Sewers

Sewer flooding incidents recorded in Thames Water's sewer flooding register were provided for the assessment. This is a register of flooding from the 'public' sewer system ('public' in this context meaning assets under the control of Water and Sewerage Companies in England and Wales). Properties at risk of flooding are recorded in a register which is made available to OFWAT, the Water Services Regulation Authority.

Thames Water and OFWAT consider the register to be confidential and do not release the data in a resolution higher than 'number of properties per 4 or 5-digit postcode'. Sewer flooding records provided by Thames Water are therefore not detailed enough to identify site-specific risks. However, Thames Water will comment on larger planning applications, and on Local Plans.

Local evidence of sewer flooding to existing properties on or near the site should be taken into account.

5.2.7 Canals

Canals may pose a flood risk if they overtop or breach, but impacts will depend on the topography.

The Grand Union Canal flows parallel to the Rivers Colne, Gade and Bulbourne, passing through the Three Rivers District Council, Watford Borough Council and Dacorum Borough Council boundaries. Flood risk from the canal has been assessed using the Canal and River Trust embankment dataset, to identify raised sections in the canal, where failure could lead to breach flooding. A buffer zone of 100m was created around the canal embankments, and each potential development site in the study area was assessed against its proximity to the embankment.

The Canal and River Trust manages its risks as part of a wider Asset Inspection Procedures approach, and this includes looking at the condition grade and

consequence of failure of all its Principal Assets, which includes embankments and culverts.

Records of canal breaches and overtopping incidents were also requested from the Canal and River Trust, and used to inform the assessment of canal flood risk in South West Hertfordshire.

5.2.8 Reservoirs

The Environment Agency Risk of Flooding from Reservoirs map has been used to identify areas that may be at risk from failure or overtopping of reservoirs. The data was published following the Environment Agency's National Reservoir Inundation Mapping project in 2009, which mapped the risk of flooding from all large raised reservoirs (storing over 25,000m^3 of water above ground level) in England. Layers showing depth, extent and speed of flooding are available, but no information is given on the likelihood of reservoir failure.

The reservoirs of Startop's End, Marsworth, Tringford and Wilstone in Dacorum Borough are included in the mapping, and may impact South West Hertfordshire. In addition, the flood risk from the smaller reservoirs and flood alleviation features of Cherry Tree Lane Reservoir in Hemel Hempstead, Markyate Flood Alleviation Scheme in Dacorum Borough, and Luton Hoo Lakes in Central Bedfordshire, are represented in the mapping.

There are also a number of service reservoirs across South West Hertfordshire. These are raised concrete structures, often covered with concrete and landscaped with earth, which water supplies are transferred to, prior to distribution. The filling and draining of these features is controlled by the water supply network and as a result, flooding from the features which would be likely to result from mechanical failure, rather than the influence of rainfall or river flow. Therefore, flood risk from service reservoirs is not assessed as part of the SFRA.

6 Understanding flood risk in South West Hertfordshire

This section provides a high-level assessment of flood risk across South West Hertfordshire. The area covers the administrative boundaries of the four Local Planning Authorities of Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council.

Further information on the flood risk within the individual districts of Dacorum Borough, St. Albans City and District, Three Rivers District and Watford Borough is provided in Appendix C.

6.1 Topography, geology, soils and hydrology

6.1.1 Topography

The topography of South West Hertfordshire is characterised by the steep chalk uplands of the Chiltern Hills, which form a central band through the study area, and the intervening river valleys (Figure 6-1). The highest elevations range from approximately 250mAOD in the Chilterns Hills, to 38mAOD in the floodplain of the River Colne, downstream of Maple Cross.

The topography predominantly slopes from north west to south east, following the valley of the River Colne and its tributaries. The exceptions are the north east and north west of the study area. The north east, between Batford to Wheathampstead, slopes directly eastwards, following the topography of the River Lee catchment. The north west corner of the study area, north of Tring, forms the boundary of several catchments, and elevations fall north westwards, towards the River Thame.

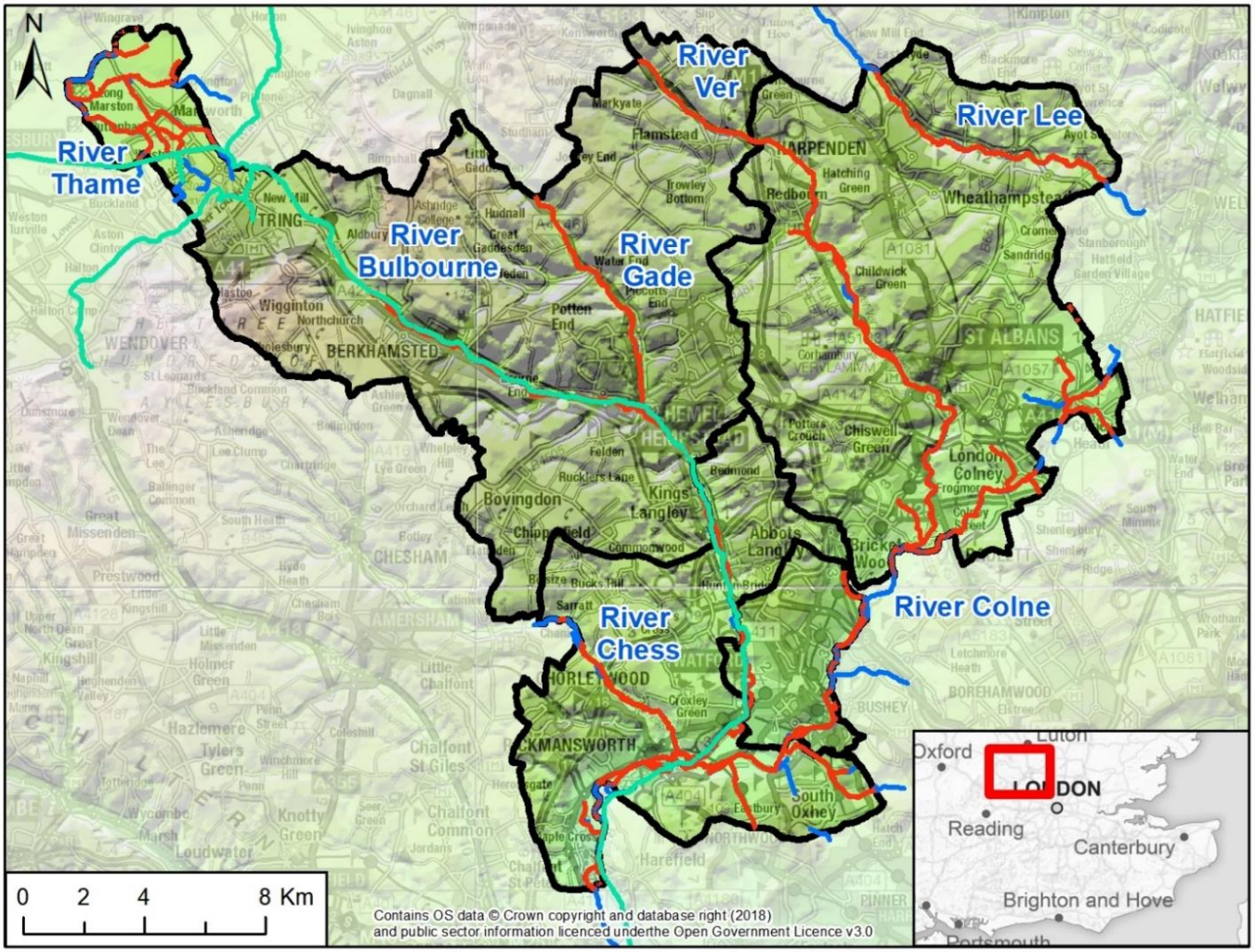
6.1.2 Bedrock and Surface Geology

The geology of the catchment can be an important influencing factor in the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

South West Hertfordshire is characterised by two bedrock geologies (Figure 6-2). The uplands are formed of Lewes Nodular, Seaford and Newhaven Chalk Formations, which form the Chiltern Hills, and the upper catchments of springs. The spring valleys, such as the Rivers Bulbourne, Chess, Ver and Lee are underlain by Holywell Nodular and New Pit Chalk Formations. Interspersed on the lower slopes of the valleys, east of Berkhamsted, Great Gaddesden, Hemel Hempstead and St. Albans, pockets of London Clay Formation and the Lambeth Group of clay, silt and sand occur.

The valley sides of the upper river catchments are overlain with clay-with-flints (Figure 6-3), often poorly consolidated surface deposits remaining from the last Ice Age. Extensive sand and gravel deposits are located in the upper catchments of the Rivers Bulbourne, Ver, Gade, Colne, Lee and Thame, and alluvium lines the floodplain of all watercourses across the study area.

Figure 6-1: Topography of South West Hertfordshire

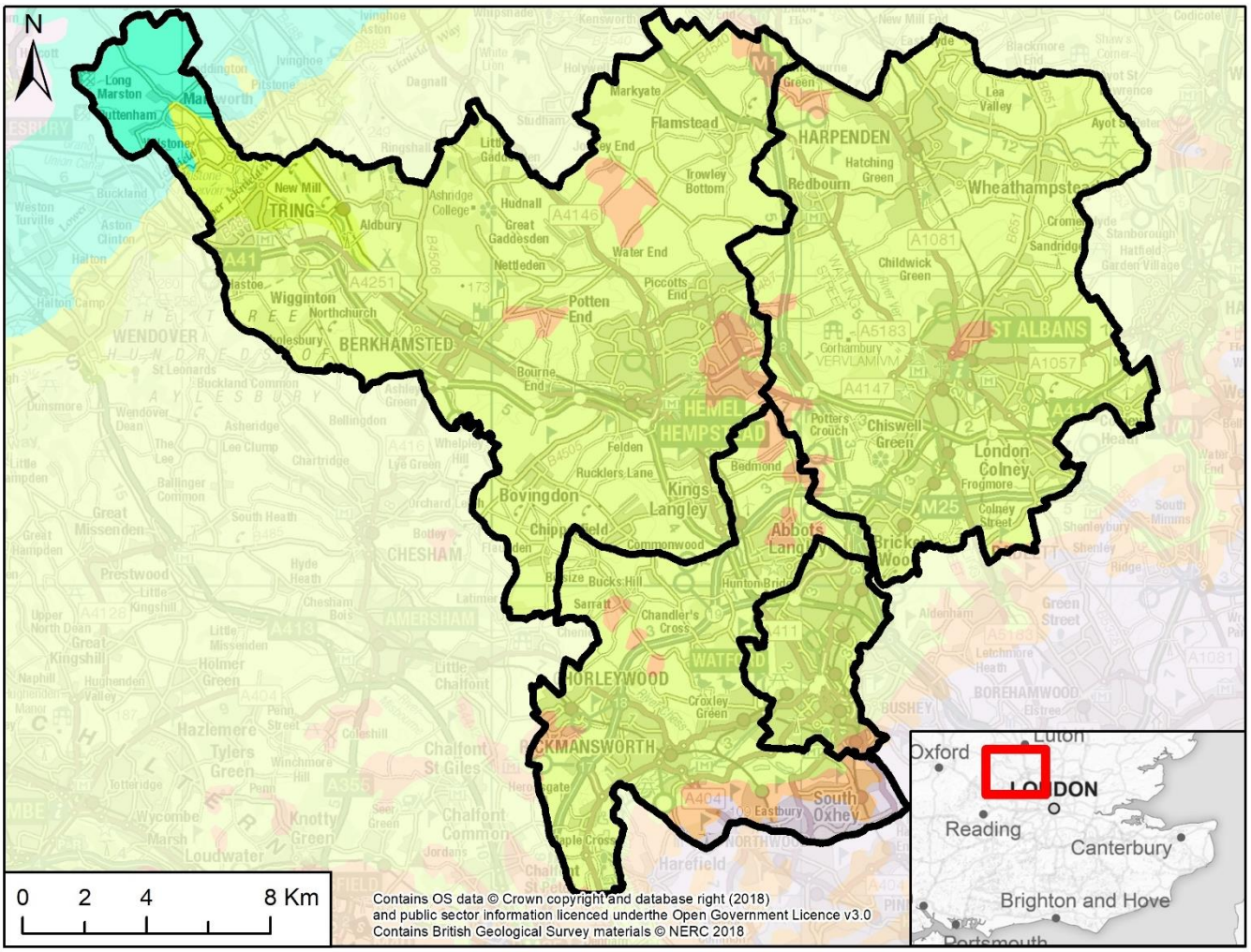


South West Hertfordshire Level 1 Strategic Flood Risk Assessment

Legend

- Grand Union Canal
- Main River
- Ordinary Watercourses
- South West Hertfordshire

Figure 6-2: Bedrock Geology of South West Hertfordshire



South West Hertfordshire Level 1 Strategic Flood Risk Assessment

Legend

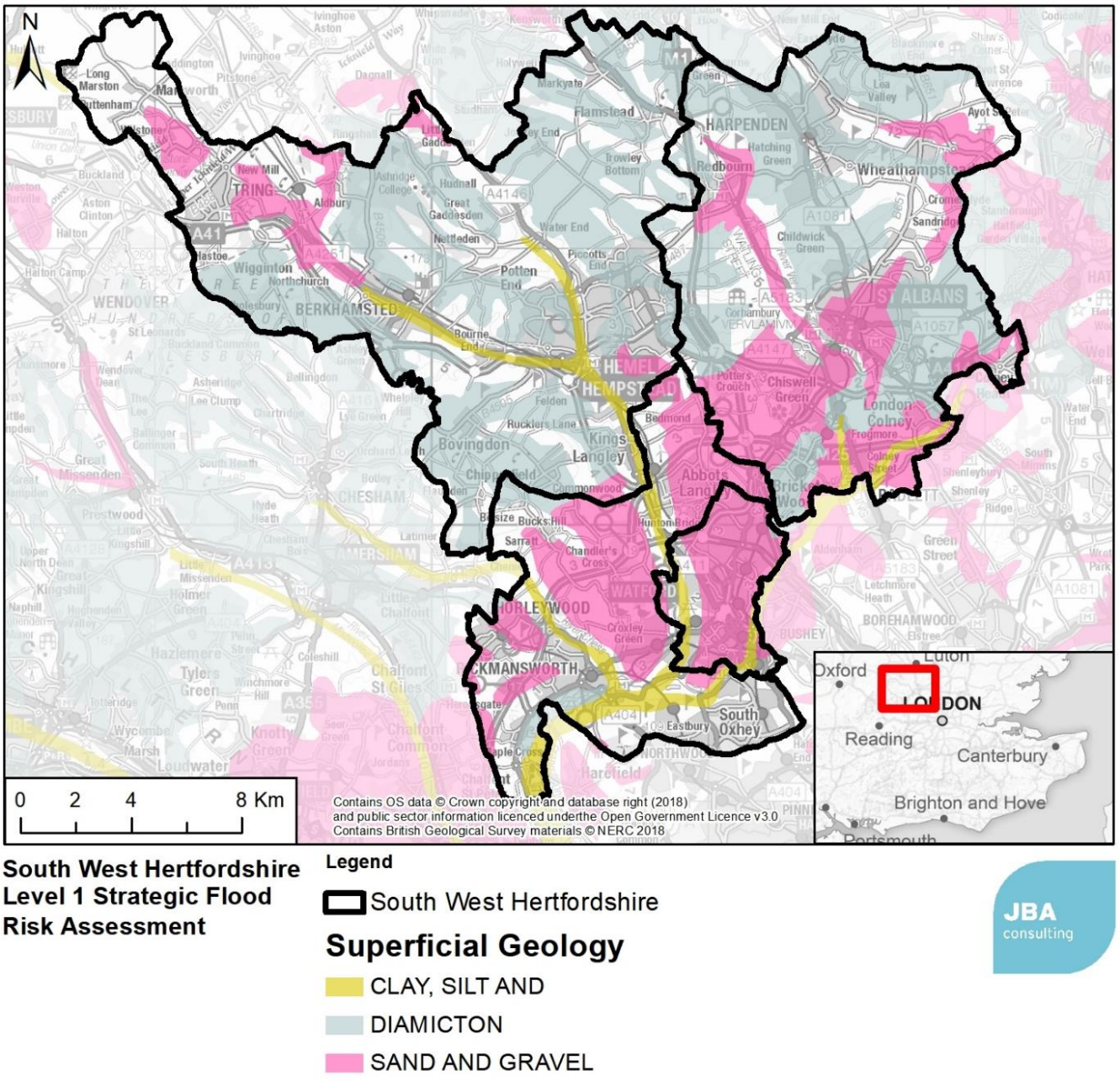
South West Hertfordshire

Bedrock Geology

Description

- THAMES GROUP - CLAY, SILT, SAND AND GRAVEL
- LAMBETH GROUP - CLAY, SILT, SAND AND GRAVEL
- GREY CHALK SUBGROUP - CHALK
- WHITE CHALK SUBGROUP - CHALK
- GAULT FORMATION AND UPPER GREENSAND FORMATION (UNDIFFERENTIATED) - MUDSTONE, SANDSTONE AND LIMESTONE
- PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE
- WEST WALTON FORMATION, AMPTHILL CLAY FORMATION AND KIMMERIDGE CLAY FORMATION (UNDIFFERENTIATED) - MU

