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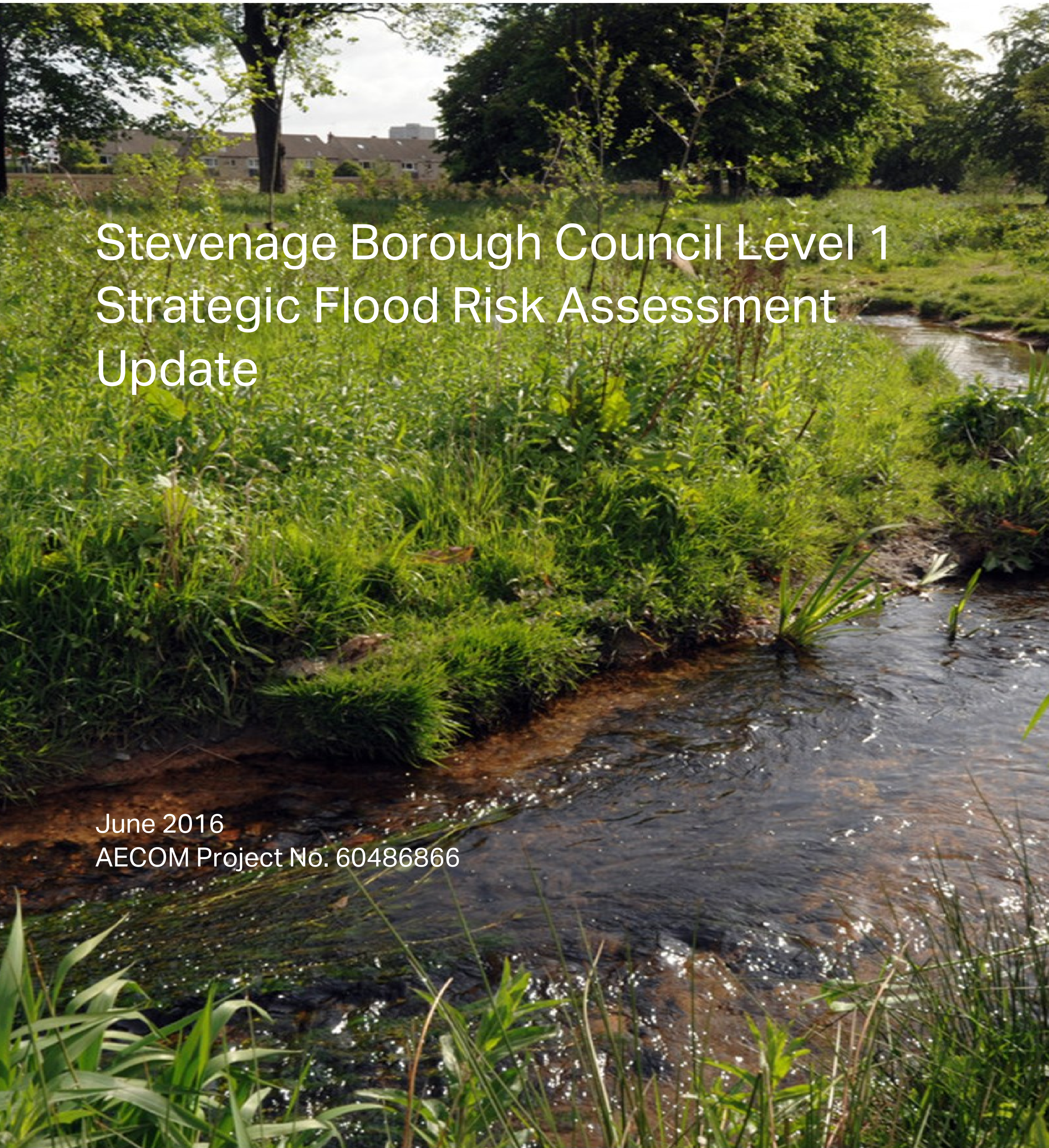

Stevenage Borough Council Level 1 Strategic Flood Risk Assessment Update

June 2016
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List of Acronyms

ABD	Areas Benefiting from Defences
AEP	Annual Exceedance Probability
AIMS	Asset Information Management System
AOD	Above Ordnance Datum
AWS	Anglian Water Services
BGS	British Geological Survey
BC	Borough Council
CC	County Council
CFMP	Catchment Flood Management Plan
DC	District Council
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Flood and Rural Affairs
DRN	Detailed River Network
EU	European Union
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FWMA	Flood and Water Management Act 2010
GCSE	General Certificate of Secondary Education
GIS	Geographic Information System
GPs	General Practioners
HCC	Hertfordshire County Council
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LoWS	Local Wildlife Sites
LPA	Local Planning Authority
NNR	National Nature Reserve
NPPF	National Planning Policy Framework
PDL	Previously Developed Land
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Policy Guidance
PPS25	Planning Policy Statement 25
RBD	River Basin District
RMAs	Risk Management Authorities
SBC	Stevenage Borough Council
SFRA	Strategic Flood Risk Assessment
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
uFMfSW	Updated Flood Map for Surface Water
UKCP09	United Kingdom Climate Projections
WCS	Water Cycle Study
WFD	Water Framework Directive
WwTW	Wastewater Treatment Works

Glossary of Terms

Glossary	Definition
Annual exceedance probability (AEP)	Chance of occurrence in any one year, expressed as a percentage. For example, a 1% annual probability event has a 1 in 100 chance of occurring in any given year.
Areas Benefitting from Defences (ABD)	Hatched areas on the Environment Agency Flood Map for Planning (Rivers and Sea) behind flood defences, which, if the flood defences were not present, would flood, in the event of a river flood with a 1 % (1 in 100) chance of happening each year, or a flood from the sea with a 0.5 % (1 in 200) chance of happening each year.
Asset Information Management System (AIMS)	Environment Agency management system of assets associated with main rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Catchment Flood Management Plan (CFMP)	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances, including flooding.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions. For fluvial events a 20% increase in river flow is applied and for rainfall events, a 30% increase. These climate change values are based upon information within the NPPF and Planning Practice Guidance (PPG).
Culvert	A channel or pipe that carries water below the level of the ground.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
Exception Test	A method set out in the NPPF to help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. The two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.
Flood and Water Management Act (FWMA)	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 Floods; the aim of which is to clarify the legislative framework for managing local flood risk (flooding from surface water, groundwater and ordinary watercourses) in England.
Flood Defence	Infrastructure used to protect an area against flooding such as floodwalls and embankments.
Resilience measures	Measures designed to reduce the impact of water that enters property and businesses and to promote fast drying and easy cleaning; for example raising electrical appliances, installing tiled flooring.
Resistance measures	Measures to prevent flood water entering a building or damaging its fabric, for example the use of flood guards. This has the same meaning as flood proofing.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Flood Zone	Areas defined by the probability of river and sea flooding, ignoring the presence of defences. Flood Zones are shown on the Environment Agency's Flood Map for Planning (Rivers and Sea), available on the Environment Agency's web site.
Fluvial	Relating to the actions, processes and behaviour of a watercourse (river or stream).
Freeboard	The height of a flood defence crest level (or building level) above a particular design flood level.
Functional Floodplain	Land where water has to flow or be stored in times of flood. It is defined by LPAs within SFRAs. Functional floodplain (also referred to as Flood Zone 3b) is not separately distinguished from Zone 3a on the Environment Agency Flood Map for Planning.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.

Glossary	Definition
Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area. In this case, Hertfordshire County Council.
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Main river	Watercourse defined on a 'main river map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for main rivers. However overall responsibility for maintenance lies with the riparian owner.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
National Planning Policy Framework (NPPF)	The National Planning Policy Framework was published on 27 March 2012. It is a framework which sets out the Government's planning policies for England and how these are expected to be applied.
Ordinary watercourse	A watercourse that does not form part of a main river. This includes "all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows" according to the Land Drainage Act 1991.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	An approach to future site planning whereby new development is directed towards areas with the lowest probability of flooding before consideration of higher risk areas. The Sequential Test helps ensure that development can be safely and sustainably delivered and developers do not waste their time promoting proposals which are inappropriate on flood risk grounds.
Sewer Flooding	Flooding caused by a blockage or overflowing of a sewer or urban drainage system.
Surface Water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
Surface Water Management Plan (SWMP)	A plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Topographic survey	A survey of ground levels.

Executive Summary

This updated Level 1 Strategic Flood Risk Assessment has been prepared in order to provide a strategic understanding of flood risk at proposed future development sites within Stevenage Borough Council, in accordance with National guidance, the National Planning Policy Framework and the NPPF Planning Practice Guidance. In addition, the activities of Stevenage Borough as Local Planning Authority need to have due regard for the Local Flood Risk Management Strategy of Hertfordshire County Council as the Lead Local Flood Authority. In discharging their flood risk management functions as a Risk Management Authority, management of flood risk from ordinary watercourses, SBC must act consistently with the local strategy and also must aim to make a contribution to sustainable development when discharging these functions.

The update will build on previous Level 1 SFRA published in February 2009 and then updated in May 2013. The study comprises of the following key stages:

This report provides a background to the SFRA and outlines the legislative and planning context which guides the assessment (Chapter 2). The partner organisations within SBC are detailed and historic flooding reports from these organisations assessed. The importance of existing flood mitigation measures are highlighted, for example the flood storage reservoirs and the water meadows in which they are situated. The water meadows are an integral part of the management of surface water flooding within SBC and there needs to be a strategy for their continuous maintenance.

To provide a long term holistic review of flood risks within the Borough, the latest climate change guidance from Environment Agency's Thames and Anglian River Basin Districts have been considered in the study (Chapter 3). It is recommended that values form Thames River Basin District are adopted in the Local Plan so that the planning decisions are robust in the face of climate change and consistent across the Borough. The impacts of the climate change projections on the high risk Local Plan sites are briefly assessed. A more in depth analysis of the results are covered by the Level 2 SFRA.

The Level 1 SFRA assessment shows that a vast majority of the potential development sites in SBC Local Plan are at low risk of flooding (Chapter 4). With appropriate flood management and mitigation solutions these sites could be acceptable for the development purposes for which they are allocated.

This report also includes guidance on the management and mitigation of flood risk (Chapter 5), application of SuDS within the Borough (Chapter 6), and guidance for preparing site-specific FRAs (Chapter 7). It is expected that site developers will consider these advice and undertake technical studies to identify specific solutions appropriate for the nature of development and the level of risk at each site.

With careful and considered planning (Chapter 8), Stevenage Borough Council should steer any future development towards areas with the lowest flood risk first and ensure adequate flood management and mitigation are adopted by developers as part of the site design.

The six sites identified to be in medium or high risk category will be assessed further in a Level 2 SFRA to provide information to support the application of the Exception Test for future development sites. The scope of the Level 2 SFRA will be to consider the detailed nature of the flood characteristics within a flood zone (Chapter 9).

1 Introduction and Background

1.1 Terms of Reference

Stevenage Borough Council (SBC) has commissioned AECOM to review and update the Level 1 Strategic Flood Risk Assessment (SFRA) for its administrative area. This Report comprises the updated Level 1 SFRA Report.

1.2 Project Background

The National Planning Policy Framework[1] (NPPF) and associated Planning Practice Guidance for Flood Risk and Coastal Change (PPG)[2] emphasise the active role Local Planning Authorities (LPAs) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. The NPPF outlines that Local Plans should be supported by an SFRA and LPAs should use the findings to inform strategic land use planning. The original SFRA for SBC was prepared by AECOM (formerly known as Faber Maunsell) in February 2009 and subsequently updated in May 2013 by SBC to take account of the change in the planning system to the NPPF.

A number of additional strategic flood risk datasets have been made available for the Stevenage study area since the 2013 update, and the Environment Agency has published new guidance on the approach for considering climate change for river flooding. In addition, SBC are in the process of developing their Local Plan for submission in July 2016, which seeks to deliver an additional 7,600 homes in the District. A majority of the proposed growth will likely be located on Greenfield land to the west, north, and south of Stevenage. In addition to this, the North Hertfordshire District Council (NHDC) draft Local Plan also includes new developments just outside SBC boundary. As a result, an update to the SFRA for SBC is required.

In addition to the proposed developments, there have been a number of further changes in legislation and guidance relating to planning and flood risk. The introduction of the Localism Act in 2011 was intended to create a planning system oriented around consideration of local planning issues. Planning Policy Statements (PPS), covering all aspects of national planning policy have since been replaced by the NPPF. The accompanying technical guidance document relating to flood risk, originally derived from the PPS documents has also been recently replaced by the Planning Practice Guidance (PPG). Furthermore, the wider planning system has been subject to considerable change since 2008 with the withdrawal of the previous regional planning framework and the revocation of Regional Spatial Strategies in 2010.

The Flood and Water Management Act (FWMA) attained royal assent in 2010, with the intention of enabling the provision of more effective flood management following the flooding of July 2007. As such, SBC is designated as a Risk Management Authority (RMA) and its primary duty is to cooperate with Lead Local Flood Authority (LLFA) and other RMAs to manage flooding from local sources across the Borough, specifically surface water, groundwater and ordinary watercourses. SBC power as an RMA includes designation of flood risk structures and features. The Environment Agency retains responsibility for leading and coordinating the management of flood risk associated with main rivers.

The purpose of the Level 1 SFRA Update is to collate and analyse the most up to date readily available flood risk information for all sources of flooding, to provide an overview of flood risk issues across the Borough. This will be used by SBC to inform the preparation of Local Plans, including the application of the Sequential Test to future site allocations. It is also intended that the revised Level 1 SFRA deliverables will assist prudent decision-making on flood risk issues by Development Management Officers on a day-to-day basis.

1.3 Approach to Flood Risk Management

The NPPF sets stringent tests to protect people and property from flooding, which all LPAs are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed. The main steps to be followed can be summarised as **Assess**, **Avoid** and **Manage and Mitigate** flood risk. These steps are set out below (Table 1-1), and are designed to ensure that if there are better sites in terms of flood risk, or a proposed development cannot be made safe, it should not be permitted.

[1] Department for Communities and Local Government. 2012. *National Planning Policy Framework*. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

[2] Department for Communities and Local Government. 2014. *Planning Practice Guidance: Flood Risk and Coastal Change.* Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

Table 1-1 Approach to Flood Risk Management set out by the NPPF

Assess Flood Risk	LPAs should undertake a SFRA to fully understand the flood risk in the area to inform Local Plan preparation. For sites in areas at risk of flooding, or with an area of 1 hectare or greater, developers must undertake a site-specific Flood Risk Assessment (FRA) to accompany planning applications (or prior approval for certain types of permitted development).
Avoid Flood Risk	SBC should apply the **sequential approach** to site selection so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of climate change and the vulnerability of future users to flood risk. In **plan-making this involves applying the Sequential Test**, and where necessary the **Exception Test** to Local Plans, as described in Section 4. In **decision-taking this involves applying the Sequential Test** and if necessary the **Exception Test** for specific development proposals.
Manage and Mitigate	Where alternative sites in areas at lower risk of flooding are not available, it may be necessary to locate development in areas at risk of flooding. In these cases, SBC and developers must ensure that development is appropriately flood resilient and resistant, safe for its users for the lifetime of the development, and will not increase flood risk overall. SBC and developers should seek flood risk management opportunities (e.g. safeguarding land), and to reduce the causes and impacts of flooding (e.g. through the use of sustainable drainage systems).

A flow chart to provide guidance on the use of the SFRA when taking flood risk into account during the planning process and preparation of the Local Plan is outlined in Figure 1-1.

1.4 Partner Organisations

There are several organisations involved in development and flood risk management across the study area. These are identified below.

Stevenage Borough Council is the LPA for the study area, responsible for long term strategic planning of future development through the preparation of Local Plans, as well as for determining planning applications within the Borough. In accordance with the FWMA and subsequent communication from Central Government, from 6th April 2015, SBC is required to ensure that Sustainable Drainage Systems (SuDS) are implemented for all major developments where appropriate, and that through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development. SBC should work with LLFA to secure Local Plan policies compatible with the local flood risk management strategy.

Hertfordshire County Council is designated as the Lead Local Flood Authority (LLFA) under the FWMA, and has a duty to lead and coordinate the management of local flood risk, which includes flood risk from surface water, groundwater and ordinary watercourses. On 24 March 2015, Government laid a statutory instrument making the LLFA a statutory consultee in planning for all major development in relation to the management of surface water drainage from 15 April 2015.

HCC, as highway authority for local road network, is also responsible for providing and managing highway drainage and roadside ditches, and must ensure that road projects do not increase flood risk.

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

Affinity Water Services has a duty as a statutory body to provide clean water services to major proportion of the study area.

Thames Water Utilities has the duty as a statutory body to provide waste water services to the majority of the study area and is responsible for the management, maintenance and operation of flood control structures. Water Companies are defined as a Risk Management Authority (RMA) within the FWMA and are responsible for flood risk management functions in accordance with the Water Resources Act 1991 and the Land Drainage Act 1991. Thames Water is responsible for surface water drainage from development via adopted sewers and for maintaining trunk sewers into which much of the highway drainage in the study area connects.

Anglian Water Services is responsible for a relative small area in the north west of Stevenage. However, wastewater from this area is currently pumped over the operational border into the Thames Water network via the Coreys Mill pumping station[3].

Highways England has responsibilities (under the Highways Act 1980) for the effectual drainage of surface water from Motorways and major A roads insofar as ensuring that drains, including kerbs, road gullies, ditches and the pipe network which connect to the sewers (often Thames Water Utilities), are maintained.

