Hertsmere Borough Council

Strategic Flood Risk Assessment
Volume I

Final Report

May 2008

Halcrow Group Limited

Hertsmere Borough Council

Strategic Flood Risk Assessment
Volume I

Final Report

May 2008

Halcrow Group Limited

Halcrow Group Limited
Windsor House Queensgate Britannia Road Waltham Cross
Hertfordshire EN8 7NX
Tel +44 (0)1992 707100 Fax +44 (0)1992 760594
www.halcrow.com

Halcrow Group Limited has prepared this report in accordance with the instructions of their client, Hertsmere Borough Council, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

© Halcrow Group Limited 2008

Hertsmere Borough Council

Strategic Flood Risk Assessment
Report

Volume I

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft Report	01/08	LM
1	1	Final Draft Report	02/08	LM
1	2	Final Report	06/08	LM

Halcrow Group Limited
Windsor House Queensgate Britannia Road Waltham Cross Hertfordshire EN8 7NX
Tel +44 (0)1992 707100 Fax +44 (0)1992 760594
www.halcrow.com

Contents

Tables

Figures

Executive Summary

Project Overview

Hertsmere Borough Council covers an area of 100km^2 (38.6 sq mi). The area is a mix of urban and rural areas, surrounded by Green Belt. The main urban settlements are Borehamwood, Potters Bar, Bushey, Radlett and Shenley. Parts of the M25 and A1(M), including the South Mimms motorway service area, are located within the study area. The entire study area falls within the catchment of the River Colne. The River Colne flows from northeast to southwest from Colney Heath through to Watford. The main tributaries of the Colne along this reach are the Hilfield Brook, Radlett Brook, Tykeswater and Mimshall Brook. The risk of flooding posed to properties arises from a number of sources including river, groundwater, surface water and sewers.

In August 2007, Hertsmere Borough Council commissioned Halcrow Group Limited to produce a Level 1 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25) and its Companion Guide, Making Space for Water (2003) and the Thames Catchment Flood Management Plan (2007). Using readily available information, the principle aim of the SFRA is to map all forms of flood risk and use this as an evidence base to locate new development primarily in low flood risk areas.

In addition, the outputs from the SFRA will enable the Council to:

- Prepare appropriate policies for the management of flood risk;
- Inform the sustainability appraisal so that flood risk is taken account of, when considering options and in the preparation of strategic land use policies;
- Identify the level of detail required for site-specific Flood Risk Assessments (FRAs), and
- Determine the acceptability of flood risk in relation to emergency planning capability.

The SFRA should be regarded as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance.

Site Allocations and the Sequential Test Process

In accordance with PPS25, areas of 'low', 'medium' and 'high' risk have been mapped using data collected from the Environment Agency, Hertfordshire Highways and Thames Water. This has included information on flooding from surface water (land drainage), groundwater, artificial water bodies and sewers.

A preliminary review of areas of search for housing (from the Hertsmere Core Strategy) was made as part of the SFRA to identify levels of risk from all sources of flooding. It is apparent that several areas of search for housing intersect with or are in close proximity to Flood Zone 3b Functional Floodplain, as well as other sources of flooding. In most cases there is a very small area of overlap between the site boundary and flood risk area and therefore opportunities to reduce flood risk via the master planning process should be taken (for example by setting aside low-lying waterside areas for recreation, amenity and environmental uses) (See ***Volume II, Tile L***).

The Council will eventually need to apply the Sequential Test to all sites within 'medium and 'high' risk flood zones to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed. Should the need to apply the Exception Test be identified, and the Council considers that there is an insufficient number of suitable sites for development, the scope of the SFRA could be widened to a Level 2 assessment. It is recommended that this is undertaken by a suitably qualified chartered engineer.

Guiding Council Policy

Following a review of emerging best practice (e.g. PPS25 and Practice Guide), guidance from national policies and a project workshop to engender a partnering approach, the following core areas in alignment with the Thames CFMP messages (***Appendix E***) have been identified for the Council's flood policy document:

- Locate new development in least risky areas, giving highest priority to Flood Zone 1 and avoid development in areas where there is a significant and frequent risk of groundwater, surface water or artificial drainage flooding.
- Ensure that all new development is 'Safe', meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain and emergency vehicular access is possible.

- Promote the use of sustainable urban drainage systems in all flood zones to achieve Greenfield discharge rates on both Greenfield and Brownfield sites.
- Prevent the development of Greenfield sites in the functional floodplain and seek flood risk reduction on redevelopment of Brownfield sites (e.g. reduction in building footprints).
- Safeguard possible sites for future flood storage.
- Seek opportunities for developer contributions to achieve flood risk reduction from all sources.
- Seek opportunities to undertake river restoration and enhancement as part of a development to make space for water.
- Work with neighbouring authorities to ensure that overall flood risk management policies are in alignment with one another.

The suggested policy and guidance notes should be used to inform the Development Control Policies and guide the Site Allocations DPD to ensure it provides clarity and outlines the requirement of the Environment Agency in response to PPS25. Furthermore, as a means of managing existing and future risk within the study area, it is recommended that the Council review their adopted flood risk response plans in light of the findings and recommendations of the SFRA.

Future Studies

Within the study area, additional modelling and mapping will be required where site allocations are proposed within or close to the 20m buffer (3b flood extent) defined for unmapped watercourses in order to more accurately define flood zones 2, 3a and 3b. In addition there are a number of reservoirs/flood storage areas (e.g. Aldenham and Hilfield Reservoirs and Radlett Flood Storage Area), which are located close to residential houses, commercial premises and highway infrastructure. It is recommended that where site allocations are proposed within the residual risk areas mapped, more detailed modelling studies should be undertaken to provide better information on the flood hazard associated with potential failure. The outputs from these studies will enable the Council's Emergency Planning teams to refine existing emergency response plans and will provide Development Control with more accurate and consistent information with which to guide future development.

.

1 Introduction

1.1 *Overview*

In August 2007, Hertsmere Borough Council commissioned Halcrow to produce a Strategic Flood Risk Assessment in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) (see ***Appendix A***). The study complies with the requirements of the Project Brief, and the methodology and the deliverables are aligned to Development and Flood Risk, a Practice Guide Companion to PPS25 (February 2007).

The Strategic Flood Risk Assessment (SFRA) will inform the site selection process for future development sites and provide recommendations for policies to deal with non-allocated sites. The SFRA will feed into the Local Authorities Sustainability Appraisals of the Local Development Documents (LDDSs) and will enable informed decisions to be made relating to land use and development allocation within the respective Development Plan Documents (DPDs).

For this study, a Level 1 SFRA approach has been agreed with the Council and the Environment Agency. A Level 1 SFRA is defined in the Practice Guide Companion to PPS25, as a desk-based study using existing information to allow application of the Sequential Test on the basis of Table D1 of PPS25 and to identify whether application of the Exception Test is likely to be necessary.

It is important to recognise that the SFRA is a 'living' document in that as new information becomes available (such as improved river models or flood events) updates will be made to the Flood Maps (see ***Volume II***) and SFRA document, to ensure that the best information is used to guide the site selection process for future developments.

1.2 *Study Area*

Hertsmere Borough Council covers an area of 100km^2. The area is a mix of urban and rural areas, surrounded by Green Belt. The main urban settlements are Borehamwood, Potters Bar, Bushey, Radlett and Shenley. Parts of the M25 and A1(M), including the South Mimms motorway service area, are located within the study area.

1.2.1 *Main Watercourses*

The entire study area falls within the catchment of the River Colne. The Colne catchment covers an area of 1014km^2 and extends from southern Bedfordshire (Luton) in the northernmost part of the area, southwards through western Hertfordshire. (Watford area), eastern Buckinghamshire and Surrey where the River Colne joins the Thames nears Staines. In terms of the SFRA study area, the northern-most boundary is proximal to the confluence of the River Colne and Tyttenhanger Stream with the southern-most boundary at Bushey Heath at the upstream end of the Hartsbourne Stream.

The River Colne flows northeast to southwest from Colney Heath through to Watford. The main tributaries of the Colne along this reach are the Hilfield Brook, Radlett Brook, Tykeswater and Mimshall Brook. Hilfield Brook flows east to west through North Bushey to its confluence with the Colne at Watford. The Radlett Brook, also know as Tykeswater flows northwest to the confluence with the Colne near Colney Street. The Radlett Brook catchment is fairly heavily urbanised, relatively steep with an average gradient of 4.84m/km and is approximately 4.7km2 in area. The Mimmshall Brook drains northwards to the Water End Swallow Holes (near Potters Bar) where it later confluences with the Colne at Colney Heath. The Mimshall Brook catchment is 53km^2 in area of which 18.5% is urbanised (principally Potters Bar).

There are also numerous other drains, ditches and brooks across the Borough. These include: Potters Bar Brook, Catherine Bourne, King George Drain, Bushey Heath Drain, Kitswell Brook, Cressals Ditch, The Rise Drain, Ashdown Drive Drain, Rowley Lane Drain, Shenley Road Drain, Barnet Lane Drain, Studio Way Drain, Gregson Close Drain, Mimms Hall Drain, Waterfields Way Ditch, Bucknalls Brook, Bentley Heath Brook, Clarehall Brook, Holmshill Brook, Kendals Brook, Kitts End Stream, The Rise Drain, Salisbury Hall Brook, Shenley Road Drain, Tyttenhanger Stream, Wrotham Park Stream and Monken Mead Brook. Many of these have recently become enmained and are now classified as 'Main River', meaning that the Environment Agency now have a statutory responsibility for maintenance and operations.

The catchment has extensive partially developed floodplain with development built up to the waters edge and narrow floodplains in the headwaters, with few properties at risk of flooding. The main urban areas such as Borehamwood, Radlett and Potters Bar are at risk of flooding from a number of sources and flooding mechanisms, including overtopping of river banks, in-channel blockages

and constrictions causing the back-up of water, overflow of surface water and sewerage drainage infrastructure, rapid surface water runoff from urban areas, breach or overtopping of flood storage areas and reservoirs and groundwater flooding.

1.2.2 *Geology &Soils*

Geologically, the Borough lies on the boundary between the chalk of Hertfordshire to the north and the London Clay and Reading Beds of the London Basin to the south. As a result of the generally impervious nature of the valley slopes the catchment has a relatively rapid run off response. There is a marked contrast in soil types across the Borough. In the headwaters of the catchment (southern end of Borough) across Borehamwood, Bushey, and Potters Bar the soils are generally clays of low permeability, seasonally waterlogged, with medium to high runoff producing potential. The soils in the lower part of the catchment (northern end of the Borough) across Radlett and Shenley are generally well-drained, loamy sandy soils permeable producing relatively low amounts of runoff.

2 SFRA Approach & Methodology

2.1 *SFRA Aims*

The aims of PPS25 planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk (see ***Appendix A***). Where new development is necessary in such areas, exceptionally, the policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall. 'Safe' in the context of this study means that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year (1%) plus climate change floodplain, and emergency vehicular access is possible.

The aim of this SFRA therefore is to map all forms of flood risk and use this as an evidence base to locate new development primarily in low flood risk areas (Zone 1). Where development cannot be located in Flood Zone 1 the Planning Authority will need to apply the Sequential Test to land use allocations and, where necessary, the Exception Test. In addition, it allows a planning authority to:

- Prepare appropriate policies for the management of flood risk;
- Inform the sustainability appraisal so that flood risk is taken account of, when considering options and in the preparation of strategic land use policies;
- Identify the level of detail required for site-specific Flood Risk Assessments (FRAs), and
- Determine the acceptability of flood risk in relation to emergency planning capability.

The findings of the SFRA will feed directly into the preparation of Local Development Documents, including the Core Strategy and Site Allocation DPDs.

2.2 *Outcomes of the SFRA Process*

A Strategic Flood Risk Assessment provides sufficient data and information to enable a planning authority to apply the Sequential Test to land use allocations and, where necessary, the Exception Test (see ***Sections 2.3*** and ***2.4)***.

PPS25 also indicates that Sustainability Appraisals should be informed by the SFRA for their area. Under the Town and Country Planning (Local Development - England) Regulations 2004, a Sustainability Appraisal (SA) is required for all LDFs. The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for LDFs should meet the requirements of the SEA Directive. A SFRA is used as a tool by a Planning Authority for the production of development briefs, setting constraints, identifying locations of emergency planning measures and requirements for Flood Risk Assessments.

It is important to reiterate that PPS25 is not applied in isolation as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy. Clearly a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base upon which informed decisions can be made.

2.3 The Sequential Test

A planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed. ***Figure 2-1*** shows the Sequential Test process as advocated in PPS25.

Preference should be given to locating new development in Flood Zone 1. If there are no reasonably available sites in Flood Zone 1, the flood vulnerability (see Table D.2 in PPS25) of the proposed development can be taken into account in locating development in Flood Zone 2 (Medium Probability) and then Flood Zone 3 (High Probability).

Within each Flood Zone new development should be directed to sites with lower flood risk (towards the adjacent zone of lower probability of flooding) from all sources as indicated by the SFRA.

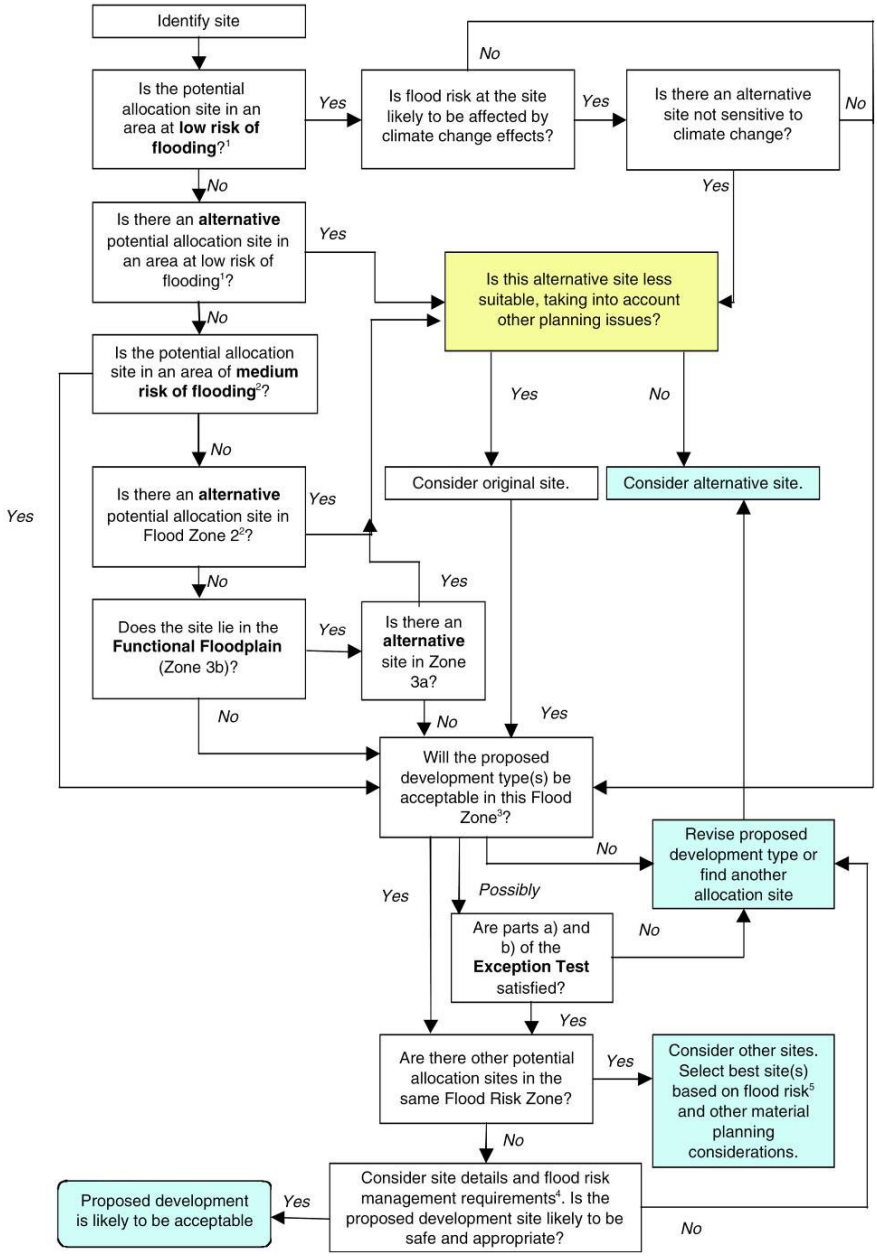


Figure 2-1 Application of the Sequential Test – Source: Development and Flood Risk: A Practice Guide Companion 'Living Draft'

2.4 The Exception Test

If, following application of the Sequential Test, it is not possible, or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied. This test provides a method of managing flood risk while still allowing necessary development to occur.

The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons (the need to avoid social or economic blight and the need for essential civil infrastructure to remain operational during floods). It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community which outweigh flood risk, informed by a SFRA where one has been prepared. If the Development Plan Document has reached the 'submission' stage (see Figure 4 of PPS12: Local Development Frameworks) the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;

b) The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and,

c) A flood risk assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

2.5 Level 1 SFRA Methodology

A Level 1 SFRA is defined in the Practice Guide Companion to PPS25, as a desk-based study using existing information to allow application of the Sequential Test (see ***Figure 2-1***) and to identify whether application of the Exception Test is likely to be necessary.