Figure 6-3: Superficial geology of South West Hertfordshire



6.1.3 Hydrology

The study area of South West Hertfordshire is reasonably dry by UK standards, with average annual rainfall of 712mm measured at the nearest climate station[30].

The London Basin Chalk Aquifer which lies below much of the study area is designated as a Principle Aquifer, providing a significant proportion of the water supply for Hertfordshire. At some locations, the aquifer lies beneath a layer of London Clay.

Due to the use of the aquifer for drinking water abstraction, large areas of South West Hertfordshire are located within Groundwater Source Protection Zones (SPZs), where the Environment Agency provide guidelines to protect groundwater from sources of pollution. These are explained in further detail in Section 11.5.1 and mapped in Figure 11-1.

In addition, the Rivers Bulbourne, Chess, Gade, Lee and Ver are groundwater-fed chalk streams, which provide globally rare habitats, and support diverse wildlife species. However, these chalk streams are fragile hydrological systems, which are dependent on seasonal rainfall patterns and therefore prone to low flow conditions. This, alongside over abstraction of aquifers and the watercourses themselves, poses a threat to chalk stream habitats.

6.1.4 Main Rivers

Several Main Rivers and ordinary watercourses flowing through South West Hertfordshire. These include:

- River Bulbourne (Dacourm Borough)
- River Chess (Three Rivers District)
- River Colne (St. Albans District, Watford Borough, Three Rivers District)
- River Lee (St. Albans District)
- River Gade (Dacorum Borough, Watford Borough, Three Rivers District)
- River Ver (Dacorum Borough, St. Albans District)
- Tring Bourne (Dacorum Borough)
- Oxhey Brook (Three Rivers District)
- Hartsbourne Brook (Three Rivers District)
- Ellen Brook (St. Albans District)

Tributaries of these watercourses include smaller ordinary watercourses and numerous unnamed drains. There are also a number of ponds and lakes within the study area, particularly in the floodplain of the River Colne between Oxhey to downstream of Maple Cross. Many of these were created following historic gravel extraction.

30 The Met Office (2018). Annual Average Rainfall 1981-2010: Rothamsted No2. Available online at: https://www.metoffice.gov.uk/public/weather/climate/gcpwmq68n. Accessed on 02/03/2018.

A map of the key watercourses can be found in Appendix A.

6.2 Historical Flood Risk

The significant fluvial flood events which have affected South West Hertfordshire in recent years are:

- Spring 1992
- Autumn 1992
- Autumn / Winter 2000
- New Year 2003
- Spring 2007
- Spring 2012
- Autumn 2012
- Winter 2013/2014

Further details of historic flooding within each district and borough are provided in Appendix C.

6.3 Fluvial flood risk

Fluvial flooding is caused by high flows in rivers or streams exceeding the capacity of the river channel and spilling onto the floodplain, usually after periods of heavy rainfall. Fluvial flood risk is present on both Main Rivers (from which the Environment Agency and riparian owners are responsible for managing flood risk) and Ordinary Watercourses (from which Hertfordshire County Council as LLFA and riparian owners are responsible for managing flood risk). The fluvial risk from the Main Rivers in South West Hertfordshire has been summarised below by river catchment area.

6.3.1 Flood risk by catchment

The principal watercourse within South West Hertfordshire is the River Colne, tributaries of which include the River Chess, River Ver and River Gade. The River Bulbourne is a tributary of the River Gade which flows alongside the Grand Union Canal, and at several locations joins the canal.

Despite the long history of flooding within South West Hertfordshire, flood risk from the Rivers Colne and Lee is relatively confined, due to the channel topography and high levels of urbanisation throughout their course.

River Colne

Along its 18km reach there are numerous tributaries that confluence with the river, until it flows into the River Thames. The Colne rises as a subterranean river at a spring located in North Mymms Park. A number of small tributaries flow into the main river in the upper reaches of the Colne such as the Potters Bar Brook and Mimmshall Brook. The river flows north into Colney Heath before flowing south west towards London Colney and Colney Street where the Colne confluences with the River Ver. It flows along a heavily modified watercourse, through several culverts in Watford and Oxhey before its confluence with the River Chess and River Gade at Rickmansworth.

The most at-risk areas, commonly impacted by fluvial flooding are within the upper reaches of the Colne at Colney Heath, Watford and London Colney. The most severe flood event from the River Colne occurred in the Winter of 2000/2001 where 20 properties and roads were inundated for several days in Watford. Properties in London Colney and Colney Heath were also severely flooded. Historical records show that flooding along River Colne is primarily caused by intense storms and high rainfall in conjunction with the impermeable clay catchment. As outlined within the Thames Catchment Flood Management Plan (2009), flood defences were sought to be constructed along the Colne in the Watford and London Colney area. Downstream at Rickmansworth, the Lower Colne Improvement Scheme has been constructed to alleviate flood risk.

River Bulbourne

The River Bulbourne is a chalk stream fed from rising groundwater in the Chilterns within the Dacorum District. The reach is approximately 17km where it flows through Berkhamsted, Bourne End and Boxmoor until its confluence with the River Gade at Two Waters, south Hemel Hempstead. It was noted in the Level 1 SFRA (Halcrow, 2007) that there were two major flooding events in the Gade and Bulbourne catchments in 1879 and 1947. Properties were flooded at the confluence with the Grand Union Canal and along the reach to Boxmoor. There have been a number of embankments created at Boxmoor along the river to alleviate flood waters and overtopping of the canal.

River Chess

The River Chess is a chalk stream located within Buckinghamshire and Three Rivers District. The source is groundwater fed, located within the lower extent of the Chilterns, from where it flows for approximately 16km through Waterside, Loudwater and Rickmansworth, where it joins with the River Colne. Historical flooding has been recorded on the River Chess, particularly in the upper catchment at Chesham and at the confluence with the River Colne in Rickmansworth.

River Gade

The River Gade flows entirely through South West Hertfordshire. It rises as a groundwater fed chalk stream and flows through notable settlements such as Hemel

Hempstead and Kings Langley. It flows in a southerly to south easterly direction where the River Bulbourne flows into the Gade at Two Waters before the Gade flows into the River Colne at Rickmansworth. The Grand Union Canal flows both alongside and forms the river, with an approximate distance of 24km from its source in the Chilterns to the confluence with the River Colne.

River Ver

The River Ver is a chalk stream, rising at Dunstable Downs (Chilterns) flowing south easterly towards its confluence with the River Colne at Rickmansworth. The Ver flows through notable places such as Flamstead, Redbourn and St Albans. There have been recorded flood incidents upstream at Markyate and Redbourn with limited historical evidence of fluvial flooding at St. Albans.

Tring Bourne

The Tring Bourne is located within the north western region of the Dacorum District and flows through Long Marston before its confluence with the headwaters of the River Thame. The river flows through the village in a number of culverts channels before it outfalls to the west and flows northwards. Long Marston has been subject to flooding from blocked culverts and poor maintenance of open sections of the Tring Bourne, which may be partly alleviated by further maintenance of the channel and its structures.

Oxhey Brook

The Oxhey Brook is located within the suburban area of Watford within the Three Rivers District. The Brook flows in a south westerly direction through a number of culverts and open channels before its confluence with the Hartsbourne Brook at Prestwick Road, South Oxhey. There has been recorded flooding along this reach due to heavy short duration of rainfall.

Hartsbourne Brook

The Hartsbourne Brook rises within the Hartsbourne Country Club and flows westerly towards Carpenders Park where it meanders to the north. The Oxhey Brook flows into the watercourse to the north of South Oxhey before its confluence with the River Colne. There has been reported flooding in Carpenders Park area on a regular occurrence where in severe flooding, over 20 properties and 30 hectares of land have been inundated.

6.3.2 Culverts

Culverts can increase flood risk, due to blockages of the culvert itself or trash screens, or because they are hydraulically inadequate due to under-capacity or condition. The risk of flooding can be exacerbated because of poor maintenance of culverts and trash screens. Responsibility for maintenance of culverts can sometimes be difficult to

determine between riparian owners, local authorities and the Environment Agency. As well as contributing to flooding, culverts can be problematic in ecological terms, often causing Water Framework Directive (WFD) compliance issues.

Hertfordshire County Council (as Lead Local Flood Authority) identifies two culverts in St Albans City and District Council within their Asset Register (updated in 2015). There are many more culverts within the four authorities that have not been identified on asset registers. Many registered culverts form part of the highways drainage system, and are therefore owned and maintained by Hertfordshire County Council, whilst others are managed by Highways England, private landowners and the Environment Agency.

The Environment Agency's Asset Information Management System (AIMS) which holds records of assets associated with flood defences. It identifies 135 culverts within the four authorities and states the culverts condition, length and description. Most of these culverts are associated with road crossings for example. However, there are several much longer culverts on Oxhey Brook and Hartsbourne, which flow through urban centres of South Oxhey and South Watford. Other longer culverts are located along the M1, A5183, M25 and on the River Bulbourne (north of Berkhamsted). The largest culvert, at 0.75km in length, is located within London Colney and discharges to the River Colne. One notable culvert within Wheathampstead, the Mill Culvert on Station Road, has a history of flooding. During such flood events, the Mill Culvert can become blocked, and water flows out of bank and floods properties along the road.

6.4 Surface water flooding

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems can be linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding. This can be made worse by local insufficient drainage capacity. Where discharge is directly to a watercourse, locally high water levels can cause backing-up and flooding to take place.

In general, the Risk of Flooding from Surface Water (RoFSW) mapping shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys, and ponds in low-lying areas, such as the fluvial floodplains.

Surface water flood risk within South West Hertfordshire is concentrated in the densely urbanised areas, including Hemel Hempstead, St. Albans and Watford. The impermeable surfaces can allow localised surface water flow paths to form on steeper slopes, and ponding to occur on flatter ground, or low points in the topography. The roads, roofs and paved areas in these settlements are largely drained by underground surface water drainage systems, which have limited capacities. During intense rainfall events, or where blockages occur, the drainage systems can be prone to exceedance, which results in surface water flooding.

Surface water flooding caused by exceedance of drainage systems was raised as a concern in Harpenden and St. Albans within the 2007 SFRA. Here, runoff from

surrounding agricultural land entered the soakaways and highway drainage systems within the urban areas, which did not have sufficient capacity to manage them. The surface water flood risk in Watford is also related to the capacity of the surface water drainage system, particularly when water levels are high on the River Colne, as drainage outfalls become restricted, causing systems to back up and flood.

Risk of Flooding from Surface Water mapping and the impact of climate change on surface water flood risk is provided in Appendix A.

6.5 Groundwater flooding

Groundwater flood risk in South West Hertfordshire is concentrated in two areas. In the upper chalk catchments, the underlying geology has the potential to store and release large volumes of groundwater, and in the areas of permeable sand and gravel deposits, which can absorb and transmit water levels close to the ground surface.

The highest levels of groundwater flood risk are identified around the Tring Reservoirs and in the chalk valleys of the Rivers Bulbourne, Gade, Lee, Ver and Colne, where groundwater levels are estimated to lie within 0.025m of the ground surface. High groundwater levels of approximately 0.025m to 0.5m below the ground surface are across the east of the study area, affecting Tring, north east St. Albans, Markyate, Oxhey and north east Watford.

There have been several incidents of groundwater flooding within South West Hertfordshire in recent years. Notably, the Chilterns were affected by groundwater flooding during the Winter of 2000/2001, with the Sandridge and Jersey Farm areas of north east St. Albans particularly affected. To a lesser extent, the upper catchment of the River Ver was affected by groundwater flooding in Winter 2014, with property curtilages and cellars affected in Markyate, Dacorum. Isolated groundwater flooding incidents have also been recorded by Hertfordshire County Council around Tring Reservoirs and Cow Roast in Dacorum, as well as the Carpenders Park area of Watford and Three Rivers.

The JBA Groundwater Flood Map for South West Hertfordshire is provided in Appendix A.

6.6 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration or entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Historical incidents of sewer flooding are compiled by Thames Water in their Sewer Flooding Register. The database records reported incidents of internal and external

property flooding relating to public foul, combined or surface water sewers. Therefore, any flooding which has not been reported to Thames Water will not be included in the register. In addition, a property can be removed from the register where a scheme has been delivered to alleviate sewer flooding to a property. For confidentiality reasons this data has been supplied on a postcode basis.

An overview of the sewer flooding incidents within individual districts and boroughs are provided in Appendix C.

6.7 Flooding from reservoirs, canals and other artificial sources

6.7.1 Reservoirs

Flooding from reservoirs occurs following partial or complete failure of the control structure designed to retain water in the artificial storage area. Reservoir flooding is very different from other forms of flooding; it may happen with little or no warning and evacuation will need to happen immediately.