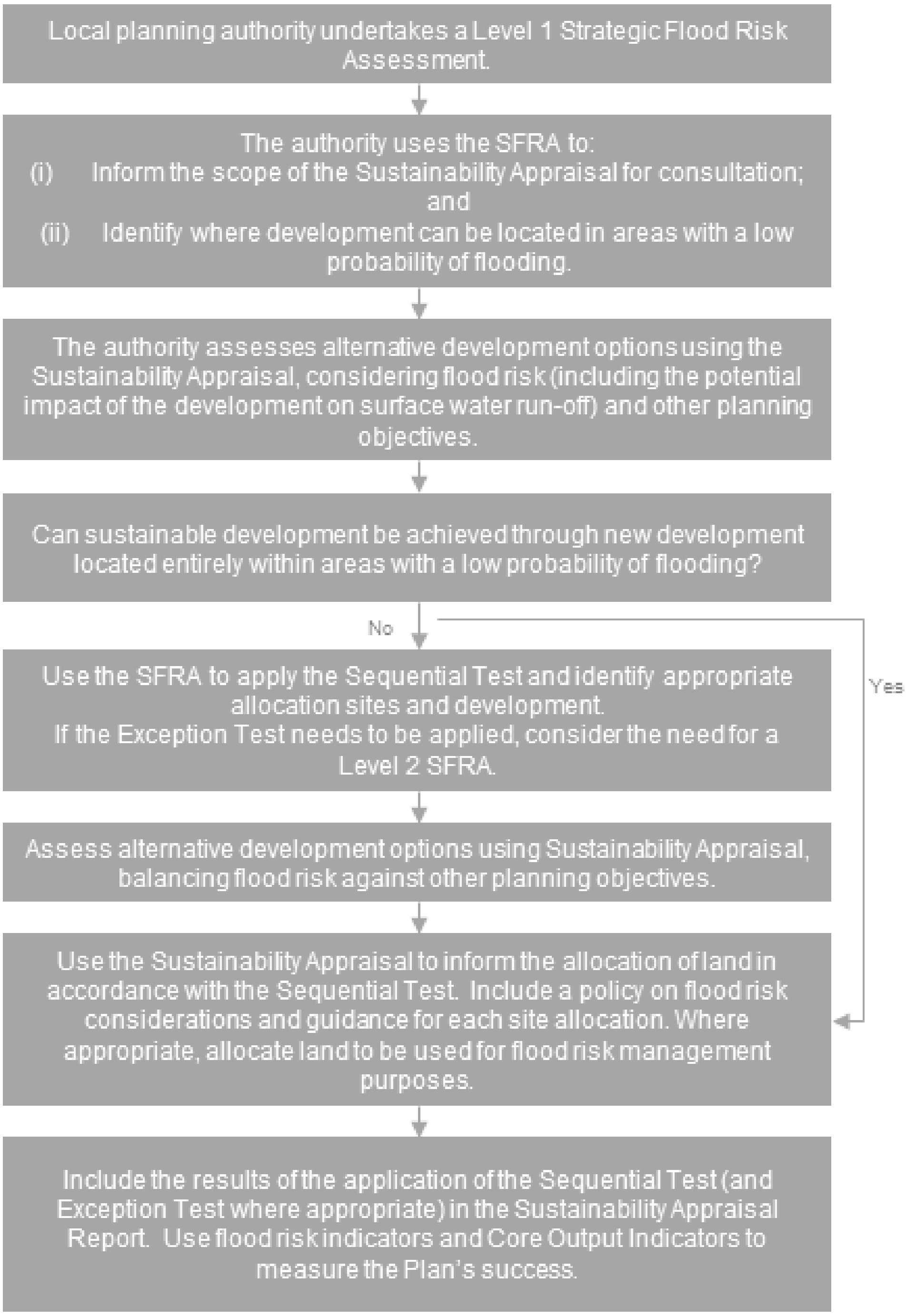


Figure 1-1 Taking flood risk into account in the preparation of a Local Plan (PPG, P6)

3 Hyder Consulting (UK) (October 2009) http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Strategy-Final-Report.pdf

1.5 Level 1 SFRA Approach

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

1.5.1 Gathering data and analysing it for suitability

Under Section 10 of NPPF, the risk of flooding from all sources must be considered as part of a Level 1 SFRA, including flooding from tidal sources, rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources.

In order to provide this assessment of all sources of flooding in the study area, an extensive set of datasets was requested from a number of organisations, including SBC, HCC (as the LLFA and Highways Authority), the Environment Agency, Thames Water and the Highways England.

Datasets and information gathered as part of the preparation of the first iteration of the SFRA in 2009 and again in 2013 have been retained where appropriate. The datasets are described further in Section 3, including detail regarding appropriate uses and limitations, and how they have been used within the Level 1 SFRA.

1.5.2 Producing strategic flood risk maps, GIS deliverables and a technical report

A series of GIS maps have been produced using the data gathered during the study. The mapping deliverables are summarised in Table 1-2 and should be referred to when reading Section 3 'Assessing Flood Risk' which provides an overview of flood risk across the Borough.

Table 1-2 Strategic Flood Risk Maps

Figure No.	Figures Title and Content
Figure 1	Study Area *(Administrative boundaries, watercourses, water bodies, development areas)*
Figure 2	Local Plan Sites
Figure 3.1 & Figure 3.2	Flooding from Rivers (Flood Zone Map)
Figure 4.1 & Figure 4.2	Flooding from the Land (updated Flood Map for Surface Water)
Figure 5	Flooding from Groundwater (Areas Susceptible to Groundwater Flooding)
Figure 6	Historic Records from Flooding Database
Figure 7	Artificial Sources
Figure 8.1 & Figure 8.2	Flood Response Measures
Figure 9.1 & Figure 9.2	Flood Risk for Local Plan Sites
Figure 10	BGS Infiltration SuDS Suitability Map

1.5.3 Providing suitable guidance

Based on Section 3 'Assessing Flood Risk', and the supporting mapping deliverables, the Level 1 SFRA Report provides specific guidance for SBC.

Section 4 provides guidance on 'Avoiding Flood Risk' through the appropriate application of the Sequential Test by SBC when allocating future development sites as part of the plan-making process, as well as by developers promoting development on windfall sites.

Sections 5 provides guidance for measures to 'Manage and Mitigate Flood Risk' on future development sites and to assist the preparation of site-specific FRAs.

Section 6 provides guidance for the application of SuDS and Section 7 guidance on the preparation of site-specific FRAs.

Section 8 outlines a number of flood risk management objectives and policy recommendations for consideration by SBC throughout the development of their strategic planning documents.

2 Legislative and Planning Policy Context

2.1 Introduction

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

2.2 Flood and Water Management Act

In response to severe flooding across large parts of England and Wales in summer 2007, the government commissioned Sir Michael Pitt to undertake a review of flood risk management. The Pitt Review – Learning Lessons from the 2007 Floods[4] and subsequent progress reviews outlined the need for change in the way the UK is adapting to the increased risk of flooding and the role different organisations have to deliver this function.

The FWMA[5], enacted by Government in response to the Pitt Review, designated county councils, such as HCC, as LLFA. As such, HCC has responsibilities to lead and co-ordinate local flood risk management. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses).

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

2.2.1 National Strategy for Flood and Coastal Erosion Risk Management

In accordance with the FWMA, the Environment Agency has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[6]. This strategy provides a framework for the work of all flood and coastal erosion risk management authorities. Stevenage is not a coastal Borough; therefore for this area the National FCERM Strategy sets out the other long-term objectives for managing all other sources of flood risk and the measures proposed to achieve them.

It sets the context for, and informs the production of local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It also aims to encourage more effective risk management by enabling people, communities, business and the public sector to work together to:

- Ensure a clear understanding of the risks of flooding, nationally and locally, so that investment in risk management can be prioritised more effectively;
- Set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risks;
- Encourage innovative management of risks taking account of the needs of the communities and the environment;
- Ensure the emergency responses to flood incidents are effective and that communities are able to respond properly to flood warnings; and,
- Ensure informed decisions are made on land use planning.

[4]Cabinet Office (2008) Sir Michael Pitt Report 'Learning lessons learned from the 2007 floods' http://www.environment-agency.gov.uk/research/library/publications/33889.aspx
[5] Environment Agency (2010) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities
[6] Defra, Environment Agency (2011) The National Flood and Coastal Erosion Risk Management Strategy for England.

The Environment Agency's 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'[7] guidance is a supporting note for the National FCERM Strategy. The 2016 version of the document reflects an assessment completed by the Environment Agency between 2013 and 2015 using UKCP09 data to produce more representative climate change allowances for river flood flows and extreme rainfall for each of the river basin districts in England. It is essential that land use planning decisions consider the impact of a changing climate where appropriate.

2.2.2 Local Flood Risk Management Strategy

As LLFA, HCC has a statutory duty to develop, maintain, apply and monitor a strategy for local flood risk management in the administrative area. HCC has prepared a Local Flood Risk Management Strategy[8] (LFRMS) to enable flood risk across Hertfordshire to be managed more effectively and holistically.

The overall aim of the LFRMS is to "to work with organisations, businesses and communities to manage flood risks, and where it is practicable, affordable and sustainable to do so, to reduce risks to life, property and livelihoods that may arise from local surface runoff, ordinary watercourse and groundwater flooding". The LFRMS will seek to implement the following strategic objectives:

1. Determine and communicate Local Flood Risk – Undertake projects to determine and understand the risks of flooding from surface run-off, ordinary watercourses and groundwater. Increase public awareness through the publication of clear and consistent information about local flood risk.

2. Partnership working – work with all RMAs and other stakeholders to coordinate flood risk management roles, responsibilities and activities. Share best practice; raise the profile of RMAs working within Hertfordshire and assist organisations in ensuring their plans and projects take proper account of flood risk from all sources.

3. Partnership Programmes and Projects – Identify, secure and optimise resources to develop and deliver measures to manage flood risk. Assist organisations to establish and update long-term plans to manage flood risk.

4. Riparian Responsibilities - Work with RMAs to encourage and where necessary enforce the management and maintenance of privately owned flood management structures and ordinary watercourses and minimise unnecessary constrictions and obstructions within local drainage networks.

5. Flood Risk and Development – Ensure that planning authorities are properly informed about local flood risk, that there is a consistent approach to the consideration of flood risk management I the new development and that new developments seek to reduce existing flood risk and contribute to the achievement of sustainable development.

6. Water Framework Directive (WFD) – Support the implementation of the WFD by ensuring that watercourse morphology, water quality and ecological status are not harmed by activities that are controlled by, or undertaken by, owners, occupiers and managers of FCERM infrastructure. Facilitate measures to improve morphology, water quality and ecological status whenever it is practicable and necessary to do so.

7. Support Water and Sewerage Company infrastructure – Work closely with water and sewerage companies to minimise flood risks associated with their infrastructure and promote the development and management of sustainable water resources.

2.3 Flood Risk Regulations

As well as the duties under FWMA, LLFAs have legal obligations under the EU Floods Directive[9], which was transposed into UK Law through the Flood Risk Regulations 2009[10] ('the Regulations'). One of the requirements is the preparation of a Preliminary Flood Risk Assessment as outlined below.

[7] Environment Agency (2016) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516116/LIT_5707.pdf
[8] Hertfordshire County Council (2011) Local Flood Risk Management Strategy For Hertfordshire 2013 – 2016 http://www.hertsdirect.org/docs/pdf/f/hertslfrmsall.pdf
[9] European Union (2007) EU Floods Directive http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT
[10] HSMO (2009) The Flood Risk Regulations http://www.legislation.gov.uk/uksi/2009/3042/contents/made

2.3.1 Preliminary Flood Risk Assessment

Under the Regulations, all LLFAs were required to prepare a Preliminary Flood Risk Assessment (PFRA) report. This is a high level screen exercise to identify areas of significant risks as 'Indicative Flood Risk Areas' across England where 30,000 people or more are at risk from flooding, for reporting to Europe.

A PFRA was prepared for HCC in 2011[11]. The PFRA seeks to provide a high level overview of flood risk from local flood sources and includes flooding from surface water (i.e. rainfall resulting overland runoff), groundwater, ordinary watercourses (smaller watercourses and ditches) and canals. It excludes flood risk from main rivers, the sea and reservoirs, as these are assessed nationally by the Environment Agency. The PFRA report looks at past flooding and where future flooding might occur across the area and the consequences it might have to people, properties and the environment. The report provides a useful baseline for Hertfordshire to inform their LFRMS as well as the preparation of this revised Level 1 SFRA.

2.4 Thames River and Great Ouse Basin District Flood Risk Management Plans

Under the EU Floods Directive and UK Flood Risk Regulations, LLFAs must prepare Flood Risk Management Plans (FRMPs) in formally identified Flood Risk Areas where the risk of flooding from local sources is significant (i.e. surface water, groundwater, ordinary watercourses). The Environment Agency is required to prepare FRMPs for all of England covering flooding from main rivers, the sea and reservoirs.

As such, the Thames River Basin District and the Great Ouse FRMPs[12] have been published by the Environment Agency and set out the measures to manage flood risk in the Thames River Basin District from 2015 to 2021. These documents draw on existing reports and plans which have been prepared in the past such as the Catchment Flood Management Plans (CFMP) for the catchments in Hertfordshire identified in Table 2-1.

CFMPs set out polices for the sustainable management of flood risk across particular catchments over the long-term (50 to 100 years) taking climate change into account. Of relevance to the Stevenage study area is Sub-area 4 of the Thames River and Sub-area 7 of the Great Ouse.

Table 2-1 Summary of CFMP Policies for SBC

Thames Catchment Flood Management Plan [13]
Sub-area 4: Colne tributaries and Wye, Middle Mole, Thame and Upper Lee – Policy 3 "Areas of low to moderate flood risk where we are generally managing existing flood risk effectively"
The issues in this sub-area The major source of flooding is rivers, sometimes in combination with high groundwater levels. Many of the river valleys across the Chilterns and northern Hertfordshire are quite steep with narrow floodplains. In many of the urban areas the river channels have been modified. Pinch points such as bridges and culverts can contribute to localised flooding. These sub-areas contain 11% (180km²) of the total area of floodplain in the Thames CFMP. There are approximately 4,000 properties with a 1% risk of flooding from rivers. This represents 3% of the total number at risk in the Thames CFMP area. This figure is estimated to increase by between 6% and 40% in the future due to the impacts of climate change. There are a few people and properties at risk in this large rural sub-area. People and properties are located in isolated towns and villages scattered throughout the rural region. River flooding is infrequent and the consequences of flooding are low. There are no formal flood defences in this sub-area. **The Key Messages** • Maintain the existing capacity of the river systems in developed areas to reduce the risk of flooding from more frequent events. Make the existing systems more efficient. • Retain the remaining floodplain for uses that are compatible with flood risk management and put in place polices that lead to long-term adaption of urban environments in flood risk areas. • Continue to increase public awareness, including encouraging people to sign-up for free Floodline Warnings Direct service.

[11] Hertfordshire County Council (2011) Preliminary Flood Risk Assessment http://www.hertsdirect.org/docs/pdf/f/hccpfra.pdf
[12] Environment Agency (March 2016) Thames River Basin District Flood Risk Management Plan 2015-2021 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/507138/LIT_10229_THAMES_FRMP_PART_A.pdf
[13] Environment Agency (December 2009) Thames Catchment Flood Management Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293903/Thames_Catchment_Flood_Management_Plan.pdf

Great Ouse Catchment Flood Management Plan [14]
Sub-area 7: Towcester, Shefford/the Flit Corridor, Alconbury/Alconbury Weston, Huntingdon/Brampton and Hitchin – Policy 3 "Areas of low to moderate flood risk where we are generally managing existing flood risk effectively"
The issues in this sub-area This sub-area contains a number of towns and villages. Currently, 617 properties within this sub-area are at risk from the 1% annual probability river flood. Currently there is about 2km2 of grade one and two agricultural land at flood risk. There are two electricity sub-stations, two sewage treatment works, a police station, a landfill site and sections of A road at risk within the current 1% annual probability river flood. **The Key Messages** • As the risks are currently managed appropriately, and flooding is not expected to increase significantly, the current level of risk will be maintained.

2.5 National Planning Policy Framework

The NPPF is a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities. The overall approach of the NPPF to flood risk is broadly summarised in Paragraph 103:

"When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- *Within the site the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and*

- *Development is appropriately flood resilient and resistant, including safe access and escape routes where required and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.*

Further detail regarding the Sequential and Exception Tests is included in Section 4 of this report and the Level 2 SFRA.

2.5.1 NPPF Guidance SuDS Policy (April 2015)

SuDS are an approach to managing rainwater and surface water that replicates natural drainage, the key objectives being to manage flow rate and volume of runoff to reduce risk of flooding and water pollution. From 6th April 2015, LPAs such as SBC are required to ensure that SuDS are implemented for all major developments where appropriate, and that through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

As the LLFA, HCC is a statutory consultee for SuDS applications. HCC will need to be consulted on the drainage elements of planning applications for major development to ensure they conform to necessary national and local SuDS standards[15].

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

2.6 Local Planning Policy

This SFRA will form part of the evidence base for the SBC's emerging Local Plan. The Local Plan will cover the period to 2031 and will replace the existing adopted Local Plan Review (2004) which adheres to the national guidance laid out in PPS25:

[14] Environment Agency (January 2011) Great Ouse Catchment Flood Management Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288877/Great_Ouse_Catchment_Flood_Management_Plan.pdf
[15] Sustainable drainage systems: non-statutory technical standards - https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

- The Council will minimise exposure of people and property to the risks of flooding. In particular the sequential test will be applied to avoid new development being located in areas of flood risk.
- Where a site lies partially in the flood zone the Sequential Approach will also be rigorously applied and only water compatible or essential infrastructure uses will be permitted in areas demonstrated to be at risk.
- SuDS will be used wherever possible to reduce flood risk, promote groundwater recharge, enhance biodiversity and provide amenity benefit, unless, following an adequate assessment, soil conditions and/or engineering feasibility dictate otherwise.
- Developers must engage in discussions with water and sewerage providers at the earliest opportunity to provide evidence with their planning application that there is capacity for their proposals.

Climate change is likely to result in more extreme weather events, including hotter and drier summers, flooding and rising sea level, leading to permanent changes in the natural environment. In order to develop sustainably, climate change must be considered to ensure flood risk is reduced both now and into the future.

2.6.1 Local Flood Risk Management Strategy

HCC as the LLFA, has the responsibility to develop, maintain, apply and monitor an LFRMS. The current LFRMS for HCC covers the period of 2013 – 2016[16]. The high level objectives of the strategy include the following:

- To reduce the potential impact and costs of flooding in the county.
- To better understand local flood risk and make best use of available information.
- To develop greater personal involvement in flood risk management amongst residents of Hertfordshire.
- To secure improvements to the water environment of Hertfordshire through the undertaking of actions associated with flood risk management.

The LFRMS identified the major sources of flooding in the county. Of these sources, those associated with main rivers are well documented through the Environment Agency. Therefore further assessment and collection of data undertaken by HCC focused on local sources of flood risk.

Prior to the LFRMS, HCC produced a PFRA in June 2011, which identified surface water flooding to be the major driver of flood risk in the county[17]. It was estimate that 2,800 properties were at risk due to surface water flooding to a depth of 0.3m with a 1 in 200 chance of occurring, based on Environment Agency 'Flood Map for Surface Water' (FMfSW, 2010).

2.7 Water Cycle Strategy

The purpose of this study is to identify any water related issues that could present significant obstacles to new development. The study examines how much growth can be accommodated within the existing infrastructure. It examines whether sufficient water resources are available to supply the forecast demand, how much growth the existing drainage and Wastewater Treatment Works (WwTW) can accommodate and whether or not the watercourses in the surrounding area can handle the additional discharges without deteriorations in water quality or water dependent habitats.

A regional WCS has been produced which includes the Stevenage Area, namely the Rye Meads WCS[18]. With respect to flooding, the WCS highlighted the fact that the sewerage network is known to be close to capacity in certain areas of the Rye Meads catchment which increases the risk of flooding from sewers. The report focused on the need for an upgrade to create the capacity for all the additional Stevenage development and the remaining development expected within the Rye Meads catchment past 2021.

[16] Hertfordshire (2013) Local Flood Risk Management Strategy for Hertfordshire 2013 – 2016 http://www.hertsdirect.org/docs/pdf/f/hertslfrmsall.pdf
[17] Hertfordshire County Council (2011) Preliminary Flood Risk Assessment http://www.hertsdirect.org/docs/pdf/f/hccpfra.pdf
[18] Hyder Consulting (UK) (October 2009) http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Strategy-Final-Report.pdf

This strategy was reviewed in 2015 by SBC[19] to take into account the changes in planning system and economic outlook in the intervening years. This review concluded the justification for significant infrastructure intervention proposed in 2009 WCS no longer existed as a result of reduction in the scale of development, both locally in Stevenage and across the broader catchment. The findings of this report was developed in consultation with, and endorsed by, both the Environment Agency and Thames Water.