The main tasks undertaken during the study were as follows:

a) Understanding the planning context (see ***Chapter 3***)
A review of the Local Development Framework process and Local Policy was undertaken to get a clear picture of the planning challenges faced in the Borough, and the various opportunities and constraints guiding the site allocation process.

b) Gathering data and reviewing it for suitability (see ***Chapter 4***)
A quality review of flood risk information was carried out by an experienced core team. The team reviewed the collected data, assessed its significance and quality, and advised on which data would be needed to drive the SFRA. The main approach adopted during the SFRA was to build on previous studies and gathered information.

c) Producing strategic flood risk maps (see ***Chapter 5***)
A series of GIS maps were produced using the data gathered in the early phases of the study. The main outputs are PPS25 Flood Maps for the entire study area taking into account flooding from all sources, including climate change impacts up to the year 2115. Other maps contain information on flood defences and structures, historical flooding, essential infrastructure and future flood alleviation scheme options. Hardcopy maps are provided in ***Volume II*** of the SFRA report, along with GIS layers and PDF copies.

d) Providing flood policy recommendations (see ***Chapter 6***)
A workshop was held to discuss flood risk management policies with the aim of making recommendations for the purpose of development control as well as providing guidance to those undertaking detailed Flood Risk Assessments. Reference was made to national flood policy documents to ensure that the recommended policies are in-line with current thinking and best practice. The Environment Agency made a valuable contribution to this part of the SFRA by providing specific policy guidance.

e) Assessing flood warning and emergency planning (see ***Chapter 7***)
The existing flood warning system was reviewed and future improvements to flood warning were identified through discussions with the Environment Agency and Herts County Council (Emergency Planners) with the aim of providing broad recommendations to improve emergency planning.

2.6 Need for Level 2 SFRA

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitably available sites for development within zones of lower flood risk or due to possible increases in flood risk arising from climate change, the scope of the SFRA may need to be widened to a Level 2 assessment.

This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding) taking into account the presence of flood risk management measures such as flood defences. This could include 2D modelling and breach/overtopping analysis for certain locations.

Level 2 SFRA outputs would include:

- An appraisal of the condition of flood defence infrastructure and likely future policy;
- An appraisal of the probability and consequence of breach or overtopping of flood defence infrastructure;
- Maps showing distribution of flood risk across zones;
- Guidance on appropriate policies for making sites which satisfy parts a) and b) of the Exception Test safe; and the requirements for satisfying part c) of the Exception Test, and
- Guidance on the preparation of FRAs for sites with varying flood risk across the flood zone.

In general, the Level 2 SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zone 3, which are protected by existing defences (see ***Section 4.6***). This should minimise the extent to which individual developers need to undertake separate studies on the same problem. However, the need for a Level 2 SFRA cannot be fully determined until the Sequential Test has been undertaken by the Council on all possible site allocations. Some areas, however, merit a more detailed assessment in order to guide the site allocation process and recommendations for this are provided in ***Chapter 8***.

3 Policy Framework

3.1 *Overview*

This section provides an overview of the planning policy framework relevant to a Strategic Flood Risk Assessment (SFRA) of Hertsmere Borough.

The information about flooding and flood risk in the SFRA will provide evidence to facilitate the preparation of robust policies for flood risk management. The SFRA should be used to inform the Sustainability Appraisal of Local Development Documents (LDD) and will enable informed decisions to be made relating to land use and development allocation within the respective Development Plan Documents (DPD).

Current policies and plans considered most relevant to the SFRA are outlined in the following paragraphs.

3.2 *Planning Policy Framework*

3.2.1 *English Planning System*

The English planning system has a comprehensive hierarchy of policies and plans, beginning with national guidance which provides a broad framework for regional plans through to development plans at the local level. Development plans are intended to provide clear guidance for prospective developers. They are prepared following community and stakeholder involvement and debate. They are intended to reconcile conflicts between the need for development and the need to protect the wider built and natural environment.

Responding to the requirements of the Planning and Compulsory Purchase Act 2004, the Government is implementing reforms to the planning system with Planning Policy Statements (PPS) replacing Planning Policy Guidance (PPG), Regional Spatial Strategies (RSS) replacing Regional Planning Guidance (RPG) and Local Development Framework Documents (LDF) replacing Structure and Local Plans and Unitary Development Plans.

The following paragraphs provide an overview of the relevant policy documents and a brief explanation of their significance for the SFRA.

3.3 National Policy

3.3.1 *Planning Policy Statement 1: Creating Sustainable Communities (2005)*

PPS1 sets out the Government's objectives for the planning system. It confirms that good planning should deliver the right development in the right place and time, and protect the environment. It identifies sustainable development as the core principle underpinning planning and requires that development plans ensure it is pursued in an integrated manner.

3.3.2 *Planning Policy Statement 3: Housing (2006)*

PPS3 has been developed in response to recommendations in the Barker Review of Housing Supply (March 2004). Its principal aim is to underpin the necessary step change in housing delivery, improving the supply and affordability of housing in all communities including rural areas.

PPS3 states that the Government's key housing policy goal is to ensure that everyone has the opportunity of living in a decent home, which they can afford, in a community where they want to live. The specific outcomes that the planning system should deliver are:

- Well designed, high quality housing that is built to a high standard;
- A mix of market and affordable housing for all households in all areas;
- A sufficient quantity of housing, taking into account need and demand and seeking to improve choice;
- Housing developments in suitable locations offering a good range of community facilities and with good access to jobs, key services and infrastructure;
- A flexible, responsive supply of land; which is used efficiently and effectively, including the use of previously developed land.

Housing policies should help to deliver sustainable development objectives, in particular seeking to minimise environmental impact taking account of climate change and flood risk, and take into account market information, in particular housing need and demand.

From 1st April 2007, PPS3 requires that local planning authorities assess and maintain a rolling 5 year supply of deliverable land for housing, excluding allowances for windfall sites. To be considered deliverable, sites should be available now, be suitable for development now and be achievable within 5 years.

3.3.3 *Planning Policy Statement 9: Biodiversity and Geological Conservation (2005)*

PPS9 sets out policies on protection of biodiversity and geological conservation through the planning system. The broad aim is that development should have minimal impacts on biodiversity and geological conservation interests and enhance them where possible. Appropriate weight should be attached to the need to protect international and national designated sites when considering site allocations.

3.3.4 *Planning Policy Guidance 15: Planning and the Historic Environment (1994)*

3.3.5 PPG15 sets out policies on the protection of the historic environment and recognises that planning plays an important role in preserving built and natural heritage. Appropriate weight should be attached to the need to protect the historic environment when considering site allocations.

3.3.6 *Planning Policy Guidance 17: Planning for Open Space and Recreation (2002)*

PPG17 recognises the importance that public open spaces, green areas and recreational rights of way can play in supporting regeneration and contributing to local quality of life. Appropriate weight should be attached to the need to protect open space and recreational areas when considering site allocations.

3.3.7 *Planning Policy Statement 25: Development and Flood Risk (2006)*

PPS25 sets out a plan led approach to flood risk. It confirms that all forms of flooding and their impact on the natural and built environment are material planning considerations. It clarifies the sequential test that matches types of development to degrees of flood risk and strengthens the requirement to include flood risk assessments at all levels of the planning process. Regional planning bodies and local planning authorities (LPA) should, inter alia, reduce flood risk by safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water and flood defences.

3.3.8 *The Town and Country Planning (General Development Procedure) Order 1995 (as amended)*

Amendments to the Town and Country Planning (General Development Procedure) Order 1995 came into force on 1 October 2006 introducing further requirements for LPA to consult the Environment Agency before determining applications for development in flood risk areas.

LPA are required to consult the Environment Agency before granting planning permission for development, other than minor development, which is to be carried out on land:

- In an area within Flood Zones 2 or 3; or in an area within Flood Zone 1 which has been notified for the purpose of this provision to the LPA by the Environment Agency; and
- Any development of land of one hectare or more.

The Environment Agency has prepared standing advice to guide decisions on individual planning applications.

3.3.9 *The Town and Country Planning (Flooding) (England) Direction 2007*

The Town and Country Planning (Flooding) (England) Direction 2007 was published in December 2006 and came into force on 1 January 2007. To safeguard against inappropriate development in flood risk areas, it introduces a requirement for LPA to notify the Secretary of State of any application for major development (e.g. 10 or more dwellings) in a flood risk area which it proposes to approve against Environment Agency advice.

3.4 The Environment Agency Regional Policy

3.4.1 *Regional Planning Guidance for the South East (2001)*

Regional Planning Guidance for the South East (RPG9) covers the period up to 2016 and sets the regional planning policy framework for the south east of England. It sets out the housing requirement for each county within the region (including Hertfordshire). RPG9 acknowledges that climate change is likely to exacerbate the risk of flooding and requires that development should be guided away from areas at risk or likely to be at risk in future from flooding.

3.4.2 *The Secretary of State's Proposed Changes to the Draft Revision to the Regional Spatial Strategy for the East of England and Statement of Reasons (December 2006)*

RPG9 is expected to be replaced by a new Regional Spatial Strategy entitled the East of England Plan in 2007. The Draft East of England Plan was prepared by the East of England Regional Assembly in 2004. It was the subject of an Examination in Public and the Panel Report was published in June 2006. The Secretary of State published for consultation Proposed Changes to the Draft Revised East of England Plan in December 2006. The deadline for consultation responses was 9 March 2007.

For the period 2001 to 2021, the Proposed Changes Report sets out a requirement for 5,000 additional dwellings to be provided in Hertsmere Borough.

The Proposed Changes Report proposes 50,000 additional jobs in the period 2001 to 2021 in the London Arc (which includes the districts of Three Rivers, Watford, Hertsmere, Broxbourne, Dacorum, St Albans and Welwyn Hatfield but excludes the rest of Hertfordshire), but does not disaggregate the total figure.

Policy WAT4: Flood Risk Management prioritises the defence of existing properties from flooding and the location of new development in areas that have little or no risk from flooding. Paragraph 10.14 of the supporting text requires SFRA's to take into account the impact of climate change.

3.5 Local Policy

3.5.1 Hertsmere Local Plan (May 2003)

The Local Plan has an important role to play in the process of balancing development pressures and the environmental impact of new development in Hertsmere. The Local Plan refers to the requirement to provide 4,600 additional dwellings in Hertsmere in the period 1991 to 2011.

Paragraph 4.2 of the Housing Chapter of the Local Plan refers to the provision of 2,968 completed dwellings in Hertsmere in the 10 year period between 1st April 1991 and 31at March 2001. This leaves a further 1,632 dwellings to be provided in the 10 years to 2011. Table 2 Housing Land Availability identifies housing provision at known estimated sites, large windfall sites (10 plus units), surplus school sites in Borehamwood and small windfall sites (1 to 9 units).

The total housing provision identified in Table 2 is 4,855 additional dwellings.

Policy D1: Watercourses, River Corridors, Floodplains and Water Meadows, states that development, including culverting of watercourses, will not be permitted where it would have an adverse impact on the Borough's watercourses, river corridors, floodplains and water meadows.

Policy D3: Control of Development Drainage and Runoff Considerations, states that planning permission will not be granted for development within areas at risk of flooding unless it incorporates appropriate flood protection measures.

3.5.2 *Hertsmere Local Development Scheme*

Hertsmere has published a Local Development Scheme (LDS) that comprises a detailed timetable and project plan for the preparation and eventual adoption of three Development Plan Documents (DPD): the Core Strategy; the Site Allocations DPD and the Development Control Policies DPD. The DPDs are being prepared alongside a number of Supplementary Development Documents that will provide additional detail and guidance in respect of key policies.

3.5.3 *Hertsmere Core Strategy Preferred Options Report (October 2007)*

In February 2006, Hertsmere Borough Council published a Local Development Framework (LDF) 'Issues and Options' report that set out a range of options for how the Borough could develop over the next 15 years. The priorities that were identified during the community and stakeholder consultation undertaken in 2006 have informed and guided the preparation of a Core Strategy Preferred Options document.

The Preferred Options stage of the Core Strategy puts forward for public discussion the preferred approach to the spatial planning of the Borough. The Report proposes that the Draft East of England Plan requirement for 5,000 additional dwellings to be provided in Hertsmere Borough is distributed principally on brownfield sites in the main settlements of Borehamwood, Potters Bar, Bushey and Radlett, including a limited number of sites within employment areas.

Taking into account the availability of brownfield sites, following the findings of the Council's Urban Capacity Study and the Central Hertfordshire Employment Land Review, the Report states that to meet the Draft East of England Plan requirement approximately 11 hectares of Green Belt land may need to be released for residential development, should insufficient large brownfield sites emerge assuming an overall development density of 40 dwellings per hectare and excluding any associated infrastructure and services.

Policy CS15 Environmental Impact of Development states, inter alia, that proposals will be required to incorporate sustainability principles, minimising their impact on the environment and ensuring prudent use of natural resources by avoiding development in the floodplain unless flood prevention/mitigation measures are in place as required by the Environment Agency.

The Hertsmere Core Strategy Preferred Options Report will be published in November 2007. Work on the Site Allocations DPD is expected to commence in 2008.

3.6 Flood Risk Defences and Other Facilities – Possible Funding Mechanisms

3.6.1 *Planning Obligations*

Funding flood defences and other facilities is likely to be an important policy consideration. Circular 05/2005 provides for S106 planning obligations to be sought where they meet the tests set out in the Circular. Such obligations are intended to secure contributions from developers to address the impact of new development, without which such development should not be permitted. Such impacts can include flood water conveyance and storage and flood defences.

There have been a number of recent initiatives to achieve enhanced contributions via S106 planning obligations. One of the most advanced schemes involves a tariff-based funding system covering development in the Expansion Areas in Milton Keynes. The tariff helps to ensure that Expansion Area development is supported by appropriate facilities, amenities and infrastructure. The Milton Keynes tariff includes flood risk management and drainage provision.

Hertsmere Borough Council published a S106 protocol in 2007 which makes general provision for drainage and flood measures to be secured through a legal agreement. Policy CS19 of the Core Strategy Preferred Options proposed a standard charge (akin to a tariff) for smaller developments, which could cover flood risk management. S106 planning obligations for larger sites will be negotiated on a site-by-site basis.

The Hertfordshire County Council publication 'Building Futures', which all Hertfordshire authorities have signed up to, includes various measures relating to flood risk management. Policy CS17 of the Core Strategy Preferred Options endorses this approach.

3.6.2 *Planning Gain Supplement*

The Government's decision how to take forward the Planning-gain Supplement (PGS) proposed in the Barker Review of Housing Supply (2004) will influence how S106 planning obligations can be used to secure strategic flood risk management contributions. The Government's PGS consultation (December 2005) proposes that flood defence should remain within the scope of S106 planning obligations.

The Government published a further PGS consultation setting out their proposals for a new system of planning obligations in England in December 2006. These include scaling-back S106 planning obligations to cover only development site environment impact, which would include flood defence, and ensure they run smoothly alongside PGS.

The Government announced in October 2007 that it intends to introduce a 'statutory planning charge' in the forthcoming Planning Reform Bill (as opposed to a PGS) to, inter alia, "capture more planning gain to finance additional investment in local and strategic infrastructure.. [and].. provide a fairer means of securing contributions from developers for infrastructure".

3.7 Summary

The Hertsmere Local Plan and Core Strategy Preferred Options Report include development proposals involving growth in homes, jobs and infrastructure. This development has the potential to impact upon flood risk over the next 10 to 15 years, particularly by contributing to increased runoff. Subject to detailed design, development can reduce the capacity to store and carry water flows. The use of sustainable urban drainage systems on brownfield and greenfield land may help address this development impact.

The findings of the SFRA will inform the preparation of policies relating to flooding, managing flood risk, land use and development allocations within future DPDs (see ***Chapter 6***).

4 Data Collection and Review

4.1 *Overview*

Throughout the data collection and review process it has been critical to make best use of the significant amount of information which already exists with respect to flood risk (held by the Environment Agency, Hertfordshire Highways, Thames Water and other key consultees). This has included a review of:

- Historical flooding information from Environment Agency flood reports and various stakeholder consultations (including Hertfordshire Highways, and Hertsmere Borough Council)
- Detailed flood risk mapping outputs (e.g. Upper Colne Flood Risk Management Strategy).
- Detailed information on the condition status and flood risk associated with major flood defences and flow control structures (from the National Fluvial and Coastal Defence Database, sourced from the Environment Agency)
- Past Flood Risk Management Strategies and Flood Risk Assessments (e.g. Upper Colne Flood Risk Management Strategy, Radlett Brook Flood Alleviation Scheme)

A full data register is provided in ***Appendix B***.

4.2 *Consultation Process*

Consultation has formed a key part of the data gathering stage of the SFRA. The following stakeholders were consulted during the SFRA (see ***Appendix C*** for a complete contacts list):

- *Hertsmere Borough Council*
  The Planning Officer and Planning Policy Manager were consulted on the development of their Local Development Documents (Core Strategy and Site Allocations). Consultation was also undertaken with the drainage engineering team within the Borough and access was provided to the Hertsmere Borough Flooding Database.

- *Environment Agency*
  The Environment Agency Development Control, Flood Mapping and Flood Incident Management teams from the North East Thames Region office (Hatfield) were consulted on the SFRA approach. This is essential given that the Environment Agency is a Statutory Consultee under PPS25 and therefore must be in agreement with regard to the scope, key findings and recommendations of the SFRA. In addition, the Environment Agency was consulted on data availability/suitability and historical fluvial and groundwater flooding (see ***Sections 4.5***).

- *Hertfordshire Highways*
  Hertfordshire Highways were consulted on known surface water (land) drainage, sewer and groundwater flooding (see ***Section 4.5.2 to 4.5.3***)

- *Thames Water and Three Valleys Water*
  Thames Water and Three Valleys Water were consulted regarding known incidents of water supply and sewer flooding, as well as possible flood risks posed by reservoir breach or overtopping (see ***Section 4.5.4***).