There are several major reservoirs in South West Hertfordshire, which measure 25,000m^3 or greater in volume, and are therefore included within the Environment Agency Reservoir Inundation Mapping. Startop's End, Marsworth, Tringford and Wilstone are all located within Dacorum, and together form Tring Reservoirs, which feed the Grand Union Canal and are owned and maintained by the Canal and River Trust. Other large water bodies identified in the Reservoir Inundation Mapping include Markyate Flood Storage Area, Hartsbourne Flood Storage Area, fishing lakes in Redbourn and Colney Heath, and Cherry Tree Lane Reservoir in Hemel Hempstead. A summary of the reservoirs larger than 25,000m^3 within South West Hertfordshire is provided in Table 6-1.

Significant proportions of South West Hertfordshire are identified as at risk of reservoir flooding. The area of the greatest extent of reservoir flood risk is around the Tring Reservoirs, and extends from north west Tring to Long Marston. Other notable areas at risk are south of the railway line at Chorleywood Bottom, Markyate and South Oxhey.

Elsewhere, reservoir flood risk is confined to the floodplains of the River Chess, Ver, Colne, Lea and Hartsbourne Brook, which will convey flood waters from several reservoirs, including Cherry Tree Lane Reservoir in Hemel Hempstead and Luton Hoo Lakes in southeast Luton, in the event of a breach event.

Table 6-1: Summary of reservoirs in South West Hertfordshire

Reservoir	Location (grid reference)	Reservoir owner	Local authority
Startop's End, Tring	491,887 213,786	Canal & River Trust	Dacorum Borough Council
Marsworth, Tring	492,174 213,726	Canal & River Trust	Dacorum Borough Council
Tringford, Tring	491,847 213,350	Canal & River Trust	Dacorum Borough Council
Wilstone, Tring	490,499 213,147	Canal & River Trust	Dacorum Borough Council
Markyate Flood Storage Area	505,874 217,046	Environment Agency	Dacorum Borough Council
Cherry Tree Lane Reservoir, Hemel Hempstead	508,316 209,654	Thames Water	Dacorum Borough Council St. Albans City and District Council
Redbourn Road, Redbourn	511,832 211,136	Redbournbury Fishery	St. Albans City and District Council
Willows Lakes (formerly Bowmans Lakes, Colney Heath	519,469 205,240	Willows Lake	St. Albans City and District Council
Hartsbourne Flood Storage Area	521,971 193,278	Environment Agency	Three Rivers District Council

However, it should be noted that flooding due to the breach or overtopping of a reservoir is extremely rare. Emergency planning teams from Hertfordshire County Council and the four authorities, represented within Hertfordshire Resilience, have developed a Multi-Agency Flood and Reservoir Inundation Plan. This identifies the key reservoirs across the county, the associated flood risk, and the required emergency response in the event of reservoir failure.

The flood map for reservoirs is provided in Appendix A.

6.7.2 Canals

Canals do not generally pose a direct flood risk as they are a regulated waterbody. However, there is a residual risk from canals associated with lower probability events such as overtopping and embankment failure (breach and sudden escape of the water retained in the canal channel).

The level of water in canals is controlled by the level and size of weirs. When surface water enters a canal, the level of water rises. The water level may then reach a point

in which it discharges from the canal through control structures such as weirs. If the capacity of these control structures is exceeded, or should they become blocked, overtopping may occur.

Flooding from a breach of a canal embankment is largely dictated by canal and ground levels, canal embankment construction, breach characteristics and the volume of water within the canal that can discharge into the lower lying areas behind the embankment. Although there is no specific flood risk mapping for canals, an assumption can be made that where canals have raised embankments, there is a potential hazard of flooding to downslope areas.

The Grand Union Canal flows through the west and south of the study area, crossing the administrative boundaries of Dacorum Borough, Three Rivers District and Watford Borough.

The canal interacts with the Rivers Gade and Bulbourne at several locations, including Hemel Hempstead, Berkhamsted, Watford and Rickmansworth. Through the sluices and side weirs linking the Grand Union Canal to other watercourses, the water body can have a significant impact on water levels in adjacent watercourses[31]. This is particularly the case in the Rivers Gade and Bulbourne at Berkhamsted and southern Hemel Hempstead.

There is a residual risk of breaching or overtopping of the Grand Union Canal at Berkhamsted (discussed further in Section 7.6). Four potential breach locations were identified within Berkhamsted as part of the Dacorum Level 2 SFRA: North of Mandelyns Road, Valley Road, Delton Road and Bridge Street. Results indicated that the area between the Grand Union Canal and River Bulbourne would be severely inundated with flood water if a canal breach occurred.

Further details of canal breach and overtopping events recorded within each district and borough are provided in Appendix C.

6.8 Flood Information Service

The Environment Agency provides a Flood Information Service covering the main rivers within South West Hertfordshire. This is a free service that residents and businesses can sign up to by phone, email or text message if their home or business is at risk of flooding.

Traditionally, the Environment Agency issues Flood Warnings to specific areas when flooding is expected, and more frequently Flood Alerts to larger areas, when flooding is possible.

There are 17 Flood Warning Areas in South West Hertfordshire, covering the Rivers Colne, Chess, Gade, Bulbourne, Ver, Lee and Thame, as well as the Radlett Brook. Nine

[31] Environment Agency (2016) Gade and Bulbourne Flood Modelling Study.

Fluvial Flood Alert Areas cover wider areas of the Rivers Colne, Chess, Gade, Bulbourne, Ver, Lee and Thame. In addition, a Groundwater Flood Alert Area covers Flamstead.

The locations of all Flood Alert Areas and Flood Warning Areas are shown in Appendix A.

7 Flood defences and flood risk assets

7.1 Defence standard of protection and residual risk

One of the principal aims of the SFRA is to outline the present risk of flooding across the study area including consideration of the effect of flood risk management measures (including flood banks and defences). The modelling that informs understanding of flood risk within the study area is typically of a catchment-wide nature, suitable for preparing evidence on possible site options for inclusion in local plans. In cases where a specific site flood risk assessment is required, more detailed studies should be performed to seek to refine the current understanding of flood risk from all sources.

Consideration of the residual risk behind flood defences has been undertaken as part of this study. The residual risk of flooding in a flood event or from failure of defences should also be carefully considered. Developers should also consider the standard of protection provided by defences and residual risk as part of a detailed Flood Risk Assessment (FRA).

7.2 Defence condition

Formal structural defences are given a rating based on a grading system for their condition. A summary of the grading system used by the Environment Agency for condition assessment is provided in Table 7-1. This detail, in addition to descriptions and standard of protection for each, were provided by the Environment Agency for the purpose of preparing this SFRA.

Table 7-1: Defence asset condition rating

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation required.
5	Very Poor	Severe defects resulting in complete performance failure.

Source: Condition Assessment Manual – Environment Agency 2006

7.3 Defences in South West Hertfordshire

There are a number of formal flood defences within South West Hertfordshire, which provide varying levels of protection. The locations of these defences are displayed in Appendix A, with further details provided in Table 7-2.

Elsewhere, naturally higher ground, such as raised channel banks and railway embankments, provide more informal flood defences. These have been removed from

the overview of defences in Appendix A, as they are not designated flood defence assets.

Table 7-2: Flood defences in South West Hertfordshire

Defence	Location	District / Borough	Standard of Protection	Areas benefitting from defence	Current condition
Markyate Flood Storage Area	Upstream River Ver, north of Markyate	Dacorum BC	1 in 200-years	Markyate Redbourn	FSA embankment 2 – Good
Hartsbourne Stream Flood Storage Area	Length of the Hartsbourne Stream to confluence with the River Colne	Three Rivers DC	1 in 200-years	Carpenders Park South Oxhey	FSA embankments 2 – Good
Chess Wall	North of Batchworth on River Chess	Three Rivers DC	1 in 100-years	Rickmansworth	2– Good, on River Chess 3 – Fair, upstream of Town Ditch
Hemel Hempstead Flood Relief Culvert	Bury Mill to Kings Park Industrial Estate on the River Gade, Hemel Hempstead	Dacorum BC	1 in 100-years	Hemel Hempstead Apsley Kings Langley	Unknown - Thames Water adopted sewer
Lower Colne Improvement Scheme	River Colne from Rickmansworth to Stains	Three Rivers DC	1 in 100-years	Rickmansworth	2 – Good to 3 – Fair
Boxmoor Embankment	Hemel Hempstead north of A4251 on River Bulbourne	Dacorum BC	1 in 5-years	Hemel Hempstead	Not assessed
Frogmore Mill Embankment	River Gade north of London road (A4251) and Mill Street in Aplsey	Dacorum BC	1 in 5-years	Apsley	Not assessed
Wheathamp-stead Wall	Left bank of River Lee in Wheathampstead, west of Station Road	St. Albans CDC	Not specified	North Wheathampstead (e.g. Station Road)	4 - Poor

Defence	Location	District / Borough	Standard of Protection	Areas benefitting from defence	Current condition
Berkhamsted culverts	River Bulbourne in Central Berkhamsted	Dacorum BC	N/A	Berkhamsted	Unknown - some of the culverts were restored as open channels during recent development

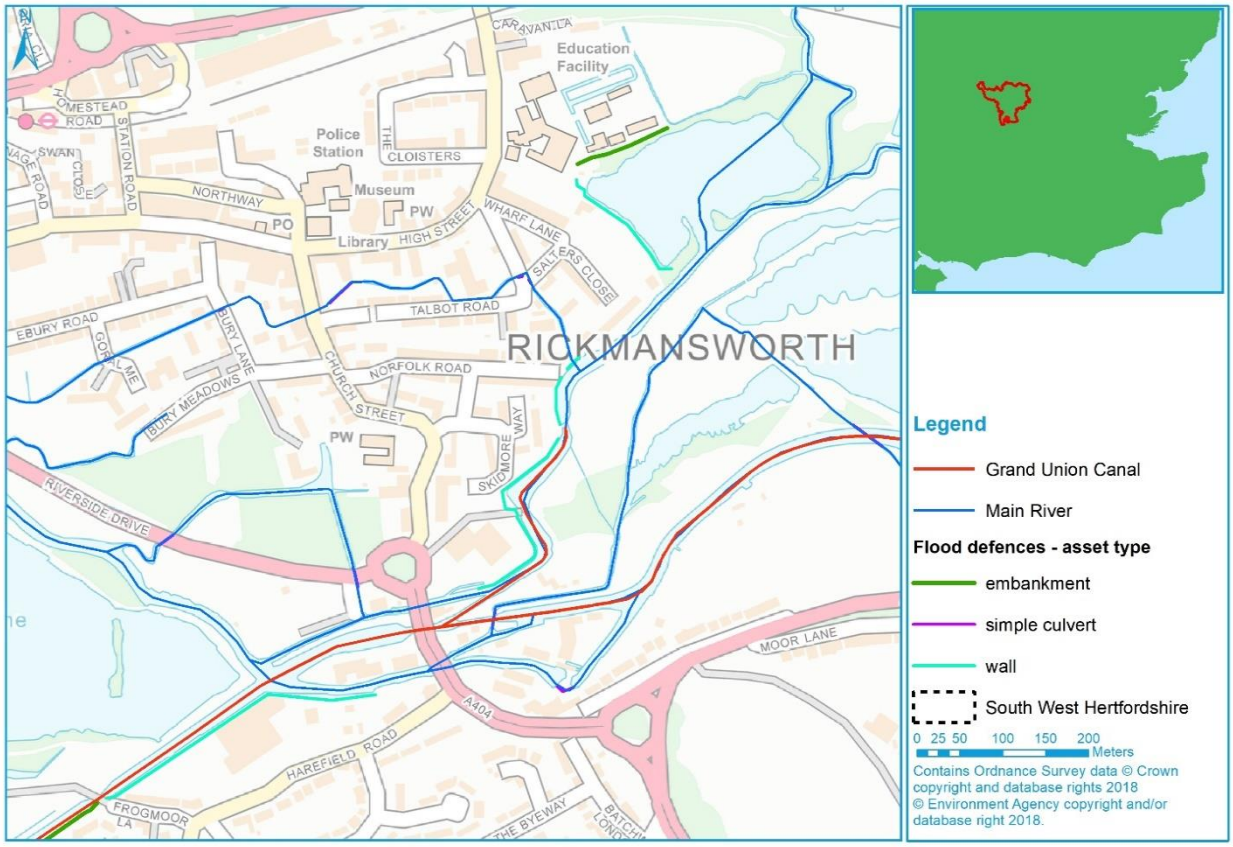
The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future requires consideration as part of the risk based sequential approach and this should inform conclusions as to whether possible site options for development are appropriate and sustainable. In addition, detailed FRAs will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

A review of key defences across the study area, their condition and standard of protection is included in the following sections.

Chess Wall, Three Rivers District

The Chess Wall is a 125m raised concrete wall running along the right bank of the River Chess, upstream of its confluence with the River Colne in Rickmansworth (Figure 7-1). The wall extends from Norfolk Road to the Ebury Way footpath, providing a 1 in 100-year standard of protection to adjacent residential areas, and defence against a 1 in 20-year flood event to the east of Norfolk Road. The overall condition of the wall is 'good'.

Figure 7-1: Location of the Chess Wall flood defence in Rickmansworth



Lower Colne Improvement Scheme Works, Three Rivers District

The Lower Colne improvement scheme comprises of 50 small flood alleviation works, which were undertaken along the main watercourses in the Colne Valley between 1988 and 1995[32]. The schemes involved the creation of bypass channels and flood barriers, as well as the removal of derelict channel structures, such as sluices.