2.8 National Receptor Dataset

The National Receptor Dataset (NRD) is a collection of risk receptors primarily intended for use in FCERM[20]. A receptor is something that is affected by a hazard. For example, within FCERM, typical receptors of concern are homes, businesses or infrastructure, which could be flooded from a river, or if a defence were to breach. In the NRD not all records are properties, therefore, the features marked for exclusion from Environment Agency's National Flood Risk Assessment (NaFRA) property counts in Appendix B of NRD2014 guidance have also been excluded for this SFRA.

The version of NRD currently available and used for the purposes of this SFRA is NRD 2014. The frequency of NRD updates is not fixed and is based on how much the base information has changed or in response to a specific business need. A softcopy version of NRD2014 with information on different sources of flooding for each receptor has been delivered to SBC as part of the outcomes of this SFRA.

2.9 Summary

Figure 2-1 provides a summary of the documents that have been outlined in this section. The figure demonstrates that the main driver for the SFRA is the NPPF and that the documents and plans prepared by both the Environment Agency and SBC are under the requirements of the FWMA and the Flood Risk Regulations, which provide key inputs to inform the preparation of the revised SFRA and new Local Plan.

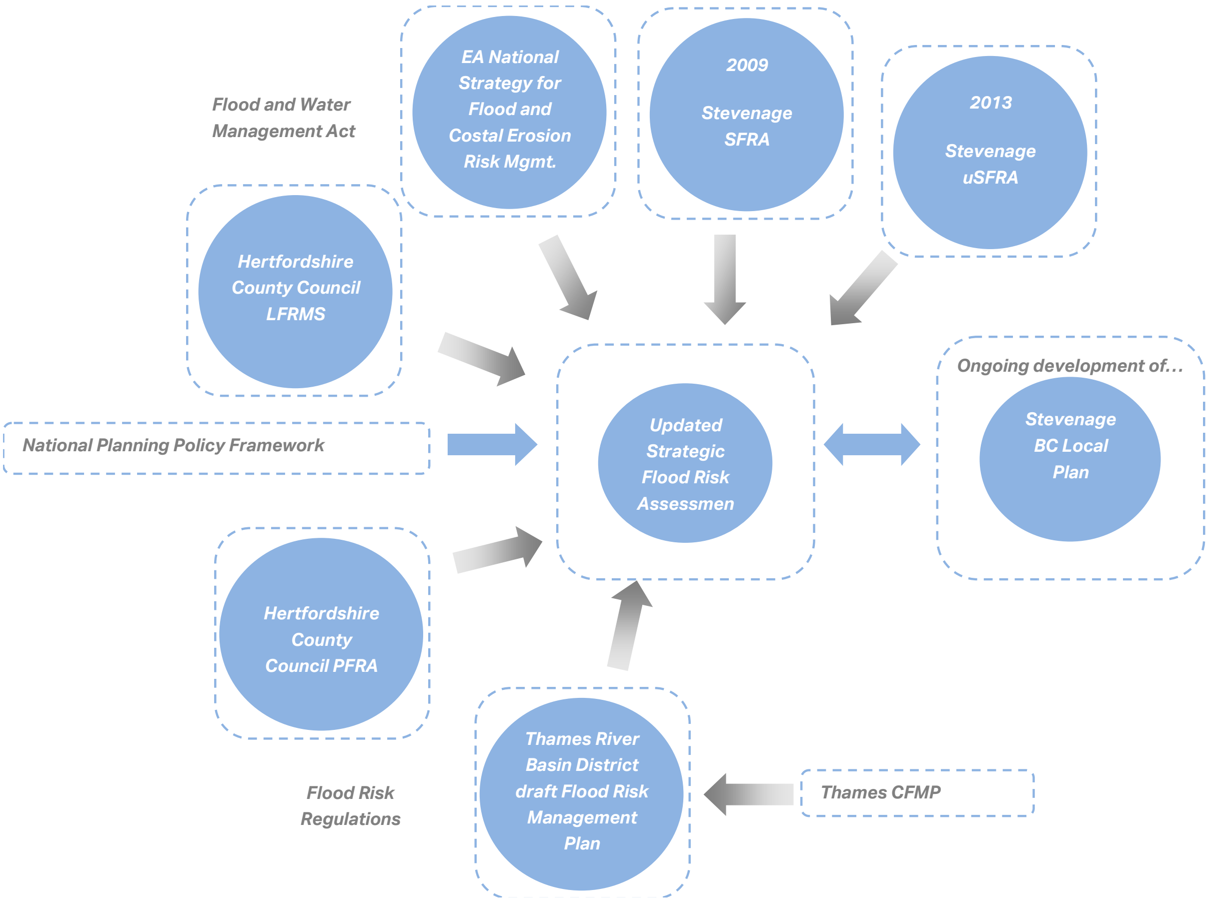


Figure 2-1 Summary of Legislative and Planning Context

19 Stevenage Borough Council (September 2015) http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Strateg-Review.pdf
20 Environment Agency (September 2015) – NRD2014 Guidance

3 Assessing Flood Risk

3.1 Introduction

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

3.2 Study Area

3.2.1 Location

The study area of SBC is shown in **Appendix A Figure 1**, together with the location of the principal watercourses and reservoirs. SBC forms part of the County of Hertfordshire, and is surrounded by the Districts of North Hertfordshire to the west and north and East Hertfordshire to the south and east.

SBC covers an area of 2,606ha on elevated land at the eastern end of the Chiltern Hills on the watershed between the River Thames and River Great Ouse (Anglian River Basin) catchments. It is largely urbanised with very little Greenfield land remaining within the Borough. SBC has no coastline and therefore tidal flooding is not considered in this report.

3.2.2 Hydrogeology

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

The chalk outcrop which forms the Chiltern Hills to the west of Hertfordshire continues eastwards and then northwards into East Anglia. Stevenage lies just south of the crest of the ridge which forms the Thames / Anglian watershed and which separates the scarp slope of the chalk to the north from its dip slope to the south. Chalk is a highly permeable stratum and has a dominant influence on the hydrological characteristics of the rivers and streams which drain it.

Throughout Stevenage most of the chalk is covered by a capping of Boulder glacial clay, with the exception of a strip of exposed chalk stretching south from Chesfield Park to the Fairlands Valley at Bedwell. There is also a small exposure of chalk in the northeast corner of the Borough at Box Wood.

The most notable geological feature of the Stevenage area is the pair of buried glacial valleys which run beneath the present day Stevenage Brook valley and, west of Stevenage, the Langley Valley. These buried valleys were formed during the ice ages by melt water flowing south from glaciers north of Stevenage incising deep valleys in the chalk, but subsequently became filled with glacial sediments to form buried valleys. The main buried valley enters the northeast corner of the Borough at Whitney Wood. For most of its length it is between 1000m and 1500m wide but diminishes to about 500m in width at Bragbury End. The smaller buried valley under Langley Valley joins the main buried valley beneath Stevenage Brook under the A1(M) at Junction 7.

3.3 Summary of Flood Sources

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

Table 3-1 Potential flood sources and pathways

Flood Type	Source	Pathway	Consider further
Fluvial	Stevenage Brook and Aston End Brook	Floodplain ponding / conveyance / breach and overtopping	Yes
Surface Water	Greenfield runoff Urban runoff	Flow paths merging from surrounding fields	Yes
Arterial Drainage Network	Urban runoff	Surcharged sewers or burst water mains (failure of infrastructure)	Yes
Tidal	SBC has no coastline, therefore there is no tidal flood risk	No coastline	No
Groundwater	Perched within alluvial deposits	Rising water level	Yes
Artificial Sources	Reservoir	Flow paths should a reservoir fail	Yes

3.4 Flooding from Rivers

3.4.1 Sources

The Environment Agency 'Detailed River Network' dataset has been used to identify watercourses in the study area and their designation (i.e. Main River or ordinary watercourse). There are 2 designated main rivers in the study area, the locations of which are shown in **Appendix A Figure 1**.

Main rivers are watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Flood and Rural Affairs (Defra). The Environment Agency has permissive powers to carry out works necessary for flood defence purposes on these rivers. The overall responsibility for maintenance however, lies with the riparian owner.

An Ordinary Watercourse is a watercourse that does not form part of a Main River. This includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows according to the Land Drainage Act 1991.

Most of the Stevenage study area falls within the catchment of Stevenage Brook, a major tributary of the River Beane which it joins at Frogmore Hall, 1.5km downstream of the borough boundary. The River Beane is one of the principal catchments of the River Lee which drains a substantial area of Hertfordshire and East London as well as the southern and western fringes of Bedfordshire and Essex respectively.

Within Stevenage the main channel of the Stevenage Brook (which has a catchment area of 11.3sq.km upstream of Fairlands Valley) drains the western side of the Borough and the town centre. The Stevenage Brook is defined as a 'main river' watercourse south of Six Hills Way.

The Brook has two principal tributaries; the Fairlands Valley Stream which drains the central part of Stevenage, and the Aston End Brook which drains the eastern side of the Borough. All three streams flow from north to south. The catchments of the first two streams are almost entirely urbanised, that of the Aston End Brook slightly less so. The Aston End Brook is also defined as a 'main river' watercourse south of Tatlers Lane.

To the north and west of Stevenage lies the catchment of the River Hiz, a major tributary of the Anglian Region's River Great Ouse. West of the A1 (M) motorway, the western edge of the borough falls within the Ippollitts Brook catchment. The northwestern corner of the borough drains to the Ash Brook catchment. These two relatively small streams (catchment areas 22.6 sq.km and 15.5 sq.km respectively) combine on the eastern side of Hitchin to form the River Purwell which then meets the River Hiz in Walsworth, a northern suburb of Hitchin.

Existing Hydraulic models

North West Stevenage Hydraulic Model

A simple and conceptual 2D hydraulic model[21] of the Ash Brook ordinary watercourse was carried out as part of a flood risk assessment on some of the north west development sites. The intention was to provide an indicative model (without the precision of a 1D – 2D link simulation) that could provide a more accurate representation of flood extent than the Environment Agency Flood Map by using the LIDAR DTM Data. This model shows the flood extents for both the 1% AEP and 0.1% AEP which appear to be much narrower than the Environment Agency Flood Map. The difference in flood extent between the 1% AEP and the 0.1% AEP are quite similar despite the difference of flow summarised in Table 3-2.

It is suggested that any future development proposal is supported by a detailed 1D –2D hydraulic model. The revised model would allow a better definition of the flooded area and more accurate assessment of flood risk at the site. The detailed modelling needs to be based on topographic survey of the area surrounding the ordinary watercourse and channel cross section survey of Ash Brook.

The downstream localities of Great Wymondley, Little Wymondley, St Ippolyts and Hitchin may also be affected by the proposed developments. Future development plan should take this into consideration and ensure that there is no increase in flood risk downstream.

Table 3-2 Ash Brook peak flow rates[22]

Waterbody	AEP	In Flow (m^3/s)	Percentage increase with respect to previous AEP
Ash Brook	5% (1 in 20 years)	0.85	-
Ash Brook	1% (1 in 100 years)	1.36	60%
Ash Brook	0.1% (1 in 1000 years)	2.65	95%

South East Stevenage Hydraulic Model

The Environment Agency hydraulic model of the area in the south east of Stevenage has been re-run using the most recent climate change projections released by the Environment Agency for the Thames River Basin. The impact on the Local Plan sites located within the modelled extent has been assessed in further detail in the Level 2 SFRA.

3.4.2 Structures

Throughout the river network there are hydraulic structures such as weirs, mills, bridges and culverts. These may elevate water level and hence exacerbate flood risk in the associated areas. Structures can promote debris dam formation which may reduce the capacity of the watercourse. Moreover, the existence of structures is likely to reduce watercourse capacity themselves.

3.4.3 Historic Records of River Flooding

The Environment Agency has provided an extract from the 'Recorded Flood Outlines' dataset for the study area[23] which details some historic fluvial flood events in the Borough. These events occurred in Stevenage in 1947, 1978, 1992, 1993, 2013 and 2015. These are understood to be the most significant flood events to have occurred in the Borough since World War II. The total extent of historical flooding is shown in Appendix A Figures 3.1 and 3.2 'Historic Flood Map'. However, it should be emphasised that not all floods that have occurred in every location have necessarily been recorded.

3.4.4 NPPF Flood Zones

The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF seeks to assess the probability of flooding from rivers by categorising areas within the fluvial floodplain into zones of low, medium and high probability, as defined in Table 3-3.

[21] RAB Consultants (2015) Land at Stevenage, J8 A1 (M) Flood Risk Assessment
[22] RAB Consultants (2015) Land at Stevenage, J8 A1 (M) Flood Risk Assessment
[23] The 'Recorded Flood Outlines' dataset identifies the flood extents associated with specific flood events. The 'Historic Flood Map' shows greatest extent of past flooding and does not identify individual flood events.

The 'Flood Map for Planning (Rivers and Sea)' is available on the Environment Agency website[24] and is the main reference for planning purposes as it contains Flood Zones 1, 2 and 3a which are referred to in the NPPF and presented in Table 3-3. The 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain.

Table 3-3 Fluvial Flood Zones (extracted from the NPPF, 2014)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land having a less than 1 in 1,000 (0.1%) annual probability of river flooding. Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	Low
Flood Zone 2	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (between 1% and 0.1% annual probability of flooding each year).	Medium
Flood Zone 3a	Land having a 1 in 100 or greater annual probability of river flooding (greater than 1% annual probability of flooding each year).	High
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The identification of the functional floodplain takes into account local circumstances but for the purposes of this SFRA, land modelled to flood during a 5% AEP event or greater in any year has been mapped.	Functional Floodplain

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

The Flood Zone Maps incorporate the results of any hydraulic modelling where it is available. The Environment Agency's River Beane Flood Mapping project was completed in May 2008 and includes modelling of the Stevenage Brook and Aston End Brook main rivers.

The large majority of the Borough is defined as Flood Zone 1, low probability of flooding from fluvial sources. Flood Zones 2 and 3 are situated alongside the two water courses and the Ash Brook, and in a more widespread in the area south of the town centre. **Appendix A Figure 3.1 and 3.2** illustrate the Flood Zone maps for 2016.

It should be noted that the scope of modelling studies typically covers flooding associated with main rivers and watercourses with a catchment of greater than 3km², and therefore ordinary watercourses that form tributaries to the main rivers may not always be included in the model. Modelling of ordinary watercourses available on the 'Flood Map for Planning (Rivers and Sea)' may be the result of the national generalised modelling carried out by the Environment Agency and may need to be refined when determining the probability of flooding for an individual site and preparing a site-specific FRA. Further detail regarding the scope of site specific FRAs is provided in Section 7

It is noted that a separate map is available on the Environment Agency website which is referred to as 'Risk of Flooding from Rivers and Sea'[25]. This map takes into account the presence of flood defences and so describes the actual risk of flooding, rather than the residual risk if there were no defences present. While flood defences reduce the level of risk they don't completely remove it as they can be overtopped or fail in extreme weather conditions, or if they are in poor condition. As a result the maps may show areas behind defences which still have some risk of flooding – a residual risk. This mapping has been made available by the Environment Agency as the primary method of communicating flood risk to members of the public, however for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated Flood Zones remains the primary source of information.

Functional Floodplain Flood Zone 3b

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

The PPG states that the identification of Functional Floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, land which would naturally flood with an annual probability of 1 in 20 (5% AEP) or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% annual probability) flood, should provide a starting point for consideration. The guidance goes on to say that 'areas

[24] Environment Agency Flood Map for Planning (Rivers and Sea) http://apps.environment-agency.gov.uk/wiyby/37837.aspx
[25] Environment Agency 'Risk of Flooding from Rivers and Sea' http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=floodmap#x=237038&y=161974&scale=1

which would naturally flood with an annual probability of 1 in 20 or greater, but are prevented from doing so by existing infrastructure or solid buildings will not normally be defined as functional floodplain'.

Flood outlines for the 1 in 20 (5% AEP) event are available for the main rivers inside Stevenage and these outlines have been used to map Functional Floodplain across the SBC, as shown in **Appendix A Figures 3.1 and 3.2**.

Receptors

The NRD described in Section 2.8 has been used to determine the number of properties that fall inside the boundaries of each Flood Zone. The total number of affected receptors has been divided into residential and non-residential and is presented in Table 3-4.

Table 3-4 Receptors at risk of flooding from rivers

Receptor type	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Residential	245	66	-
Non residential	72	47	-

Climate Change

A considerable amount of research is being carried out worldwide in an endeavour to quantify the impacts that climate change is likely to have on flooding in future years. Climate change may increase peak rainfall intensity and river flow, which could result in more frequent and severe flood events. Climate change is perceived to represent an increasing risk to low lying areas of England, and it is anticipated that the frequency and severity of flooding will change measurably within our lifetime.

In February 2016 the Environment Agency published revised guidance on climate change allowances in an update to the document 'Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities[26]. This version of the document reflects an assessment completed by the Environment Agency between 2013 and 2015 using UKCP09 data, to produce more representative climate change allowances for river basin districts across England. While the greater part of Stevenage Borough falls within Thames River Basin District, a smaller part in the North is located within Anglian River Basin District. As set out in Table 3-5, the values for Thames River Basin District are more stringent. It is recommended that Thames River Basin District guidance is adopted in the Local Plan so that planning decisions are more robust in the face of climate change and consistent across the Borough.

Table 3-5 Revised climate change allowances for the Thames River basin

Allowance category	Total potential change anticipated for '2020s' (2015-39)	Total potential change anticipated for '2050s' (2040-2069)	Total potential change anticipated for '2080s' (2070-2115)
Old NPPF allowance (all England) for comparison	10% (1990-2025)	20% (2025-2115)	20%
Upper end	25%	35%	70% (65%*)
Higher central	15%	25% (20%*)	35%
Central	10%	15%	25%
* Values from Anglian River Basin are shown within parentheses where different			

Given the strategic nature of Level 1 SFRAs, providing evidence to allocate a variety of development types with varying vulnerabilities to flood risk and varying lifetimes, it is expected, as a minimum, the potential impact for climate change under the central, higher central and upper end allowance for the 2080s epoch. This will identify the likely range of future flood risk in order to understand and minimise vulnerability to future flood risk.

The Level 2 SFRA will consider the type of land allocation and therefore there will have more certainty over the development vulnerability and development lifetime. Based on the land allocation the appropriate climate change allowance should be applied.

[26] Environment Agency, February 2016, Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516116/LIT_5707.pdf

Applying Peak River Flow Climate Change Allowances

To understand if a land use allocation is appropriate in the context of likely future flood risk, the climate change allowance guidance states that Table 3-6 should be used to determine the appropriate allowance according to current flood zone and vulnerability for the type of development it is allocated for.