- *Neighbouring Borough Councils*
  The neighbouring borough councils (Welwyn Hatfield Borough Council and London Borough of Barnet) to Hertsmere were consulted on their future development plans/areas of growth which may have an impact on flood risk in the Borough (see ***Section 5.8***).

As part of the consultation process, a workshop was held to allow key stakeholders to share their experience and knowledge of flooding issues across the study area. It specifically reviewed the draft flood maps, provided feedback on the initial findings, and contributed to the development of flood risk management policies. The benefits of adopting a partnering approach (as advocated by PPS25) are significant and have helped to ensure that the findings and recommendations of the SFRA are relevant and workable for the Council.

4.3 *Environment Agency Flood Zone Maps*

The Environment Agency Flood Zone Maps show the areas potentially at risk of flooding from rivers or the sea, ignoring the presence of defences (although areas benefiting from formal defences are identified). PPS25 defines the flood zones as follows:

Zone 1 - Low Probability

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Zone 2 - Medium Probability

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Zone 3a - High Probability

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Zone 3b - The Functional Floodplain

This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

The Flood Zone Maps have been produced from a combination of sources:

- National generalised computer model
- Detailed local hydraulic modelling
- Historic flood event outlines

The Environment Agency Flood Zone Map is continuously being improved as new studies are undertaken, detailed hydraulic models are constructed and more flooding data and information becomes available.

It is important to note that the river centrelines sourced from the Environment Agency and from the Borough Council differed in specific locations. Therefore consultation was undertaken within the Environment Agency to determine which centrelines were correct. The new main river centreline has been approved by the Environment Agency and covers the rivers which they legally have control over

and within 8m of. The new proposed amendments (both demainments and same are enmainments), which are being proposed to DEFRA will be enmained by April 2009. It is recommended that a review is undertaken of the main river lines in future updates to the SFRA.

4.4 Detailed Hydraulic Modelling

A flood risk study was commissioned by the Environment Agency for the River Colne (Upper Colne Flood Risk Management Strategy, 2005). This study involved the development of a detailed hydraulic model and production of flood maps for a range of return periods (including climate change scenarios). Undefended and defended outlines were not available for all return periods (i.e. Upper Colne 1 in 100 year outline) however since there are very few major defences within the borough there will be little difference between the defended and undefended outlines.

The River Colne and Mimmshall Brook has been mapped using a detailed hydraulic model developed as part of the Upper Colne Flood Risk Management Strategy which commenced in 2001 and was finalised in 2005. The original flood maps were reviewed as part of the Dacourm SFRA and were simplified (i.e. outlines re-digitised) in order to represent the PPS25 flood zones. This approach was agreed with the Environment Agency and is therefore considered a robust source of data to inform the Level 1 SFRA.

The Environment Agency Flood Zone Map is continuously being improved as new studies are undertaken, detailed hydraulic models are constructed and more flooding data and information becomes available. Critically within the study area, the Environment Agency has recently commissioned a flood mapping study for the Upper River Colne. This will involve the development of an updated hydraulic river model. It is anticipated that the study will be completed by the end of 2009/2010 and will provide improved flood zones maps for the entire Upper River Colne (note: this will not include the chalk tributaries). It is recommended that the outputs from this major mapping study are used to update future versions of the SFRA (see ***Section 8.5***).

For the Radlett, Hilfield and Potters Bar Brooks, Flood Zone 3 (High Probability) and Flood Zone 2 (Medium Probability) are from the original Environment Agency Flood Zone Map based, which is based on a high-resolution Digital Terrain Model. This has been accepted by the Environment Agency and is

therefore considered a reasonable source of data with which to inform the Level 1 SFRA.

For the remaining unmapped brooks, drains and ditches, Flood Zone 3 (High Probability) has been mapped by applying a 20m buffer strip to both sides of the watercourse. This has been accepted by the Environment Agency and is therefore considered a reasonable source of data with which to inform the Level 1 SFRA. However it is important to note that any development within 100m of the river centreline along these watercourses will require a site-specific FRA or Level 2 SFRA due to the broad assumptions made in this study.

4.5 Historical Flooding

Historical evidence of flooding in the study area has been gathered from past studies and reports and through consultation with key stakeholders. Hertsmere Borough Council also holds a 'land drainage history database' which provides a record of flooding since 1986 until the present day. The following information is provided for each property flooded:

- Actual date of the flooding incident
- OS grid reference (linked to GIS system – MapInfo)
- Source of flooding (foul, land drainage, surface water, sewer, highways drainage, private drainage and main river)
- Category of flooding (hydraulic inadequacy and operational problems)
- House number, road town and postcode
- Property type (house, school, commercial, industrial, hospital)
- Flood level (above ground and below ground)
- Where flooded (internal, external, restricted)
- Source of report (letter, telephone, observation and form)

This information has been mapped as points and are categorised into the 'source of flooding' (see ***Volume II, Tile B***). The continued application and development of this database is supported by this study and is regarded as an invaluable source with which to guide future development decisions.

In accordance with PPS25, this study has included a review of historical flooding from all sources (i.e. fluvial, groundwater, surface water, drainage and sewerage infrastructure and other artificial water bodies such as reservoirs). This information

has been mapped to support the site allocation process and inform site-specific flood risk assessments (see ***Volume II, Tile B***)

4.5.1 *Fluvial Flooding*

Flooding in much of the Borough has increased over the last century due to a combination of factors. Urban development, road construction, land drainage and agriculture have all altered water and sediment discharges within the catchment, and the watercourses are therefore no longer in their natural form, having been altered to meet development and agricultural drainage requirements.

The study area has a history of fluvial flooding with some areas suffering more than others. Recorded fluvial flooding has affected properties within the study area for decades with the most recent occurring in 2000.

- River Colne

Fluvial Flooding from the River Colne has occurred in 1987, 1993 and 2000. Properties have most frequently been flooded in the main urban area of Watford (Lower High Street, Water Lane and Bushey Mill Lane) around the boundary of Hertsmere and Watford Borough Councils. Historical fluvial flooding within Hertsmere has mostly been in recreational areas and open space, with limited damage caused to property. The Hertsmere Borough Council database identified fluvial flooding of properties in Woolmerdine Court, Greatham Road, Walton Road, Arthur Street and Bushey Hall Road/Water Lane.

- Potters Bar Brook

Consultations with various stakeholders revealed that Potters Bar was worst affected by fluvial flooding in 1993. The Hertsmere Borough Council flooding database identified a history of properties flooding on Darkes Lane in addition to the Potters Bar Golf Course both are thought to be attributed to the Billy Lows Drain confluence with the Potters Bar Brook combined with surcharging of the Thames Water drainage system. Properties have also flooded on Elmroyd Avenue and Brackendale due to insufficient capacity of the channel and the difficulty in undertaking maintenance work due to close proximity of development to rivers.

- Radlett Brook

Prior to the construction of the Radlett Brook Flood Alleviation Scheme (FAS) Radlett was subject to flooding from the Radlett Brook. Flooding occurred in 1974, 1976, 1979, 1982 and 1992 with properties frequently flooded in Watling Street and Oakridge Avenue. The most serious flood was in September 1992 when

50 retail and residential properties suffered damage due to high water levels. The return period of this event has been estimated to be just less than the 1 in 100yr event. A flood storage area (FSA) was constructed in 2002 upstream of the town of Radlett consisting of a 4m high clay embankment and a control structure to impound a 1 in 75 year flood on the Radlett Brook. The embankment has been designed to temporarily store up to 185,000 m^3 of water at the maximum flood levels. No properties have been flooded from the Brook since the FAS was implemented however there have been no major fluvial flood events since construction. However properties in Radlett continue to flood from surface water and drainage infrastructure (see ***Section 4.52 and 4.5.3***).

- Mimmshall Brook

The downstream part of the Mimmshall Brook catchment has a history of flooding with serious flooding to houses and property recorded on five occasions since 1928. The serious events of 1992 and 2000 initiated the investigation into options for a flood defence scheme. Regular flooding has occurred to properties in Warrengate Lane, Warrengate Road (see ***Section 4.6*** for recent flood defence scheme) and Tollgate Road in South Mimms and also the adjacent highways bordering the Brook.

The flooding is thought to be attributed to insufficient channel capacity however blockage/insufficient capacity at bridges is also thought to be a factor.

- Hilfield Brook

Limited evidence of historical fluvial flooding has been gathered on Hilfield Brook however the Environment Agency historical flood map identified flooding along the Brook in 1988 with properties flooded along Bushey Mill Lane and Sandy Lane. Consultations with stakeholders also identified flooding of properties in Bushey Mill Lane and Park Avenue. Hertsmere Borough Council has recently installed additional trash screens along the Brook to reduce flooding.

- Others brooks, drains and ditches

Limited evidence of historical fluvial flooding has been sourced from the Environment Agency given that the majority were classified as critical ordinary watercourses (COWs) until recently. Consultation with Hertsmere Borough Council revealed little evidence of fluvial flooding from these watercourses however numerous minor schemes have been implemented, including the Borehamwood flood relief scheme (Borehamwood Brook) and the King George Recreation Ground storage tanks (King George Drain).

Data appraisal

A comparison has been made between historical fluvial flooding data and information gathered from various sources and the Environment Agency historical flood maps (see ***Volume II, Tile B***). In summary, there is a good correlation between the data sets, suggesting that the historical fluvial flooding map provided by the Environment Agency will be suitable for informing the PPS25 Flood Zones and Sequential Test process.

4.5.2 *Surface Water (Land Drainage) Flooding*

The Environment Agency holds no records of historical surface water flooding, however a monitoring system has recently been set up, which will provide a useful resource for future updates to the SFRA.

Surface water flooding has been highlighted as a major cause of frequent flooding in the Borough and often occurs in combination with surface water and groundwater flooding (***see Sections 4.5.3 and 4.5.4)***. Evidence of historical local drainage issues (surface water flooding) within the Borough have been sourced from:

- Consultation with Hertsmere Borough Council, Hertfordshire Highways and the Environment Agency
- Hertsmere Borough Council flooding database (1986 – 2006): categorised by source of flooding (including land drainage, drainage infrastructure and fluvial flooding) (see ***Volume II, Tile B***)

Known areas of surface water flooding are summarised in Table 4-1 below and are shown in ***Volume II, Tile B*** (the preceding reference code can be used to locate the flooding incidents in the flood history maps – please note some historical flooding extents have not been mapped where information was not available*). Historical flooding sourced from the Hertsmere Borough Council flooding database are shown in ***Volume II, Tile B***.

- **Radlett**

Radlett experiences flooding from surface water (see Table 4-1). This is partly attributed to the topography of the area. The main road (Watling Street) is situated in a valley therefore acting as a drainage low point and limiting the ability of

surface water drainage to infiltrate into the drainage systems, often resulting in flooding of the main high street and off-side roads. This is often combined with insufficient drainage infrastructure capacity which further exacerbates flooding. The limited capacity of the railway culverts was also highlighted as a contributing factor. The Hertsmere Borough Council flooding database identified properties flooded from land drainage in Radlett Park Road, Watling Street, Kitswell way and Oakridge Avenue.

GIS Reference	Location	Cause	Consequences
SW_1	Shenley Hill, Radlett	Drainage low point in front of the railway bridge. Thames Water system is not adequate enough to take water away.	Flooding of the road and railway. Herts Highways in negotiation with Thames Water.
SW_2	Theobald Street, Radlett	Flooding from land drainage or insufficient drainage infrastructure capacity.	Road and properties flooded.
SW_3	Loom Lane, Radlett	Flooding from soakaway. Recent installation of an overflow behind allotment of property number 42.	Road and properties flooded
SW_4	Field (Radlett Road)	Field higher than the road so floods from highway drainage also attributed to land drainage (floods downhill)	Flooding of the field
No GIS reference*	Watling Street (A5) – off-side roads (Rose Walk, Lume Lane, Aldenham	Watling Street is situated in a valley therefore water cannot reach the surface water	Flooding of the road and properties.

GIS Reference	Location	Cause	Consequences
	Ave, The Drive), Radlett	drainage systems quick enough.	

Table 4-1 Surface water flooding locations in Radlett

- **Bushey**

Both Bushey and Bushey Heath experience flooding from surface water (see Table 4-2). This is often in combination with flooding from ditches, drainage infrastructure and groundwater (spring lines) and therefore it is often difficult to identify the main source of flooding. This is backed up by the Hertsmere Borough Council flooding database which identifies numerous locations where both drainage infrastructure and land drainage flooding has occurred (See ***Volume II, Tile B***). The database identified major flooding of properties from land drainage in Willow Dene, Woodfield Rise, Caldecote Gardens, Chiltern Avenue, Bournehall Avenue, Spring Crofts and Moatfield Road.

GIS Reference	Location	Cause	Consequences
SW_5	Merry Hill Road/Victoria Road	Flooding from drainage off the fields and ditches filled in. Water drains down into Oxhey and floods the village	Road and properties flooded
SW_6	Grange Rd/Woodlands Rd	Flood from surface water and field opposite which floods	Flooding of the road. Thames Water scheme recently implemented
SW_7	Little Bushey Lane field	Flood from surface water	Flooding of the road
SW_8	Windmill Lane (Upper street)	Uneven road therefore water ponds in drives and gardens of houses.	Flooding of the road and property drives. Road to be re-surfaced with new pipe work being installed by Three Valleys Water
No GIS reference*	Aldenham Road (B462), Bushey	Natural valley dip in the road	Road closed

GIS Reference	Location	Cause	Consequences
No GIS reference*	B462 (under motorway), Bushey	Not known	Road flooded
No GIS reference*	Willow Way, at junction with Watford Road.	Surface water flooding from gullies and site at a natural low point	Extensive road flooding (either side of Radlett/ Willow Rd)
No GIS reference*	Cold harbour Lane/Chiltern Close/Chiltern Avenue	Combination of flooding from watercourse, land drainage and drainage infrastructure and potentially a spring line	Road and properties flooded. Scheme implemented in King George Recreation Ground (two storage tanks).

Table 4-2 Surface water flooding locations in Bushey

- **Borehamwood**

Borehamwood experiences flooding from surface water often combined with drainage infrastructure (see Table 4-3). Many of the brooks/ditches in Borehamwood are culverted and as a consequence insufficient culvert capacity and blockages is a major cause of flooding. Properties in Theobalds Road and Barnet Lane have flooded from this source. The Borehamwood Flood Relief Scheme which included the installation of tanks on the sewer network and online storage within the Aberford Lakes has contributed to reducing much of the historical flooding from surface water in Borehamwood. New developments such as Studio Way have also been designed with on-site attenuation such as storage tanks (although these are not in alignment with best SUDS practice – see Section 6.5.1). The Hertsmere Borough Council flooding database identifies a history of flooding of properties in Melrose Avenue and around the Boulevard Centre however tanks have since been installed on the watercourses and improvements have been made to the Thames Water system.

GIS Reference	Location	Cause	Consequences
No GIS reference*	Theobalds Road	Culvert is under capacity and becomes surcharged or blocked by debris	Road flooded.

GIS Reference	Location	Cause	Consequences
No GIS reference*	Barnet Lane	Limited culvert capacity and trash screen blockage	Road flooded.
No GIS reference*	Brook Road/Eldon Avenue	Surface water discharges into the watercourse and backup occurs if river levels are high	Road flooded.
No GIS reference*	Organ Hall Road	Surface water flooding from runoff and blockages of grills	The footpath under the railway floods and the substation close by may be at risk of flooding

Table 4-3 Surface water flooding locations in Borehamwood

- **Potters Bar**

Potters Bar experiences flooding from surface water (See Table 4-4). Consultations have identified that flooding in the area is often attributed to difficulties relating to access for maintenance. Properties in Brackendale and Elmroyd Avenue have historically flooded unless regular maintenance is undertaken. The Hertsmere Borough Council flooding database also identified properties flooded in Clive Close, Aberdale Gardens, The Drive and Oakmere Avenue. Much like most the other urban areas in Hertsmere, surface water flooding occurs in combination with drainage infrastructure flooding and it is therefore difficult to identify a single cause of flooding.

GIS Reference	Location	Cause	Consequences
No GIS reference*	Mutton Lane	Culvert surcharging and maintenance issues	Flooding of road.
No GIS reference*	Mount Grace Road/Ladbroke Drive	Flooding from land drainage and culvert collapse	Flooding of road.

GIS Reference	Location	Cause	Consequences
No GIS reference*	Darkes Lane/Billy Lowes Lane	Confluence of watercourses in combination with backup of the Thames Water system.	Flooding of road and properties.

Table 4-4 Surface water flooding locations in Potters Bar

4.5.3 *Groundwater Flooding*

Groundwater flooding has been highlighted as a significant cause of flooding in the Borough, often occurring in combination with drainage infrastructure and surface flooding (***see Sections 4.5.2 and 4.5.5***).

PPS 25 states that "groundwater flooding occurs when water levels in the ground rise above surface elevations," however groundwater may also cause harm in other ways, for example when it enters sub-surface structures (such as basements etc).

Recent research being carried out for Defra, identifies seven types of groundwater flooding event, as follows:

(i) rise of typically high groundwater levels to extreme levels in response to prolonged extreme rainfall;

(ii) rising groundwater levels in response to reduced groundwater abstraction in an urban area (termed groundwater rebound);

(iii) subsidence of the ground surface below the current groundwater level;

(iv) rise of groundwater level in aquifers in hydraulic continuity with high in-bank river levels or extreme tidal conditions;

(v) rise of groundwater levels due to leaking sewers, drains and water supply mains;

(vi) faulty borehole headworks or casings causing upward leakage of groundwater through confining layers driven by artesian heads;

(vii) increases in groundwater levels and changed groundwater flow paths due to artificial obstructions or pathways(e.g. foundation structures), and loss of natural storage and drainage paths.