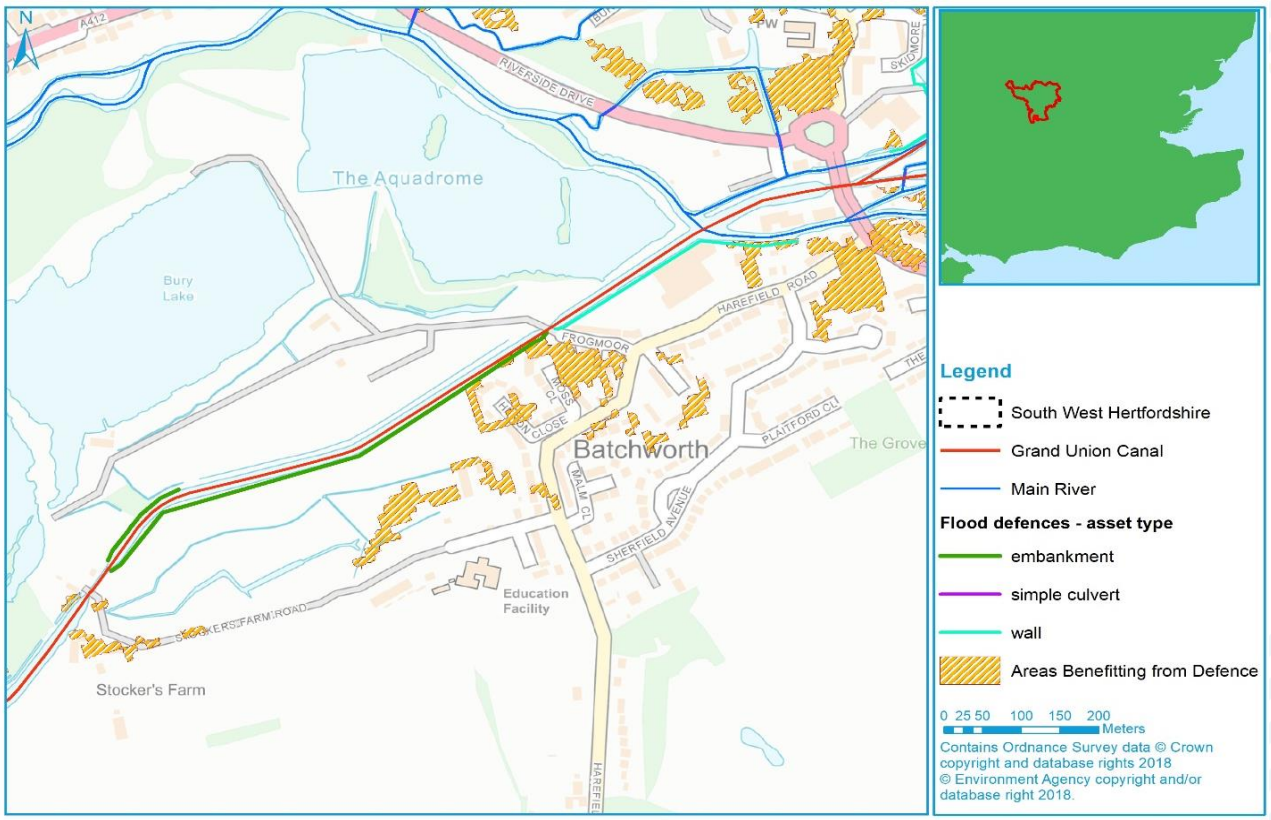
In South West Hertfordshire, the Lower Colne works comprise of a series of reinforced walls and embankments from Rickmansworth to Maple Cross. The largest is the sheet piled wall and continuing embankment north of Batchworth (Figure 7-2), constructed to provide a 1 in 100-year standard of protection to residential and commercial properties from flooding from the perched Grand Union Canal[33]. A series of smaller walls and embankments east of Maple Cross and West Hyde, including the Maple Embankment, provide further protection to residential properties and the Sewage

32 National Rivers Authority Thames Region (1994) Fact File: River Colne. Available at: http://www.environmentdata.org/archive/ealit:3026.

33 Halcrow Group Ltd. (2007) Dacorum Borough Council, St Albans City & District Council, Three Rivers District Council, Watford Borough Council Strategic Flood Risk Assessment.

Treatment Works, also to a 1 in 100-year design standard of protection. The overall condition of the walls ranges from 'good' to 'fair'.

Figure 7-2: Flood wall and embankment at Batchworth, part of the Lower Colne Improvement Scheme works



Other defences on the River Colne, Three Rivers District and Watford

Less extensive flood defences have been constructed on the River Colne in Watford and Oxhey in Three Rivers District.

A concrete flood wall extends along the right bank of the River Colne at the former Gas Works site off Waterfields Way/Lower High Street in Watford. The structure is designed to defend against a 1 in 50-year food event. Elsewhere along the River Colne in Watford, there are sections where the channel banks are reinforced by concrete lining or sheet piling with concrete caps, providing a 1 in 20-year standard of protection.

A section of the River Colne upstream of Hampermill Lane, Oxhey is defended by a reinforced concrete wall and clay core earth embankment. Up to a 1 in 100-year standard of protection is provided to communities in The Pastures, Thorpe Crescent, Brookside Road and Prestwick Road Flood Storage Areas.

There are a number of Flood Storage Areas within the four authorities and the surrounding area that act as a storage basin or balancing pond. The purpose of these areas is to attenuate incoming flood peak to a flow level that can be accommodated downstream. Flood Storage A do not completely remove the risk of flooding

downstream but can delay the timing of flood peak, so that its volume is discharged over a longer time period.

Hartsbourne Flood Storage Area, Three Rivers

The Hartsbourne Flood Storage Area was constructed in response to frequent flooding of properties and disruption to the road network in the Carpenders Park area. The scheme comprises of a Flood Storage Area, created by impounding the Hartsbourne Stream with an earth bund, immediately above Oxhey Lane. The scheme only comes into effect during high flows, with normal stream flows passing on their natural course under Oxhey Lane and through Carpenders Park.

The earth dam is 280m long, with a crest height 4.1m above the valley floor, and is designed to hold 42,000m^3 of water[34]. During storm events, river flows enter the storage area, and are slowly discharged downstream via a small pipe in the earth dam. Excess water spills into the adjacent field, allowing temporary flood storage over a period of a few hours.

Markyate and Wheathampstead Flood Storage Areas, Dacorum and St Albans City and District

Two further Flood Storage Areas are located in the north of the study area. The largest is Markyate Flood Alleviation scheme in Dacorum. The on-line storage area is located on the River Ver, upstream of the B4540 Luton Road in northern Markyate. An additional smaller Flood Storage Area in central Wheathampstead, is located on the left bank of the River Lee, west of Station Road.

Luton Hoo Reservoirs, Central Bedfordshire

Reservoirs at Luton Hoo are seen to provide attenuation of flood flows upstream of Batford and Wheathampstead. However, the 2007 SFRA concluded that the capacity of the lakes is slowly being exceeded due to increased runoff from the expanding urbanised areas of Luton and therefore their ability to attenuate flood flows on the River Lee entering St. Albans District is diminishing.

7.4 Planned Flood Alleviation Schemes

There are no planned flood alleviation schemes identified in South West Hertfordshire within the Environment Agency and Hertfordshire County Council programmes.

Investigation into the management of water abstraction on the Rivers Ver and Mimram is currently being undertaken, and will cover the potential for flood alleviation schemes.

7.5 Flood risk assets

In its role as Lead Local Flood Authority, under Section 21 of the Flood and Water Management Act, Hertfordshire County Council is required to produce and maintain a

34 National Rivers Authority Thames Region (1996) Hartsbourne Stream Proposed Flood Alleviation Scheme. Available at: http://www.environmentdata.org/archive/ealit:3257.

register of assets in the county which are deemed to have a significant impact on flood risk. The Flood Risk Asset Register is made publicly available on the County Council website[35].

The significant flood risk assets identified in the Asset Register are provided in Table 7-3.

Table 7-3: Significant Flood Risk Assets in South West Hertfordshire, as identified within the Hertfordshire Section 21 Asset Register

Asset ID	Location	District / Borough	Asset type
01SADC	Jersey Farm, St Albans	St Albans CDC	Culvert
02SADC	Entrance to Rose Acre, Redbourn	St Albans CDC	Speed Table (raised traffic calming device)
03SADC	On edge of Oaklands Lane (comes out from under road)	St Albans CDC	Culvert
03TRDC	In grounds of St Mary's School	Three Rivers DC	Headwall
04TRDC	Just off Stockers Farm Road	Three Rivers DC	Outfall

In addition, Watford Borough Council operate two sluices on the River Colne at Riverside Road in Watford, which impact on control of river levels and the managing the severity of flooding experienced on Riverside Road. Two weirs operating in the Durrants lake area (Two Waters, Hemel Hempstead) in Dacorum Borough also have an impact on flood risk, with blockage of these assets resulting in localised flooding of Durrants Hill.

7.6 Residual risk in South West Hertfordshire

Relatively few areas in South West Hertfordshire rely on formal flood defences. Therefore, there are limited areas where there is potential for rapid inundation to occur in the event of a breach/ failure.

In the case of all forms of residual risk, topography is the dominant factor in determining how quickly flood flows could be routed towards properties or infrastructure. Any inundation resulting from a failure in raised embankments (which

35 Hertfordshire County Council (2015) Section 21 Asset Register. Available at: https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/flood-risk-management/section-21-asset-register-march-2015.pdf

are not formal flood defences) in South West Hertfordshire would be unlikely to cause flooding which extended beyond the existing Flood Zones.

An asset which poses a residual flood risk is the Hemel Hempstead Flood Relief Culvert, which diverts a considerable proportion of flow from the River Gade through the town centre. Blockage or collapse of this structure is predicted to cause localised flooding of densely populated areas within Hemel Hempstead, as previously assessed within the Dacorum Level 2 SFRA.

In terms of impounding structures, although the probability of occurrence is low, there is the potential for the structures to fail suddenly, releasing significant volumes of floodwater within a short duration towards downstream areas.

There is a residual risk of reservoir flooding across much of South West Hertfordshire, although the likelihood of such an event occurring is very low. Environment Agency Reservoir Inundation Mapping suggests that, due to the steep topography and well-defined river channels within South West Hertfordshire, flood waters would be conveyed and confined within the main watercourses, rather than causing extensive flooding to low-lying areas of settlements.

Perhaps a greater residual risk in South West Hertfordshire is the breach or overtopping of the Grand Union Canal, particularly where the canal is raised by embankments above a populated urban area. This is particularly the case at Berkhamsted in Dacorum, where the existing Level 2 SFRA identified a residual risk of inundation to land between the Grand Union Canal and River Bulbourne, due to canal overtopping. Unlike fluvial flood risk, canal water levels can be controlled and contained within individual reaches through the use of locks, and therefore the risk can be contained.

However, the actual and residual risk of canal flooding needs to be assessed on a site by site basis for any proposed allocation or future development sites. A high level screening of sites within a radius of canal embankments has been undertaken within the Level 1 SFRA. However, where sites are identified as at risk, it may be necessary for canal risk to be further assessed within a site-specific Flood Risk Assessment, and where required a Level 2 SFRA to be undertaken.

8 Cross-Boundary Considerations

8.1 Cumulative impact of development

When allocating land for development, consideration should be given not only to flood risk on the site, but also the potential cumulative impacts on flood risk within a catchment. Development increases the impermeable area within a catchment, which if improperly managed, can cause loss of floodplain storage, increased volumes and velocities of surface water runoff, and result in heightened downstream flood risk. Whilst individual developments may only have a minimal impact on the hydrology and flood risk of an area, the cumulative effect of multiple developments may be more severe.

The cumulative impact should be considered throughout the planning process, from the allocation of sites within the Local Plan, to the planning application and development design stages.

It should be noted that, during the preparation of this Level 1 SFRA, all known potential development sites have been assessed, regardless of their feasibility or availability for development. Sites within the four Local Authorities have been provided from Strategic Housing Land Availability Assessments (SHLAAs), Brownfield Land Registers, the Local Planning Authority Call for Sites process, and more strategic development areas. Once preferred options for the Local Plan are identified, their cumulative impact can be considered in more detail.

In consultation with Hertfordshire County Council and the Environment Agency, conditions set by Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council should support the implementation of SuDS and appropriate flood mitigation measures. As a minimum, development should have a neutral impact on flood risk, and where possible should improve existing issues, to ensure that flood risk is not exacerbated either within, or outside of, the Council's administrative area.

All developments should include an allowance for long-term storage within their calculations of surface water storage requirements, in order to manage runoff from the site during rainfall events in excess of 6 hours. Advice on how to calculate long-term storage volumes is provided in the CIRIA SuDS manual[36].

8.1.1 Cumulative impacts at a catchment-scale

To keep pace with forecasted population growth, the scale of development expected in South West Hertfordshire across the Local Plan periods is likely to lead to significant changes in land use from rural to urban, and this trend might reasonably be expected to continue beyond the plan period.

[36] CIRIA (2015) The SuDS Manual (C7530). Available at: https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

A high-level assessment has been undertaken, to provide an indication of the pattern of growth across the study area, the hydrological catchments within which this growth is likely to fall, and the existing flood risk issues which should be taken into account when allocating development.

The catchments were ranked based on the level of potential future development pressure (based on all sites received by Councils during the Local Plan process), and the extent of predicted and recorded flood risk within each catchment. The assessment considered flood incidents reported to Hertfordshire County Council, Environment Agency recorded outlines of fluvial flood incidents, as well as locations of higher surface water flood risk, identified as part of Surface Water Management Plans within South West Hertfordshire.

Further details of the methodology used to assess the cumulative impacts of development on flood risk are provided in Appendix D.

Planning policy considerations have been identified for the below catchments, where cumulative development is likely to have the greatest impact on flood risk to communities.

Thame upstream of Aylesbury Catchment (Dacorum)

Should development be proposed around Tring, it would lie within the headwaters of the Upper Thame catchment. Surface water flooding issues have been identified within Tring itself, as well as at Long Marston, to the north. The major settlement of Aylesbury, located downstream on the River Thame, also experiences fluvial flooding.

Providing longer-term storage of surface water within such development sites at Tring could provide some attenuation of flows in the upper Thame catchment, reducing the flood peak on the River Thame where it enters Aylesbury. In addition, it may help to manage surface water flooding issues both within the town and at Long Marston, further downstream.

Ver Catchment (Dacorum, St. Albans)

The Ver catchment extends from southeast Luton to southern St. Albans, where it forms a confluence with the Upper Colne. The upper Ver catchment is relatively rural, however it becomes increasingly urbanised downstream, incorporating the settlements of Markyate, Redbourn, eastern Hemel Hempstead and western St. Albans.

With the exception of Markyate, fluvial flood risk is largely concentrated in rural areas. However, the Ver is a comparatively narrow and steep catchment within South West Hertfordshire, which has the potential to convey surface water runoff quickly downstream. This is supported by surface water flood incidents and SWMP hotspots located in Markyate, Redbourn, St. Albans and eastern Hemel Hempstead. As a tributary of the River Colne, flows from the Ver may impact the downstream flood risk associated with the Colne, particularly within the nearest settlements of eastern Watford and Oxhey.

Development in the catchment may well be wide-ranging, with the potential for larger allocations in rural areas and suburban peripheries, and smaller infill sites within existing built up areas. Providing appropriate storage for surface water in the sites upstream of the key settlements could help to alleviate existing surface water flooding issues. For brownfield and infill sites, which could have a large collective impact on surface water, opportunities should be taken to improve upon existing runoff rates through implementation of SuDS.

As a groundwater-fed watercourse, the River Ver catchment may also be sensitive to increases in impermeable area, as the ability of rainfall drain into the ground and maintain groundwater levels may be restricted. Maintaining Green Infrastructure within the catchment, and using these spaces to accommodate above-ground, landscaped SuDS is likely to be appropriate in both managing surface water runoff, and encouraging recharge of the groundwater-fed watercourse.

Upper Colne and Ellen Brook Catchment (St. Albans)

The Upper Colne and Ellen Brook Catchment extends from Luton in the north to the confluence with the River Ver in southern St. Albans. It is a largely rural catchment, however incorporates the settlements of Harpenden, eastern St. Albans and London Colney.

Fluvial flood risk in Harpenden, London Colney and southern St. Albans is confined to a relatively narrow floodplain, due to the steeper topography. However, significant surface water flow paths form in the east of the catchment, with several flood incidents recorded in Harpenden and the Jersey Farm area of St. Albans. Surface water flow paths which have contributed to flooding issues are identified within the SWMP hotspots in Harpenden and east St. Albans.