For the allowances identified above, the site should be assessed as to whether it will move from FZ1 to FZ2 or FZ2 to FZ3. If so, it is recommended that the development be treated accordingly, referring to the flood risk vulnerability and flood zone compatibility table in PPG. Following which the site will need to be assessed if the development is still appropriate, or if the exception test is required.

If the development is still appropriate in Flood Zones 2 and 3, assessment of future flood risk will be needed for planning applications for the type of development allocated in site specific policies.

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

Table 3-6 Peak river flow allowances for flood risk assessments

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	**Highly vulnerable**	**More vulnerable**	**Less vulnerable**	**Water compatible**
Zone 2	Higher central and Upper	Higher central and Upper	Central and Higher central	Central	None
Zone 3a	Upper	X	Higher central and Upper	Central and Higher central	Central
Zone 3b	Upper	X	X	X	Central
X – development should not be permitted					

Existing Hydraulic Models and the Impact of Climate Change

South East Stevenage

As part of the hydraulic modelling study for the River Beane, simulations have been run by AECOM for the 1 in 20 year and 1 in 100 year events including the implications of climate change based on the allowances set out by the Environment Agency. It should be noted that whilst the modelling of the annual probability events to generate the NPPF Flood Zones (and Flood Map for Planning) do not account for the presence of flood defences, the simulations including an allowance for climate change typically tend to include the presence of existing flood defences. The hydraulic modelling of the River Beane which included the Stevenage Brook and the Aston End Brook preceded the latest UKCP18 projections. As such the peak river flow allowances have been applied to the updated hydraulic model of the area to the South East.

The climate change modelling shows a marked increase in the flood envelop for the 1 in 20 year event and highlights the need for more a detailed investigations in the Level 2 SFRA. There is not a substantial change in the 1 in 100 year flood extents when taking into account the allowances. This may be attributed the topology of the area.

North West Stevenage

The existing hydraulic model of Ash Brook does not include the latest Environment Agency climate change allowance. Therefore, to estimate the effect of climate change on the Ash Brook the sensitivity of the existing model to a decreasing AEP can be assessed. For the Ash Brook a decrease in AEP from 1% to 0.1% resulted in an increase in flow of approximately 95%. This is higher than the 70% increase for the Upper end value shown in Table 3-5 for the 2080s epoch. The increase in flow does not seem to have a major impact on the flood envelope as shown in Figure 3-1 and Figure 3-2. However, as highlighted in Section 3.4.1, existing basic and conceptual model needs to be converted to a detailed 1D – 2D model to assess flood risk to any potential future development. The flood risk as a result of climate change can then be reassessed.

Figure 3-1 Flood extent and depth in meters (1% AEP) for North West Stevenage[27]

The stretch of Ash Brook between A1(M) and A602 has been realigned as a highways drainage channel and no longer follows the natural watershed. This causes the apparent discrepancy between the water course and modelled flood extent or Environment Agency flood zones.

Figure 3-2 Flood extent and depth in meters (0.1% AEP) for north west Stevenage[27]

3.4.5 Flood Risk Management Measures

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

A 'formal' flood risk management asset has been specifically built to control floodwater. It is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In accordance with the FWMA, the Environment Agency has discretionary powers to construct and maintain defences to help protect against flooding.

[27] RAB Consultants (2015) Land at J8 A1, Stevenage, SG1 4FD

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

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

In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the Environment Agency Asset Information Management System (AIMS). This dataset contains details of flood defence assets associated with main rivers and provides a good starting point for identifying significant local defences and potential areas benefiting from defences, but the quantity and quality of information provided differs considerably between structures. The AIMS is intended to provide a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA or site specific FRA where the need arises).

Flood defences in the study area are presented in **Appendix A Figures 3.1 and 3.2.**

The extent of existing flood defences within the Borough is limited. Information provided by the Environment Agency indicates that formal flood defences protect areas adjacent to the Stevenage Brook and Aston End Brook. Most of them are natural banks or culverts alongside these two rivers.

Any works in, over, under or within 8 metres of a designated main river or flood defence requires formal written consent from the Environment Agency prior to the works commencing. This includes the construction of any buildings, culverts, bridges, footways and outfalls. In addition, any works that could affect the flow of an ordinary watercourse (i.e. not designated as a Main River) require consent from the Environment Agency prior to the commencement of works. This includes culverting, diverting, and can include outfalls and bridges depending on the likely affect to the flow of the watercourse.

3.4.6 Flood Warning Areas

The Environment Agency provides a free Flood Warning Service[28] for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency has provided a GIS layer of Flood Warning Areas in the study area which are presented in **Appendix A Figure 8.** There is one Environment Agency Flood Warning Area in the Borough, namely Stevenage Brook at Stevenage which covers the flood area of this brook from its intersection with Broadhall Way.

3.5 Flooding from Surface Water

Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. Overland flow of this nature has a short response time and results in localised flooding, particularly in urban areas. This has the potential to occur in Stevenage as it is a largely urban catchment. The NPPG states that an SFRA should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well other available information.

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

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

[28] Environment Agency Flood Warning Service http://apps.environment-agency.gov.uk/wiyby/37835.aspx

Development of new sites could increase the risk of flooding from surface water if the runoff from rainfall is not controlled. This might also occur from developments outside the boundaries of SBC where the development catchment drains into the district. The NHDC draft Local Plan[29] has safeguarded Greenfield land to the west of Stevenage. If incorrectly managed this could increase the risk on the downstream area of Stevenage. The council should stay up-to-date with changes to the NHDC Local Plan.

3.5.1 Historic Records

Records of flooding from surface water, drains, ditches and ordinary watercourses have been provided from a number of sources. Reports and datasets included in the previous iterations of the SFRA report have been retained to provide a consistent record. Records of flooding which are georeferenced are presented in **Appendix A, Figure 6.** Due to the topography most of these are concentrated in the southern half of Stevenage.

SBC Records

SBC provided a flooding database (2002 – 2015) with records categorised by source of flooding, including surface water, foul and land drainage. A summary of this information is shown in the **Appendix B**.

In summary, it shows different properties flooding during storm events in 2002, 2010, 2011, 2012, 2014 and 2015 and the actions taken after each event. They are located in different parts of the Borough. However, the most frequently affected areas are in the vicinities of Monkswood Way, Shephall Way and Stevenage Brook.

Highways England Records

No records have been provided by Highways England during the consultation as part of the SFRA update.

HCC Records

HCC has a role as LLFA to co-ordinate management of local flood risk in the county. As a LLFA it is required to carry out Section 19 Flood Investigations as defined in the FWMA. Flood investigation reports for HCC area available through the county website: http://www.hertsdirect.org/services/envplan/water/floods/floodrisk/investigations/

3.5.2 Updated Flood Map for Surface Water

The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual probability events: 1 in 30 year (3.33% annual probability), 1 in 100 year (1% annual probability) and 1 in 1,000 year (0.1% annual probability). The latest version of the mapping is referred to as the 'updated Flood Map for Surface Water' (uFMfSW) and the extents have been made available for the Level 1 SFRA as GIS layers. This dataset is also available on the Environment Agency website, and is referred to as 'Risk of Flooding from Surface Water'.

The uFMfSW provides all relevant stakeholders, such as the Environment Agency, LPAs and the public access to information on surface water flood risk which is consistent across England and Wales[30]. The modelling helps the Environment Agency take a strategic overview of flooding, and assists LLFAs in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within the study area which may have a surface water flood risk.

The modelling represents a significant improvement on previous mapping, namely the FMfSW (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:

- Increased model resolution to 2m grid,
- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers,
- Use of a range of storm scenarios, and
- Incorporation of appropriate local mapping, knowledge and flood incident records.

However, it should be noted that this national mapping has the following limitations:

[29] North Hertfordshire District Council Local Plan http://www.north-herts.gov.uk/home/planning/planning-policy/local-plan-emerging-policy/draft-local-plan-2011-2031 .
[30] Environment Agency (2013) 'What is the updated Flood Map for Surface Water?'

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

The uFMfSW shows that surface water flooding largely follows the fluvial pathways, yet is much more extensive, often originating upstream of the tributaries. There are also multiple localised surface water flood areas that follow some of the main streets of Stevenage from north to south. The uFMfSW for the study area is presented in **Appendix A Figures 4.1 and 4.2**.

Receptors

Table 3-7 presents the number of receptors from the NRD at risk of flooding from surface water flooding according to their risk level (3.3% AEP, 1% AEP or 0.1% AEP).

Table 3-7 Receptors at risk from surface water flooding

Receptor type	UMfSW 1 in 1000	UMfSW 1 in 100	UMfSW 1 in 30
Residential	1162	233	71
Non residential	491	51	11

Climate Change

The uFMfSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

3.5.3 Surface Water Management Plan

HCC is scheduled to complete the Stevenage Surface Water Management Plan (SWMP) by 2017[31]. This will give greater insight into the surface water flood risk of those areas. Developers should seek these maps to assist the layout and design of their development site.

3.5.1 Bragbury End Flood Investigation Report

A flood investigation report has been produced for the flood event which occurred in February 2014 in Bragbury End, where several properties were damaged after heavy rainfall fell on saturated ground, leading to high levels of surface water runoff. The report concludes that the flooding was primarily as a result of a succession of storms combining with heavy rainfall over an extended period of time. Blocked highway gullies were also considered as a factor, however, their capacity to cope with the flood water would have been limited even if they had been fully clear.

A technical assessment was made to support the Section 19 report that recommended an improvement to highway drainage in that area and the installation of flood protection measures to individual properties.

The Environment Agency Map for Surface water Flood Risk[32] highlights that this area at Bragbury End is at high risk of surface water flooding, therefore it is particularly necessary that the drainage system functions effectively in order to prevent highway and property flooding.

[31] Level 1 SFRA Update, SBC, 2013

[32] Environment Agency (2015) Map for Surface Water Flood Risk

3.6 Flooding from Groundwater

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

The Borough is situated on chalk strata and chalk is associated with groundwater flooding. However, Stevenage lies well upstream of the point where groundwater flooding would be expected to appear in typical chalk bourne or valley, even under extreme conditions. The risk from groundwater flooding is therefore considered to be low.

3.6.1 Areas Susceptible to Groundwater Flooding

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

The British Geological Survey (BGS) Susceptibility to groundwater flooding dataset is a strategic scale map that can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come close to the ground surface on the basis of geological and hydrogeological conditions.

This dataset is presented in **Appendix A, Figure 5** and divided into three classes – high, medium and low. The highest risk areas are those with the potential for groundwater flooding to occur at the surface, medium risk are those which may experience groundwater flooding of property situated below the ground surface i.e. basements; and low risk are those with limited potential for groundwater flooding to occur. The dataset highlights that the majority of the Borough has a low susceptibility to groundwater flooding. However, there are some areas in the southeast where potential groundwater flooding might occur although there are no records of this type of flooding inside the Borough.

Receptors

Table 3-8 presents the number of receptors from the NRD located in areas of high and medium susceptibility to groundwater flooding according to the dataset from the BGS.

Table 3-8 Receptors at areas susceptible to groundwater flooding

Receptor type	Medium susceptibility to Groundwater flooding	High susceptibility to Groundwater flooding
Residential	96	-
Non residential	3	-

3.7 Flooding from Sewers

The sewer system is made up of foul, surface water and combined systems. After a heavy rainfall event the surface water system could reach full capacity resulting in surcharge from manholes and drains (referred to external flooding where no property flooding is involved). Where the surface water and foul systems are combined there is also a risk of full capacity leading to surcharging. However, with the combined sewer system this could result in surcharging within buildings from toilets and drains (referred to as internal flooding). Basement conversions are particularly prone to sewer flooding, where they lie low relative to the depth of the public sewer.

Sewerage managed by Thames Water

Though as a modern town, Stevenage has almost entirely separate foul and surface water sewerage systems, some surface water runoff will inevitably find its way into foul sewers during heavy rainfall. The volume of this runoff will probably be small but the large Stevenage Trunk Sewer, which conveys the whole of the town’s foul drainage flow, should also be regarded as a possible source of flooding along the downstream portion of its route through the southern end of the town.

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

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

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

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

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

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

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

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

<u>Sewerage managed by Anglian Water</u>

No additional information with regard to risk from sewer flooding is available for this area.

3.7.1 Water Cycle Strategy

The WCS was prepared for SBC to study the capacity of the sewer infrastructure in the Rye Meads area[33] and updated in 2015 to be adapted to the changes in planning systems[34]. The report made several valuable conclusions for the sewage in Stevenage:

- Stevenage is one of the towns where major network upgrades will be required, as development in towns further down the network have a lesser effect on overall flows in the trunk sewers;
- The sewer network is known to be at capacity in places, increasing the risk of sewer flooding impacting people and the environment due to the planned growth and potential climate change impacts;
- SWMPs should be completed by SBC to further understand and mitigate against flood risk from surface water; and
- Green Infrastructure Strategies should form part of the Local Authorities' Local Plans, to investigate and identify opportunities to enhance the biodiversity of the water (and wider) environment across the entire study area. SuDS design should be linked to these strategies to create an integrated network of flood risk mitigation, pollution control and biodiversity enhancement.

3.7.2 Historic Records of Sewer Flooding

Records of sewer flooding from Thames Water were requested, but were unavailable during the production of this report.

[33] Hyder Consulting (UK) (October 2009) http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Strategy-Final-Report.pdf
[34] SBC (September 2015) http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Strateg-Review.pdf

3.8 Reservoirs, Canals and Other Artificial Sources

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

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

The Environment Agency dataset 'Risk of Flooding from Reservoirs' available online identifies areas that could be flooded if a large[35] reservoir were to fail and release the water it holds. The mapping shows areas at risk of flooding downstream of the Fairlands Lakes and the Wychdell, Ridlins Wood and Aston Valley which are classified as large reservoirs. It should be noted that reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925 and all large reservoirs must be inspected and supervised by reservoir panel engineers.

The Large Reservoirs and Flood Storage Reservoirs (FSRs) present in the SBC are listed in Table 3-9. These reservoirs were designed to mitigate surface water flooding on an area by area basis as Stevenage was developed. There is no previous record of reservoir flooding and none of the reservoirs present have been classified in terms of risk severity.

A key element of flood protection in Stevenage will therefore be the maintenance and enhancement where appropriate, of this system of water meadows. It is anticipated that the land on which the water meadows are sited will be deemed by developer organisations as attractive for further development and it will be essential to ensure that these flood storage areas are protected. As such the flood storage areas are classified as Fluvial Flood Zone 3B – Functional Flood Plain as determined by NPPF. It must be noted that in addition to providing for storage of floodwater the water meadows also have a significant value as green space. The possible removal of any of them for new development would have an additional impact on Stevenage BC environmental/biodiversity strategy. A detailed description of each FSR is given in the following paragraphs.

Table 3-9 Reservoirs in SBC

Name	FSR/Large Reservoir	Catchment	OS Grid	Date established
Sainsbury's	FSR	River Hitz	TL 2250 2670	Pre-1960
Meadway	FSR	Stevenage Bk	TL 2265 2475	Pre-1960
Burymead	FSR	Stevenage Bk	TL 2350 2600	1964
Elder Way	FSR	Stevenage Bk	TL 2395 2340	Pre-1960
Old Knebworth Lane	FSR	Stevenage Bk	TL 2430 2195	Pre-1960
Broad Oak	FSR	Stevenage Bk	TL 2445 2260	1964
Wychdell	Large Reservoir	Stevenage Bk	TL 2645 2155	Pre-1960
Camps Hill Park	FSR	Aston End Bk	TL 2595 2465	Post-1980
Ridlins Wood	Large Reservoir	Aston End Bk	TL 2650 2235	Pre-1972
Aston Valley	Large Reservoir	Aston End Bk	TL 2655 2175	1966
Bragbury End	FSR	Stevenage Bk	TL 2690 2095	1975/6
Boxbury	FSR	River Beane	TL 2725 2665	Pre-1972
Fairlands Valley Lakes	Large Reservoir	Stevenage Bk	TL 2530 2399	1973

Sainsbury's (Corey's Mill) - FSR

This FSR is situated in the angle between Hitchin Road (A602) and the A1(M) motorway. It has a compact shape, approximately 80m by 60m, and is bounded by a HCC Highways depot on the north, a supermarket to the south and the motorway on the west. Its top water level is approximately 85mOD.

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

This FSR was one of the "water meadows" constructed by the Development Corporation and was originally known as Corey's Mill FSR. It was enlarged to approximately 16,000 cu.m circa 1992, the work being funded by the supermarket developer. It is unusual in that it lies to the north of the Thames / Anglian watershed and drains into the head of Ash Brook, a tributary of the River Hiz. Unlike all the older FSRs, it retains a substantial depth of water at all times and acts as a de facto nature reserve.

The reservoir has been constructed on-line but with a piped inflow. The outfall from the reservoir is to a culvert beneath the motorway which discharges to an open watercourse beyond. The embankment at the west end of the reservoir has a sheet piled retaining wall because of its close proximity to the motorway embankment. The natural catchment draining to this FSR, which includes the village of Graveley, is approximately 2.4 sq.km.

Meadway - FSR

A very small (approx. 1,500 cu.m) on-line FSR (also known as Symonds Green FSR) situated on the west side of Gunnels Wood Road (A1072) and north of Meadway. The watercourse that flows into the reservoir from the north and into which it discharges (the inflow and outflow) is culverted both upstream and downstream of the reservoir. This watercourse is one of the headwater tributaries of Stevenage Brook.

Much of the small earth embankment at the south end of the reservoir is taken up with the concrete outfall structure. There is a Thames Water surface water sewer pumping station immediately to the east of the outfall structure which is understood to supplement the low level drainage of the upstream catchment.

The relatively narrow reservoir basin extends for about 80m upstream of the reservoir embankment and is heavily overgrown with scrub. In September 2007 the reservoir basin was dry although there was a small flow in the watercourse through the reservoir. When full the top water level of the reservoir is at approximately 95mOD.

Burymead - FSR

Another small FSR, it is situated just east of Burymead and north of Martins Way (A1 072) in the valley of the Chesfield Park stream, a major tributary of Stevenage Brook. Upstream of the FSR its catchment area is 1.9 sq.km although only about 13 hectares at the downstream end of the catchment is at present urbanised. The stream is culverted beneath the northern outskirts of Stevenage and the inflow to and outflow from the reservoir is piped.

There is an orifice plate control structure embedded in the embankment at the southern end of the reservoir. The public footpath along the western edge of the reservoir is embanked and appears to form part of the reservoir embankment. The land to the east of the FSR is a public recreation area and the reservoir basin is maintained as open grassland.

It is possible that this FSR may operate (like Camps Hill Park FSR) as an off-line reservoir with an in-line throttle in the piped section of stream beneath the reservoir which diverts excess flows into the reservoir (top water level approximately 100mOD) when the capacity of the pipe is exceeded.

Elder Way - FSR

This substantial off-line FSR is situated alongside Stevenage Brook a short distance downstream of Stevenage town centre. Stevenage Brook is an open watercourse both upstream and downstream of the FSR. The Main River section of the Brook extends as far as the St Georges Way / Six Hills Way roundabout, 300m upstream of the reservoir. The reservoir is bounded by London Road to the west and Monkswood Way (A602) to the east, with Elder Way on the south.