The Defra research also identifies the following impacts observed as a direct result of excess groundwater at or close to surface:

- flooding of basements of buildings below ground level;
- flooding of buried services or other assets below ground level;
- inundation of farmland, roads, commercial, residential and amenity areas;
- flooding of ground floors of buildings above ground level; and
- overflowing (surcharging) of sewers and drains.

High groundwater levels will also affect the capacity of soakaways and other infiltration drainage to remove surface water, thereby exacerbating surface water flooding (see ***Section 4.5.2***).

The consequence of groundwater flooding may be severe, since flood water may take a significant time to abate (weeks or months). This can increase the damage to property as more extensive water and damp penetration will occur. As little can be done to reduce the likelihood of groundwater flooding, Hertsmere Borough Council will need to develop robust policies (see ***Chapter 6***) which help to reduce the consequences of groundwater flooding.

Evidence of historical groundwater flooding within the Borough has been sourced from:

- Consultation with Hertsmere Borough Council, Hertfordshire Highways and the Environment Agency (see Table 4-6)
- Environment Agency records of groundwater flooding (since 2000) - the extent of this information is limited for this SFRA, the Environment Agency database will provide a useful source of flood history data for future updates to the SFRA.

The Hertsmere Borough Council flooding database (1986 – 2006) recorded groundwater flooding however it has been categorised under land drainage flooding hence it was difficult to determine the exact locations.

The Environment Agency database identified groundwater flooding in 2002, 2003, 2004, 2006 and 2007 (See Table 4-5). Groundwater flooding was recorded most frequently in Potters Bar, Radlett and Borehamwood since records have started. Suffolk Road, Wroxham Gardens, The Walk, Newberries, Reston Close, Alexandra Road, Mandeville Road, Highfields and King George Avenue have all experienced flooding from groundwater.

(See ***Volume II, Tiles B*** which map the locations of all historical flooding from groundwater).

Events	Date	Groundwater flooding location
1	12.08.02	Potters Bar
2	30.09.02	Potters Bar
3	18.11.04	Potters Bar
4	07.01.03	Radlett
5	10.09.03	Borehamwood
6	13.05.04	Borehamwood
7	12.04.06	Potters Bar
8	04.12.06	Radlett
9	30.04.07	Bushey

Table 4-5 Environment Agency records of groundwater flooding

Events recorded in late summer/early autumn (events 1, 2, 5 in the Table 4-5) are unlikely to relate to groundwater flooding as this time of year generally coincides with the lowest groundwater levels of the year. These particular incidents are more likely to be related to flash flooding and surface drainage issues brought on by intense summer storms.

GIS Reference	Location	Cause	Consequences
GW_1	Field, Radlett	Groundwater spring	Field flooded
GW_2	Field, Radlett	Groundwater spring	Field flooded
GW_3	Ashfield Ave/Catsey Lane, Bushey	Groundwater spring	Road flooded
N/A	Parkfield, Potters Bar	Groundwater spring	Road flooded

Table 4-6 Records of groundwater flooding identified through consultations with the Borough Council and Herts Highways

4.5.4 *Drainage and Sewerage Infrastructure Flooding*

Historical flooding from drainage and sewerage infrastructure in the study area has been identified from Thames Water data and the Hertsmere Borough Council flooding database. This is often combined with surface water/land drainage flooding and groundwater flooding.

- Thames Water data

The data received was provided at postcode level, hence no street level information on flooding was available (see Table 4-7 and ***Appendix D***). The total number of properties flooded from overloaded sewers in the last ten years were recorded which was further divided into the number of properties flooded by surface water, foul water and combined sewers. In summary, it is evident that over the last ten years 52 properties have experienced flooding from overloaded sewers, 28 of which are in WD23 (covering most of Bushey/Bushey Heath). Flooding from foul water seems to be the most common type of flooding from sewers, with 28 properties flooded from this source over the last ten years.

Postcodes	Total no. properties flooded from sewers	Total no. properties flooded by surface water sewers	Total no. properties flooded by foul water sewers	Total no. properties flooded by combined sewers
AL2	2	1	1	0
AL4	10	0	9	1
EN4	0	0	2	2
EN5	4	0	4	0
EN6	0	0	0	0
HA7	0	0	0	0
WD19	1	0	1	0
WD23	28	12	9	7
WD25	1	1	0	0
WD6	5	3	2	0
WD7	1	1	0	0
Total	**52**	**18**	**28**	**10**

Table 4-7 Thames Water sewer flooding records over the last 10 years

- Hertsmere Borough Council flooding database

The database identifies that Hertsmere Borough Council has a history of drainage infrastructure flooding. Drainage infrastructure flooded has been recorded in all the urban areas across the Borough however it appears most significant in Bushey and Borehamwood and least significant in Radlett. This is backed up by the Thames Water data which has identified WD23 (Bushey) and WD6 (Borehamwood) with the greatest number of properties flooded over the last ten years. Table 4-8 below provides a summary of the roads where there is a history of properties flooding from drainage infrastructure as identified in the Hertsmere Borough Council database.

Main urban areas	**Roads flooded from drainage infrastructure**
Radlett	Watling Street, Shenley Road
Bushey	Chiltern Close, Coldharbour Lane, Chiltern Avenue, Walton Road, Arthur Street, Caldecote Gardens, Aldenham Road
Borehamwood	Brook Close, Eldon Avenue, Willow Deane, Fairway House, Newark Green, Byng Drive
Potters Bar	Quakers Lane, Carpenters Way

Table 4-8 Drainage infrastructure flooding from the Hertsmere Borough Council Database

4.5.5 *Reservoirs*

As part of the SFRA it is necessary to consider the risk of overtopping or breach of Hilfield and Aldenham reservoirs (See ***Volume II Tile G***). The Borough Council and Three Valleys Water were consulted to determine the risk of flooding from these sources.

Three Valleys Water own Hilfield Park Reservoir, which is situated to the west of Bushey within Hertsmere. The reservoir was constructed to provide drinking water and is now designated as a Local Nature Reserve. The site has been managed under a long-standing partnership with the Herts and Middlesex Wildlife Trust, whose members use the facilities.

Hertfordshire County Council own Aldenham Reservoir, which is situated adjacent to Hilfield Park reservoir to the west of Bushey. The reservoir opened in 1957 and is 65 acres in size. It was built to assist and regulate water levels in the River Colne,

following the construction of the Grand Union Canal. The reservoir is now used for leisure purposes including sailing, windsurfing and fishing.

Both are designated statutory reservoirs under the Reservoirs Act 1975 and have therefore undergone annual inspections by an Inspecting Engineer and ten year reviews by the Supervising Reservoir Engineers. Should any major development be proposed that intersect with or are in close proximity to the mapped residual risk area, a breach analysis will be required as part of a level 2 SFRA (See ***Volume II, Tile I*** and ***Section 8.2***).

Under the Reservoirs Act 1975, there is now a requirement for all reservoir undertakers (including Three Valleys Water and Herts County Council) to develop Flood Plans for their Statutory Reservoirs. This work will be undertaken from 2009 onwards and will include detailed breach and overtopping analysis. It is recommended that the outputs from these studies and refined information on residual risk are incorporated into future updates to the SFRA.

4.6 Flood Defences & Structures

Flood defences are structures which affect flow in times of flooding and therefore prevent water from entering property. They generally fall into one of two categories: 'formal' or 'informal'. A 'formal' defence is a structure which has been specifically built to control floodwater. It is maintained by its owner (this is not necessarily the Environment Agency) so that it remains in the necessary condition to function (See below for definition of an 'informal' defence).

In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the NFCDD. This is a good starting point for identifying significant flood defences and potential areas benefiting from defence, but the quantity and quality of information provided differs considerably between structures. The NFCDD is intended to give a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA where the need arises).

River structures and defences sourced from the NFCDD have been mapped (see ***Volume II, Tile D)***. Of these defences, the Radlett Flood Storage Area embankment is considered of most significance in the Borough however there are a number of minor defences and structures which are also discussed below (also see ***Volume II, Tile D*** for locations of minor defences):

Embankment in the Radlett Brook Flood Storage Area (FSA) is a major structure located off Theobald Street in Radlett Brook. The raised earth embankment has a crest lined with large plastic mesh, an inward face lined with fine plastic mesh and concrete kerbing at the sides of the crest. It forms a bund at the downstream end of FSA. This structure is maintained by the Environment Agency.

Flood Wall at Bushey Golf Course is a minor structure located between the entrance and exit bridges upstream of Bushey golf course and downstream of the leisure centre. The structure is a brick wall providing a flood crest approximately 3m above *CB* protecting an unused building and an area beyond the right bank due to be re-developed.

Bungalows Embankment 1 is a structure located east of Warrengate Road. The man made earth embankment with a crest width of approximately 1 metre provides protection to bungalows on Warrengate Lane.

Flood Wall in Radlett is a structure located in a car park off the A5183 in Radlett. It is thought that this wall may not have a flood defence purpose as the wall is set back from the channel and is a boundary wall.

Munden House Embankment 1 & 2 are structures located east of Munden House, south east of Bricket Wood Common. This structure is a slightly raised natural embankment with concrete side walls around the ford area. This structure is privately owned and maintained.

Aberford Lake Weir, is a flood defence structure located 353m upstream of Gateshead Road Culvert. It is a masonry weir holding the pond for Aberford Lake. The structure consists of a timber jetty to left bank with access gate and a 450mm concentrated outfall with trash screen. This structure is privately owned and maintained.

Channel flow restrictors, located on Bushey Mill Lane, 20 meters upstream of a trash screen. The structure consists of 2 poured concrete structures set in channel to restrict flow rate. These structures are 2 metres in height and in length along the channel. Flow backed up can escape via the designed Outfall Outwards just upstream of the restrictors.

As mentioned previously a history of flooding in the Mimmshall Brook initiated the construction of a Flood Alleviation Scheme (FAS) on the boundary between Hertsmere and Welwyn and Hatfield Borough Councils. The FAS was designed to provide protection to properties downstream of the Mimmshall Brook close to the boundary with Hertsmere. The following defences were implemented as part of the FAS:

Mimmshall Brook FAS - Flood Wall - Alongside Warrengate Road. Flood wall running alongside Warrengate Road. Outfalls for surface runoff at intervals, with flap valves and isolation valves. Works in tandem with flood gates to protect 13 bungalows and electricity sub-station on Warrengate road.

Mimmshall Brook FAS - Flood Gates. At junction of Hawkshead Lane and Warrengate Road Mitred floodgate closing off Warrengate road, works in tandem with flood wall to provide protection to 13 bunglows and electricity sub-station.

An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function. An assessment of major informal defences has been undertaken by inspecting Flood Zone 3 (modelled flood extents) for all main watercourses. There are approximately 18 road and railway embankments which cross the River Colne which could provide a barrier to flow and result in upstream flood storage. For example the Hilfield Brook crosses M1 twice prior to entering the Colne. Should any changes be planned in the vicinity of the informal defences, it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal defences should be identified as part of site-specific detailed FRA's and the residual risk of their failure assessed.

From this review areas have been identified where there is a 'residual risk'. Within these areas there is a high residual risk of flooding as a result of failure of the flood management infrastructure or exceedance of the design standard of the flood management infrastructure. This is discussed in more detail in ***Section 5.6***.

4.7 Topographical Data

Environment Agency Light Detection and Ranging (LiDAR) data was collected and reviewed (see ***Volume II, Tile C)***. This was used to construct a high-

resolution Digital Terrain Model (DTM) (including 2m and 5m contour data) which assisted the:

- verification of the PPS25 Flood Zone Maps;
- delineation of Functional Floodplain (Flood Zone 3b) in areas where no other data existed;
- delineation of major surface water flooding areas; and,
- identification of areas for future flood storage.

This information may be used by the Councils' Development Control team to review the general topography within and around a proposed development, as well as to guide future updates to the SFRA by enabling the identification of 'low spots' which may be liable to surface water or groundwater flooding.

4.8 Key Flood Risk Management Studies - Environment Agency

The Environment Agency advocates a strategic approach to flood risk management on a 'whole catchment' basis. In line with this thinking, a number of flood risk management strategies have been undertaken by the Environment Agency within the Thames region, encompassing many of the river systems within the study area. Most notably, for this SFRA these include the Thames Catchment Flood Management Plan (2007) and the Upper Colne Flood Risk Management Strategy (2007). A brief overview of these and their main recommendations for flood risk management is provided below.

4.8.1 Thames CFMP

The Thames Region Catchment Flood Management Plan (CFMP) is a high-level strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years.

A summary consultation document was published in 2007 outlining proposed flood risk management policies for the Thames Region. It takes into account the likely impacts of climate change and future development across the region. The plan does not propose specific or detailed measures, but identifies where further work is needed.

The four main messages from the Thames Region CFMP are:

- Flood defences cannot be built to protect everything;

- Climate change will be the major cause of increased flood risk in the future;
- The floodplain is our most important asset in managing flood risk; and
- Development and urban regeneration provide a crucial opportunity to manage the risk.

The Key CFMP messages for the Colne and tributaries (***See Appendix E***):

The overall approach for flood risk management in these areas involves:

- Restoring river channels, water meadows and the natural floodplain;
- Reducing run-off from agricultural land;
- Using structural measures to control water levels and retain more water on floodplains; and
- Constructing engineered schemes to store floodwater.

A key aim is to prevent development that compromises the capacity of the flood plain to retain water. Also, future maintenance on river channels should aim to increase the capacity of the flood plain. The application of PPS25 is critical to ensuring that this aim is achieved.

The main action identified within the CFMP is for the Environment Agency to make sure that flood risk is managed appropriately in these areas by applying PPS25. This is reflected within the flood policy recommendations provided in ***Section 6.3***.

4.8.2 *Upper Colne Flood Risk Management Strategy, Position Statement, 2005*

The first phase of the Upper Colne Strategy Study started in September 2001 during which the following final reports were produced:

- Chalfont St Giles and Chalfont St Peter, Pre-Feasibility Study, January 2004 (report no: WHR437, Rev 3)
- London Colney and Colney Heath, Pre-Feasibility Study, January 2004 (report no: WHR438, Rev 3)
- Watford, Pre-Feasibility Study, January 2004 (report no: WHR 436, Rev 3)
- Inception Report, February 2004 (report no: WHR278, Rev1)
- Inception Report Addendum (report no: WHR439, Rev 1)

The second phase of the strategy study started in November 2003 culminating in the publication of a position statement in 2005. From the search for potential flood storage areas, the results of the pre-feasibility studies and examination of the strategy model flood outlines, the following strategic options were identified for future consideration. It should be noted that no further work has been undertaken on any of the identified options since the publication of this report in 2005.

Flood Storage Areas (FSAs)

In general, there were found to be no locations for flood storage within the Upper Colne which would result in a substantial reduction in downstream flood risk. The only likely options were three flood storage areas (FSAs) in the headwaters of the Mimmshall Brook (see ***Volume II, Tile G***). These were assessed as being potentially effective in terms of improving levels of flood protection, although their economic viability was not fully determined. Policy recommendations are provided in Section 6.3.3 to safeguard these areas from future development.

4.9 Other Relevant Studies

4.9.1 *Rye Meads Water Cycle Strategy Scoping Study, 2007*

A scoping study was undertaken by the Environment Agency to confirm the need for a water cycle study in the Rye Meads area, which would provide information on whether the water infrastructure in the local area can support the proposed levels of housing growth. This study identified the need for an integrated water cycle strategy across the wider geographic area and recommended that the local planning authorities fund and commission one or more water studies to confirm the environmental and infrastructure constraints to development alongside the preparation of the local planning authorities LDF. The Rye Meads Water Cycle Strategy outline study was due to commence the November 2007 and will provide a further evidence base for particular sources of flooding such as surface water flooding (development of a surface water management plan). It is recommended that the Borough review the water cycle strategy once complete and incorporate any new findings into an updated SFRA.

4.9.2 *Various flood alleviation scheme studies (feasibility, Health and Safety files, detailed design)*

There are two major flood alleviation schemes (FAS) which have been completed within the Borough. These include the Radlett Brook Flood Alleviation Scheme and the Mimmshall Brook Flood Alleviation Scheme. A number of studies were

undertaken prior to construction such as pre-feasibility studies, feasibility studies, Health and Safety Files and detailed design reports. It is recommended that the Borough review theses studies if site allocations are proposed in proximity to either of the FASs.

5 Strategic Flood Risk Mapping

5.1 *Overview*

This chapter provides a clear description of what data has been used for the purpose of strategic flood risk mapping. It is based on the findings of the data collection and review exercise which included an assessment of suitability (see ***Chapter 4***).

A number of maps have been produced across the study area in accordance with emerging best practice, guidance from PPS25 (and it's Companion Guide) and the terms of the SFRA contract. Hard copies of these are provided in ***Volume II*** of this report (1:25,000 maps are provided). Map Info GIS layers and pdf's are also available for inspection.

The mapping outputs provided in ***Volume II*** are as follows:

- ***Tile A*****:** Location Plan
- ***Tiles B*****:** Historical Flooding
- ***Tiles C*****:** Topography
- ***Tiles D*****:** Structures and Defences
- ***Tiles E*****:** Flood Map (2007)
- ***Tile F:*** Flood Map (2025-2115)
- ***Tile G:*** Existing and Future Flood Alleviation Schemes
- ***Tile H*** Hydrometry and Flood Warning
- ***Tile I:*** Residual Risk Areas
- ***Tile J:*** Infrastructure & Emergency Planning
- ***Tile K:*** Thames Water Sewer Flooding
- ***Tile L:*** Summary of Flood Risk

All historical fluvial flooding incidents are mapped in ***Volume II, Tile B***, along with all other sources of flooding. The PPS25 Flood Zones are provided in ***Volume II, Tile E***.