Without appropriate management of surface water, development within Harpenden, London Colney, and the northern and eastern periphery of St. Albans has the potential to lead to an increase flooding to these areas. Due to the large surrounding rural areas, catchment-scale approaches could be used to slow and hold back the flow of surface water pathways by creating storage areas, particularly upstream of key settlements and SWMP hotspots.

Colne (from Confluence with Ver to Gade) Catchment (St. Albans, Three Rivers, Watford)

The urbanised catchment extends from Abbots Langley in the north, to eastern Watford, Carpenders Park, Oxhey and South Oxhey. Within the catchment, there is significant flood risk from the River Colne, Hartsbourne Stream and Oxhey Brook, as well as surface water flow paths which follow the topography and are impeded by embankments for major transport infrastructure.

Due to the more urbanised nature of the catchment, development sites are likely to involve redevelopment or infill, on comparatively smaller sites than elsewhere in South West Hertfordshire. Taken individually, these sites may not require a FRA or drainage

strategy. However, taken collectively, their cumulative impact could significantly increase the volume of surface water runoff within the catchment, increasing flood risk to existing properties. Development of these sites should strive to limit discharge rates and volumes to greenfield, in line with Hertfordshire County Council policy.

To provide wider flood risk benefits to the mid-Colne catchment, development sites in the upper catchment, such as north of Watford and around Abbots Langley, should consider the provision of long-term storage. This would control the release of surface water volumes from the site during and immediately after storm events, help to reduce and delay the peak flows on the River Colne reaching south Watford and Oxhey.

Development within Flood Zone 3 should strictly adhere to national guidance on ensuring no net loss in floodplain storage, and seek to deliver additional flood risk management benefits within the site, to restrict the volume of flood water reaching downstream communities.

Gade (Bulbourne to Chess) Catchment (Dacorum, Three Rivers, Watford)

The catchment forms the lower extent of the River Gade, extending from the confluence with the River Bulbourne in Hemel Hempstead, to the confluence with the River Chess at Rickmansworth.

To the east and south the catchment is urbanised, covering east Hemel Hempstead, west Watford and Croxley Green, whereas the western area is more rural, with Bovingdon forming the largest settlement.

Significant surface water flow paths flow towards the River Gade, following the natural topography. This is reflected in the high number of surface water flooding incidents reported in Bovingdon, Frogmore End in Hemel Hempstead and Croxley Green, which have been identified, alongside west Watford, as SWMP hotspots.

As rural areas fringe the major towns, areas at the edge of these towns will be considered for development, within the Gade (Bulbourne to Chess) catchment. If left unattenuated, the developments have the potential to worsen surface water flooding issues in the catchment towns, as well as increasing river flows in the Lower Gade and the River Colne downstream at Rickmansworth.

Opportunities should be taken to implement SuDS schemes which reduce runoff to greenfield runoff rates or less, and hold back surface water during storm events. A catchment-based approach could also be taken, to manage surface water, particularly in the northwest of the catchment, by creating storage areas and interrupting known surface water flow paths.

8.1.2 Recommendations

The overall analysis provides a context for further appropriate consideration of catchment-scale flood risk issues, once the Local Plans reach Pre-Submission (draft site allocation) stage.

In addition to assessment at a SFRA level, it is recommended that site-specific FRAs are required to include consideration of the cumulative effects of the proposed

development. It should be demonstrated that flood risk downstream will not be made worse by the combination of effects from more than one development allocation.

As in the case of this assessment, the four Councils should consider the impacts of development both within and adjacent to their Local Authority boundaries. Where required, this may form part of a Level 2 SFRA.

8.2 Cross-boundary issues

In addition to catchment-scale flood risk considerations, South West Hertfordshire is formed of four authorities, and borders a further ten authorities, therefore cross-boundary flood risk is a key consideration.

The South West Hertfordshire study area borders the following Local Authorities:

- Aylesbury Vale District
- Central Bedfordshire District
- Chiltern District
- East Hertfordshire District
- Hertsmere District
- London Borough of Harrow
- London Borough of Hillingdon
- North Hertfordshire District
- South Bucks District
- Welwyn Hatfield Borough

The topography of the study area and direction of watercourse flow means that South West Hertfordshire has the potential to affect the flood risk in all of the above neighbouring authority areas, with the exception of Central Bedfordshire. In contrast, as the steep chalk uplands of South West Hertfordshire form the headwaters of the surrounding river catchments, the study area is likely to be affected by relatively few neighbouring authorities, namely Aylesbury Vale, Central Bedfordshire, Chiltern and Hertsmere.

A high-level overview of potential cross-boundary flood risk issues is provided in Table 8-1 for the four authorities within South West Hertfordshire, and the neighbouring authorities. In the vast majority of cases, if appropriate flood risk considerations and management of surface water drainage are provided, development in neighbouring authorities is unlikely to affect flood risk in South West Hertfordshire.

Where sites are located near an authority boundary, or have the potential to contribute to, or be affected by, flood risk in an adjacent authority, site developers are advised to also consult the SFRAs of the relevant adjacent authorities.

It is recommended that the four authorities within South West Hertfordshire consult both each other and neighbouring authorities, particularly during the consultation

phases of their respective Local Plans, to identify and review potential cross-boundary issues.

Table 8-1: Summary of potential cross-boundary flood risk issues in South West Hertfordshire and neighbouring authorities

	Within South West Hertfordshire		Surrounding Authorities	
	Potential to Affect	**Potential to be Affected by**	**Potential to Affect**	**Potential to be Affected by**
Dacorum	Three Rivers	N/A	Aylesbury Vale	Aylesbury Vale
	St. Albans		Chiltern	Central Bedfordshire
St. Albans	Watford	Dacorum	East Hertfordshire	Central Bedfordshire
			North Hertfordshire	
			Hertsmere	
			Welwyn Hatfield	
Three Rivers	Watford	Dacorum	South Buckinghamshire	Chiltern
		Watford	LB of Hillingdon	Hertsmere
			LB of Harrow	
Watford	Three Rivers	Three Rivers	N/A	Hertsmere
		St. Albans		

9 Guidance for planners and developers: Flood risk

9.1 When is an FRA required?

The requirement for an FRA is set out in Paragraph 163 of the NPPF (footnote 50). The Flood Risk Assessment: Local Planning Authorities[37] guidance and Flood Risk Assessment for Planning Applications[38] guidance describe when a FRA is needed as part of a planning application, how it should be prepared and how it is processed. In South West Hertfordshire, an FRA is required in the following circumstances:

- All developments greater than 1 ha located in Flood Zone 1. The FRA must consider the vulnerability of the site to flooding from other sources (surface water, groundwater, ordinary watercourses and sewers), as well as the effect of the new development on flood risk and surface water runoff.
- All developments located within Flood Zone 2 or 3 or 3a plus climate change. This includes standing advice for minor developments such as non-residential extensions, alterations which do not increase the size of the building or householder developments. It also includes changes of use of an existing development.
- All developments where proposed development or a change of use in development type (e.g. conversion of commercial to residential) could be subject to other sources of flooding. This applies to those less than 1ha in Flood Zone 1.
- All developments located in an area which has been highlighted as having critical drainage problems by the Environment Agency.

Sites which do not fall within the above requirements, for example sites smaller than 1ha, are still required to carry out an appropriate level of assessment, relative to the scale of development and flood risk to the site.

Advice should be sought from the LPA (Dacorum Borough Council, Three Rivers District Council, St. Albans City and District Council and Watford Borough Council), the LLFA (Hertfordshire County Council) and/or the Environment Agency, as appropriate, at the pre-planning application stage to determine the need for a site-specific FRA. The Environment Agency charge a fee for this advice. Hertfordshire County Council and the LPAs also have a charging schedule for pre-application discussions, which can include flood risk matters.

Hertfordshire County Council will be consulted on the flood risk and surface water drainage aspects of all major development proposals (see Section 11). The

37 Department for Environment, Food and Rural Affairs (2017) Flood risk assessment: local planning authorities. Available at: https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities.

38 Department for Environment, Food and Rural Affairs (2017) Flood risk assessment for planning applications. Available at: https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications.

Environment Agency will be consulted on development in areas of fluvial flood risk from Main rivers (see Section 13.1.5) and within Groundwater Source Protection Zones.

9.2 Requirements for flood risk assessments

The aim of an FRA is to demonstrate that the development is protected to the 1 in 100-year (1% AEP) event and is safe during the design flood event, including an allowance for climate change. This includes an assessment of mitigation measures required to safely manage flood risk.

FRAs should follow government guidance on development and flood risk, complying with the approach recommended by the NPPF (and its associated guidance)[39] in appraising, managing and reducing the consequences of flooding both to and from a development site.

An FRA should first assess in detail the level of flood risk to the site, including but not limited to:

- The area liable to flooding from all sources of flood risk, including fluvial, surface water and drainage.
- The probability of flooding occurring now and over time.
- The extent and standard of existing flood defences and their effectiveness over time.
- The likely depth of flooding.
- The rates of flow likely to be involved.
- The likelihood of impacts to other areas, properties, habitats and protected species.
- The effects of climate change.
- The nature and currently expected lifetime of the development proposed.

Proposals for the design of the site should:

- Be performed in accordance with the requirements of the Sequential Test and, when necessary, the Exception Test.
- Not increase flood risk, either upstream or downstream, of the site, taking into account the impacts of climate change.
- Not increase surface water volumes or peak flow rates that would result in increased flood risk to the receiving catchments.
- Ensure that where development is necessary in areas of flood risk (after application of the Sequential and Exception Tests and the sequential approach),

39 Environment Agency (2014) Flood risk assessments for planning applications. Available at: https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

it is made safe from flooding for the lifetime of the development, taking into account the impact of climate change as stated in Paragraph 157 of the NPPF.

- Use opportunities provided by new development to reduce flood risk and provide betterment within the site and elsewhere.
- Seek to use natural flood management such as increasing floodplain connectivity and enhancing natural flood storage to provide connectivity for the movement of flood water, habitats and protected species.

Planning Applications should use, and be assessed against, the latest flood risk data and guidance available. These include the Flood Zone mapping, flood risk assessment requirements and climate change allowances made available by the Environment Agency, as well as flood risk management policies and guidance from Hertfordshire County Council, as Lead Local Flood Authority.

Where a proposed site lies close to the Grand Union Canal, detailed supporting evidence, including hydraulic modelling, should be provided, to demonstrate that the proposed development would remain safe from the risk of flooding due to breach or overtopping of the canal. Particular attention should be given to sites where the canal is embanked and raised above site level.

In circumstances where FRAs are prepared for windfall sites, then they should include evidence that demonstrates that the proposals are in accordance with the policies set out in the Local Plan.

9.3 Assessing the impact of climate change

At all stages of the development process it is important to understand not only the current flood risk to a site but also the flood risk for the lifetime of the development, taking into account the future impact of predicted climate change. The Hertfordshire and North London Area Environment Agency guidance should be consulted for all types of development.

As many areas currently situated within Flood Zone 2 may become part of Flood Zone 3a in the future, due to the effects of climate change, it is essential that the potential risk of flooding in the future is considered when planning development.

In accordance with the Flood Risk Assessments: Climate change allowances guidance issued by the Environment Agency, FRAs are required to demonstrate that future implications of climate change have been considered, and that risks are managed for the lifetime of the proposed development. This may include for instance:

- Consideration of the vulnerability of the proposed development types or land use allocations to flooding and directing the 'more vulnerable' land uses away from areas at higher risk due to climate change.
- Use of 'built in' resilience measures (e.g. raised floor levels).

- Designation of non-habitable areas of the site as to confine the expected flood extent, under predicted climate change scenarios.

When carrying out an FRA, it may be necessary to carry out new or additional modelling to properly test these climate change allowances. It is advisable to contact the Environment Agency to establish what is expected for any particular site, and whether any new modelling is available. If a site is located close within Flood Zone 1 but close to Flood Zone 2, consideration may need to be given to whether the increased flood extents may impact the site.

9.3.1 Fluvial flooding

A climate change outline for the 1 in 100-year event (Flood Zone 3a plus climate change) for the period up to 2115 has been provided in Appendix A. The climate change allowance that has been applied to this study has produced a Flood Zone 3a + Climate Change extent which combines both the 1 in 100-year plus 35% and plus 70% climate change modelled flood extents. Further detail on the choice of climate change scenario used for this SFRA is given in Section 4.2.

However, climate change affects the frequency, as well as the extent of flooding. For example, a storm which currently has a 2% probability of occurring in any one year, may increase to a 5% probability under climate change.

The impact of an event with a given probability is also likely to become more severe. As water depths, velocities and flood hazard increase, so will the risk to people and property.

Although qualitative statements can be made as to whether extreme events are likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of the localised impact of these changes.

9.3.2 Surface water flooding

Climate change is predicted to increase rainfall intensity in the future by a range of between 20% and 40% (the recommended national precautionary sensitive range for 2085 to 2115). This will increase the likelihood and frequency of surface water flooding across South West Hertfordshire. The impact of climate change on surface water flooding has been assessed as part of this SFRA, and is shown in Appendix A.

9.3.3 Groundwater flooding

The effect of climate change on groundwater flooding, and those watercourses where groundwater has a large influence on winter flood flows is more uncertain. Groundwater flooding linked to permeable surface deposits (e.g. in river floodplain gravels) is predicted to increase with fluvial flood frequency, whereas the future behaviour groundwater flooding from chalk aquifers is less well understood[40].

40 Sayers and Partners Ltd. (2015) UK Climate Change Risk Assessment 2017: Projections of future flood risk (Main Report). Available at: https://www.theccc.org.uk/wp-content/uploads/2015/10/CCRA-Future-Flooding-Main-Report-Final-06Oct2015.pdf.pdf

9.4 Reducing flood risk through site layout and design

9.4.1 Sequential approach to site design

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. The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from all sources of flood risk.

In terms of fluvial risk, all built development should ideally be sited within Flood Zone 1, leaving higher risk Flood Zones undeveloped (e.g. open space) preserving flow routes and flood storage. If this is not possible, then Table 3 of the NPPF[41] indicates appropriate development within each Flood Zone.

Areas at risk from surface water or locations at risk of groundwater emergence should also be protected from development to ensure flow routes are not blocked, preventing water from building up to potentially dangerous depths (see also Section 7). The RoFSW maps, groundwater monitoring and detailed surface water or groundwater modelling should be used to inform the site design at the masterplanning stage. The Councils promote innovative and flexible design where it is in keeping with the character of the area. Development proposals will be assessed and considered on a site by site basis.

Waterside areas, SuDS, or areas along known surface water flow routes can act as Green Infrastructure. These can be used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time, providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas and avoid the creation of isolated islands as water levels rise.

More flood-compatible development (e.g. vehicular parking, recreational space) may be located in higher risk areas. In assessing the acceptability of vehicular parking in floodplains account should be taken of the nature of parking, flood depths and hazard, including evacuation procedures and flood warning.

There is a requirement to have a buffer of at least 8 metres between the top of the bank of any Main River, and the built environment. The built environment includes formal landscaping, sport fields, footpaths, lighting and fencing, and the buffer should be managed for native biodiversity. If this buffer is not provided, the development is likely to be subject to an objection by the Environment Agency. For Ordinary Watercourses, Hertfordshire County Council also seek to retain a reasonable clearance, with a buffer of at least 3m from the top of each bank expected along watercourses[42].