There was originally a much smaller FSR just upstream of the existing reservoir but this disappeared and was replaced by the existing FSR when the NHC Stevenage Campus site was redeveloped. The existing reservoir was originally operated as an on-line FSR but was modified to off-line operation when it was enlarged from about 7,000 cu.m to its present capacity of about 15,000 cu.m. The catchment area upstream of the reservoir is approximately 10.1 sq.km.

The Environment Agency states that flows from the Brook to the reservoir are controlled by the operation of "a bank of penstock valves" in a concrete structure across the Brook near the downstream end of the reservoir. When water levels in the Brook exceed predetermined levels, excess water overflows side-spillway weirs in the left bank of the stream and cascades into the normally dry reservoir. Top water level, when full, is approximately 85mOD.

Elder Way FSR is divided into two separate but hydraulically linked compartments by a line of trees along the central axis of the reservoir basin, although each compartment has its own outflow structure for the return of flood water to the stream after a flood event. The pre-existing trees were left in situ for amenity purpose when the reservoir basin was excavated on either side of them. The reservoir basin is maintained as rough grassland.

Thames Water sold this reservoir to a private individual who applied for a planning permission for a new development at the site. SBC and Environment Agency objected to the application. In order to maintain the flood storage function of the FSR, this has to be protected for any future development.

Old Knebworth Lane - FSR

Old Knebworth Lane FSR operates as an off-line reservoir situated in the angle between Old Knebworth Lane and the East Coast Main Line railway, south of the lane and west of the railway at the north end of Knebworth golf course. At this location Old Knebworth Lane is the borough boundary and the reservoir lies just outside the borough. This FSR superseded an earlier, smaller FSR located north of the lane when the site of the earlier FSR was required for industrial development.

Excess flood flows in Stevenage Brook are piped to Old Knebworth Lane FSR, a distance of about 100m. Flows are diverted to the reservoir by a control structure on the Brook which has a 15.1 sq.km catchment upstream of the diversion. The same pipe serves both inflows to and outflows from the reservoir. The capacity of the reservoir is approximately 24,000 cu.m, slightly less than would make it subject to the provisions of the Reservoirs Act. Its top water level is approximately 80mOD.

Because of the proximity to the railway embankment, the reservoir itself is formed by concrete capped steel sheet pile walls along its northern and eastern sides. The reservoir's inlet / outlet structure is located at the angle of the two sheet pile walls.

This FSR is situated at the downstream end of the Knebworth Park valley which has a catchment area of 3.7 sq.km. Although the downstream end of this valley appears to be a dry bourne under normal conditions, there is a stream-fed lake in the park. The Ordnance Survey map also shows this lake discharging into an open watercourse which disappears 700m downstream of the lake and 900m upstream of the FSR. It must be assumed that in an extreme event flood flows continue down the valley along the normally dry bourne. It is not known whether the design of the FSR allows for any such surface water inflow from Knebworth Park.

Broad Oak - FSR

Broad Oak FSR is situated near the downstream end of the Fairlands Valley Stream, about 200m upstream of its confluence with Stevenage Brook. The reservoir is located in open woodland south east of Stevenage Town Football Club's stadium, between Broadhall Way (A602) and London Road (B197). This reservoir is also known as Fairlands Valley FSR but will be referred to in this Report as Broad Oak FSR to avoid confusion with the Fairlands Valley Lakes which are 2 km upstream.

Broad Oak is an on-line reservoir with open watercourse inflows and outflow and a top water level of between 80m and 85mOD. There is an orifice plate control structure set in the embankment at the southern end of the reservoir. It is understood that this FSR has not been enlarged and its capacity is not known. The catchment area upstream of the reservoir is approximately 3.1 sq.km but this includes the Fairlands Valley Lakes.

Wychdell - Large Reservoir

The largest of Stevenage's FSRs, with a capacity of about 44,500 cu.m (Environment Agency data) and therefore subject to the provisions of the Reservoirs Act. It is situated just upstream of the confluence of Stevenage Brook and Aston End Brook, between Ashdown Road and Broadhall Way (A602). The earth embankment is located at the east end of the elongated reservoir basin, much of which is open scrubland. This is an on-line FSR and Stevenage Brook, in which there was a substantial flow in September 2007, runs from end to end through the reservoir basin.

There is a flow control structure consisting of a penstock and an overspill weir in a concrete chamber set in the reservoir embankment. No formal spillway could be seen on the crest of the embankment (approx. 75mOD) and flood water has been observed overflowing the embankment during a flood event. Wychdell FSR is operated and maintained by the Environment Agency who state that the whole length of the embankment constitutes the emergency spillway "that is protected to receive the probable maximum flood". The Environment Agency has produced evidence that this protection is provided by a buried layer of scour protection matting (Enkamat) over the whole downstream face of the embankment. This protection was installed in 2004 as a consequence of recent housing development adjacent to Stevenage Brook at Bragbury End, less than 1 km downstream, which has resulted in the reservoir being reclassified for safety purposes as 'Category A'.

Upstream of the reservoir Stevenage Brook has a catchment area of 22.3 sq.km. Recent hydrological and hydraulic modelling[36] has found that the storage capacity of Wychdell FSR would currently be exceeded in a flood event with a return period of between only 2 and 5 years.

Camps Hill Park - FSR

A small off-line reservoir situated in a children's play area south west of Chells Way, in open parkland between Harvey Road and Warwick Road. The most recent of Stevenage's FSRs, Camps Hill Park FSR was built to alleviate recurring localised flooding of residential properties in the Warwick Road area from a trunk surface water sewer. The valley in which the reservoir lies drains south eastwards to the head of Aston End Brook.

Inflow and outflow to the reservoir are both piped from the nearby trunk sewer. Flows from the sewer to the reservoir are controlled by an orifice plate in the section of sewer between the junctions with the FSR inflow and outflow pipes. The reservoir capacity is not known. Its top water level when full is approximately 105mOD.

Ridlins Wood - Large Reservoir

Ridlins Wood FSR is situated on Aston End Brook, west of Gresley Way and just north of Broadwater Lane. It is an on-line reservoir with the Brook in open channel both upstream and downstream of the reservoir. The reservoir, which is now operated and maintained by the Environment Agency, was enlarged by the then Thames Water Authority in about 1982 and now has a capacity of 51,800 cu.m (Environment Agency data) and a top water level of about 75mOD.

Aston End Brook has a catchment area of 6.1 sq.km upstream of the reservoir. Recent hydrological and hydraulic modelling has found that currently the storage capacity of Ridlins Wood FSR would only be exceeded in a flood event with a return period of between 100 and 200 years. Aston End Brook is a Main River as far as Tatlers Lane at Aston End, 1.5km upstream of the reservoir.

Broadwater Lane runs along a berm on the downstream side of the reservoir embankment with the reservoir outflow piped beneath the road. The road originally ran along the crest of the embankment and the reservoir was enlarged by raising the embankment on the upstream (north) side of the road and extending the embankment for a short distance along both sides of the reservoir. There is a control structure consisting of a penstock and internal overspill weir in a concrete chamber embedded in the raised section of the embankment.

Despite the size of the reservoir, there appears to be no formal spillway over the reservoir embankment, although the Environment Agency state that it has a spillway, occupying about 80% of the embankment's length and some 400mm lower than the remainder of the embankment "that is protected to receive the probable maximum flood". The 1982 enlargement involved the placing of a gabion mattress under a thin layer of soil along the downstream face of the embankment. It is not known whether the downstream face of the embankment is also lined with a layer of scour protection matting (Enkamat). The presence of the road along a berm on the downstream side of the embankment will also provide some degree of scour protection.

Aston Valley - Large Reservoir

Aston Valley FSR is located at the downstream end of Aston Valley, just upstream of the confluence between Aston End Brook and Stevenage Brook. The substantial on-line reservoir lies east of Broadhall Way (A602) on the western edge of Stevenage golf course. This reservoir is operated and maintained by the Environment Agency and although it might therefore be expected to have a capacity greater than 25,000 cu.m, the Reservoirs Act minimum, the Agency state that the capacity of this reservoir is "somewhere around 14,000 cu.m." The reservoir is believed to have been enlarged, though further enlargement is limited by the proximity of recent housing development at Goddard End, close to the northern (upstream) end of the reservoir.

Outflow from the reservoir is controlled by an orifice plate structure and an internal overspill weir in a concrete chamber set in the reservoir embankment. The embankment has a crest level of between 70m and 75mOD. As with Wychdell and Ridlins Wood FSRs, there does not appear to be any formal spillway on the crest of the embankment and the Environment Agency state that the full width of the embankment constitutes the spillway. Since this reservoir does not come within the provisions of the 1975 Reservoirs Act it is not known whether scour protection matting was installed along the downstream face of the embankment as at Wychdell and possibly Ridlins Wood.

[36]Halcrow Group Ltd (2007) Stevenage Flood Storage Areas Performance Study - Final Report (for Environment Agency)

The catchment of the Aston Valley upstream of the reservoir is about 6.5sq.km. Recent hydrological and hydraulic modelling has found that the storage capacity of Aston Valley FSR would only be exceeded once in between 10 and 20 years.

Bragbury End - FSR

This small on-line FSR is located behind the residential development along the east side of Bragbury Lane. It was constructed in 1975/6 to deal with urban runoff from new residential development in the southeastern corner of the borough at Bragbury End, between the Stevenage - Hertford railway line and the A602 road.

There is a piped inflow to and piped outflow from the reservoir. Discharge into the piped outflow is controlled by an orifice plate structure in the embankment at the north end of the reservoir. The top water level in the reservoir is between 70m and 75mOD.

The reservoir has a natural catchment area of 4.6sq.km extending as far as Knebworth and Datchworth. The chalk catchment is mainly rural but includes much of the large village of Knebworth. There are no surface watercourses shown within the catchment on the OS map - the valley between Knebworth and the FSR is a dry bourne - and the presence of the railway embankment across the valley less than 100m upstream of the reservoir means that there is no open channel inflow to the reservoir. There is a surface water drainage pipe which was installed by the Department of Transport which runs from Knebworth towards Bragbury End terminating at an outfall pond west of the railway.

Boxbury - FSR

Boxbury FSR is the only one of the Stevenage “water meadows” that lies well outside the borough boundary. It is situated 1 50m northwest of Boxbury Farm, 1.5km west of Walkern village, in a tributary valley of the River Beane. This valley is a dry bourne as far downstream as Walkern. Above Walkern the valley has a catchment area of 5.1 sq.km. This diminishes to 3.7 sq.km upstream of the reservoir although only about half of this area is at present urbanised. Top water level in the reservoir is approximately 1 00mOD.

This small on-line FSR has two separate piped surface water sewer inflows from urban development in the northeast corner of the Borough. There is an orifice plate control structure set in the reservoir embankment that discharges directly into a piped outflow. As there is no stream channel down the Boxbury Valley this pipe extends down the valley as far as Walkern where it discharges, via an oil interceptor south of Stevenage Road, into the River Beane. The capacity of this FSR is less than 25,000 cu.m and it is understood that it has not been enlarged. The capacity of the 2 km pipeline down the Boxbury Valley to the River Beane could prove to be a constraint to the enlargement of this reservoir.

Fairlands Valley Lakes - Large Reservoir

Fairlands Valley is a 3km ribbon of undeveloped land running from north to south through the centre of the Borough from Pin Green to London Road (B197). Most of Fairlands Valley is managed by the SBC as the Fairlands Valley Park although the downstream end of the valley south of Broadhall Way (A602) is scrubland and rough woodland. Broad Oak FSR (see above) is located at this end of the valley.

The three Fairlands Valley Lakes, completed in 1973, are situated towards the northern (upstream) end of Fairlands Valley Park. Although there are actually four lakes in series, the first lake is little more than an enlarged stream channel and the second and third lakes are relatively small. The fourth and most downstream lake is, however, of considerable size (90,910 cu.m capacity) and subject to the provisions of the Reservoirs Act. It has a catchment area of 2.0 sq.km and its top water level is 101 .7mOD.

Although the lakes were established as amenity lakes, it is understood that the three smaller lakes were intended to have a secondary function as oil interceptors. The three largest lakes were formed by constructing earth embankments across the Fairlands Valley Stream. The largest lake, also known as the Sailing Lake, is used for dinghy sailing (Stevenage Sailing Club is situated at the upstream end) and coarse fishing.

It should be emphasised that the Fairlands Valley Lakes were created as amenity lakes and were never intended or designed as “water meadows” or FSRs. They are operated by the SBC as amenity lakes and maintained full for that purpose. Nevertheless, it is inevitable that the largest lake will have an attenuation effect on surface water runoff entering and leaving the lake and the Environment Agency state that the Boating Lake “is considered to be an FSR and is registered as such”.

All surface water inflows to the Fairlands Valley Lakes are piped. The Boating Lake has a concrete overflow structure embedded in the reservoir embankment which discharges into a pair of large diameter pipes. This lake has a siphon spillway in the centre of the embankment but no conventional overflow spillway on the crest of the embankment. There is a 450mm diameter valve-controlled outlet pipe through the base of the embankment.

In flood conditions these pipelines become surcharged and surplus flood water is designed to emerge from a concrete overflow chamber located immediately downstream of Six Hills Way. From here the surplus water flows overland through Fairlands Valley Park into an emergency flood storage area in the valley bottom, upstream of Broadhall Way. This flood storage area is designed to accommodate the peak of the 1000-year return period flood event which will fill the storage area in five minutes.

3.8.1 An Optimisation Study of the FSRs

The Environment Agency is currently developing an optimisation study for some of the Stevenage FSRs. The brief of the project is to evaluate the hydrology affecting Wychdell, Aston Valley and Ridlins FSRs to ensure that they can be operated and maintained for the best performance of the reservoirs as a linked system. At the moment the FSRs do not seem to be evaluated as a connected system, which is mainly due to limitations in the modelling available for the area.

As referred to in 2.2.2 of this report the water meadows are vital assets that have been provided historically to provide attenuation of surface flows generated from the urbanisation of previously green field areas. These features have been largely successful in managing flood risk in the town and any decisions to remove them will have to be supported by comprehensive/detailed assessments.

It is thought that Wychdell FSR may not be performing to its design capacity. There is a continuing concern in respect to flood risk associated with this storage area necessitating detailed flood studies in the event of proposals for new development being received.

3.8.2 Increase capacity of the FSRs

Future development and the effects of climate change could result in the necessity to increase the capacity of the current FSRs. The lack of space and other constraints may impede the enlargement of the reservoirs; therefore, other measures related to SuDS infiltration systems could improve their operation without the need to increase land occupied by the reservoir.

The BGS Infiltration SuDS Map (see Section 6.4) provides a preliminary indication of the suitability for infiltration. Table 3-10 summarises the percentage area of each FSR by the Infiltration SuDS Suitability category. It should be noted that this map provides a strategic overview and further investigation should be made before assessing measures specific to the FSRs.

Table 3-10 FSRs Infiltration Suitability for the application of SuDS

Name	FSR/Large Reservoir	Infiltration SuDS Suitability	Percentage area of FSR
Sainsbury's	FSR	Very significant constraints are indicated	100%
Meadway	FSR	Opportunities for bespoke infiltration SuDS	59%
		Very significant constraints are indicated	41%
Burymead	FSR	Opportunities for bespoke infiltration SuDS	100%
Elder Way	FSR	Opportunities for bespoke infiltration SuDS	100%
Old Knebworth Lane	FSR	*Outside of SBC Infiltration SuDS Map*	-
Broad Oak	FSR	Opportunities for bespoke infiltration SuDS	100%
Wychdell	Large Reservoir	Opportunities for bespoke infiltration SuDS	93%
		Very significant constraints are indicated	6%

Name	FSR/Large Reservoir	Infiltration SuDS Suitability	Percentage area of FSR
		Probably compatible for infiltration SuDS	1%
Camps Hill Park	FSR	Opportunities for bespoke infiltration SuDS	93%
		Probably compatible for infiltration SuDS	7%
Ridlins Wood	Large Reservoir	Opportunities for bespoke infiltration SuDS	94%
		Probably compatible for infiltration SuDS	6%
Aston Valley	Large Reservoir	Opportunities for bespoke infiltration SuDS	92%
		Very significant constraints are indicated	8%
Bragbury End	FSR	Opportunities for bespoke infiltration SuDS	100%
Boxbury	FSR	*Outside of SBC Infiltration SuDS Map*	-
Fairlands Valley Lakes	Large Reservoir	*Not suitable for Infiltration SuDS*	-

4 Avoiding Flood Risk – Applying the Sequential Test

4.1 Sequential Approach

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

The sequential approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test, where required, will ensure that new developments in areas of particular flood risk will only occur where flood risk is clearly outweighed by other sustainability drivers and where development can be made safe from flooding and not increase the risk of flooding elsewhere.

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

4.2 Applying the Sequential Test – Plan-Making

As the LPA, SBC must demonstrate that throughout the site allocation process a range of possible sites have been considered in conjunction with the flood risk and vulnerability information from the SFRA. A draft version of SBC Local Plan was published previous to the realisation of this SFRA with information on the proposed development sites. As part of this SFRA a Site Assessment Database has been carried out and is presented in **Appendix A, Figure 9.1 and Figure 9.2**. This database shows the proposed development sites along with statistics regarding the flood risk posed to each site and enables sites to be directly compared to one another. A different weightage, showed in brackets in Table 4-1, has been given to each source of flooding according to its risk level.

Table 4-1 Flood Risk Classifications for Sequential Test

<table>
<tr><th rowspan="2">Risk (weightage)</th><th colspan="6">Source of Flooding</th></tr>
<tr><th>Fluvial</th><th>Surface Water</th><th>Historic Records</th><th>Groundwater</th><th>Sewer</th><th>Reservoir</th></tr>
<tr><td>Low (0)</td><td>Flood Zone 1</td><td>uFMfSW Very Low</td><td>N/A</td><td>Low (Limited potential for groundwater flooding to occur)</td><td rowspan="4">Thames Water to assess the sewer network for each site</td><td>Use Environment Agency Flooding from Reservoirs map</td></tr>
<tr><td>Medium (0.5)</td><td>Flood Zone 2</td><td>uFMfSW Low</td><td>Historic records from HFM (0.5)
Historic records from flooding database (0.25)</td><td>Medium (Potential for groundwater flooding of property situated below ground level)</td><td>N/A</td></tr>
<tr><td>High (1)</td><td>Flood Zone 3a</td><td>uFMfSW Medium</td><td rowspan="2">N/A</td><td>High (Potential for groundwater flooding to occur at surface)</td><td>N/A</td></tr>
<tr><td>Very High (1.5)</td><td>Flood Zone 3b</td><td>uFMfSW High</td><td>N/A</td><td>N/A</td></tr>
</table>

The overall risk of each proposed site is classified as low (0-2 points), medium (2.25-3 points) or high (>3 points). Number of sites in different risk category is summarised in Table 4-2 and detail site assessment database is presented in **Appendix D.**

Table 4-2 Local Plan sites by risk category

Flood risk category	Number of sites
No identifiable risk	3
Low	50
Medium	4
High	2
Total	**59**

As an example, Table 4-3 illustrates the risk calculation made for three proposed development sites whose risk vary from low to high. This table shows the different punctuation given to each one of these sites in accordance to their flood risk. It should be noted that the highest risk level of each source found inside each site was considered.