It is important to note that the data collected on historical flooding is not exhaustive and since the data is based on historical events rather than predictive modelling (and therefore may not represent very rare events) the full extent of these flooding mechanisms may not have been captured. It is therefore

recommended that during future updates to the SFRA, additional reviews and consultations are undertaken to ensure that the best information is used to inform site allocations.

5.1.1 *Zone 3b – Functional Floodplain*

Functional Floodplain Zone 3b is defined as those areas in which water has to flow or be stored in times of flood. Within this study functional floodplain has been defined by the following criteria:

- Land subject to flooding in the 20 year flood event.
- Land which provides a function of flood conveyance or flood storage, through natural processes or by design (e.g. washlands, flood storage areas).
- Areas which would naturally flood with an annual exceedance probability of 1 in 20 (5% Annual Exceedance Probability, AEP) or greater, but which are prevented from doing so by existing buildings, defences and other flood risk management infrastructure will not normally be defined as Functional Floodplain.

The approach used to map Zone 3b for each watercourse is summarised in ***Table 5-1***.

Watercourse	Zone 3b Data Source
Upper River Colne and Mimmshall Brook	Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 50 outlines (as agreed with the Environment Agency in the Dacorum SFRA)
Radlett, Potters Bar and Hilfield Brooks	Estimated from the topographical model and available soil maps
Unmapped tributaries*	Assumed a 20m buffer strip on both sides of the watercourse

Table 5-1 Flood Zone 3b (Functional Floodplain) mapping

*Due to the uncertainty associated with flood zone 3b defined for the unmapped tributaries any site allocations proposed within or close 20m buffer will require a site-specific FRA or more refined Level 2 SFRA, as requested by the Environment Agency.

5.1.2 *Zone 3a – High Probability*

The High Probability Zone 3a is defined as those areas within the study area which are situated within the defended 1 in 100 year (or 1% AEP) flood extent (see ***Section 4.4***). A number of approaches have been used to define the extent of Zone 3a, including the use of detailed hydraulic modelling studies and Environment Agency's Flood Map based on a relatively coarse national computer model. The approach used to map Zone 3a is summarised in ***Table 5-2***.

Watercourse	Zone 3a Data Source
Upper River Colne and Mimmshall Brook	Upper Colne Flood Risk Management Strategy (2005) modelled defended 1 in 100 year flood outline (See ***Section 4.4***)
Radlett, Potters Bar and Hilfield Brooks	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)
Unmapped tributaries	**NO** 1 in 100 year flood outline mapped for these watercourse (see assumption at foot of table 5-1)

Table 5-2 Flood Zone 3a mapping

5.1.3 *Zone 2 – Medium Probability*

The Medium Probability Zone 2 is defined as those areas which are situated between the undefended 1 in 1000 year (0.1% AEP) and 1 in 100 year (1% AEP) flood extents. A number of approaches have been used to define the extent of Zone 2, including the use of detailed hydraulic modelling studies and Environment Agency's Flood Map based on a relatively coarse national computer model. For the Upper River Colne and Mimmshall Brook the greater of the Environment Agency Flood Map flood extent (based on coarse national computer model) or Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 200 year flood extent was utilised as agreed by the Environment Agency for Dacorum SFRA.

The approach used to map Zone 2 is summarised in ***Table 5-3***.

Watercourse	Zone 2 Data Source
Upper River Colne and Mimmshall Brook	The greater of the Environment Agency Flood Map flood extent (based on coarse national computer model) or Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 200 year flood extent
Radlett, Potters Bar and Hilfield Brooks	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)
Unmapped tributaries	**NO** 1 in 1000 year outline mapped for these watercourse

Watercourse	Zone 2 Data Source
	(see assumption at foot of table 5-1)

Table 5-3 Flood Zone 2 mapping

The Low Probability Zone 1 is defined as those areas which are situated outside of the undefended 1 in 1000 year flood extent. For the purpose of the SFRA maps, this includes all land that is outside of Zone 2 and Zone 3 flood risk areas. It is important to note however that for sites greater than one hectare it will still be necessary for a developer to produce a site-specific FRA which takes account of all sources of flooding, including surface water, groundwater and sewer sources (see ***Section 6.4***)

5.1.4 *Summary of Data Source for flood mapping*

The approach used to map the flood zones is summarised in ***Table 5-4***.

Watercourses	Flood Zone 3b Data Source	Flood Zone 3a Data Source	Flood Zone 2 Data Source
Upper River Colne and Mimmshall Brook	Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 50 outlines (as agreed with the Environment Agency in the Dacorum SFRA)	Upper Colne Flood Risk Management Strategy (2005) modelled defended 1 in 100 year flood outline	The greater of the Environment Agency Flood Map flood extent (based on coarse national computer model) or Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 200 year flood extent
Radlett, Potters Bar and Hilfield Brooks	Estimated from the topographical model and available soil maps	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)

Unmapped tributaries	Assumed a 20m buffer strip on both sides of the watercourse	**NO** 1 in 100 year flood outline mapped for these watercourse (see assumption at foot of table 5-1)	**NO** 1 in 1000 year outline mapped for these watercourse (see assumption at foot of table 5-1)

Table 5-4 Summary of Data Source for flood mapping

5.2 Surface Water (Land Drainage) Flooding

Flooding from surface water (land drainage) sources has been identified from the Hertsmere Borough Council flooding database and through stakeholder consultations (See ***Section 4.5***.). Where possible GIS 'polygons' have been used to indicate where surface water flooding occurs. The approximate extents were delineated through consultation with key stakeholders (Hertfordshire Highways and Hertsmere Borough Council). Flood risk from surface water is included in the historical flood maps (***Volume II, Tile B***) with a reference code to ***Sections 4.5.2***. This information is combined with all sources of flooding in the overall flood map (***Volume II, Tile E***) which should be used to guide the Sequential Test.

5.3 Groundwater Flooding

Flooding from groundwater sources has been mapped using the historical data collected in ***Section 4.5.3***. GIS 'points' have been mapped from the Environment Agency database and through consultations. Flood risk from groundwater is included in the historical flood maps (***Volume II, Tile B***) with a reference code to ***Sections 4.5.2*** and is combined with all sources of flooding in the overall flood map (***Volume II, Tile E***) which should be used to guide the Sequential Test. See ***Section 6.3.2*** for recommended groundwater flooding policies and ***Section 6.4.6*** for guidance to developers on proposed development in groundwater flood risk areas.

5.4 Sewer Flooding

Flooding from overloaded sewers (from surface water, foul water and combined sewers) has been mapped using the historical data collected in ***Section 4.5.4***. Data was gathered from Thames Water and the Hertsmere Borough Council Flooding database (see ***Volume II, Tile K***).

The data collected from Thames Water spans a period of 10 years (1997 to 2007) and therefore future updates to the SFRA should ensure that the most recent data

is used. Furthermore, Thames Water only provide sewer flooding records at a relatively coarse resolution (first part of post code, e.g. HP1) which limits the use of the data for the purpose of spatial planning. However, the Hertsmere Borough Council database identifies specific 'point' locations of drainage infrastructure flooding which will provide a useful starting point for developers to assess sewer flood risk as part of a site-specific FRA (***see Section 6.4)***.

5.5 Climate Change

In its November 2006 publication of the predicted effects of climate change on the United Kingdom, Defra described how sea levels in Eastern England would increase by over 1m in the next 100 years. The publication also sets out how short duration rainfall could increase by 30% and flows by 20%, and suggests winters will become generally wetter whilst summers, although drier, will be characterised by more intense rainfall events. These effects will tend to increase both the size of flood zones associated with the sea and rivers, and the amount of flooding experienced from other sources.

Current guidance on incorporating climate change effects into flood risk assessments is as follows (see Table 5-5).

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Table 5-5 Climate change guidance (from PPS25)

The following approaches have been used to map/represent the impacts of climate change on, Flood Zone 3a (Functional Floodplain) and Flood Zone 3b (High Probability) (see Table 5-6). Given the inherent uncertainty over the extent of this Zone 2 (climate change scenario) no additional mapping of this zone has been undertaken.

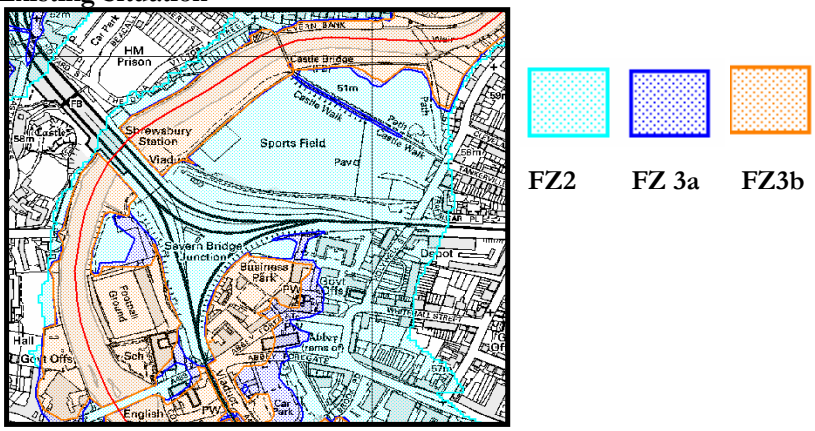
Watercourse	Climate Change Assumptions
Upper River Colne and Mimmshall Brook	Flood Zone 3a = Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 200 year flood outlines. Flood Zone 3b (climate change scenario) extent = Flood Zone 3a (present day scenario) extent*

Watercourse	Climate Change Assumptions
Radlett, Potters Bar and Hilfield Brooks	Flood Zone 3a (climate change scenario) extent = Flood Zone 2 (present day scenario) extent* Flood Zone 3b (climate change scenario) = Flood Zone 3a (present day scenario) extent*
Unmapped tributaries	No climate change mapping

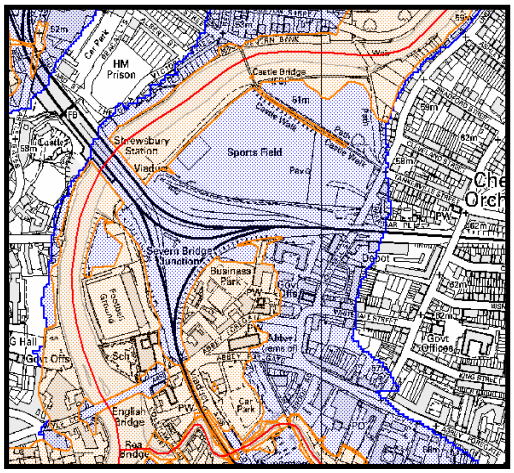
Table 5-6 Climate change mapping (*Future* = 2025 – 2115, *Present* = 2007)

*Please note that the assumption is based on an increase in aerial extent not probability. For example Flood Zone 2 (1 in 1000 year return period) will become Flood Zone 3 (1 in 100 year return period) (See example below). Hence a site currently located within a lower flood risk zone (e.g. Flood Zone 2) could in the future be re-classified as lying within a flood higher risk zone (e.g. Flood Zone 3) (See PPS25 Annex B).

Existing Situation



Climate Change Scenario



It is expected that flooding from sewer or surface water sources will generally increase due to the expected wetter winters (causing more frequent and prolonged groundwater flooding) and incidence of short-duration high intensity rainfall events associated with summer convective storms (causing more frequent surface water and sewer flooding). Further guidance on how planning should secure new development to the effects of climate change will soon be available in the new Planning Policy Statement: Planning and Climate Change (a supplement to PPS1). It is recommended that future updates to the SFRA take account of this and other emerging guidance (see ***Section 8.5***).

Detailed climate change maps are provided in ***Volume II, Tile F***.

5.6 *Residual Risk and Flood Hazard*

Residual flood risks can arise due to:

- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system; or,
- a severe flood event that exceeds a flood management design standard and results in, for example, overtopping.

There are two reservoirs and one flood storage area within the Borough (see ***Section 4.6***). With each of these there is a residual risk of overtopping or breach, which could result in significant damage to buildings and highway infrastructure as well as posing danger to life.

Within the flood maps (***Volume II, Tile I***), the residual risk area has been broadly estimated for the Aldenham reservoir, Hilfield Park reservoir and Radlett Flood Storage Area. This is represented in the GIS as a simple outline of the expected affected area. The extent should be treated with caution given that it has been approximated using 2m contour data and no modelling/breach analysis has been undertaken. Actual levels of residual risk will vary spatially depending on flow routes, velocities, flood depths and proximity to the breach or overtopping location. In the event that site allocations are proposed in close proximity to or within the indicative residual risk extents mapped, the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood hazard in these locations.

All structures and defences are mapped in ***Volume II, Tile D.*** These should be referenced by those proposing development to identify the possibility of localised residual risks as well as opportunities for deculverting and restoring the natural channel.

5.7 Infrastructure and Emergency Planning

Infrastructure (i.e. emergency services, utilities, pumping stations) and Flood Zones 2, 3a and 3b have been mapped in ***Volume II, Tile J***. This will enable the Council to identify locations where critical infrastructure is located in high flood risk areas or where access to or from these sites may be limited in a flood event.

Infrastructure	Number in Flood Zone 2	Number in Flood Zone 3a	Number in Flood Zone 3b
Utilities (sub-stations, power and electricity stations)	0	0	0
Emergency Services (police, ambulance, fire stations)	0	0	2
Schools	0	0	10
Hospitals	0	0	0
Total	**0**	**0**	**13**

Table 5-7 Infrastructure located in PPS25 flood zone

Table 5-7 shows that 13 infrastructure sites are located in or intersect with Flood Zone 3b, which is of potential concern given the high vulnerability of these land uses (i.e. school children) and implications of services being impacted upon and the people using them (i.e. reduced emergency services capability or impact on power supplies). For example the St Albans Road police station, Radlett Fire, Royal Caledonian School (Bushey) and Nicholas Hawksmoor School (Borehamwood) all intersect with flood zone 3b. This information is vital to inform the Council's Emergency Response Plan to ensure that safe evacuation and access for emergency services is available during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is recommended that the Council's Emergency Response is reviewed at both the Local Authority and County level and updated in light of these findings.

5.8 Development in neighbouring boroughs

As part of the SFRA it was essential to consult with neighbouring local authorities where rivers cross council boundaries to identify any development/growth areas which may impact on flood risk within the Borough.

- Watford Borough Council

Watford Borough Council has completed their SFRA but has not yet decided on their site allocations. However, possible growth areas include Watford town centre close to the boundary with Hertsmere Borough Council and the Heath campus development located close to the River Colne which both may impact on parts of east Watford and Bushey. As part of the SFRA recently completed, polices have been recommended which recognise the importance of SUDS to manage surface water and the need to protect the functional floodplain and prevent infill development. These are in alignment with the recommended the flood risk management polices for Hertsmere and other key policies (i.e. PPS25 and the Thames CFMP).

- St Albans District Council

St Albans District Council has completed their SFRA but has not yet decided on their site allocations. The core strategy issues and options paper identified potential growth areas north, south-west, south-east and east of St Albans and west and south of London Colney both of which could potentially impact on flood risk in Hertsmere by adding additional flow to the River Colne. In addition any spate flows (i.e. sudden flows) in excess of the capacity of the swallow holes at Water End in the Mimmshall Brook sub catchment within Hertsmere will be transmitted directly into the headwaters of the Colne at Colney Heath.

As part of the recent SFRA, polices have been recommended which recognise the importance of SUDS to manage surface water and encourage the protection of possible areas for future flood storage. These are in alignment with the flood risk management polices for Hertsmere and other key policies (PPS25 and the Thames CFMP).

- Welwyn Hatfield Borough Council

Welwyn Hatfield Borough Council has not yet decided on their site allocations and is awaiting completion of their Strategic Housing Land Availability Assessment (SHLAA). The East of England Plan identified urban extensions of the main urban areas, Welwyn and Hatfield which may have an impact on Potters Bar where Turkey Brook confluences with the Potters Bar Brook. Welwyn Hatfield Borough Council are currently undertaking their SFRA therefore polices have not yet been defined. It is recommended that Hertsmere Borough Council liaise directly with the Welwyn Hatfield Borough Council to discuss future flood risk management polices.

It is recommended that once completed, the SFRAs of neighbouring Councils are reviewed (in terms of potential growth/development areas) to provide a more robust assessment of potential off-site impacts on flood risk within the Borough and ensure alignment of flood risk management policies. In addition it is also important that the neighbouring Councils are made aware of the Borough's intention to safeguard storage areas identified in the Upper Colne Flood Risk Management Strategy (see ***Section 6.2***).

5.9 ***Review of areas of search for housing***

A preliminary review of areas of search for housing (the more specific or likely sites for our Site Allocations, including the designated Safeguarded land from the Local Plan) has been made as part of the SFRA to identify levels of risk from all sources of flooding. It is apparent that the areas of search for housing intersect with or are in close proximity to Zone 3b Functional Floodplain. In some cases there is a very small area of overlap between the site boundary and Zone 3b and therefore opportunities to apply the Sequential Test within the site should be taken e.g. Gullimore Farm (Bushey), Land off Theobald Street (Borehamwood) and Potters Bar Golf Club (Potters Bar)). In some cases, however, where the site falls almost wholly within Zone 3b it may be necessary to consider swapping the site to a lower flood risk zone via the Sequential Test process (e.g. Warehouse behind Hartspring Lane (Bushey) and Rear of Warren (Radlett)) (see ***Figure 2-1***) (See ***Volume II, Tile L***).

However it is important to note that the areas of search for housing only provide a general overview of potential development areas and do not reflect the number or actual locations of the development sites, which will subject to the Sequential Test following completion of the Level 1 SFRA.