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41 Department for Communities and Local Government (2014) Technical Guidance to the National Planning Policy Framework. Table 3: Flood risk vulnerability and flood zone 'compatibility'. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf

42 Hertfordshire County Council (2018) Policy 8: Construction near to culverts, Local Flood Risk Management Strategy – Consultation Version. Available at: https://www.hertfordshire.gov.uk/about-the-council/consultations/environment/local-flood-risk-management-strategy-2018.aspx

It is recommended that the four authorities of South West Hertfordshire adopt the Environment Agency and Hertfordshire County Council requirements, within Local Plan policy where possible, for construction to be located at least 8m from a Main River and at least 3m from an Ordinary Watercourse.

9.4.2 Access and egress

Safe access and egress must be provided during the 100-year plus climate change event from any source of flooding. Of particular importance in South West Hertfordshire, the Councils will seek to ensure that safe access and egress is provided for changes of use to a More Vulnerable classification (e.g. commercial to residential) within surface water risk areas in Flood Zone 1.

9.5 Mitigation measures

In accordance with the Flood Risk Management Hierarchy in Figure 5-1, mitigation measures should be considered as a last resort to address flood risk issues, where the Sequential and Exception Tests have demonstrated that development is necessary for wider sustainability benefits.

Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

The minimum acceptable standard of protection against flooding for new residential property within flood risk areas is 1 in 100-year (1%) plus climate change annual probability for fluvial flooding. An allowance for climate change over the lifetime of the development must be made when assessing each of these scenarios. The measures chosen will depend on the nature of the flood risk.

Where a site is at risk of other forms of flooding, including canals and surface water, property mitigation measures must take into account the maximum flood extent from these sources.

9.5.1 Building design and raised floor levels

The raising of floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of a flood. Finished Floor Levels (FFL) are usually recommended in line with the Environment Agency's Guidance on Flood Risk, which requires a minimum FFL of 300mm above the modelled 1 in 100-year (1%) Annual Exceedance Probability (AEP) fluvial water level with allowance for climate change. This additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

The allowance of 300mm above the 1 in 100-year (1% AEP) flood extent also applies to sites at risk of canal flooding, where there further hydraulic modelling of the residual risk of a breach or overtopping event has been undertaken.

If residual surface water flood risk remains following the site drainage design (see also Section 7), the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk. FFLs should also be 300mm above the modelled 1 in 100-year (1%) AEP surface water level with allowance for climate change where available. If no surface water model is available, FFLs should be 300mm above ground level.

When raising FFLs, consideration must be given to ensuring that the development is still accessible to all.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water. This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test.

9.5.2 Development and raised defences

Construction of localised raised floodwalls and embankments to protect new development is unlikely to be an option in South West Hertfordshire. Raised defences have been installed to alleviate flooding in other locations across the study area. However, a residual risk of flooding remains, and will need to be assessed and mitigated within a site-specific FRA. Compensatory storage must be provided where raised defences remove storage from the floodplain.

Temporary or demountable defences are not acceptable forms of flood protection for a new development, but they might be appropriate to address circumstances where the consequences of residual risk are severe.

In addition to the technical measures, the proposals must provide details of how any temporary or permanent measures will be erected and decommissioned, responsibility for maintenance, lifetime maintenance costs and the cost of replacement when the defences deteriorate.

Adoption and maintenance of any raised defences will be the responsibility of the developer and not the Environment Agency, local authorities, or the Canal and River Trust.

9.5.3 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site, in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities, property or protected habitat.

There should be no interruption to flood flows or loss of flood storage as a result of any proposed development. Flood storage compensation may be appropriate for sites on the edge of the existing floodplain or within a flood cell.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary.

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment and must demonstrate that there is no adverse impact on the hydrological and hydrogeological setting.

9.5.4 Developer contributions

In some cases, and following the application of the Sequential Test, it could potentially be necessary for the developer to make a contribution to the improvement of flood management provision that would benefit both proposed new development and the existing local community.

Where a proposed development is deemed to have a direct impact on flood risk, a contribution towards a flood alleviation scheme may be required under Section 106 of the Town and Country Planning Act, to make a development acceptable. Elsewhere, the Community Infrastructure Levy may be used for the provision of flood risk management infrastructure.

9.5.5 Groundwater mitigation

Groundwater flooding has a complex, and very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. An available option to manage groundwater flood risk would be through building design (development form), ensuring Finished Floor Levels are raised 300mm above the water levels caused by a 1 in 100-year plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream. Obstruction of sub-surface flows by buried services and basements should be avoided.

Infiltration SuDS can cause locally increased groundwater levels and subsequently may increase flood risk on or off the site. High groundwater levels would also cause them not to operate to their design capacity. Developers should provide evidence that this has been considered in the design and ensure that this will not be a significant risk. The depth of the proposed SuDS must be kept to a minimum and developers should make allowance for wide shallow SuDS such as wetlands and detention basins.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution and basements should be avoided in high groundwater zones.

9.5.6 Sewer flooding mitigation

Where development is proposed within, or further up the network from, areas where sewer flooding has been recorded, it is recommended that Thames Water are consulted as early as possible in the planning process, as there may be network capacity issues which need to be dealt with.

When redeveloping existing buildings, the installation of some permanent or temporary flood-proofing and resilience measures could protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.

10 Water Framework Directive, Green Infrastructure and Natural Flood Management

10.1 Water Framework Directive

Requirements of the WFD should be accounted for in the site layout and design. Developments should look at opportunities for river restoration and enhancement, and projects which reconnect rivers with their floodplains. These ideas and plans should be incorporated into the development plans from an early stage. Options include: backwater creation, de-silting, de-culverting and naturalising the channel through in-channel habitat enhancements and removal of structures.

Early engagement with the Environment Agency for guidance and advice is strongly encouraged. Where works alter flow within a watercourse, designs will require supporting hydraulic modelling.

When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river. Advice on river restoration, de-culverting and providing other environmental enhancements on development sites is available from the Environment Agency[43].

In South West Hertfordshire, achievement of WFD requirements is variable (summarised in Table 10-1). The majority of watercourses, including the Rivers Ver, Chess, Colne and Lee, as well as the Grand Union Canal, are classified as of 'Moderate' overall status. The Tring summit of the Grand Union Canal, in Dacorum, is the only watercourse to achieve a 'Good' overall status.

The River Thame upstream of Aylesbury, River Bulbourne, River Gade and Upper Colne are classified as 'Poor' in overall status, with the Upper Gade which flows through Hemel Hempstead, classified as 'Bad' in status. On most of these watercourses, the Environment Agency has set a target to achieve 'good' status by 2027.

From a groundwater quality perspective, a significant plume of bromate pollution was previously discovered in the chalk aquifer which provides the public water supply, from a former chemical works at Sandridge, St. Albans[44]. The groundwater quality is being monitored, and the affected area has been designated as contaminated land by St. Albans City and District Council. This area of pollution has significant implications on the extraction and discharge of water to ground, including the use of infiltration SuDS, in the east of St. Albans District.

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43 Environment Agency (2006). Building a better environment. A guide for developers http://www.environment-agency.gov.uk/static/documents/1_GETH1106BLNE-e-e(1).pdf

44 Sage, R. (2011) Contamination of public drinking water supply by boreholes by bromate. UK Groundwater Forum. Available at: http://www.groundwateruk.org/Groundwater-projects-bromate-pollution.aspx.

Table 10-1: Summary of Water Framework Directive (WFD) status of watercourses in South West Hertfordshire

Watercourse	Section	Overall WFD Status	Objective	District / Borough crosses	Key settlements
Grand Union Canal	Grand Union Canal, Tring summit to Milton Keynes	Moderate	Good by 2021	Dacorum BC	Wilstone
	Grand Union Canal, Tring summit	Good	Good by 2015	Dacorum BC	Tring Hemel Hempstead
	Grand Union Canal, Tring summit to Berkhamsted	Moderate	Good by 2027	Dacorum BC	Berkhamsted
				Three Rivers DC	Rickmansworth
	Grand Union Canal, Berkhamsted to Maple Lodge (Rivers Bulbourne, Gade and Colne)	Moderate	Good by 2027	Dacorum BC	Bourne End Hemel Hempstead Tring
				Three Rivers DC	Kings Langley
				Watford BC	Watford
River Bulbourne	Bulbourne	Poor	Good by 2027	Dacorum BC	Berkhamsted Hemel Hempstead Tring
River Chess	Chess	Moderate	Moderate by 2015	Three Rivers DC	Loudwater Rickmansworth
River Colne	Colne (upper east arm including Mimshall Brook)	Bad	Bad by 2015	St. Albans CDC	Roestock Colney Heath

Watercourse	Section	Overall WFD Status	Objective	District / Borough crosses	Key settlements
	Upper Colne and Ellen Brook	Poor	Good by 2027	St. Albans CDC	Napsbury Park Park Corner
	Colne (from Confluence with Ver to Gade)	Moderate	Moderate by 2015	Three Rivers DC	Rickmansworth
				Watford BC	Watford
River Gade	Gade (from confluence with Bulbourne to Chess)	Poor	Good by 2027	Dacorum BC	Hemel Hempstead Kings Langley
				Three Rivers DC	Croxley Green Abbots Langley
				Watford BC	Watford
River Lee	Lee (from Luton Hoo Lakes to Hertford)	Moderate	Moderate by 2015	St. Albans CDC	St. Albans Wheathampstead
River Thame	Thame upstream of Aylesbury	Poor	Good by 2027	Dacorum BC	N/A
River Ver	Ver	Moderate	Good by 2027	St. Albans CDC	Redbourn
				Dacorum BC	Markyate

10.2 Natural Flood Management, river restoration and enhancement

Natural Flood Management (NFM), also known as Working with Natural Processes (WWNP), is a means of managing the risk of flooding and erosion, through restoring the natural functions of river catchments or coastlines[45]. NFM schemes also provide ecological and water quality benefits which can aid the achievement of Water Framework Directive targets.

A series of strategic maps indicating the relative suitability of areas in England for NFM measures has been produced by the Environment Agency. The 'Mapping Areas of Potential for Working with Natural Processes' maps identify the potential for a range of options, including:

- Floodplain reconnection.
- Run-off attenuation features.
- Gully blocking.
- Woodland planting covering floodplain planting, riparian planting and wider catchment woodland.
- Broad land cover that could be used for targeting areas for soil structure improvement.

South West Hertfordshire is predominantly covered by the Colne Surface Water Management Catchment of the River Thames, with Dacorum Borough also covering the eastern section of the Thames and South Chilterns catchment.

Nationally-mapped opportunity areas for NFM measures across South West Hertfordshire are provided in Appendix A**Error! Reference source not found.**, and summarised in Table 10-2. However, it should be noted that opportunities for using NFM techniques are not limited to these areas (consideration should be given on a site by site basis when planning applications are determined).

45 Environment Agency (2014) Working with natural processes to reduce flood risk: research and development framework: summary (SC130004:S). Available at: https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk-a-research-and-development-framework.

Table 10-2: Opportunities for Natural Flood Risk Management (NFM) measures in South West Hertfordshire

NFRM Measure	Dacorum BC	St. Albans CDC	Three Rivers DC	Watford BC
Floodplain reconnection	River Bulbourne at Berkhamsted (Bourne End) to Confluence with River Gade at Two Waters, Hemel Hempstead	River Colne at London Colney	Confluence of the Rivers Colne, Chess and Gade at Rickmansworth	River Colne floodplain at Oxhey Park and Woodmere Avenue
	River Gade at Hemel Hempstead (near Park and Ride on Leighton Buzzard Road)	River Colne at Carpenders Park (west of Oxhey Lane and north of Brookdene Avenue)	River Colne at Rickmansworth (Maple Cross to Bury Lake, railway line at Moor Park)	
		River Ver at Sopwell, St. Albans (between Holywell Hill and Bluehouse Hill)	River Colne at Carpenders Park (west of Oxhey Lane and north of Brookdene Avenue)	
Woodland Planting (Floodplain, Riparian, Wider Catchment)	Floodplain: River Bulbourne at Berkhamsted	All: River Colne and River Ver catchments (south and east of St. Albans)	Floodplain, Riparian: River Chess (Chorleywood to Rickmansworth)	Floodplain: River Colne floodplain
	Riparian, Wider Catchment: Upper catchment of the River Thame, upstream of Tring at Wilstone and Long Marston	Floodplain: River Ver at Redbourn (and adjacent M1 corridor)		Wider Catchment: Bricket Wood Common and at South Way in the Woodside area
Runoff Attenuation Features	Upstream of Hemel Hempstead (at Jockey End and Little Gaddesden)	Areas surrounding St. Albans (How Wood, Park Street and St. Julians to the south. In the north, Delph Wood and the land adjacent to Redbourn Lane and Harpenden	Lower Gade catchment (Bovingdon, Kings Langley and Chandler's Cross)	North and west Watford (Leavesden Green, Kingswood and Garston areas)

NFRM Measure	Dacorum BC	St. Albans CDC	Three Rivers DC	Watford BC
		Road)		
		Harpenden (east and south at Nomansland, Sandridge and along Harpenden Road)		

10.3 Existing watercourses and assets

Permanent or temporary works within or adjacent to a watercourse require a Flood Risk Activity Permit from the Environment Agency (in the case of Main Rivers) or Ordinary Watercourse Consent from Herefordshire County Council (in the case of Ordinary Watercourses) under the Land Drainage Act 1991.

Proposed developments which are adjacent to Environment Agency assets, including Main River channels, must demonstrate a minimum clearance of 8m from these assets to permit maintenance and renewal. The Council will also seek to maintain a reasonable clearance from Ordinary Watercourses. It is recommended within all four authorities of South West Hertfordshire that a 8m wide buffer is maintained from a Main River, and construction is not permitted within 3m of an ordinary watercourse, in line with Policy 8 of the Hertfordshire Local Flood Risk Management Strategy[46].

The Environment Agency and Hertfordshire County Council have a presumption against allowing further culverting and building over culverts on Main Rivers. All new developments with culverts running through the site should seek to de-culvert main rivers and ordinary watercourses for flood risk management and conservation benefit. It is also encouraged that de-culverting is supported through Local Plan policy, where possible.

Existing watercourses and drainage channels should be retained, offering risk management authorities benefits in terms of maintenance, future upgrading, biodiversity and pollution prevention. The CIRIA (2010) Culvert Design and Operation Guide provides guidance in this area.

10.3.1 Riparian ownership

Where a watercourse runs across, under or next to a property, the landowner is known as a riparian owner, and is responsible for making sure water can flow freely. Watercourses can take many forms, from a natural channel above ground, to a piped

46 Hertfordshire County Council (2018) Hertfordshire Local Flood Risk Management Strategy – Consultation Version. Available at: https://www.hertfordshire.gov.uk/about-the-council/consultations/environment/local-flood-risk-management-strategy-2018.aspx

or culverted stream below ground. Riparian owners have the responsibility to make sure water can flow freely, without obstruction and without increasing the risk of flooding to neighbouring properties.