The Sequential Test should be undertaken by SBC and accurately documented to ensure decision processes are consistent and transparent. Figure 4-1 and Table 4-1 illustrate an approach for applying the Sequential Test that SBC could adopt in the development of future local plans.

Table 4-3 Example for Site Assessment Database

Site Ref	Source of Flooding / Punctuation					
	Fluvial	Surface Water	Historic Records	Groundwater	Weightage	Overall Risk
HO 1/15	Flood Zone 1	uFMfSW Medium	N/A	Very Low	**1**	**Low**
	0	1	0	0		
EC 1/7	Flood Zone 3a	uFMfSW High	N/A	Very Low	**2.5**	**Medium**
	1	1.5	0	0		
HO 1/2	Flood Zone 3b	uFMfSW High	Historic Flood Map	High risk	**4**	**High**
	1.5	1.5	0.5	0.5		

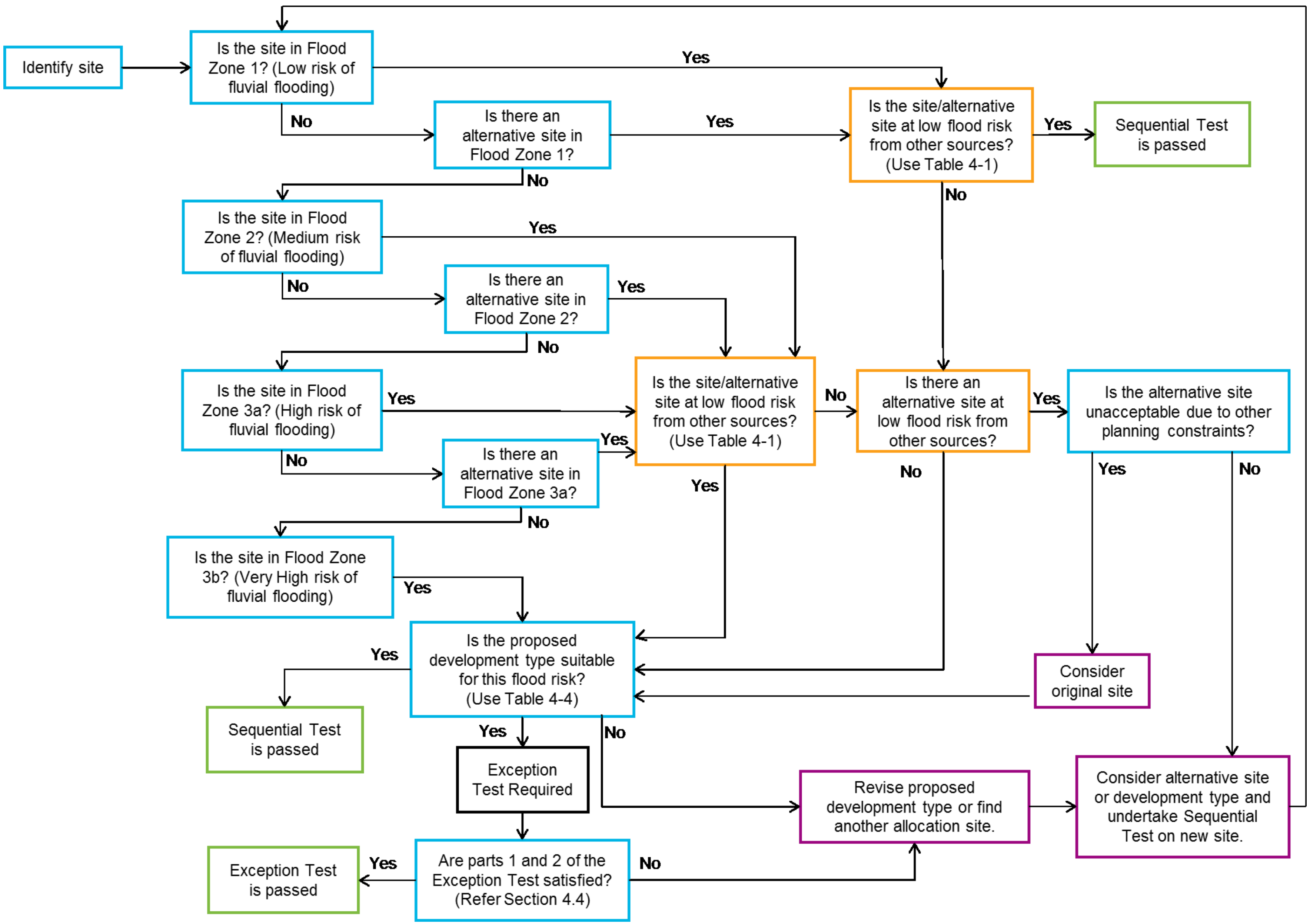


Figure 4-1 Application of Sequential Test for Plan-Making

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

Table 4-4 Flood Risk Vulnerability Classification (PPG, 2014)

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

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

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

The recommended steps in undertaking the Sequential Test are detailed below. This is based on the Flood Zone and Flood Risk Vulnerability. Table 4-5 indicates the compatibility of different development types with the Flood Zones.

Table 4-5 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014)

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

✓ - Development is appropriate × - Development should not be permitted

4.2.1 Recommended stages for LPA application of the Sequential Test in Plan-Making

The information required to address many of these steps is provided in the accompanying GIS layers and maps presented in **Appendix A**.

a. Assign potential developments with a vulnerability classification (Table 4-4). Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.

b. The location and identification of potential development should be recorded.

c. The Flood Zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea). Where these span more than one flood zone, all zones should be noted.

d. The risk of flooding from other sources should also be identified, based on readily available datasets and local information.

e. Identify existing flood defences serving the potential development sites. (However, it should be noted that for the purposes of the Sequential Test, flood zones ignoring defences should be used).

f. The design life of the development should be considered with respect to climate change:
   - 100 years – up to 2116 for residential developments; and
   - Design life for commercial / industrial developments will be variable, however a 75 year design life may be assumed for such development, unless demonstrated otherwise.

g. Highly Vulnerable developments to be accommodated within the LPA area should be located in those sites identified as being within Flood Zone 1 and at low risk of flooding from other sources. If these cannot be located in areas of low flood risk, because the identified sites are unsuitable or there are insufficient sites in areas of low risk, sites in Flood Zone 2 can then be considered. Highly Vulnerable developments in Flood Zone 2 will require application of the Exception Test. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development or seek opportunities to locate the development outside their administrative area. Within each flood zone Highly Vulnerable development should be directed, where possible, to the areas at lowest risk from all sources of flooding. It should be noted that Highly Vulnerable development is not appropriate in Flood Zones 3a and 3b.

h. Once all Highly Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located in any unallocated sites in Flood Zone 1 and at low risk of flooding from other sources. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test. As with Highly Vulnerable development, within each flood zone More Vulnerable development should be directed to areas at lowest risk from all sources of flooding. It should be noted that More Vulnerable development is not appropriate in Flood Zone 3b.

i. Once all More Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located in any remaining unallocated sites in Flood Zone 1 and at low risk of flooding from other sources, continuing sequentially with Flood Zone 2, then Flood Zone 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.

j. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.

k. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.

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

4.2.2 Windfall Sites

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

4.3 Applying the Sequential – Individual Applications

If development is proposed in Flood Zone 2 or 3, and the Sequential Test has not already been carried out for the site for the same development type at the Local Plan level, then it is necessary to undertake a Sequential Test for the site. The Environment Agency publication 'Demonstrating the Flood Risk Sequential Test for Planning Applications'[37] sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the Borough area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area identified for regeneration in Local Plan policies).
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency Flood Map for Planning, the SFRA mapping, site-specific FRAs if appropriate, other mapping of flood sources.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 4-5, apply the Exception Test.
- Apply the Sequential approach to locating development within the site (as described in Section 5.2).

It should be noted that it is for LPAs, taking advice from the Environment Agency as appropriate, to consider the extent to which Sequential Test considerations have been satisfied, taking into account the particular circumstances in any given case. The developer should justify with evidence to the LPA what area of search has been used when making the

[37] Environment Agency, April 2012, 'Demonstrating the flood risk Sequential Test for Planning Applications', Version 3.1

application. Ultimately SBC needs to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere.

4.3.1 Sequential Test Exemptions

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

- Individual developments proposed on sites which have been allocated in development plans through the Sequential Test.
- Minor development, which is defined in the NPPF as:
    - minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2;
    - alterations: development that does not increase the size of buildings e.g. alterations to external appearance;
    - Householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats;
- Change of Use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site;
- Development proposals in Flood Zone 1 (land with a low probability of flooding from rivers or the sea) unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, through the impact of climate change);

4.4 Exception Test

The purpose of the Exception Test is to ensure that where it may be necessary to locate development in areas at risk of flooding, new development is only permitted in Flood Zone 2 and Flood Zone 3 where the flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

The NPPF states that for the Exception Test to be passed:

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

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

In order to determine Part 1) of the Exception Test, applicants should assess their scheme against the objectives set out in the Sustainability Appraisal as set out in the Stevenage Borough Local Plan Sustainability Appraisal Report which can be found via the following link:

www.stevenage.gov.uk/content/15953/26379/90035/Local-Plan-Sustainability-Appraisal.pdf

In order to demonstrate satisfaction of Part 2) of the Exception Test, relevant measures, such as those presented within Section 5, should be applied and demonstrated within a site-specific FRA as detailed in Section 7.

5 Managing and Mitigating Flood Risk

5.1 Overview

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

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

- 100 years (up to 2115) for residential developments; and
- 75 years (up to 2090) for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.

5.2 Development Layout and Sequential Approach

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

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

5.3 Riverside Development

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

The Environment Agency is likely to seek an 8 metre wide undeveloped buffer strip alongside main fluvial rivers for maintenance purposes, and would also ask developers to explore opportunities for riverside restoration as part of any development. Whilst HCC will work with developers to improve the functioning of ordinary watercourses where possible, there is no specific requirement for a buffer strip.

As of 6th April 2016, the Water Resources Act 1991 and associated land drainage byelaws have been amended and flood defence consents will now fall under the Environmental Permitting (England and Wales) Regulations 2010. Any works within 8m of a Main River will be subject to the Environmental Permitting Regulations (EPR). Further details and guidance are available on the GOV.UK website: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits. The Environment Agency can be consulted regarding permission to do work on or near a river, floor or sea defence by contacting enquiries@environment-agency.gov.uk.

HCC, as the LLFA will be minded to reject applications for culverting in areas identified as being in Flood Zone 2 or 3a/3b and/or in an area of surface water flooding identified within the Environment Agency Flood Map for Surface Water, due to the potential of proposed works increasing flood risk. Exceptions to this policy will only be considered if the applicant is able to demonstrate that, on the balance of probabilities, the proposed development would not increase flood risk. Where HCC is made aware of breaches to other legislation then it will make the appropriate organisation aware of this.

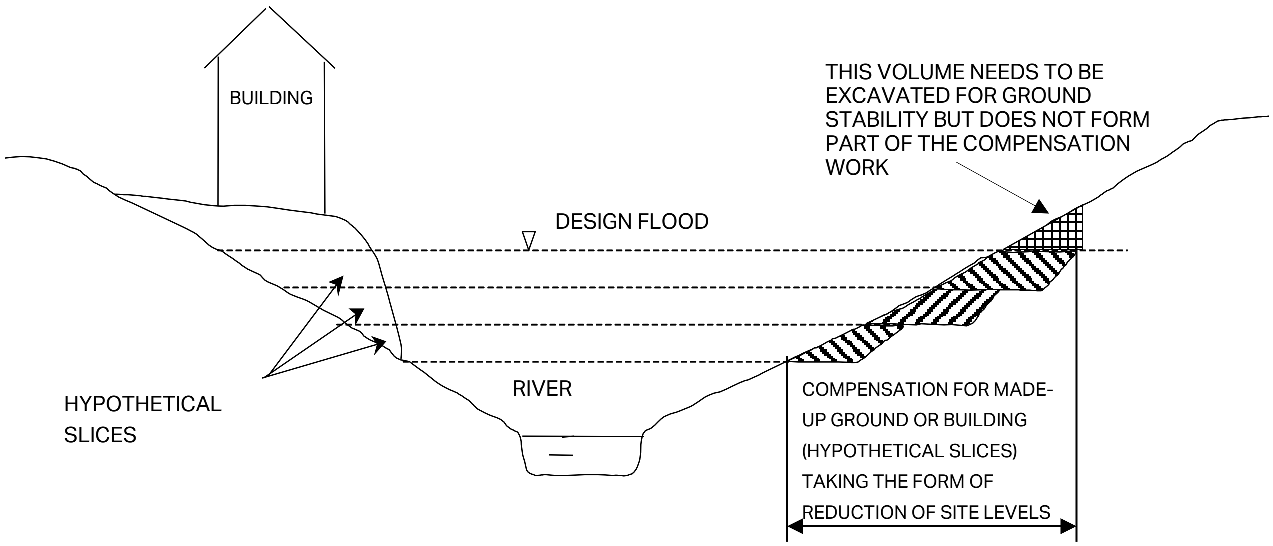
5.4 Floodplain Compensation Storage

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

Where proposed development results in a change in building footprint, the developer must ensure that it does not impact upon the ability of the floodplain to store water, and should seek opportunities to provide betterment with respect to floodplain storage. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

As depicted in Figure 5-1, floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it should be in the immediate vicinity, in the applicant's ownership and linked to the site. Floodplain compensation must be considered in the context of the 1% annual probability (1 in 100 year) flood level including an allowance for climate change. When designing a scheme flood water must be able to flow in and out and must not pond. An FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[38].

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



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

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

5.5 Finished Floor Levels

Policy Recommendation 4: All More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.

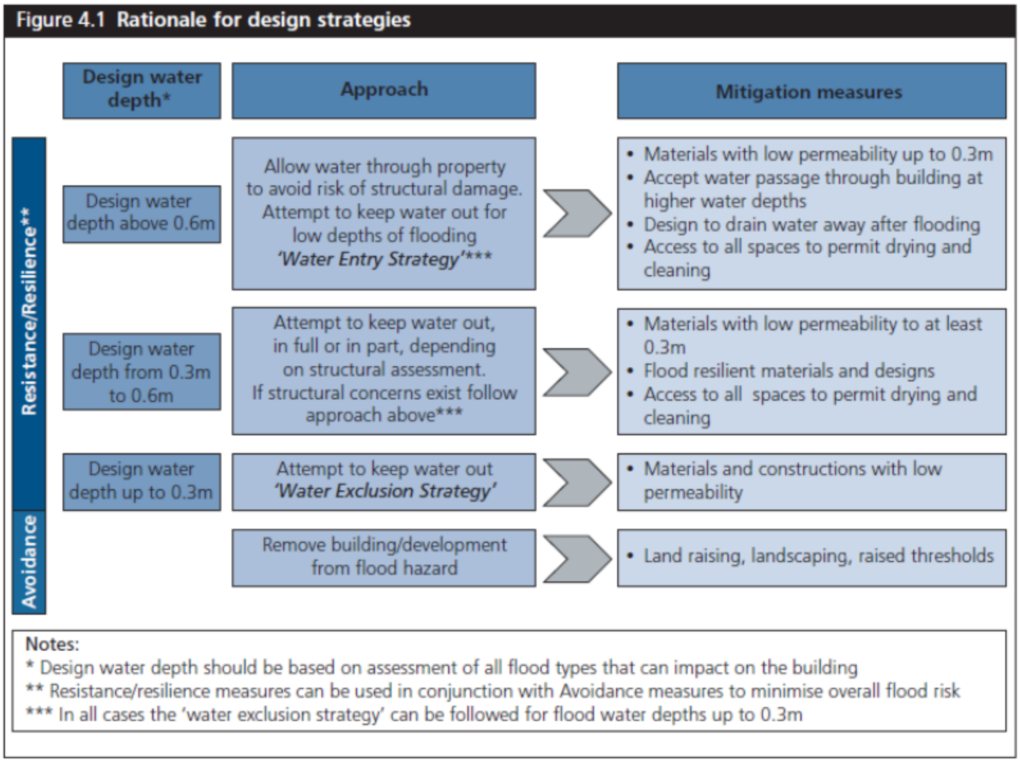
Where developing in Flood Zones 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly Vulnerable land uses, is to ensure internal floor levels are raised a freeboard level above the design flood level.

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

5.6 Flood Resistance 'Water Exclusion Strategy'

There are a range of flood resistance and resilience construction techniques that can be implemented in new developments to mitigate potential flood damage. The Department for Communities and Local Government (CLG) have published a document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[39], the aim of which is to provide guidance to developers and designers on how to improve the resistance and resilience of new properties to flooding through the use of suitable materials and construction details. Figure 5-2 provides a summary of the Water Exclusion Strategy (flood resistance measures) and Water Entry Strategy (flood resilience measures) which can be adopted depending on the depth of floodwater that could be experienced.

Figure 5-2 Flood Resistant/Resilient Design Strategies, Improving Flood Performance, CLG 2007



[39] CLG (2007) *Improving the Flood Performance of New Buildings, Flood Resilient Construction*

Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m, although these measures should be adopted where depths are between 0.3m and 0.6m and there are no structural concerns.

Policy Recommendation 5: In areas at risk of flooding of low depths (<0.3m), the following flood resistance measures could be considered:

- Using materials and construction with low permeability.
- Land raising.
- Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk to neighbouring properties).
- Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance.

Property flood protection devices are available on the market, designed specifically to resist the passage of floodwater (Figure 5-3 and Figure 5-4). These include removable flood barriers and gates designed to fit openings, vent covers and stoppers designed to fit WCs. These measures can be appropriate for preventing water entry associated with fluvial flooding as well as surface water and sewer flooding. The efficacy of such devices relies on their being deployed before a flood event occurs. It should also be borne in mind that devices such as air vent covers, if left in place by occupants as a precautionary measure, may compromise safe ventilation of the building in accordance with Building Regulations.

Figure 5-3 Examples of flood barriers, air bricks and on-return valves

Figure 5-4 Example of flood gates

5.7 Flood Resilience 'Water Entry Strategy'

For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, but to implement careful design in order to minimise damage and allow rapid re-occupancy. This is referred to as the Water Entry Strategy. These measures are appropriate for uses where temporary disruption is acceptable and suitable flood warning is received.

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

Policy Recommendation 6: In areas at risk of frequent or prolonged flooding, the following flood resilience measures could be implemented:

- Use materials with either, good drying and cleaning properties, or, sacrificial materials that can easily be replaced post-flood.
- Design for water to drain away after flooding.
- Design access to all spaces to permit drying and cleaning.
- Raise the level of electrical wiring, appliances and utility metres.
- Coat walls with internal cement based renders; apply tanking on the inside of all internal walls.
- Ground supported floors with concrete slabs coated with impermeable membrane.
- Tank basements, cellars or ground floors with water resistant membranes.
- Use plastic water resistant internal doors.

Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[40].

5.8 Structures

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

5.9 Safe Access and Egress

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

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

Guidance prepared by the Environment Agency[41] uses a calculation of flood hazard to determine safety in relation to flood risk. Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain along with a suitable debris factor to account for the hazard posed by any material entrained by the floodwater. The derivation of flood hazard is based on the methodology in Flood Risks to People FD2320, the use of which for the purpose of planning and development control is clarified in the abovementioned publication.

Table 5-1 Hazard to People Rating (HR=d x (v +0.5) + DF) (Table 13.1 FD2320/TR2)

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

[40] CLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction. http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf?bcsi_scan_E956BCBE8ADBC89F=0&bcsi_scan_filename=flood_performance.pdf

[41] Environment Agency (2008) Supplementary note on Flood hazard ratings and thresholds for development planning and control purpose. Clarification of Table 13.1 FD2320/TR2 and Figure 3.2 FD2321/TR1. http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2321_7400_PR_pdf.sflb.ashx

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

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

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

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

5.10 Safe Refuge

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

5.11 Car Parks

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

5.12 Flood Routing

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

- Removing boundary walls or replacing with other boundary treatments such as hedges, fences (with gaps).
- Considering alternatives to solid wooden gates, or ensuring that there is a gap beneath the gates to allow the passage of floodwater.
- On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede.
- Create under-croft car parks or consider reducing ground floor footprint
- Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.

In order to demonstrate that 'flood risk is not increased elsewhere', development in the floodplain will need to prove that flood routing is not adversely affected by the development, for example giving rise to backwater affects or diverting floodwaters onto other properties.

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

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

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

5.13 Flood Warning and Evacuation Plans

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

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

The Environment Agency has a tool on their website to create a Personal Flood Plan[1]. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.

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

Flood Warning and Evacuation Plans should include:

<u>How flood warning is to be provided, such as:</u>

- availability of existing flood warning systems (refer **Appendix A Figure 8**);
- where available, rate of onset of flooding and available flood warning time; and
- how flood warning is given.

<u>What will be done to protect the development and contents, such as:</u>

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

<u>Ensuring safe occupancy and access to and from the development, such as:</u>

- Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate;
- Safe access route to and from the development;
- If necessary, the ability to maintain key services during an event;

- Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
- Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.)

There is no statutory requirement for the Environment Agency or the emergency services to approve evacuation plans. SBC is accountable via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with emergency planning staff.

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

6.1 What are SuDS?

Policy Recommendation 10: Suitable surface water management measures should be incorporated into new development designs in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should be achieved by incorporating Sustainable Drainage Systems (SuDS).

SuDS are surface water drainage solutions designed to manage surface water runoff and mitigate the adverse effects of urban storm water runoff by reducing flood risk and controlling pollution[42]. SuDS techniques allow surface water runoff from development to be controlled in ways that imitate natural drainage by controlling the rate of discharge to a receiving watercourse. SuDS may also provide valuable habitat and amenity value when carefully planned for in development.

The SuDS Manual[43] identifies four processes that can be used to manage and control runoff from developed areas. Each option can provide opportunities for storm water control, flood risk management, water conservation and groundwater recharge:

A. **Infiltration:** the soaking of water into the ground. This is the most desirable solution as it mimics the natural hydrological process. The rate of infiltration will vary with soil type and condition, the antecedent conditions and with time. The process can be used to recharge groundwater sources and feed baseflows of local watercourses, but where groundwater sources are vulnerable or there is risk of contamination, infiltration techniques are not suitable.

   The use of traditional infiltration techniques that infiltrate to the ground is dependent on the underlying ground conditions. However, it is also possible to use shallow infiltration techniques in combination with storage techniques on sites which have impermeable geology, and therefore these techniques should not be overlooked.

B. **Detention/Attenuation:** the slowing down of surface flows before their transfer downstream, usually achieved by creating a storage volume and a constrained outlet. In general, though the storage will enable a reduction in the peak rate of runoff, the total volume will remain the same, just occurring over a longer duration.

   Detention measures are not constrained by geology, though in areas of permeable geology, there will also be a degree of infiltration of runoff taking place.

C. **Conveyance:** the transfer of surface runoff from one place to another, e.g. through open channels, pipes and trenches.

D. **Water Harvesting:** the direct capture and use of runoff on site, e.g. for domestic use (flushing toilets) or irrigation of urban landscapes. The ability of these systems to perform a flood risk management function will be dependent on their scale, and whether there will be a suitable amount of storage always available in the event of a flood.

As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development. Table 6-1 has been reproduced from the SuDS Manual, CIRIA C697 and outlines typical SuDS techniques.

[42] Defra, Environment Agency (March 2015) Cost Estimation for SuDS – Summary of Evidence
[43] CIRIA C697 (2015) SuDS Manual http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

Table 6-1 Typical SuDS Components (Y; primary process. * some opportunities, subject to design)

Technique	Description	Conveyance	Detention	Infiltration	Harvesting
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.		Y	Y	*
Filter Drains	Linear drains/trenches filled with a permeable material, often with perforated pipe in the base of the trench. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site.	Y	Y		
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and particulates.	*	*	*	
Swales	Shallow vegetated channels that conduct and/or retain water, and can permit infiltration when unlined.	Y	Y	*	
Ponds	Depressions used for storing and treating water.		Y	*	Y
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. Based on geology these measures can also incorporate some degree of infiltration.	*	Y	*	Y
Detention Basin	Dry depressions designed to store water for a specified retention time.		Y		
Soakaways	Sub-surface structures that store and dispose of water via infiltration.			Y	
Infiltration Trenches	As filter drains, but allowing infiltration through trench base and sides.	*	Y	Y	
Infiltration Basins	Depressions that store and dispose of water via infiltration.		Y	Y	
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof (CIRIA C697).		Y		
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing because, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event.	*	*	*	Y

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

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

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

6.2 Management Train

The concept used in the development of drainage systems is the surface water 'management train'[44] whereby different techniques can be used in series to change the flow and quality characteristics of runoff in stages that attempt to mimic natural drainage. The hierarchy of techniques that should be considered in developing the management train are[49]:

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

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

- Into the ground (shallow infiltration)
- To a surface water body
- To a surface water sewer, highway drain, or another drainage system
- To a combined sewer

Where possible, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas. The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at the source should always be considered before site or regional controls. However, where upstream control opportunities are restricted, a number of lower hierarchy options should be used in series. Water should only be conveyed elsewhere if it cannot be dealt with at the site[49].

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

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

6.3 SuDS Costs

6.3.1 Whole Life Costs

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

Information on typical capital costs and maintenance costs are provided below. For further detail, and information on the other associated costs noted above, reference can be made to industry guidance such as the Defra and Environment Agency publication 'Cost Estimation for SuDS- Summary of Evidence' (Defra Environment Agency, March 2015 and Ciria Report C753, The SuDS Manual.)

[44] ttp://www.ciria.org.uk/suds/suds_management_train.htm

6.3.2 Capital Costs

Defra and the Environment Agency have prepared a document containing unit costs for particular SuDS components based on a number of industry references. These have been compiled in Table 6-1. It is noted that these costs are based on actual costs from a number of projects from within the UK and from a wider literature review. If used for cost estimating purposes these costs should be increased to allow for inflation to present day values.

It should be noted that these costs are provided as an indicative cost for each type of SuDS. Whilst they provide a range of costs for each type and a relative assessment between SuDS features, the costs associated with any specific site will depend on a number of factors as follows:

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

Table 6-2 Indicative costs for SuDS options (Defra, Environment Agency 2015)

Option	Unit cost	Source
Green roofs	£90/m^2 - covered roof with sedum mat £80/m^2 - biodiverse roof (varied covering of plants, growing medium and aggregates) Variable costs for Sedum blanket , turf and growing medium roof options	Bamfield, 2005. Bamfield, 2005. Rawlinson, 2006
Simple rainwater harvesting (water butts)	£100 - £243 per property (includes installation and connection pipe)	Stovin & Swan 2007
Advanced rainwater harvesting	£2,100 - £2,400 per residential property £2,500 - £6,000 per residential property £2,600 - £3,700 per residential property £6,300 - £21,000 per commercial / industrial property £45 per m^2 for residential properties £9 per m^2 for non-residential properties	Woking BC Environment Agency, 2007 RainCycle, 2005 RainCycle, 2005 Environment Agency, 2007 Environment Agency, 2007
Greywater re-use	£1,900 - £3,500 per residential property £3,000 per property	Woking BC Environment Agency, 2007
Permeable paving	£30-£40 per m^2 of permeable surface £27 per m^2 of replacement surface £54 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Filter drain / perforated pipes	£100 - £140 per m^3 stored volume £61 per m £120 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Swales	£10-£15 per m^2 swale area £18-£20 per m length using an excavator £12.5 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Infiltration basin	£10-£15 per m^3 stored volume	CIRIA, 2007
Soakaways	>£100 per m^3 stored volume £454 -£552 per soakaway	CIRIA, 2007 Stovin & Swan 2007

Option	Unit cost	Source
Infiltration trench	£55-£65 per m^3 stored volume £74-£99 per m length £60 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Filter strip	£2-£4 per m^2 filter strip area	CIRIA, 2007
Constructed wetland	£25-£30 per m^3 treated volume	CIRIA, 2007
Retention (wet) pond	£15-£25 per m^3 treated volume £80,000 per 5000m^3 pond (£16 per m3)	CIRIA, 2007 SNIFFER, 2007
Detention basin	£15-£20 per m^3 detention volume £35-£55 per m^3 stored volume £18 per m^3	CIRIA, 2007 Stovin & Swan 2007 SNIFFER, 2007
Onsite attenuation and storage	£449-£518 per m^3 for reinforced concrete storage tank. No data available for oversized pipes	Stovin & Swan 2007

6.3.3 Operation and Maintenance Costs

As with any other flood risk management structure, SuDS require ongoing maintenance to ensure the system remains in good working order and the design life of the system is extended as long as possible. Operation and maintenance activities will include the following:

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

Additional costs may include the allocation of resources and materials as a result of maintenance activities.

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

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

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

Table 6-3 outlines some generic SuDS costs based on review of literature and some UK case studies undertaken by HR Wallingford (2004).

Table 6-3 Indicative annual maintenance costs for key SuDS options[45]

Option	Annual Maintenance costs	
Green roofs	£2,500/yr. for first 2 years for covered rood with sedum mat, £600/yr. after. £1,250/yr. for first 2 years for covered rood with biodiverse roof, £150/yr. after.	Bamfield (2005) Bamfield (2005)
Simple rainwater harvesting (water butts)	Negligible	
Advanced rainwater harvesting	£250 per year per property for external maintenance contract	RainCycle
Permeable paving	£0.5 - £1/m^3 storage volume	HR Wallingford, 2004
Filter drain/perforated pipes	£0.2 - £0.1/m^2 of filter surface area	HR Wallingford, 2004
Swales	£0.1/m^2 of swale surface area £350/yr.	HR Wallingford, 2004 Ellis, 2003

[45] Defra, Environment Agency (March 2015) Cost Estimation for SuDS – Summary of Evidence.

Option	Annual Maintenance costs	
Infiltration basin	£0.1 - £0.3/m^2 of detention basin area £0.25 - £1/m^3 of detention volume	HR Wallingford, 2004
Soakaways	£0.1/m^2 of treated area	HR Wallingford, 2004
Infiltration trench	£0.2 - £1/m^2 of filter surface area	HR Wallingford, 2004
Filter strip	£0.1/m^2 of filter surface area	HR Wallingford, 2004
Constructed wetland	£0.1/m^2 of wetland surface area. Annual maintenance of £200-250/yr. for first 5 years (declining to £80 - £100/yr. after 3 year)	HR Wallingford, 2004 Ellis, 2003
Retention (wet) pond	£0.5 - £1.5/m^2 of retention pond surface area £0.1 - £2/m^3 of pond volume	HR Wallingford, 2004 HR Wallingford, 2004 Ellis, 2003
Detention basin	£0.1 - £0.3/m^2 of detention basin area £0.25 - £1/m^3 of detention volume £250-£1000 per basin	HR Wallingford, 2004 HR Wallingford, 2004 Ellis, 2003

6.4 Infiltration SuDS Specific to Stevenage

In Stevenage the generally permeable nature of the soil, subsoil and underlying strata makes the disposal of runoff to groundwater by means of SuDS incorporating soil infiltration processes a desirable and potentially feasible option. There should therefore be an initial presumption within Stevenage in favour of using these types of SuDS in preference to those that merely attenuate peak discharges to sewers or watercourses by the retention of runoff in temporary storage facilities. Since chalk is the dominant stratum in the Stevenage area, developers should be made aware of the presence of a number of groundwater source protection zones in the area and it is essential that the chemical and bacteriological quality of the runoff disposed of by infiltration is fully taken into account.

As part of this SFRA, an assessment of the suitability of using infiltration SuDS techniques across the Borough has been undertaken. The BGS infiltration SuDS suitability map shown on **Appendix A Figure 10** is largely based on the BGS infiltration SuDS suitability dataset. It is understood from the BGS guidance notes that the dataset is derived from the following data:

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

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

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

The majority of areas inside the Borough have been designated as 'Probably compatible for infiltration SuDS' in the eastern half and 'Opportunities for bespoke infiltration SuDS in the west. 'Very significant constraints' are shown in approximately 11% of the Borough and the percentage of land identified as 'Highly compatible for infiltration SuDS' is 16%. A range of other types of SuDS measures (Table 6-2) can be adopted in sites where infiltration SuDS is not particularly suitable.

6.5 What is the role of the HCC?

HCC is a statutory consultee for surface water drainage as part of their role as LLFAs. From 6th April 2015, all major development should include provision for SuDS and a Sustainable Drainage Strategy will need to be completed and signed by a competent drainage engineer to verify that the proposals conform to the Government's 'Sustainable Drainage Systems: Non-Statutory Technical Standards[46].

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

http://www.hertsdirect.org/services/envplan/water/floods/surfacewaterdrainage/sudsguidance/.

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

6.5.1 What are the Technical Standards?

A set of non-statutory Technical Standards have been published, which set the requirements for the design, construction, maintenance and operation of SuDS. The Technical Standards that are of chief concern in relation to the consideration of flood risk to and from development relating to peak flow control and volume control are presented below.

LASOO is the Local Authority SuDS Officer Organisation which is a professional association of local authority officers that have involvement in SuDS. LASOO are the owners and writers of a Practice Guidance document which sits alongside the Non-Statutory Technical Standards for SuDS. The Practice Guidance is a living document that is regularly updated and is available on the LASOO website http://www.lasoo.org.uk/non-statutory-technical-standards-for-sustainable-drainage.

Flood risk outside the development

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

Peak flow control

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

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

Volume control

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

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

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

[46] Sustainable drainage systems: non-statutory technical standards - https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

Flood risk within the development

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

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

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

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

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

6.5.2 What should a Sustainable Drainage Strategy include?

There will be some variation between LLFAs regarding specific requirements for preparing a Sustainable Drainage Strategy, and at the time of writing, requirements are still being developed. The following provides an indication of the type of information that would be required as part of a Sustainable Drainage Strategy:

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

Applicants are encouraged to discuss their proposals with HCC at the pre-application stage and in due course the Flood Risk Management Team at HCC will offer pre-application advice to developers on a chargeable basis. Once resources and charging schedules are in place to support this element of the services service stakeholders will be informed. Details on the charging schedule are presented in the pre-application guide:

http://www.hertsdirect.org/docs/pdf/p/preeappguide.pdf

7 Guidance for preparing site-specific FRAs

7.1 What is a Flood Risk Assessment?

A site-specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development, and demonstrates how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with paragraph 100 of the NPPF and PPG. An FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow SBC to satisfy itself that the requirements have been met.

7.2 When is a Flood Risk Assessment required?

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

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

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

7.3 How detailed should a FRA be?

The PPG states that site-specific FRAs should be proportionate to the degree of flood risk, the scale and nature of the development, its vulnerability classification (Table 4-4) and the status of the site in relation to the Sequential and Exception Tests. Site-specific FRAs should also make optimum use of readily available information, for example the mapping presented within this SFRA and available on the Environment Agency website, although in some cases additional modelling or detailed calculations will need to be undertaken. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, SBC would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater SBC may require a more detailed assessment, for example, the preparation of site-specific hydraulic modelling to determine the flood risk to and from the site pre and post-development, and the effectiveness of any management and mitigation measures incorporated within the design.

As a result, the scope of each site-specific FRA will vary considerably. Table 7-1 presents the different levels of site-specific FRA as defined in the CIRIA publication C624[47] and identifies typical sources of information that can be used. Sufficient information must be included to enable the Council and where appropriate, consultees, to determine that the proposal will be safe for its lifetime, not increase flood risk elsewhere and where possible, reduce flood risk overall. Failure to provide sufficient information will result in applications being refused.

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

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

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

7.3.1 Environment Agency Data Requests

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

- Products 1 – 4 relate to mapped deliverables including flood level and flood depth information and the presence of flood defences local to the proposed development site;
- Product 5 contains the reports for hydraulic modelling of the Main Rivers;
- Product 6 contains the model output data so the applicant can interrogate the data to inform the FRA.
- Product 7 comprises the hydraulic model itself.

Products 1 – 6 can be used to inform a Level 2 FRA. In some cases, it may be appropriate to obtain Product 7 and to use as the basis for developing a site-specific model for a proposed development as part of a Level 3 FRA. This can be requested via either their National Customer Contact Centre via enquiries@environment-agency.gov.uk or the Hertfordshire and North London Customer and Engagement Team via HNL.Enquiries@environment-agency,gov.uk.

7.3.2 Modelling of Ordinary Watercourses

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

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

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

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

7.5 Flood Risk Assessment Checklist

Appendix C provides a checklist for site-specific FRAs including the likely information that will need to be provided along with references to sources of relevant information. As described in Section 7.3, the exact level of detail required under each heading will vary according to the scale of development and the nature of the flood risk.

7.6 Pre-application Advice

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

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

- **SBC** offer free pre-application advice. Enquiries can be submitted by completing the Preliminary Enquiries Form available online at http://www.stevenage.gov.uk/149690/planning/152088/152114/
- **Environment Agency** http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/research/planning/33580.aspx The following government guidance sets out when LPAs should consult with the Environment Agency on planning applications https://www.gov.uk/flood-risk-assessment-local-planning-authorities.

8 Flood Risk Management Policy Considerations

8.1 Overview

In order to encourage a holistic approach to flood risk management and ensure that flooding is taken into account at all stages of the planning process, this Section builds on the findings of the SFRA to set out key recommendations for consideration by SBC in relation to flood risk planning policy and with respect to development management decisions on a day-to-day basis.

8.2 Policy Considerations

It is recommended that the following flood risk objectives are taken into account by SBC during the policy making process. Guidance on how these objectives can be met throughout the development control process for individual development sites is included within Section 5.