6 Flood Risk Management Policy Recommendations

6.1 *Overview*

This chapter provides recommendations for what should be included in the Council's policy for flood risk management as well as providing guidance to developers on the preparation of site-specific Flood Risk Assessments (FRA). Council policy is considered essential to ensure that the recommended development control conditions can be imposed consistently at the planning application stage.

The policy recommendations provided in this chapter are not exhaustive and it is therefore recommended that the Council refer to the following key flood risk management documents in order to fully inform their own flood risk management policies. It is recommended that the policy and guidance notes should be used to inform the Development Control Policies DPD to ensure it provides clarity and outlines the minimum requirement of the Environment Agency in response to PPS25 (see ***Section 8.3***).

- **Planning Policy Statement 25: Development and Flood Risk** – sets out national policy for development and flood risk and supports the Government's objectives for sustainable communities.
- **Thames Catchment Flood Management Plan** (See ***Appendix E***)- strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years
- **Upper River Colne Flood Risk Management Strategy** – undertaken by the Environment Agency to develop, appraise and recommend short and long-term flood risk management options for the Upper Colne
- **Making Space for Water** - outlines the Government's proposals for forward planning of flood management over the next 20 years advocating a holistic approach to achieve sustainable development. The protection of the functional floodplain is central to the strategy.
- **Water Framework Directive** - European Community (EC) water legislation which requires all inland and coastal waters to reach good ecological status by 2015.

- **The Pitt Review** – An independent review by Sir Michael Pitt based on learning lessons from the 2007 floods.

6.2 Future Flood Alleviation Schemes

During the Upper Colne Flood Risk Management Strategy (2005), sites for potential flood storage were identified on the River Colne and its major tributaries. Three of the potentially viable storage areas identified during the Upper Colne Strategy are located in the headwaters of the Mimmshall Brook in Hertsmere Borough Council (see ***Section 4.9.3 and Volume II, Tile G***). Whilst the economic viability of these schemes were not fully determined, future storage in this location, potentially funded from other sources (developers, private residents and businesses, local levy), could help alleviate flooding within Warrengate, Colney Heath and London Colney, all of which have been subject to significant historical flooding.

A further review of the area has been made during this study, resulting in the identification of two additional sites for future flood storage. The first of these is located in Hertsmere Borough Council on the Potters Bar Brook at its confluence with the Mimmshall Brook. Storage here could attenuate flood flows from heavily urbanised area of Potters Bar and provide potential flood alleviation to Warrengate, Colney Heath, and London Colney. Although the benefits of such storage are outside of the Borough, it is recommended that Hertsmere Borough Council works with the local authorities of Welwyn Hatfield, St. Albans and Watford to help provide flood risk reduction to the wider community.

A further potential storage area was identified as part of St. Albans' SFRA (see ***Volume II, Tile G***) and recommendations were provided to safeguard this storage area from future development. Storage here could provide benefit to the section of the Upper Colne which runs through Watford (providing benefit to both Watford Borough Council and Hertsmere Borough Council).

As mentioned, in some cases it may be reasonable for future developers to contribute (in full or in part) to the cost of such strategic flood alleviation schemes which provide benefit to the wider community (further information on developer contributions can be found in Annex G of PPS25).

6.3 ***Policy Recommendations***

6.3.1 *Existing Policies*

Hertsmere Borough Council produced a comprehensive policy statement on flood defence in November 2000, a brief summary of which is provided below (see ***Appendix F*** for the full policy document). It is recommended that the statement is updated in accordance with PPS25, Making Space for Water and the Thames CFMP, and the recommendations provided within this report (see ***Section 4.8***).

Objective (a) To encourage the provision of adequate and cost effective flood warning systems

- Ensure that emergency response plans take account of flooding emergencies and that such plans are reviewed regularly, in consultation with Environment Agency
- Maintain awareness of and contribute to Environment Agency's flood warning plan
- Play a role in flood warning emergency exercises organised by Environment Agency

Objective (b) To encourage the provision of adequate, economically, technically and environmentally sound and sustainable flood defence measures

- Adopt a strategic approach to flood defences
- Aim to provide sustainable flood defences
- Ensure work is undertaken in accordance with best practice
- Consider alternative approaches to funding (PPP)
- Seek contributions from developers
- Ensure that appropriate maintenance regimes are in place for areas where the Council has riparian owner responsibilities
- Inform landowners of their maintenance responsibilities
- Make expenditure plans available to the public
- Play a positive role in its statutory responsibility in furthering nature conservation

Objective (c) To discourage inappropriate development in areas at risk of flooding

- Take account of flooding risks in all planning matters including development plans

6.3.2 *Workshop Consultation*

As part of the SFRA, a workshop was held with planning officers and drainage engineers from the Hertsmere Borough Council, key Environment Agency representatives and local flood wardens. The principle aim of the workshop was to review the existing policies outlined above and discuss how these could be updated to fully align with PPS25, the Thames CFMP and Making Space for Water (see ***Section 6.3.3***).

The Environment Agency was a key contributor to this exercise and as such the policy objectives and considerations provided in ***Section 6.3.3*** are in line with current legislation and accepted best practice.

6.3.3 *Recommended Policy Objectives*

It is recommended that the following flood risk objectives are taken into account during the policy making process and, where appropriate, used to strengthen or enhance existing flood risk management and development control policies.

Flood risk objective 1: Achieve flood risk reduction through spatial planning and site design

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1. Any application of the Sequential Test should also take into account flooding from other sources, including groundwater, artificial drainage and surface water, as identified in ***Volume II, Tile B.***
- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits (e.g. Land around Cranbourne Link Road and Potters Bar Golf Club)
- Ensure that lost floodplain is compensated for through on-site level for level and volume for volume floodplain compensation.
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Ensure that redevelopment behind defences reduces residual flood risk.

- Ensure development is 'Safe'. For residential developments to be classed as 'safe', dry pedestrian egress should be provided to and from the development without crossing through the 1 in 100 year plus climate change floodplain.
- Ensure the preservation of flood flow routes.

Flood risk objective 2: Enhance and restore the river corridor

- For any riverside developments an assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment or /and renewal should be made to ensure the lifetime is commensurate with lifetime of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. deculverting (Borehamwood and Potters Bar), the use of bioengineered river walls, raising bridge soffits to take into account climate change).
- Avoid further culverting and building over of culverts. All new developments with culverts running through their site should deculvert rivers for flood risk management and conservation benefit.
- Set development back from rivers, with a minimum 8 metre wide undeveloped buffer strip.

Flood risk objective 3: Reduce the risk of groundwater flooding

- Avoid development in areas where there is a significant and frequent risk of groundwater flooding.
- In areas where there is a risk of groundwater flooding, but where such risk is known to be low, and development is allowed to occur, then the following mitigation measures may be appropriate:
  - (i) Zone development to avoid areas of likely groundwater flooding and setting aside affected areas for environmental and amenity enhancement
  - (ii) Avoid basements and other large underground structures which may impede the flow of groundwater and cause up-gradient emergence of groundwater

(iii) Use flood proofing measures, where appropriate, to limit the potential impacts of groundwater flooding

(iv) Raise development on stilts (although this is dependent on the ground conditions)

Flood risk objective 4: Reduce surface water runoff from new developments

- All new development on Brownfield and Greenfield sites will require the following:
  - SUDS,
  - Greenfield discharge rates,
  - 1 in 100 year on-site attenuation taking into account climate change.

  For sites greater than 1 Ha or 10 houses, the Environment Agency will be the Statutory Consultee. For all other developments, Hertsmere's drainage team should be consulted as part of the planning application process.
- Space should be specifically set-aside for SUDS and used to master plan the overall site layout (e.g. in particular in Borehamwood, Bushey and Potters Bar)
- Developer contributions should be sought for improving surface water drainage systems and their maintenance.
- Ensure all stakeholders work together to manage surface water flooding.
- Future maintenance responsibilities for SUDS need to be identified prior to the development commencing

Flood risk objective 5: Safeguard functional floodplain and areas for future flood alleviation schemes

- Protect Greenfield functional floodplain from future development and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Safeguard areas identified for potential flood storage as part of the Upper Colne Flood Risk Management Strategy and within this study (e.g. storage areas identified on the Mimmshall Brook)
- Identify sites where developer contributions could be used to fund strategic flood risk management schemes identified by the Environment Agency, and local improvements to drainage infrastructure, identified by Hertfordshire Highways and the drainage authority. For example contributions to Section 106 could be obtained from developers on urban extensions of existing settlements with drainage issues for the production of surface water management plans.

Flood risk objective 6: Improve flood awareness and emergency planning

- Improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within Flood Zone 3a and 3b (residential and commercial occupiers) to sign-up to Flood Warnings Direct service operated by the Environment Agency.
- Ensure robust emergency (evacuation) plans are implemented for new developments greater than one hectare in size.
- Ensure safe evacuation and access for emergency services is available during times of flood both for existing developments and those being promoted as possible sites within the LDF process.
- Support the Environment Agency in implementing new flood warning systems across the Borough
- Take part in Emergency Planning exercises with the Environment Agency.

Flood risk objective 7: Improve multi-agency working and collaboration

- Ensure site-specific Flood Risk Assessments for major sites are submitted to key external stakeholders (e.g. Hertfordshire Highways & Thames Water) to identify potential developer contributions towards implementing new and improving existing assets where required. For example where any new development is proposed which contains a watercourse, contributions to the maintenance of that watercourse should be required.
- Ensure consultation and collaboration with neighbouring Councils occurs to ensure that the flood storage areas identified in ***Section 6.2*** are safeguarded and that there is alignment of key flood risk management polices.
- Ensure all stakeholders work together to manage surface water flooding.

We would welcome discussion into contributions to advise the local authority on what could be required. Fro example where any new development is proposed which contains a watercourse, contributions to the maintenance of that watercourse should be required. Contributions to Section 106 could also be obtained from developers on urban extensions of existing settlements with drainage issues for the production of these surface water management plans.

6.3.4 *Development Control Policies*

For the purposes of development control, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated 'windfall' sites. The following reflects the minimum requirements under PPS25 (reference should be made to Tables D.1-D.3 in PPS25).

Future Development within Flood Zone 1

In this zone, developers and local authorities should realise opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development. There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1, although for all sites, the vulnerability from other sources of flooding (groundwater, artificial drainage and land drainage) should be considered as well as the effect of the new development on surface water runoff.

Typically, a Drainage Impact Assessment will be required to demonstrate that runoff from the site is reduced, thereby reducing surface water flood risk. This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions (see ***Section 6.5*** for SUDS guidance). The site layout and surface water drainage systems should cope with events that exceed the design capacity of the existing drainage system so that excess water can be safely stored on or conveyed from the site without adverse impacts, hence flow routes will need to be identified across the site. For sites larger than one hectare, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield (pre-development) condition (see requirements set out in ***Section 6.5.3*** which should be applied to Greenfield and Brownfield sites alike). For sites less than one hectare (or 10 houses), consultation is not normally required with the Environment Agency. However, given the high potential of surface water and artificially drainage flooding, a Drainage Impact Assessment should be undertaken for any development over 3 houses, in accordance with current standing advice on drainage criteria (see ***Appendix F***).

Future Development within Flood Zone 2

Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category. Where other planning pressures dictate that 'highly vulnerable' land uses are acceptable, it will be necessary to ensure that the requirements of the Exception Test are satisfied (see ***Section 2.4***). The following should be considered:

- A detailed site-specific Flood Risk Assessment should be prepared in accordance with PPS25 and Council Development Control policies

- Floor levels should be situated above the 1% (100 year) plus climate change predicted maximum level plus a minimum freeboard of 300mm

- The development should be safe, meaning that dry pedestrian access to and from the development should be possible above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood.

- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For sites greater than one hectare the post development runoff volumes and peak flow rates should be attenuated to the Greenfield (pre-development) condition for both Greenfield and Brownfield sites (see ***Section 6.5.3***). Space should be set-aside for SUDS.

- The proposed development should be set back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.

- Attenuation must be provided for a 1 in 100 year return period with an allowance for climate change

Future development within High Probability Flood Zone 3a

Land use within High Probability Flood Zone 3a should be restricted to the 'less vulnerable' uses to satisfy the requirements of the Sequential Test. For 'more vulnerable' uses it is necessary to ensure that the requirements of the Exception Test are satisfied. The following should be considered:

- A detailed site-specific Flood Risk Assessment should be prepared in accordance with PPS25 and Council Development Control policies. Properties situated within close proximity to formal defences or water retaining structures (e.g. Hilfield Reservoir or Radlett Brook Flood Storage Area) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Environment Agency.

- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and deculverting). The can be achieved by developing land sequentially, with areas at risk of flooding favoured for green space.

- Floor levels should be situated above the 1% (100 year) plus climate change predicted maximum level plus a minimum freeboard of 300mm. Within defended the areas the maximum water level should be assessed from a breach analysis.

- The development should allow dry pedestrian access to and from the development above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood. An evacuation plan should be prepared (see ***Section 7.3***). With respect to new developments, those proposing the development should take advice from the LPA's emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. All access requirements should be discussed and agreed with the Environment Agency.

- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 300 mm above the 1 in 100 year flood level plus climate change.

- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For sites greater than one hectare the post development runoff volumes and peak flow rates should be attenuated to the Greenfield (pre-development) condition for both Greenfield and Brownfield sites (see ***Section 6.5.3***).

- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.

- Attenuation must be provided for a 1 in 100 year return period with an allowance for climate change.

Future development within Functional Floodplain Zone 3b

The Environment Agency Thames Region Development Control is adopting the following approach to development in the functional floodplain (Flood Zone 3b):

a) Greenfield Sites:

Development on Greenfield Sites should be restricted to 'water-compatible uses' and 'essential infrastructure' that has to be there. 'Essential infrastructure' in this zone must pass the Exception Test and be designed and constructed to remain operational in times of flood and not impede water flow.

b) Brownfield Sites:

When defining Flood Zone 3b, buildings, unless permeable to flood waters, are not considered to be part of the functional floodplain. However, land and other infrastructure around these buildings are considered to be functional.

It is recommended that the following design principles are adopted on Brownfield sites in order to achieve flood risk reduction:

- Remove buildings and restore the natural floodplain
- Use the Sequential Approach within the development boundary to minimise flood risk (i.e. adapting the form, layout and use of the development)
- Change the proposed land use to a less vulnerable classification
- Reduce building footprints
- Preserve flood flow routes
- Improve conveyance and storage by replacing solid buildings with buildings on stilts
- Ensure that dry pedestrian egress out of the 1 in 100 year plus climate change is possible from the site

<u>Future development within groundwater flood risk areas</u>
Flooding problems related to groundwater are not well understood, and indeed have only recently been properly recognised. Often the identification of a flood event caused by groundwater is problematic and anecdotal evidence may be unreliable. Incidents of groundwater flooding are often under reported as a result.

Within the UK there is currently no designated organisation with the responsibility of managing groundwater flooding. Following Defra's (2005) Making Space for

Water consultation the Environment Agency (EA) assumed, in Spring 2006, a strategic overview for monitoring groundwater flooding. There is however currently no clear cut responsibility for actions to address the occurrence, effects or management of groundwater flood risk. The EA role, and the legislative details necessary to define this role, is currently under review (see ***Section 6.4.6***).

Given the potentially severe consequences of groundwater flooding, any proposed development in an area with a known history of frequent groundwater flooding should be avoided (unless robust mitigation measures can be put in place) and alternative locations should be sought if the groundwater flooding cannot be mitigated. Where an area is known to be susceptible to groundwater flooding, and when such risk is high, a groundwater flood risk assessment should be undertaken in accordance with the approach outlined in ***Section 6.4.6.*** In areas where there is a risk of groundwater flooding, but where such risk is known to be low, and development is allowed to occur, mitigation measures more appropriate to that level of risk should be adopted (see ***Section 6.3.3***).

6.3.5 *Sensitive Development Locations*

The majority of watercourses within Hertsmere drain into the main Upper River Colne, along which there are several areas of high fluvial flood risk, most notably Colney Heath, London Colney, Watford and Rickmansworth. These areas have a long history of flooding and the potential impacts of climate change and future development (without appropriate policies in place) could further reduce existing levels of protection afforded to local communities.

Accordingly, the cumulative impact of future development within Hertsmere on flood risk within these areas could be significant, and the whole of the Borough may be considered as a sensitive development location. In particular, future development in and around Potters Bar may increase flood risk within Warrengate, Colney Heath and London Colney, and future development in and around Borehamwood, Radlett and Bushey may increase flood risk within Watford.

The most effective measure to mitigate this impact is to ensure that any additional surface water is attenuated to Greenfield rates by using appropriate Sustainable Urban Drainage Systems (SUDS) (see ***Section 6.5***). This is essential not only for sites greater than 1 hectare, for which the Environment Agency is a Statutory Consultee, but also at smaller scales involving the development of just a few houses.

More locally, within the main urban areas (Potters Bar, Radlett, Borehamwood and Bushey) there are many recorded instances of flooding from artificial drainage infrastructure, groundwater and surface water sources. Any development in the vicinity of these known flooding locations (see ***Volume II, Appendix B***), may itself be at risk of flooding or exacerbate the risk of flooding elsewhere. It is critical that assessments of flood risk include other forms of flooding and that appropriate mitigation measures are put in place (see ***Section 6.4***). In areas where there are known drainage issues, opportunities for developer contributions should be sought to provide flood risk reduction to the wider community.

6.4 Guidance to Developers

6.4.1 *Overview*

A SFRA is a strategic document that provides an overview of flood risk throughout the study area. Site-specific Flood Risk Assessments (FRAs) will be required for most proposed developments and the level of detail will depend on the level of flood risk at the site (see general details about FRA requirements in Appendix E in PPS25). The onus is on the developer to provide this information in support of a planning application.