Works to a watercourse by a riparian owner still require a Flood Risk Activity Permit from the Environment Agency for Main Rivers, or an Ordinary Watercourse Consent from Hertfordshire County Council for Ordinary Watercourses.

Where developers are riparian owners, they should also assess existing assets (e.g. bridges, culverts, river walls, embankments) and renew them to last the lifetime of the development. Enhancement opportunities should be sought when renewing assets, e.g. bioengineered river walls, raising bridge soffits to account for climate change. Any works should be designed to be maintenance free, but there is an obligation to the riparian owner to undertake maintenance when required.

Further guidance on riparian ownership can be found on the government website[47], within the Hertfordshire County Council leaflet 'Responsibilities of a riparian owner'[48] and in the Environment Agency document 'Living on the Edge'[49].

47 Environment Agency (2018) Guidance: Owning a watercourse. Available at: https://www.gov.uk/guidance/owning-a-watercourse#owners-your-responsibilities

48 Hertfordshire County Council (2018) Responsibilities of a riparian owner. Available at: https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/ordinary-watercourses/service-standards/new-owc-leaflet-web-version-fv.pdf

49 Environment Agency (2012) Living on the Edge: a guide to your rights and responsibilities of riverside ownership. Environment Agency: Bristol.

11 Guidance for planners and developers: Surface water runoff and drainage

11.1 Introduction

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner and to mimic the local natural drainage. The inclusion of SuDS within developments is an opportunity to enhance ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy.

The Level 1 SFRA provides surface water drainage considerations to inform Local Plan policy, and the review of planning applications as part of the Development Management process. Technical guidance on SuDS design is provided by Hertfordshire County Council, as Lead Local Flood Authority, as well as within the Defra Non-statutory Technical Standards[50] and CIRIA SuDS Manual[51].

11.2 Local SuDS design guidance

Requirements and design principles for managing surface water runoff and drainage in South West Hertfordshire are outlined in detail within the Hertfordshire County Council SuDS Policy Statement[52].

The series of nine policies set out local design criteria for Hertfordshire, encourage the integration of SuDS in all development sites. The policies cover the management of flood risk both within and beyond the site boundary, construction and maintenance of SuDS schemes, and that the delivery of SuDS provides wider benefits of water quality, amenity and biodiversity.

11.2.1 SuDS suitability

SuDS can be integrated into the design of all new development within South West Hertfordshire. The effectiveness of SuDS within a site is defined by site characteristics including (but not limited to) topography, geology, soil permeability, water table, existing flow paths across the site, land ownership and the proportion of site area necessary to effectively manage surface water runoff and drainage.

Site characteristics can vary across a single site, so the type of SuDS and design should be specific to each site. For example, despite the underlying chalk geology, the potential for infiltration varies significantly across South West Hertfordshire. As a

50 Defra (March 2015) Non-statutory technical standards for sustainable drainage systems https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

51 CIRIA (2015) The SuDS Manual (C753). http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

52 Hertfordshire County Council (2018) Lead Local Flood Authority SuDS Policy Statement: Meeting Sustainable Drainage Systems Standards in Hertfordshire. Available at: https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/suds-policies-rev1-v2-webpage.pdf

result, the suitability of proposed infiltration techniques, such as soakaways or filter strips, will need to be informed by site-specific infiltration testing.

Areas of South West Hertfordshire with known high water tables and vulnerability to groundwater flooding may also be constrained by the suitability of certain types of SuDS techniques, such as infiltration.

Opportunities for SuDS in densely urbanised areas of South West Hertfordshire such as St. Albans, Hemel Hempstead, Rickmansworth and Watford may appear limited. However, there are a range of suitable, space-efficient options for managing surface water, such as green roofs, rainwater harvesting systems, rills and permeable paving, which can provide benefits in terms of efficient use of water resources, amenity, biodiversity and overall water quality.

11.2.2 SuDS design

Design requirements for all SuDS components are provided within the Hertfordshire SuDS Policy Statement. The CIRIA SuDS Manual also details the industry standards for the design of SuDS, and should be consulted in all surface water drainage designs.

A comprehensive understanding of the hydrological processes within a catchment (i.e. the nature and capacity of the existing drainage system) is essential in the design of SuDS. The site drainage must be designed around the natural flow routes (both onsite, and entering the site) at the masterplanning stage, keeping water on the surface to provide maximum benefits and must not contribute to flooding off site.

Details of the maintenance requirements for the surface water drainage system, and the party responsible for this maintenance should be provided and guaranteed for the lifetime of the development. There is a presumption against the four Local Planning Authorities in South West Hertfordshire adopting and maintaining SuDS, either directly or through the use of commuted sums.

Planning and managing the construction of SuDS is a key consideration, and a construction management plan should accompany SuDS proposals. Further construction guidance and considerations are detailed in the CIRIA Guidance on the Construction of SuDS[53].

11.2.3 Runoff rates and storage volumes

Hertfordshire guidance on designing runoff rates and storage volumes is in keeping with, or an improvement on, best practice (Defra Non-Statutory Technical Standards for Sustainable Drainage), with the following requirements for developments on greenfield and previously developed sites:

53 CIRIA (2018) Guidance on the Construction of SuDS (C768). Available at: https://www.ciria.org/Resources/Free_publications/Guidance_on_the_construction_of_SuDS_-_C768.aspx.

- The peak runoff rate and volume from the development for the 1 in 1-year and the 1 in 100-year events must not exceed the peak greenfield runoff rate for the same event.
- Flooding must not occur on any part of the site for a 1 in 30-year rainfall event.
- Flooding must not occur during a 1 in 100-year plus climate change 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.
- Rainfall in excess of a 1 in 100-year plus climate change rainfall event must be managed via exceedance routes that minimise the risks to people and property.

On previously developed sites, runoff rates should be restricted to the greenfield rate. Where this can be demonstrated to be unfeasible, the site is required to meet a "betterment" rate, which is considerably lower than the previously developed state.

For residential development, which has an assumed design life of 100 years, the 'upper end' (2080s) climate change allowance of 40% must be applied to storage volumes for the 1 in 30-year and the 1 in 100-year rainfall events. The upper end '2050s' allowance of 20% may be appropriate for developments with a short to medium-term design life, such as employment sites.

An allowance in calculations must also be made for 'urban creep', the impact of permeable surfaces in a development (e.g. front gardens), gradually becoming paved over to form impermeable extensions (such as patios or driveways). The urban creep allowance referenced within the latest Hertfordshire SuDS Design Guidance should be applied.

11.2.4 Discharge location

The destination of surface water that is not collected for use on site should be prioritised, with water re-use preferred, followed by infiltration, then discharge to surface waters, such as a watercourse or lake.

New connections to existing surface waters or combined sewers are the least preferred options, and should only be considered where other discharge routes are proven to be infeasible. Discharge to a foul sewer is not a viable option, as it is a major contributor to sewer flooding.

The sewerage undertaker should be consulted at an early stage to ensure that sufficient capacity is available in the existing drainage system. Where a connection is to be made to the surface water or combined sewer, the FRA should include confirmation from the sewage undertaker that the connection will not result in an increase in the flood risk off-site.

11.2.5 Water quality, biodiversity and amenity

Several stages of treatment are required before surface water runoff enters the ground or a surface water body, to ensure the removal of pollutants. The initial 10-15mm of rainfall, or "first flush" of pollutants, is required to be treated where it falls. Developments in Hertfordshire are required to ensure the subsequent levels of treatment are proportionate to the water quality sensitivity of the receiving water body.

The concept of delivering multiple benefits through SuDS is central to the guidance for Hertfordshire. SuDS are encouraged to be incorporated into public spaces, schools and play areas to provide multifunctional spaces, which also manage flood risk. SuDS in Hertfordshire are also recommended to use natural, native planting, to provide habitats for local wildlife.

Appendix I provides an overview of the accessible green spaces in South West Hertfordshire, which provide opportunities for SuDS features providing a public amenity value.

11.3 Further guidance on SuDS

Further general guidance on SuDS can be found in the documents and websites below:

- Hertfordshire County Council Local Flood Risk Management Strategy Principle 6: Ensuring that flood risk arising from new development is managed appropriately[54].
- CIRIA - there are several CIRIA guides relating to SuDS, most notably the CIRIA SuDS Manual[55] and Guidance on the construction of SuDS[56].
- Defra Non-statutory Technical Standards for Sustainable Drainage Systems[57].
- Institution of Civil Engineers & ACO (2018) SuDS Route Maps: Guide to Effective Surface Water Management[58].
- Susdrain website[59] - online community for delivering sustainable drainage.
- Local Authority SuDS Officer Organisation - Non-Statutory Technical Standards for Sustainable Drainage: Best Practice Guidance[60].

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54 Hertfordshire County Council (2018) Local Food Risk Management Strategy: Principle 6 – Consultation Version. Available at: https://www.hertfordshire.gov.uk/media-library/documents/about-the-council/consultations/environment/principle-6.pdf.

55 CIRIA (2015) The SuDS Manual (C753). http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

56 CIRIA (2017) Guidance on the construction of SuDS (C768). Available at: https://www.ciria.org/Resources/Free_publications/Guidance_on_the_construction_of_SuDS_-_C768.aspx

57 Defra (March 2015) Non-statutory technical standards for sustainable drainage systems https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

58 Institution of Civil Engineers & ACO (2018) SuDS Route Maps: Guide to Effective Surface Water Management. Available at: https://www.ice.org.uk/getattachment/knowledge-and-resources/best-practice/sustainable-drainage-systems/ICE-ACO-SuDS-Route-Map-Booklet-Feb2018.pdf.aspx

59 Susdrain website http://www.susdrain.org/

60 Local Authority SuDS Officer Organisation - Non-Statutory Technical Standards for Sustainable Drainage: Best Practice Guidance

- BSI Standards Publication BS8582 Code of practice for surface water management for development sites[61].

11.4 Wastewater

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and regionally.

Major developments and those upstream of areas where sewer flooding is known to be a problem must carry out wastewater capacity checks and should liaise with the sewerage undertaker at an early stage. This is to prevent an increase in sewer flooding and/or spills from combined sewer overflows (CSOs) further down the wastewater system, as a result of the development.

The impact of an increased volume of foul water discharge on watercourses should also be considered for large sites, or where several sites are likely to be developed in the same Sewage Treatment Works (STW) catchment, particularly where the receiving STW discharges into the same watercourse as the surface water runoff from the site.

Strategic wastewater capacity and infrastructure recommendations provided by the Hertfordshire Water Study (once available, see Section 2.6) should be reviewed in light of the scale of development proposed in the new Local Plans, to ensure its assumptions are aligned to the emerging Local Plan proposals. These documents will determine the potential impacts of growth on the wastewater infrastructure and environmental capacity. In addition, further local guidance on wastewater considerations when assessing planning applications, such as the Dacorum Wastewater Advice Note, may be provided by the Councils in South West Hertfordshire. If local guidance is available, these should be reviewed when considering wastewater drainage design.

11.5 Groundwater quality

The Environment Agency defines Groundwater Source Protection Zones (GSPZ) in the vicinity of groundwater abstraction points. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. The definition of each zone is noted below:

- Zone 1 (Inner Protection Zone) – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.

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http://www.lasoo.org.uk/?publications=non-statutory-technical-standards-for-sustainable-drainage

61 BSI Standards Publication (2013) Code of practice for surface water management for development sites http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030253266

- Zone 2 (Outer Protection Zone) – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction.
- Zone 3 (Total Catchment) - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management.
- Zone 4 (Zone of Special Interest) – A fourth zone SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future, this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone.

The Environment Agency's approach to groundwater protection[62] was updated in March 2017 and is summarised below:

- Development must be appropriate to the sensitivity of the site. Where potential consequences of a development or activity are serious or irreversible the EA will adopt the precautionary principle to manage and protect groundwater. The EA will also apply this principle in the absence of adequate information with which to conduct an assessment.
- The Environment Agency expects developers and operators to assess the area of influence of their activities and to take account of all current and future groundwater uses and dependent ecosystems. Developers and operators are expected to assess and mitigate the potential impact on groundwater throughout planning, construction, operation, and decommissioning phases of the development or operation.

With regards to infiltration SuDS in source protection zones, position statement G13 issued by the Environment Agency[63] contains relevant advice.

Under this guidance, the scheme and its treatment stages must be appropriate to the sensitivity of the location and subject to a relevant risk assessment, considering the types of pollutants likely to be discharged, design volumes and the dilution and attenuation properties of the aquifer. Unless the supporting risk assessments show that

62 Environment Agency (2017) Groundwater Protection Position Statements. Available at: https://www.gov.uk/government/publications/groundwater-protection-position-statements

63 Environment Agency (2017) The Environment Agency's approach to groundwater protection. G13 - Sustainable drainage systems. Available at: https://www.gov.uk/government/publications/groundwater-protection-position-statements

SuDS schemes in SPZ1 will not pose an unacceptable risk to drinking water abstraction, the EA will object to the use of infiltration SuDS under position statement G10 (developments posing an unacceptable risk of pollution).

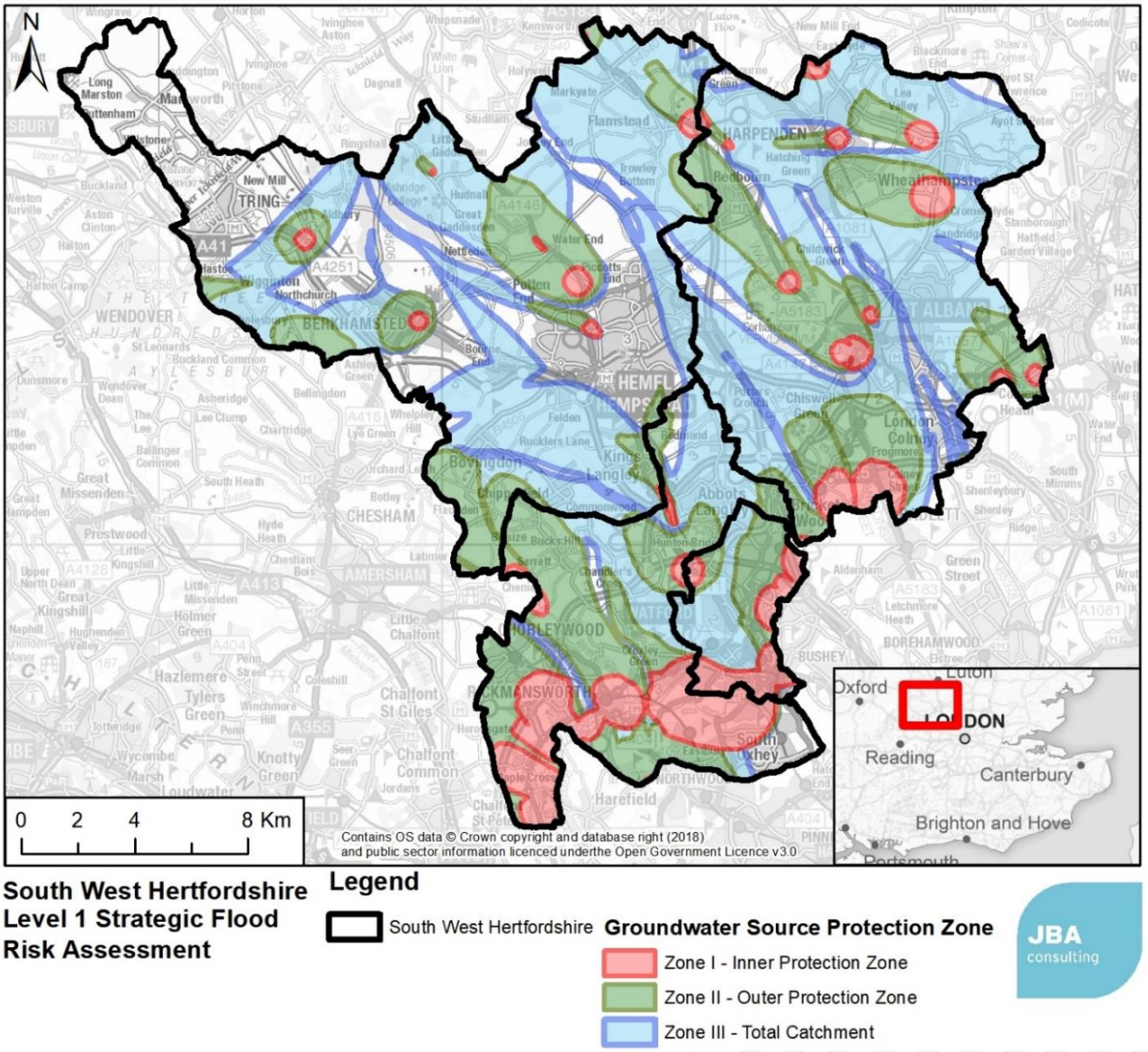
Where infiltration SuDS are proposed for anything other than clean roof drainage in a SPZ1, a hydrogeological risk assessment should be undertaken, to ensure that the system does not pose an unacceptable risk to the source of supply.