Since the release of PPS25 in December 2006, the Environment Agency has power of direction over the determination of planning applications, which can be refused on the grounds of flood risk. Should the Council wish to disregard the advice of the Environment Agency then, in exceptional circumstances, the planning application could be put before the Secretary of State. It is therefore imperative that developers hold discussions over the need for a Flood Risk Assessment (FRA) early on within the planning process. Consultation should be undertaken with the Environment Agency and the Council to ensure that the Council's policies on flood risk management are respected and taken account of, and that the scope of the FRA is commensurate with the level of flood risk. The following reflects best practice on what should be addressed within a detailed FRA. Those proposing development should also be directed towards Annex F of PPS25 (***Figure 6-1*** shows the recommended process of undertaking an FRA as part of an individual planning application).

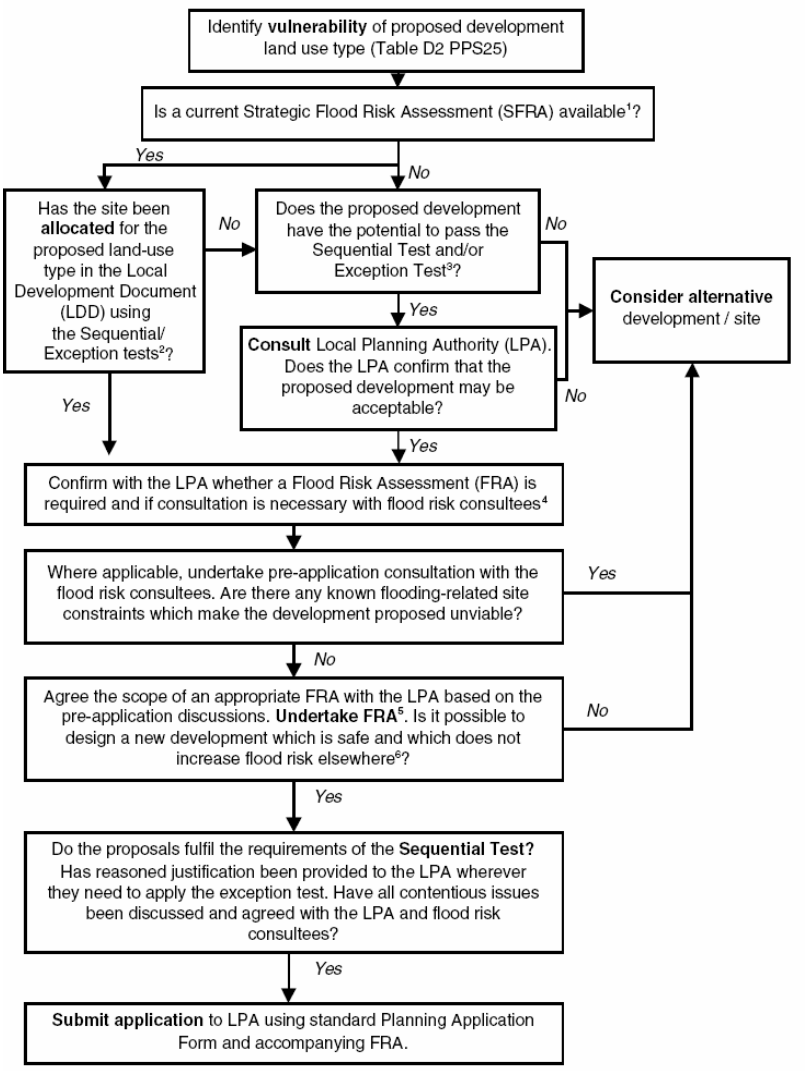


Figure 6-1 Guidance for developers for individual planning applications

6.4.2 *Proposed Developments within Functional Floodplain Flood Zone 3b*

Development will not normally be allowed in the Functional Floodplain unless it is classified as a 'water compatible' or 'essential infrastructure' use. However, it is possible that existing buildings on Brownfield sites can be redeveloped. Site specific FRA's for such sites should seek to reduce flood risk by implementing a number of important design principles (See ***Section 6.3.4*** for the recommended approach to redeveloping Brownfield sites located within the functional floodplain). Site specific FRA's should also include an assessment of all

components listed for proposed developments within Flood Zone 3a (see ***Section 6.4.3***, below).

6.4.3 *Proposed Developments within High Probability Flood Zone 3a*

All FRA's supporting proposed development within High Probability Zone 3a should assess the proposed development against all elements of the Council's flood policy, and include an assessment of the following:

- The vulnerability of the development to flooding from other sources (e.g. surface water drainage, groundwater) as well as from river flooding. This will involve discussion with the Council and the Environment Agency to confirm whether a localised risk of flooding exists at the proposed site.

- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change), i.e. maximum water levels, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.

- An assessment of the likelihood and consequence of culvert blockages on flooding within and beyond the site boundary.

- The potential of the development to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment to be carried out by a suitably qualified engineer.

- It is highlighted that all forms of flooding need to be considered as localised flooding may also occur, typically associated with local catchment runoff following intense rainfall passing directly over the Borough. This localised risk of flooding must also be considered as an integral part of the detailed Flood Risk Assessment.

- Where risk of flooding from groundwater has been identified an assessment must be undertaken as part of a detailed Flood Risk Assessment (see ***Section 6.4.6***)

- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.

- Details of existing site levels, proposed site levels and proposed ground floor levels. All levels should be stated relevant to Ordnance Datum.

It is essential that developers thoroughly review the existing and future structural integrity of informal defences, if present, upon which the development will rely (i.e. over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the unlikely event of a defence failure (see ***Section 7.3***).

6.4.4 *Proposed Development within Medium Probability Zone 2*

For all sites within Medium Probability Zone 2, a scoping level FRA should be prepared based upon readily available existing flooding information, sourced from the Environment Agency. If significant flood risk from other sources (e.g. groundwater or sewer flooding) is identified then a more detailed FRA should be prepared. It will be necessary to demonstrate that the residual risk of flooding to the property is effectively managed throughout, for example, the provision of raised floor levels and the provision of planned evacuation routes or safe havens.

6.4.5 *Proposed Development within Flood Zones 1 and 2*

The risk of alternative sources of flooding (e.g. surface water, sewage, and/or groundwater) must be considered, and sustainable urban drainage techniques must be employed to ensure no worsening of existing flooding problems elsewhere within the area.

The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular 'zones' of the area. These recommendations should form the basis for the site-based FRA.

6.4.6 *Proposed Development within Groundwater flood risk areas*

Work carried out for Defra (Defra 2004) identified groundwater flooding incidents across the country and identified some 5 incidents reported as groundwater flooding (in Bushey, Potters Bar and Radlett). These incidents may include emerging springs. The Defra report also attempted to identify areas of groundwater emergence (dominantly in chalk catchments) and published groundwater emergence maps. These maps are necessarily crude and are based on a limited data set, with a range of assumptions concerning both the basis of, and the potential for groundwater emergence. These show that the northern boundary of the Borough, south east of the River Colne, may be susceptible to groundwater emergence. The susceptible area is primarily underlain by Chalk strata. The level of confidence in this "emergence zone" is relatively low and requires refinements based on the hydrogeological properties of the aquifers in the area. To the central and southern parts of the Borough, the occurrence of Tertiary deposits (Woolwich and Reading Beds and London Clay) is likely to preclude the occurrence of groundwater flooding.

The British Geological Survey (BGS) also provide groundwater flooding hazard maps on their website – although again this is small scale mapping, it appears to show that Hertsmere lies in an area of "low potential" for groundwater flooding. These generic sources of data must be used with care and site specific conditions must be considered for any development (see below).

With the level of reporting available, and the overall lack of perception of the hazard from groundwater flooding, the scale and extent of groundwater flooding within Hertsmere is not known. Although there does appear to be some (albeit possibly low) risk of this type of flooding occurring, the mechanisms by which groundwater flooding may occur in the Borough are not fully understood and would require more focussed local analysis.

For any proposed development (allocated or non-allocated) an appropriate assessment of groundwater flood risk should be made. It is advised that the Local Planning Authority should initially use the national Groundwater Emergence Maps (Defra 2004) as a planning (screening) tool to provide a better indication of the areas potentially at risk from groundwater flooding.

A groundwater flooding flood risk assessment should be carried out by an expert hydrogeologist or geotechnical engineer. In areas away from the floodplain this could be undertaken as part of a geotechnical desk study for the proposed

development site, otherwise it should be included as part of an overland flow FRA (see ***Section 6.3.4***). As a minimum, the following tasks should be taken to assess the risk of groundwater flooding:

- A site walkover should be made to assess on-site conditions (e.g. the type and distribution of vegetation can be a clear indicator of areas prone to frequent water logging)
- A review of geological maps should be undertaken to assess the hydrogeological characteristics of the site (data should be obtained from the Environment Agency (EA) and British Geological Survey (BGS))
- Consultation should be undertaken with the British Geological Survey (BGS), the Environment Agency and local water supply companies to obtain the following: records of flows from springs, water levels in boreholes, recorded flood levels, groundwater flood maps and aerial photographs or photographs of ground water flood events
- Consultation should also be undertaken with local residents to help develop a complete understanding of groundwater flooding history

If the above tasks indicate that groundwater flooding is likely to impact a proposed development site, then depending on the scale of the development, it may be necessary to undertake a more detailed appraisal. The impact of the development itself (for example deep foundations disrupting groundwater flow, use of infiltration drainage) must also be assessed. The appraisal may require the installation of instrumentation to monitor groundwater levels, statistical analysis of borehole records and/or hydrogeological modelling. The scope and detail of a detailed ground water flood assessment should be provided by an appropriately qualified hydrogeologist.

Essentially all FRA's supporting proposed development within Groundwater flood risk areas should assess the proposed development against all elements of the Council's flood policy (See Objective 3 in ***Section 6.3.3*** for specific guidance). Development Control at the Borough should also use the maps where historical groundwater flooding has been identified (See ***Volume II, Tile B***) to guide the location of new developments in 'safe locations'.

6.4.7 *Raised Floor Levels & Basements (Freeboard)*

The raising of floor levels above the 1 in 100 year (1% probability peak) flood level will ensure that the damage to property is minimised. Given the anticipated

increase in flood levels due to climate change, the adopted floor level should be raised above the 1 in 100 year flood level assuming a 20% increase in flow over the next 20 to 100 years.

It is highlighted that many of those areas currently situated within Medium Probability Zone 2 could become part of the High Probability Zone 3. This is important as it means that properties that are today at relatively low risk will, in 20 to 100 years, be within High Probability Zone 3a. It is imperative therefore that planning and development control decisions take due consideration of the potential risk of flooding in future years.

Floor levels should be situated a minimum of 300mm above the 1 in 100 year flood level plus climate change flood level, determined as an outcome of the site-based FRA, or 600mm above the 1 in 100 year flood level if no climate change data is available. The height that the floor level is raised above flood level is referred to as the 'freeboard', and is determined as a measure of the residual risks.

The use of basements within flood affected areas (from fluvial or groundwater sources) should be discouraged. Where basements are permitted however, it is necessary to ensure that the basement access points are situated 300mm above the 1 in 100 year flood level plus climate change. The basement must have unimpeded access and waterproof construction to avoid seepage. Habitable uses of basements within flood affected areas should not be permitted.

6.4.8 *Development Behind Defences*

Areas behind defences (see ***Section 4.6)*** are at particular risk due to breach or overtopping, resulting in the rapid on-set of fast-flowing, deep water flooding with little or no warning. Risks will therefore be highest closest to these defences and as such it is recommended that the Borough should set back developments and ensure that those proposing developments develop robust evacuation plans as part of their FRA in consultation with the Environment Agency.

Consideration of flood risk behind defences should be made as part of detailed FRAs. Developers should review ***Volume II, Tile D*** to determine the location of structures and defences in proximity to the site and therefore identify the possibility of localised residual flood risk. As a minimum the FRA should take into account:

- the potential mechanisms of failure of flood defence infrastructure;

- the standard of protection and design freeboard;
- the asset condition of the flood defence;
- the height of the flood defence infrastructure and retained water levels compared to ground levels;
- the potential location, width and invert level of breach(es) in the flood defences;
- the duration of water levels during a flood event or tidal cycle;
- the period it would take the operating authority to close the breach;
- the period it would take for water to drain from the flooded area following a breach or overtopping event.

In addition to it is recommended that should any development be proposed in a defended flood area, the potential cumulative impact of loss of storage on flood risk elsewhere should be considered.

6.4.9 *Car Parks*

Car parking may be appropriate in areas subject to shallow, low velocity flooding (in High Probability Zone 3a) provided sufficient flood warning is available, and appropriately located and worded signs are in place. However, this would need to discussed and agreed with the Local Planning Authority and Environment Agency. As part of a FRA, the developer should consider the likelihood of people being able to move their cars within the flood warning time.

6.5 Sustainable Urban Drainage Systems

6.5.1 *Overview*

PPS1: Delivering sustainable development and PPS25 requires that LPAs should promote SUDS. LPAs should ensure policies encourage sustainable drainage practices in their LDDs. SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of rainfall (surface water) is considered an essential element of reducing future flood risk to both the site and its surroundings. Indeed, reducing the rate of discharge from urban sites to Greenfield runoff rates is one of the most effective ways of reducing and managing flood risk within the area.

6.5.2 *Types of SUDS Systems*

SUDS may improve the sustainable management of water for a site by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;

- reducing volumes of water flowing directly to watercourses or sewers from developed sites;
- improving water quality compared with conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open space and wildlife habitat; and,
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

Any reduction in the amount of water that originates from any given site is likely to be small however if applied across the catchment, the cumulative effect from a number of sites could be significant with respect to flood risk reduction.

There are numerous different ways that SUDS can be incorporated into a development. The appropriate application of a SUDS scheme to a specific development is heavily dependent upon the topography and geology of the site and the surrounding areas. Careful consideration of the site characteristics is necessary to ensure the future sustainability of the adopted drainage system. The most commonly found components of a SUDS system are described below:

- Pervious surfaces: Surfaces that allow inflow of rainwater into the underlying construction or soil.
- Green roofs: Vegetated roofs that reduce the volume and rate of runoff and remove pollution.
- Filter drains: Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
- Filter strips: Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
- Swales: Shallow vegetated channels that conduct and retain water, and may also permit infiltration; the vegetation filters particulate matter.
- Basins and ponds (including wetlands) where water may be stored on the surface. Basins are free from water during dry weather flow conditions, while ponds are permanently wet
- Infiltration Devices: Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.

- Bioretention areas: Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground.

For more guidance on SUDS, the following documents and websites are recommended as a starting point for those proposing development:

- Planning Policy Statement 25: Development and Flood Risk, Communities and Local Government, December 2006
- Development and Flood Risk: A Practice Guide Companion to PPS25, 'Living Draft', Communities and Local Government, 2007
- *Sustainable Drainage Systems – Draft Best Practice Guidance (August 2006)* – specifically for the Thames Region, providing a clear hierarchy for SUDS requirements at the planning application stage (available from the Environment Agency Development Control teams)
- Interim Code of Practice for Sustainable Drainage Systems, National SUDS Working Group, 2004 (see www.ciria.org.uk/suds for emerging SUDS selection toolkits)

6.5.3 *Application of SUDS for the Proposed Allocation and Future Development*

It is recommended that as part of an outline planning application and site-specific FRA, those proposing development will need to provide the following (for both Greenfield and Brownfield sites);

- Information to demonstrate how the principles of Sustainable Drainage Systems have been applied to the development identifying what techniques will be used;
- A SUDS design strategy which identifies the most suitable options (taking into account specific site constraints) for the design of the surface water drainage system and how it will affect the site layout;
- Plans which show that land has been specifically set aside for SUDS;
- Calculations of the Greenfield discharge rate for the site and required attenuation volume for the 1 in 100 year rainfall event with consideration of the effects of climate change; and,
- A long term management plan to identify future maintenance requirements and responsibilities

In terms of SUDS selection, in the headwaters of the catchment (southern end of Borough) across Borehamwood, Bushey, and Potters Bar, the soils are generally clays of low permeability, seasonally waterlogged, with medium to high runoff producing potential. In these locations, it is recommended that techniques which

focus on storing surface water above the ground surface (e.g. basins and ponds) are considered since infiltration techniques are likely to be ineffective.

The soils in the lower part of the catchment (northern end of the Borough) across Radlett and Shenley are generally well-drained, permeable loamy sandy soils which produce relatively low amounts of runoff. Here, consideration should be given to the use of infiltration drainage techniques (e.g. soakaways, permeable surfaces), although the depth of soil to the underlying rock (consisting of impermeable mudstones) and localised variations in the water table should be taken into consideration.

It is also important to note that there are also a number of groundwater source protection zones within the Borough. These zones are defined in terms of how groundwater behaves and are designed to protect against the transmission of toxic chemicals and water-borne diseases. The zones are classified into to Zone 1 (inner protection zone), Zone 2 (outer protection zone) and Zone 3 (total catchment). Zones 1 to 3 increase in time taken for pollution to travel to the borehole, hence areas in Zone 1 require greatest protection from pollution.

There are three pockets of Zone 1 (inner protection zone) protection areas within the Borough, located in Watford along the borough boundary, Smug Oak/Colney Street and the western end of Potters Bar. Zone 1 (inner protection zone) is defined as 'Any pollution that can travel to the borehole within 50 days from any point within the zone'. It is recommended that the Environment Agency groundwater team are consulted on the type of drainage techniques which would be most appropriate within these high risk locations (Zone 1).

6.5.4 *SUDS Adoption*

It should be noted that whilst there are no specific provisions for the adoption of SUDS techniques, existing legislation, such as Section 38 of the Highways Act, 1980 and the Town and Country Planning Act, 1990, can provide a mechanism for their adoption. However, this requires early consultation with the relevant stakeholders to ensure responsibilities for long term maintenance are agreed and a robust management plan is defined. Further guidance on this is provided in the CIRIA publication (C625 Model Agreements for SUDS) which aims to facilitate the uptake of SUDS by providing a mechanism for maintenance, either as a planning obligation under Section 106 of the Town and Country Planning Act, or as a condition attached to planning permission.

7 Flood Warning and Emergency Planning

7.1 *Existing Flood Warning System*

The current flood warning service in the study area is operated by the Environment Agency. The Agency monitors rainfall and river levels 24 hours a day at a number of Flood Warning telemetry stations throughout the study area and uses this information to forecast the probability of flooding. Flood warnings are issued using a set of four codes, each indicating the level of risk with respect to flooding. The warnings issued are Flood Watch, Flood Warning, Severe Flood Warning and All Clear. A Flood Warning is issued if property is expected to flood and a Severe Flood Warning if there is extreme danger to life. The 'All Clear' is issued to indicate receding flood waters.

Within the study area there are a total of 4 Flood Warning Areas covering specific reaches of each watercourse (See ***Volume II, Tile H):***

- Mimmshall Brook from Borehamwood to Water End
- Salmons Brook from Barnet to Lower Edmonton
- Turkey Brook from Potters Bar to Enfield
- Upper River Colne and its tributaries from North Mymms to Maple Cross

Within each area the Environment Agency promotes those within Flood Zone 3 to sign up to the Floodline Warnings Direct Service (FWD), which has recently replaced the Automatic Voice Messaging System (AVM). The FWD service enables individuals, emergency services, local authority emergency planners and response teams to be effectively warned by delivering warnings simultaneously via telephone, mobile, pager, fax, email, SMS text messaging, digital TV and radio.

In areas where there is a good network of telemetry stations, the full FWD service (high level service) is available. This includes the Upper River Colne, Mimmshall Brook and Radlett Brook. However, the remaining tributaries of the Colne only have a low level of flood warning service, which consists of broadcasted messages through the media.

The Environment Agency advise that people that live in or near un-serviced flood risk areas register to receive warnings for the wider catchment, although the warnings they receive will not represent exactly what is happening on these un-

serviced watercourses, they will provide an indication of what is happening in the local area.

The Environment Agency only offers a Flood Warning service for properties at risk of flooding from river and coastal sources, and cannot offer any warning service for other sources of flooding. Consultation undertaken with the Borough Council suggested that the current flood warnings from the Environment Agency would be of limited use in Hertsmere given that the majority of flooding occurs from non-fluvial sources such as surface water, groundwater and drainage infrastructure.

The on-going National Flood Risk Area/Flood Warning Area Project being undertaken by the Environment Agency is working towards refining the flood risk areas, thus providing a more targeted flood warning service to local communities. Flood risk areas represent areas of similar land use, floods from the same scenario and floods of similar return period. The risk areas will form flood warning areas based on communities in the floodplain (i.e. flood warnings issued to Radlett, rather than issued to certain rivers); a flood warning area will consist of one or more flood risk areas.

The exact definition of the splits between Flood Warning Areas remains subject to further consultation with key stakeholders. However it is proposed that Radlett Brook will be assigned its own Flood Warning Area (covering the area of Radlett) and Mimmshall Brook will be assigned its own Flood Warning Area (covering Warrengate Road and Water End). It is likely that any proposed changes for the River Colne and its various tributaries will not be operational until August 2008 at the earliest. These improvements will provide more accurate and area specific information for use by the Local Authorities emergency planning teams, local communities and emergency services.

7.2 Emergency Planning Recommendations

It is recommended that each Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that the Local Authorities work with the Environment Agency to promote the awareness of flood risk to maximise the number of people signed up to the FWD service (previously this has involved targeted mail shots to those identified as living within Flood Zone 3a). Within the study area particular

attention should be given to vulnerable people including those with impaired hearing or sight and those with restricted mobility.

The SFRA findings and the infrastructure and flood risk map (See ***Volume II, Tile J)*** will be of value to two main users:

(a) Emergency Planning (Borough and County level)
Emergency Planning at both the County and Borough level can use the SFRA findings and map to inform the Council's Emergency Response Plan to ensure that safe evacuation and access for emergency services is available during times of flood both for existing developments and those being promoted as possible sites within the LDF process. The SFRA findings can also be used to inform the proposed County-wide emergency plan specifically for flooding which will be built on the 'lessons learnt from the Summer 2007 floods' recently published by Defra.

(b) Development Control
Development Control at the Borough will use the SFRA findings and map to locate new development in 'safe locations'. This includes both allocated and non-allocated sites (windfall sites). For example if planning want to locate a new hospital or care home ('more vulnerable' use) in the Borough, the map can be used to ensure that it is located in low flood risk area and that there would be safe evacuation and access for emergency services during a flood.

With respect to new developments, those proposing the development should take advice from the LPA's emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. As a minimum these plans should include information on:

How flood warning is to be provided

- Availability of existing warning systems
- Rate of onset of flooding and available warning time and
- Method of dissemination of flood warning

What will be done to protect the infrastructure and contents

- How more easily damaged items could be relocated
- The potential time taken to respond to a flood warning
- Ensuring safe occupancy and access to and from the development

- Occupant awareness of the potential frequency and duration of flood events
- Provision of safe (i.e. dry) access to and from the development
- Ability to maintain key services during an event
- Vulnerability of occupants and whether rescue by emergency services may be necessary and feasible
- Expected time taken to re-establish normal practices following a flood event

In some areas, particularly for existing properties and proposed developments behind defences, it may be necessary to extend the scope of the SFRA to Level 2 (see ***Section 5.7*** and ***Sections 8.1 and 8.2***). The outputs from detailed overtopping and breach analysis of the key defences will provide refined hazard information on flood depths, velocities and flow paths, which could be used by the LPA emergency planning teams to define new or refine existing emergency plans for these areas.

8 Recommendations

A number of recommendations have been made throughout this report on the basis of the findings of the SFRA. These are summarised below.

8.1 *Site Allocation Process*

It is recommended that the outputs from this study are used as an evidence base from which to direct new development to areas of low fluvial flood risk (Flood Zone 1) and away from other sources of flooding. Where development cannot be located in such areas, the Council should use the flood maps to apply the Sequential Test to their remaining land use allocations.

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitable sites for development within zones of lower flood risk, the scope of the SFRA will need to be widened to a Level 2 assessment. The need for a Level 2 SFRA cannot be fully determined until the Council have applied the Sequential Test. It is recommended that as soon the need for the Exception Test is established, Level 2 SFRA(s) are undertaken by a suitably qualified engineer so as to provide timely input to the overall LDF process.

In the event that site allocations are proposed in close proximity to or within the indicative residual risk extents mapped for the Aldenham reservoir, Hilfield Park reservoir and Radlett Brook Flood Storage Area, the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood hazard in these locations.

It is recommended that when the SFRA is updated, the SFRAs of neighbouring Councils are consulted (in terms of potential growth/development areas) to provide a more robust assessment of off-site impacts on flood risk in the Borough.

8.2 *Additional Studies*

It is recommended that more detailed modelling studies are undertaken by the Council in selected areas to provide better information on the flood hazard associated with the failure of flood risk management infrastructure. The areas are:

- Aldenham Reservoir – detailed assessment of the residual risk of overtopping or breach of the reservoir

- Hilfield Park Reservoir – detailed assessment of the residual risk of overtopping or breach of the reservoir
- Radlett Brook FSA – detailed assessment of the residual risk of overtopping or breach of the flood storage area
- Unmapped watercourses – modelling and mapping will be required where site allocations are proposed within or close to the 20m buffer (assumed 3b outline) in order to accurately define flood zones 2, 3a and 3b.

The Pitt review (2007) recommends that Local authorities lead on the management of Surface Water through Surface Water Management Plans. It is therefore recommended that in the areas identified as having surface water flooding problems SWMPs should be implemented.

The outputs from these studies would enable the Council's Emergency Planning teams to refine existing emergency response plans and provide Development Control with more accurate and consistent information with which to guide the location and form of future development.

8.3 Council Policy

It is recommended that the Council's existing flood risk management policies are updated and aligned with the recommendations provided in Section 6.3.3 of this report. These should include the following core policies:

- Locate new development in least risky areas, giving highest priority to Flood Zone 1 and avoid development in areas where there is a significant and frequent risk of groundwater, surface water or artificial drainage flooding.
- Ensure that all new development is 'Safe', meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain and emergency vehicular access is possible.
- Promote the use of sustainable urban drainage systems in all flood zones to achieve Greenfield discharge rates on both Greenfield and Brownfield sites.
- Prevent the development of Greenfield sites in the functional floodplain and seek flood risk reduction on redevelopment of Brownfield sites (e.g. reduction in building footprints).
- Safeguard possible sites for future flood storage.

- Seek opportunities for developer contributions to achieve flood risk reduction from all sources.
- Seek opportunities to undertake river restoration and enhancement as part of a development to make space for water.
- Work with neighbouring authorities to ensure that overall flood risk management policies are in alignment with one another.

8.4 Emergency Planning

It is recommended that the Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible future development sites. It is further recommended that the Council work with the Environment Agency to promote the awareness of flood risk and encourage communities at risk to sign-up to the Environment Agency Flood Warning Direct service.

8.5 Future Updates to the SFRA

The SFRA should be retained as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance. It is recommended that outputs from the following studies are used to update future versions of the SFRA report and associated maps:

- Upper Colne Strategic Flood Risk Mapping Study (Environment Agency due to commence in 2008 but will not be finalised until 2010/2011) – will provide updated modelling and mapping of the River Colne and its major tributaries.
- Flood Plans for Statutory Reservoirs (Environment Agency, due to commence in 2008) - will provide detailed information on the residual risk of breach or overtopping of the reservoirs (Aldenham and Hilfield Reservoirs).
- Planning Policy Statement: Planning and Climate Change (supplement to PPS 1) – will provide further guidance on how planning should secure new development to the effects of climate change.
- Neighbouring Borough Council SFRAs (Welwyn Hatfield Borough Council and London Borough of Barnet) – will provide a more robust assessment of cross-boundary issues on flood risk within Hertsmere Borough Council.

- Surface Water Management Plans (SWMP) - In the areas identified as having surface water flooding problems SWMPs should be implemented and the report updated accordingly.

Glossary

1) Defra - Department of Environment, Food and Rural Affairs Development.

2) DCLG - Department of Community and Local Government.

3) Environment Agency - The leading public body for protecting and improving the environment in England and Wales.

4) Planning Policy Statements - The Government has updated its planning advice contained within Planning Policy Guidance Notes (PPGs) with the publication of new style Planning Policy Statements (PPSs).

5) 'Making Space for Water' (Defra 2004) - The Government's new evolving strategy to manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches, so as: a) to reduce the threat to people and their property; b) to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles, c) to secure efficient and reliable funding mechanisms that deliver the levels of investment required.

6) Planning Policy Statement 25 (PPS 25): Development and Flood Risk - PPS 25 reflects the general direction set out in 'Making Space for Water'.

7) The South East Plan - It is a new Regional Spatial Strategy which identifies the vision for the region through to 2026. It will set a new housing requirement for each district or borough.

8) Local Development Framework - The Local Development Framework (LDF) consists of a number of documents which together form the spatial strategy for development and the use of land.

9) Development Plan Document (DPD) - A spatial planning document within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination.

10) Core Strategy - The Development Plan Document which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.

11) Supplementary Planning Document (SPD) - Provides supplementary guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan, nor are they subject to independent examination.

12) Sustainability Appraisal (SA) - Appraisal of plans, strategies and proposals to test them against broad sustainability objectives.

13) Sustainable Development - Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987).

14) Strategic Environmental Assessment (SEA) - European Community Directive (2001/42/EC) on the assessment of the effects of certain plans and programmes on the environment.

15) Flood Risk Management Hierarchy - PPS 25 reaffirms the adoption of a risk-based approach to flooding by following stepped hierarchical measures at all stages in the planning process. Avoidance/prevention is the first measure, followed by substitution, control and then mitigation.

16) Strategic Flood Risk Assessment (SFRA) - A Strategic Flood Risk Assessment is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints, informing sustainability appraisals and identifying locations of emergency planning measures and requirements for flood risk assessments.

17) The Sequential Test - Informed by a SFRA, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

18) The Exception Test - If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS 25 sets out strict requirements for the application of the Test.

19) Flood Risk Vulnerability - PPS 25 provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone.

20) Environment Agency Flood Map - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

21) Formal Flood Defence - A structure built and maintained specifically for flood defence purposes.

22) Informal Flood Defence - A structure that provides a flood defence function, however has not been built and/or maintained for this purpose (e.g. boundary wall).

23) AEP - Annual Exceedance Probability, for example 1% AEP is equivalent to 1% probability of occurring in any one year (or, on average, once in every 100 years).

24) Functional Floodplain Zone 3a - Defined as areas at risk of flooding in the 5% AEP (20 year) design event.

25) High probability Zone 3a - Defined as areas at risk of flooding in the 1% AEP (100 year) design event.

26) Medium probability Zone 2 - Defined as areas at risk of flooding in events that are greater than the 1% AEP (100 year), and less than the 0.1% AEP (1000 year) design event.

27) Low Probability Zone 1 - Defined as areas outside Zone 2.

28) Residual Risk - The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

29) Habitable Room - A room used as living accommodation within a dwelling but excludes bathrooms, toilets, halls, landings or rooms that are only capable of being used for storage. All other rooms, such as kitchens, living rooms, bedrooms, utility rooms and studies are counted.

30) LiDAR - Light Detection and Ranging (LiDAR) is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground.

31) JFlow - A computer river model based on routeing a flood calculated by Flood Estimation Handbook methodology along a river corridor the levels of which are derived from a Side Aperture Radar (SAR) remote sensed Digital Terrain Model.

32) Flood Estimation Handbook - The latest hydrological approach for the estimate of flood flows in UK.

33) Previously Developed (Brownfield) Land - Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land.

9 References

1) Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft', A Consultation Paper, Communities and Local Government, February 2007

2) Upper Colne Flood Risk Management Strategy, 2005

3) Planning Policy Statement 25: Development and Flood Risk, Communities and Local Government, 2006

4) Regional Planning Guidance for the South East, 2001

5) Hertfordshire Structure Plan Review 1991 – 2011, April 1998

6) Thames Region Catchment Flood Management Plan, Summary Document, Environment Agency, January 2007

7) Flooding and Coastal Defence Project Appraisal Guidance FCDPAG 2 Strategic Planning and Appraisal, 2001, MAFF

8) Making Space for Water, 2005, Defra

9) Water Framework Directive, 2003, European Community (200/60/EC)

10) Defra – Making Space for Water. Groundwater flooding records collation, monitoring and risk assessment (reference HA5). Draft Consolidated Report Main Summary Report (2007 - in Preparation)

11) Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study (LDS 23) Final Report Defra March 2004

12) Rye Meads Water Cycle Strategy Scoping Study.

Appendices

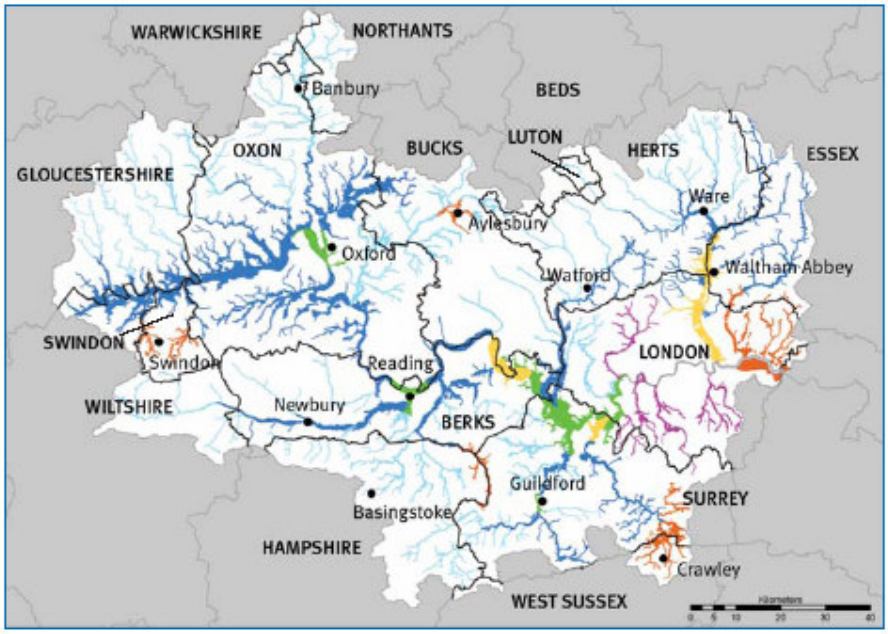
Appendix A – PPS25 Overview

Appendix B – Data Register

Appendix C – Communication Plan

Appendix D – Sewer Flooding History

Appendix E – Thames CFMP Messages



Key

The colours on the map above represent the different types of flood plain in Thames Region.

Undeveloped natural flood plain

Undeveloped natural flood plain

Example: flood plains across much of Oxfordshire, Berkshire, Surrey and Hertfordshire

- The flood plain is our most important asset in managing flood risk.
- Maximising the capacity of the flood plain to retain water in these areas can have many advantages for people and the natural environment.
- Managed flooding of some areas of the natural flood plain will reduce the risk to some communities.
- We will do all we can to prevent development that compromises the capacity of the flood plain to retain water. Future maintenance work on river channels should aim to increase the capacity of the flood plain.

Appendix F – Hertsmere Borough Council Policy Statement on Flood Defence