11.5.1 Groundwater Source Protection Zones in the study area

Due to the presence of an underlying chalk aquifer, the vast majority of South West Hertfordshire is located within a Groundwater SPZ (Figure 11-1). Areas within a Groundwater SPZ are located along the corridors and tributaries of the Rivers Colne and Lee, specifically:

- Zone 1 SPZ covers the River Colne valley from the confluence with the River Ver east of Bricket Wood to Rickmansworth. Smaller, isolated areas of Zone 1 occur on the River Lee at Wheathampstead, the River Ver in western St. Albans, the River Gade in Northern Hemel Hempstead, the River Chess upstream of Loudwater and the River Bulbourne at Berkhamsted.
- Areas classified as Zone 2 are surrounded by Zone 3 and can be found in the upper to middle catchments of the Rivers Gade, Ver, Lee and Bulbourne, as well as the lower reaches of the River Colne, covering areas such south west St. Albans, eastern Watford, and Croxley Green.

Figure 11-1: Groundwater Source Protection Zones in South West Hertfordshire



12 Assessment of flood risk in potential development areas

12.1 Introduction

As part of this Level 1 SFRA, all sites and development areas considered for allocation within the Councils' Local Plans were assessed for suitability. This ensures that all potential sites are assessed equally, regardless of their suitability on other planning grounds, and provides a solid evidence base to allow application of the Sequential Test.

12.2 Site flood risk summary

Flood risk from all sources was assessed for each of the potential development areas. This information is provided in a 'summary sheet' format and gives more detailed information regarding the risks posed to each development site.

The following information is provided for each potential development area:

- % of site within each Flood Zone (3b, 3a, 3a plus climate change, and 2).
- % of site within Risk of Flooding from Surface Water (3.3%, 1%, 1% plus climate change and 0.1% probabilities).
- Historic flooding (based on the Environment Agency's Historic Flood Map).
- % within Risk of Flooding from Reservoirs maximum extent.
- % of site within JBA Groundwater flood map categories 3 (between 0.025m and 0.5m of ground surface) or 4 (within 0.025m of ground surface).
- Presence of watercourse mapped in OS Open River layer (watercourses under 3km² may not have Flood Zones).
- Presence of canal with raised embankment, as identified within the Canal and River Trust dataset.

Interactive mapping showing the currently available flood risk information is provided with this report, in Appendix A.

13 Local Plan Policy Considerations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA. Following this, several recommendations have been made for the Councils to consider as part of their planning policy and flood risk management. These are summarised below.

13.1 Development considerations

13.1.1 Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within South West Hertfordshire.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance.
- Relocating development to zones with lower flood risk.
- Creating space for flooding.
- GI should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

Developers should apply the sequential approach to locating development within the site, by considering less vulnerable uses for the site and amending the site layout to better manage flood risk.

Proposed development sites will be required to pass the Sequential Test and, where necessary, Exception Tests in accordance with the NPPF. To demonstrate the Exception Test has been passed, flood resilience design and emergency planning must be accounted for including:

- The development will remain safe and operational under flood conditions.
- A strategy for safe evacuation and / or safely remaining in the building under flood conditions.
- Key services will continue to be provided under flood conditions.
- Buildings are designed for a quick recovery following a flood.

Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council should use the information in this SFRA when deciding which development sites to take forward in their respective Local Plans. Developers should consult Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council, Hertfordshire

County Council and the Environment Agency (where relevant), at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

13.1.2 Site-specific flood risk assessments

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences, or downstream of a canal embankment. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

Where there is historical evidence of flooding at sites, any developments will require a detailed Flood Risk Assessment to fully understand and verify flood risk and flooding mechanisms.

Opportunities to reduce flood risk to wider communities could be sought through the regeneration of brownfield sites, through reductions in the amount of surface water runoff generated on a site. The functional floodplain should be protected from development and returned to greenfield status.

13.1.3 Guidance for developers

For sites located in Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council, it is recommended that developers consider the following:

- Aim to take positive measures to conform to the WFD, which can be impacted as a result of development, for example in terms of 'deterioration' in ecological status or potential. This is of particular importance for sites located in the Upper Thame, Colne, Gade and Bulbourne catchments where waterbodies are failing to meet the WFD objectives (see Section 10.1).
- The latest Environment Agency climate change guidance must be considered in all new developments and planning applications (see Sections 4.1 and 9.3).
- Whilst it is acknowledged that the Flood Zones in places are inconsistent, these should not be dismissed. The existing Flood Zone dataset should be used in conjunction with evidence from reported flood incidents, to establish the fluvial flood risk (see Appendix B).
- Any site-specific FRA would need to adequately assess the local topography, geology and drainage systems (including sewer capacity) to ensure the risk posed

from surface water is appropriately taken into account (see Sections 6.4, 9.3.2 and 11).

- Any development proposed adjacent to a canal, should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific Flood Risk Assessment (see Section 9.1).
- The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage (see Section 6.7.1).
- Safety is a key consideration for any new development and includes the likely impacts of climate change and, where there is a residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures (see Section 9.4.2).
- Consider the management of the residual risk as well as the actual risk (see Section 3.5 and 7.6).
- Consider adopting measures which complement the River Thames CFMP actions, listed in Section 2.3. For example, consider the inclusion of green corridors in urban areas, through landscaping and the use of SuDS (see Sections 10.2 and 11).

13.1.4 Windfall sites

Windfall sites are those which have not been specifically identified in a Local Plan, do not have planning permission and have unexpectedly become available. Local authorities are expected to make a realistic allowance for windfall development based on past trends.

The acceptability of windfall applications in flood risk areas should be considered at the strategic level, through setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

It may be possible for the local authority to apply the Sequential Test, taking into account reasonably available sites, historic windfall rates and their distribution across the borough or district, relative to Flood Zones.

When assessing flood risk to windfall sites within the Development Management process, consideration must be given to the Local Plan policies on flood risk and SuDS, and the requirements of the Local Flood Risk Management Strategy. The application must demonstrate that the proposals are compliant with these policies and national policy on managing flood risk. This assessment should be included in the site-specific FRA.

13.1.5 Council review of planning applications

In reviewing planning applications for developments at low risk and vulnerability of flooding, Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council should consult the Environment Agency 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities'.

Where developments are of a flood risk vulnerability, located in the Flood Zones or a critical drainage area, or are within 20m of a main river, the Environment Agency should be consulted. Guidance and full details of when development proposals require consultation or standing advice are provided on the government website[64].

When considering planning permission for developments, planners may wish to consider the following:

- Any adverse effects on watercourses or the natural land drainage system.
- Sufficient space is provided adjacent to the top of both banks of any Main River or Ordinary Watercourse for maintenance purposes, and is appropriately landscaped for amenity and biodiversity benefits.
- There is no loss of open water features through draining, culverting or enclosure by other means and where present, culverts are opened up.
- Sustainable drainage systems are given priority to manage surface water flood risk.
- Betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk.
- Ensuring the application is compliant with the conditions set out by the LLFA.

13.2 Drainage assessments and promotion of SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan. Wherever possible, SuDS should be promoted:

- A detailed site-specific assessment would be needed to incorporate SuDS successfully into development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed in response to site characteristics and policy factors.
- It should be demonstrated that a proposed drainage scheme, site layout and design will prevent properties from flooding from surface water, allowing for climate change effects. Onsite attenuation schemes would need to be tested to ensure flows are not exacerbated downstream within the catchments.

64 Environment Agency (2017) Flood risk assessment: local planning authorities. Available at: https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities#check-if-you-need-to-consult.

- SuDS proposals should contain an adequate number of treatment stages to ensure any pollutants are managed on site and do not have a detrimental impact on receiving waterbodies.
- The promotion and adoption of water efficient practices in new development will help to manage water resources, contribute to sustainable development and reduce pressures on existing water and wastewater infrastructure.

Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council should seek to promote the use of SuDS for the management of runoff, and also:

- Ensure policies and decisions on applications support and compliment the building regulations on sustainable rainwater drainage, giving priority to infiltration over watercourses and then sewer conveyance.
- Incorporate favourable policies within development plans and adopt policies for incorporating SuDS requirements into Local Plans.
- Encourage developers to utilise SuDS whenever practical, if necessary, through the use of appropriate planning conditions.
- Develop joint strategies with sewerage undertakers to further encourage the use of SuDS.

13.3 Safe access and egress

Safe access and egress will need to be demonstrated at all development sites; the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during times of flood. Finished Floor Levels should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning. The Local Resilience Forum, Hertfordshire Resilience, has prepared a Flood Contingency Plan which covers the four administrative areas of South West Hertfordshire.

13.4 Future flood management in South West Hertfordshire

13.4.1 Flood defences

Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard should be identified and the use of developer contributions considered to fund improvements. Where new defences are proposed, developers with proposed sites in these communities should contact the Environment Agency or Hertfordshire County Council, for up to date information on these schemes.

13.4.2 Strategic solutions

The SFRA provides a basis for investigating potential strategic flood risk solutions within the borough, such as the restoration works occurring along the River Ver. Opportunities could consist of the following:

- Floodplain restoration (the most sustainable form of strategic flood risk solution), by allowing watercourses to return to a more naturalised state, for example by bank stabilisation, re-naturalisation, structure removal/ modification and enhancing outfalls.
- The construction of new upstream storage schemes as part of upstream catchment-based approaches could be considered, such as where they are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches, providing benefit to the urban area downstream. It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency.
- If flood defences are to be constructed to protect a development site, it should be demonstrated that defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.
- In addition, opportunities where it may be possible to improve the WFD status of watercourses, for example by opening up culverts, weir removal, and river restoration, should be considered.

The Catchment Flood Management Plan actions echo these solutions, recommending that opportunities are investigated for storage or reduced conveyance upstream of urban areas, and to identify locations where flood attenuation ponds or wetlands could be developed with associated habitat improvement.

13.4.3 Cumulative impacts of development on flood risk

The cumulative impact of development on flood risk should be considered throughout the planning process, from the allocation of sites within the Local Plan, as well as part of the planning application and development design stages. A broad scale assessment of potential development and flood risk issues within the catchments of South West Hertfordshire has been provided as part of this assessment (see Appendix D, with suggested ways in which the adverse impacts could be managed.

Once preferred options for development are identified in the emerging Local Plans, it is recommended that their cumulative impact is considered in further detail.

13.4.4 Cross-boundary partnership working

For successful future flood risk management, it is recommended that the four authorities of South West Hertfordshire, and neighbouring planning authorities, adopt a catchment partnership working approach in tackling flood risk and environmental management.

This assessment provided a high-level overview of potential cross-boundary flood risk, showing which authority areas have the potential to influence flood risk on others based on topography, river flow direction and residual risk. New developments should mitigate any potential flood risks, but dialogue and engagement between neighbouring authorities can only strengthen the direction of future flood risk management and flood risk solutions.

14 Summary and conclusions

14.1 Summary

The 2018 South West Hertfordshire SFRA has been produced to reflect recent changes in climate change allowance and data availability, to aid development of the new Local Plans for Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council.

The SFRA provides general advice for planners and developers on:

- Sources of flood risk mapping and other evidence to inform the Sequential Test.
- Flood risk from potential sources of flooding including Main River, ordinary watercourse, surface water, groundwater and sewer flooding sources within South West Hertfordshire.
- Requirements of a Flood Risk Assessment.

14.2 Use of SFRA data

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change. The Environment Agency has a rolling programme of flood modelling and mapping studies, and updates to the Flood Map are made quarterly. Where new mapping studies are carried out this will also affect the definition of the functional floodplain (Flood Zone 3b) and Flood Zone 3a + climate change. It is important that the Environment Agency is consulted to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment.

The SFRA should be periodically updated when significant new information or guidance becomes available. This may include catchment-scale flood modelling and mapping studies, flood risk assessment requirements, climate change allowances, or new planning guidance and legislation. It is recognised that new information or guidance on flood risk may also be provided by Dacorum Borough Council, St. Albans City and District Council, Three Rivers District Council and Watford Borough Council, Hertfordshire County Council, Thames Water, the Environment Agency and the Canal and River Trust.

It is recommended that the SFRA is reviewed internally on an annual basis, by checking with the above bodies on whether any new, significant information has become available. Where it has, it should be noted that this could affect the conclusions within this Level 1 study. In particular, the Environment Agency and Hertfordshire County Council should be consulted to ensure the latest flood risk guidance and data is used in decision-making.

14.3 Next steps

As the Councils move forward with their Local Plans, the most up-to-date information must be used in applying the Sequential Test. Both planners and developers should be aware of any future changes to advice in the consideration of climate change for planning FRAs.

The Flood and Water Management Act (2010) and the NPPF offer opportunities for a more integrated approach to flood risk management and development. Developing a Local Plan, provides an opportunity to approach planning for flood risk, sustainable drainage, green infrastructure, water quality, amenity, biodiversity and habitat, and Water Framework Directive considerations in an integrated way.

Appendices

A Mapping of all sources of flood risk

B Level 1 SFRA site screening spreadsheet

C Borough/District-Scale Assessment of Flood Risk

D Assessment of Cumulative Impacts in South West Hertfordshire

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
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