8.2.1 Seeking Flood Risk Reduction through Spatial Planning and Site Design

- Use the Sequential Test to locate new development in areas of lowest risk, giving highest priority to areas within Flood Zone 1. Locating new development away from the most vulnerable flood risk areas would minimise the cost of installing and maintaining new flood defences and land drainage measures.
- Use the Sequential 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.
- Avoid development immediately downstream of FSRs which will be at high hazard areas in the event of failure.
- Seek opportunities for new development to achieve reductions to wider flood risk issues where possible, e.g. larger developments may be able to make provisions for flow balancing within new attenuation SuDS features.
- Identify long-term opportunities to remove development from the floodplain through land swapping.
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. Dry pedestrian access/egress should be possible for the 1 in 100 year return period event including an allowance for climate change associated with fluvial flooding.

8.2.2 Reducing Surface Water Runoff from New Developments

- All sites require the following:
  - Use of SuDS (where possible use of strategic SuDS should be made).
  - Discharge rates should be restricted to Greenfield runoff rates.
  - 1 in 100 year attenuation of surface water, taking including an allowance for climate change.
- Space should be specifically set aside for SuDS and used to inform the overall layout of development sites.
- Surface water drainage proposals should have a clear plan for the long term maintenance and adoption of the systems, prior to approval of any planning permission in line with national planning policy.
- Large potential development areas with a number of new allocation sites will be required to develop a strategy for providing a joint SuDS scheme. This will need to be on an integrated and strategic scale and where necessary will require the collaboration of all developers involved in implementing a specific expansion area or site.
- Careful assessment of the potential impact of surface water drainage from new developments will be necessary in areas with constrained drainage networks, particularly those networks that are dependent upon sewers and culverted watercourses with limited capacity.

- Further work is necessary to understand the full extent of risk from surface water flooding in Stevenage, including the preparation of SWMPs.
- Reducing the potential impacts of sewer flooding may require the installation of SuDS in both new and existing developments. The risk of foul sewer flooding that result from the misconnection of surface water drainage to the foul sewer network could be addressed if opportunities to disconnect surface water from foul sewers are taken.
- Consideration may need to be given to further use of rural SuDS to reduce both the risk of flooding and the risk of rivers drying out (smoothing out the peaks and troughs of local rainfall).

8.2.3 Enhancing and Restoring the River Corridor

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. de-culverting, the use of bio-engineered river walls, raising bridge soffits to take into account climate change).
- Avoid further culverting and building over culverts. Where practical, all new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit. Any culverting or works affecting the flow of a watercourse requires the prior written consent of either the Environment Agency (for main rivers), or HCC (for ordinary watercourses) under the terms of the Land Drainage/Water Resources Act 1991 and Flood and Water Management Act 2010. These regulatory bodies seek to avoid culverting, and their consent for such works will not normally be granted except as a means of access.
- Set development back from rivers, seeking an 8 metre wide undeveloped buffer strip for development by all watercourses including those where the Flood Zone does not exist. Under the terms of the Water Resources Act 1991 and the Land Drainage Byelaws, the prior written consent of the Environment Agency or HCC is required for any proposed works or structures in, under, over or within 8m of a main river, or within 8m of ordinary watercourse asset or structure. This is to allow easy maintenance of the water course, and includes consent for fencing, planting and temporary structures.

8.2.4 Protecting and Promoting Areas for Future Flood Alleviation Schemes

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

8.2.5 Improving Flood Resilience and Emergency Planning

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

- Seek to improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within existing Flood Zone 3a and 3b (residential and commercial occupiers) to sign up to Flood Warning Service operated by the Environment Agency.
- Ensure robust emergency (evacuation) plans are implemented for new developments.

8.3 Development Management Considerations

8.3.1 Flood Zone 3b Functional Floodplain

The Functional Floodplain, including water meadows (FSRs), have been defined within this SFRA. These areas should be safeguarded from development, with exemptions where development could reduce flood risk overall or improve floodplain storage.

Only Water Compatible developments are permitted in Flood Zone 3b, and Essential Infrastructure developments require the Exception Test (refer to Section 4.4). Where Water Compatible or Essential Infrastructure development cannot be located elsewhere, it must:

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

Proposals for the change of use or conversion to a use with a higher vulnerability classification should not be permitted. Basements, basements extensions, conversions of basements to a high vulnerability classification or self-contained units should not be permitted.

Where minor development is proposed, schemes should not affect floodplain storage or flow routes through the incorporation of the following mitigation measures in line with CIRIA guidance on SuDS:

- Raised finished floor levels;
- Voids and where possible;
- Direct or indirect floodplain compensation;
- Flood resilience measures;
- The removal of other non-floodable structures;
- Replacement of impermeable surfaces with permeable;
- Improved surface water drainage through the implementation of SuDS features such as water butts/rainwater harvesting;
- Living roofs;
- Infiltration trenches/soakaways; and
- Below ground attenuation tanks.

8.3.2 Flood Zone 3a High Probability

Flood Zone 3a High Probability comprises land having a 1% (1 in 100 year) annual probability or greater. Water Compatible and Less Vulnerable developments are permitted in Flood Zone 3a; Essential Infrastructure and More Vulnerable developments require the Exception Test and Highly Vulnerable development is not permitted in this flood zone (see Table 4-5). Where development is proposed opportunities should be sought to:

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

8.3.3 Flood Zone 2 Medium Probability

Flood Zone 2 Medium Probability comprises land having between a 1% (1 in 100 year) and 0.1% (1 in 1000) annual probability of flooding from fluvial watercourses. Water Compatible, Essential Infrastructure, Less Vulnerable and More Vulnerable developments are permitted in the Flood Zone 2 and Highly Vulnerable development requires the Exception Test (see Table 4-5). Where development is proposed in areas of Flood Zone 2, the planning policy approach is similar to Flood Zone 3a. Opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding;
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- Ensure it remains safe for users in times of flood; and

- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

8.3.4 Flood Zone 1 Low Probability

Flood Zone 1 Low Probability comprises land having a less than 0.1% (1 in 1000 year) annual probability of flooding from fluvial watercourses. All development vulnerability classifications are permitted in Flood Zone 1 (see Table 4-5). Where development over 1ha is proposed or there is evidence of flooding from another localised source in areas of Flood Zone 1, opportunities should be sought to:

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

8.3.5 Changes of Use

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

For change of use applications in Flood Zone 2 and 3, applicants must submit a FRA with their application. This should demonstrate how the flood risks to the development will be managed so that it remains safe through its lifetime including provision of safe access and egress and preparation of Flood Warning and Evacuation Plans where necessary. Further guidance will be provided within the Level 2 SFRA Report.

As changes of use are not subject to the Sequential or Exception Tests, SBC could consider when formulating policy what changes of use will be acceptable, having regard to paragraph 157 (6th bullet) of the NPPF and taking into account the findings of this SFRA. This is likely to depend on whether developments can be designed to be safe and that there is safe access and egress.

8.4 Summary of Policy Recommendations

Policy Recommendation	Description
1	A sequential approach to site planning should be applied within new development sites.
2	Retain an 8 metre wide undeveloped buffer strip alongside Main Rivers and explore opportunities for riverside restoration. Retain an 8 metre wide buffer strip alongside Ordinary Watercourses. New development within 8m of a Main River or Ordinary Watercourse will require environmental permitting from the Environment Agency, or consent from HCC (as LLFA).
3	All new development within Flood Zone 3 must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.
4	All More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.
5	In areas at risk of flooding of low depths (<0.3m), the following flood resistance measures could be considered: • Using materials and construction with low permeability. • Land raising. • Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk to neighbouring properties). • Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance. • Flood gates with waterproof seals.

Policy Recommendation	Description
6	In areas at risk of frequent or prolonged flooding, the following flood resilience measures could be implemented: • Use materials with either, good drying and cleaning properties, or, sacrificial materials that can easily be replaced post-flood. • Design for water to drain away after flooding. • Design access to all spaces to permit drying and cleaning. • Raise the level of electrical wiring, appliances and utility metres. • Coat walls with internal cement based renders; apply tanking on the inside of all internal walls. • Ground supported floors with concrete slabs coated with impermeable membrane. • Tank basements, cellars or ground floors with water resistant membranes. • Use plastic water resistant internal doors.
7	For developments located in areas at risk of fluvial flooding, safe access / egress must be provided for new development as follows in order of preference: • Safe dry route for people and vehicles. • Safe dry route for people. • If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people. • If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater. In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.
8	All new development in Flood Zones 2 and 3 should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water, such as: • Removing boundary walls or replacing with other boundary treatments such as hedges, fences (with gaps). • Considering alternatives to solid wooden gates, or ensuring that there is a gap beneath the gates to allow the passage of floodwater. • On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede. • Create under-croft car parks or consider reducing ground floor footprint and creating an open area under the building to allow flood water storage. Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.
9	For all developments (excluding minor developments and change of use) proposed in Flood Zones 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population. The Environment Agency has a tool on their website to create a Personal Flood Plan. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.
10	Suitable surface water management measures should be incorporated into new development designs in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should be achieved by incorporating SuDS.

9 Next Steps

9.1.1 Sequential Test

The Level 1 SFRA assessment shows that a vast majority of the potential development sites in SBC Local Plan are at low risk of flooding (Table 4-2). Only six sites out of a total of 59 fall within medium or high category. Using the flood risk information presented within this report, SBC should undertake the Sequential Test for these sites to confirm their levels of risk and document the process. SBC needs to make sure any future development is steered towards areas of lowest flood risk.

9.1.2 Level 2 SFRA

For the six sites identified to be at medium or high risk of flooding, a Level 2 SFRA is required to provide information to support the application of the Exception Test for future development sites. The scope of the Level 2 SFRA would be to consider the detailed nature of the flood characteristics within a flood zone.

The Level 2 SFRA would provide a more detailed assessment of the flood risk for specific development sites which may require the application of the Exception Test.

9.1.3 Future Updates to the SFRA

This SFRA has been updated building heavily upon existing knowledge and newly available datasets with respect to flood risk within SBC, made available by the Environment Agency. In the future, new modelling studies or new information may influence future development management decisions within SBC. Therefore it is important that the SFRA is adopted as a ‘living’ document and is reviewed regularly in light of emerging policy directives, flood risk datasets and an improving understanding of flood risk within SBC.

Appendix A. Figures

Appendix B. Stevenage Borough Council Flood Records

Ward	Date	Flooding Type	No. of Records
Bandley Hill Ward	2002	Surface Water	6
	2014	Surface Water	1
Bedwell Ward	2002	Surface Water	6
	2012	Surface Water	1
	2014	Land Drainage	1
	2014	Surface Water	1
	2015	Foul & Surface	1
	2015	Surface Water	1
Chells Ward	2002	Surface Water	3
	2014	Surface Water	1
Longmeadow Ward	2002	Surface Water	4
	2002	Foul & Surface	1
	2010	Surface Water	1
	2015	Surface Water	1
Manor Ward	2002	Surface Water	1
Martins Wood Ward	2002	Surface Water	1
	2014	Surface Water	1
	2015	Surface Water	1
Old Town Ward	2002	Surface Water	1
	2015	Surface Water	1
Pin Green Ward	2002	Surface Water	1
Roebuck Ward	2002	Surface Water	5
	2010	Surface Water	1
	2012	Surface Water	1
	2014	Surface Water	1
	2015	Surface Water	2
Shephall Ward	2002	Surface Water	8
	2012	Surface Water	1
	2014	Land Drainage	1
	2014	Surface Water	1
St. Nicholas Ward	2002	Surface Water	2
	2014	Surface Water	1
	2015	Surface Water	1
Symonds Green Ward	2011	Surface Water	1
	2012	Surface Water	1
	2014	Surface Water	1
	2015	Surface Water	1
Woodfield Ward	2014	Land Drainage	1
	2015	Surface Water	1

Appendix C. Flood Risk Assessment (FRA) Checklist

What to Include in the FRA		Source(s) of Information
1.Site Description		
Site address	-	-
Site description	-	-
Location plan	Including geographical features, street names, catchment areas, watercourses and other bodies of water	SFRA Appendix A
Site plan	Plan of site showing development proposals and any structures which may influence local hydraulics e.g. bridges, pipes/ducts crossing watercourses, culverts, screens, embankments, walls, outfalls and condition of channel	OS Mapping Site Survey
Topography	Include general description of the topography local to the site. Where necessary, site survey may be required to confirm site levels (in relation to Ordnance datum). Plans showing existing and proposed levels.	Site Survey
Geology	General description of geology local to the site.	BGS geological data Ground Investigation Report
Watercourses	Identify Main Rivers and Ordinary Watercourses local to the site.	SFRA Appendix A, Figure 1
Status	Is the development in accordance with the Council's Spatial Strategy?	SBC website
2. Assessing Flood Risk		
The level of assessment will depend on the degree of flood risk and the scale, nature and location of the proposed development. Refer to Table 4-4 regarding the levels of assessment. Not all of the prompts listed below will be relevant for every application.		
Flooding from Rivers	Provide a plan of the site and Flood Zones. Identify any historic flooding that has affected the site, including dates and depths where possible. How is the site likely to be affected by climate change? Determine flood levels on the site for the 1% annual probability (1 in 100 chance each year) flood event including an allowance for climate change. Determine flood hazard on the site (in terms of flood depth and velocity). Undertake new hydraulic modelling to determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.	SFRA Appendix A Environment Agency Flood Map for Planning (Rivers and Sea). New hydraulic model.
Flooding from Land	Identify any historic flooding that has affected the site. Review the local topography and conduce a site walkover to determine low points at risk of surface water flooding. Review the Risk of Flooding from Surface Water mapping. Where necessary, undertake modelling to assess surface water flood risk.	SFRA Area Assessments. Topographic survey. Site walkover. Risk of Flooding from Surface Water mapping (Environment Agency website). New modelling study.
Flooding from Groundwater	Desk based assessment based on high level BGS mapping in the SFRA. Ground survey investigations. Identify any historic flooding that has affected the site.	SFRA Appendix A, Figure 5. Ground Investigation Report
Flooding from Sewers	Identify any historic flooding that has affected the site.	Refer SFRA Section 3.7.
Reservoirs, canals	Identify any historic flooding that has affected the site.	Risk of Flooding from

What to Include in the FRA		Source(s) of Information
and other artificial sources	Review the Risk of Flooding from Reservoirs mapping.	Reservoirs mapping (Environment Agency website). Refer SFRA Section 3.8.
3. Proposed Development		
Current use	Identify the current use of the site.	-
Proposed use	Will the proposals increase the number of occupants / site users on the site such that it may affect the degree of flood risk to these people?	-
Vulnerability Classification	Determine the vulnerability classification of the development. Is the vulnerability classification appropriate within the Flood Zone?	SFRA Table 4-1 SFRA Table 4-4
4. Avoiding Flood Risk		
Sequential Test	Determine whether the Sequential Test is required. Consult SBC to determine if the site has been included in the Sequential Test. If required, present the relevant information to SBC to enable their determination of the Sequential Test for the site on an individual basis.	SFRA Section 4.
Exception Test	Determine whether the Exception Test is necessary. Where the Exception Test is necessary, present details of: Part 1) how the proposed development contributes to the achievement of wider sustainability objectives as set out in the SBC Sustainability Appraisal Report. (Details of how part 2) can be satisfied are addressed in the following part 5 'Managing and Mitigating Flood Risk'.)	SFRA Table 4-5 Refer to Section 4.4
5. Managing and Mitigating Flood Risk		
Section 6 of the SFRA presents measures to manage and mitigate flood risk and when they should be implemented. Where appropriate, the following should be demonstrated within the FRA to address the following questions: How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime? How will you ensure that the proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? Are there any opportunities offered by the development to reduce flood risk elsewhere? What flood-related risks will remain after you have implemented the measures to protect the site from flooding (i.e. residual risk) and how and by whom will these be managed over the lifetime of the development (e.g. flood warning and evacuation procedures)?		
Development Layout and Sequential Approach	Plan showing how sensitive land uses have been placed in areas within the site that are at least risk of flooding.	SFRA Section 5.2
Riverside Development Buffer Zone	Provide plans showing how a buffer zone of relevant width will be retained adjacent to any Main River or Ordinary Watercourse in accordance with requirements of the Environment Agency or HCC.	SFRA Section 5.3
Floodplain Compensation Storage	Provide calculations or results of a hydraulic modelling study to demonstrate that the proposed development provides compensatory flood storage and either will not increase flood risk to neighboring areas or will result in an overall improvement. This should be located and designed to achieve level for level and volume for volume compensation, should be provided on land that is in hydrological continuity with the site within the applicant's ownership and subject to appropriate maintenance regimes for its lifetime.	SFRA Section 5.4

What to Include in the FRA		Source(s) of Information
	Include cross sectional drawings clearly showing existing and proposed site levels.	
Finished Floor Levels	Plans showing finished floor levels in the proposed development in relation to Ordnance Datum taking account of indicated flood depths.	SFRA Section 5.5
Flood Resistance	Details of flood resistance measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 5.6
Flood Resilience	Details of flood resilience measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 5.7
Safe Access / Egress	Provide a figure showing proposed safe route of escape away from the site and/or details of safe refuge. Include details of signage that will be included on site. Where necessary this will involve mapping of flood hazard associated with river flooding. This may be available from Environment Agency modelling, or may need to be prepared as part of hydraulic modelling specific for the proposed development site.	SFRA Section 5.9
Flow Routing	Provide evidence that proposed development will not impact flood flows to the extent that the risk to surrounding areas is increased. Where necessary this may require modelling.	SFRA Section 5.14
Flood Warning and Evacuation Plan	Where appropriate reference the Flood Warning and Evacuation Plan or Personal Flood Plan that has been prepared for the proposed development (or will be prepared by site owners).	SFRA Section 5.15
Surface Water Management	Completion of SuDS Drainage Statement, as described in Section 7.	SFRA Section 6. HCC website - http://www.hertsdirect.org/docs/pdf/s/hertssudsguide.pdf

Appendix D. Site Assessment Database

Site Ref.	Site Name	Flood Risk from Rivers (Flood Zones)				Updated Flood Map for Surface Water			Historic Records		Susceptibility to Groundwater Flooding		Flood Response Measures		Total	Overall Risk
		FZ 1	FZ 2	FZ 3a	FZ 3b	High	Medium	Low	Historic Flood Map	Flooding Database	Medium	High	FWA	FAA		
Weightage		0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5				
EC1/1	GSK / Stevenage Bioscience Catalyst	Y				Y	Y	Y							1.5	L
EC1/2	South of Bessemer Drive, Gunnels Wood	Y				Y	Y	Y							1.5	L
EC1/3	West of Gunnels Wood Road	Y						Y							0.5	L
EC1/4	Land West of North Rd	Y	Y	Y		Y	Y	Y						Y	2.5	M
EC1/5	Stevenage Central	Y					Y	Y							1	L
EC1/6	West of Stevenage	Y				Y	Y	Y							1.5	L
EC1/7	Land west of Junction 8	Y	Y	Y		Y	Y	Y						Y	2.5	M
EC2	Gunnels Wood Employment Area	Y				Y	Y	Y		Y					1.75	L
EC2B	Edge-of-Centre Zone	Y				Y	Y	Y		Y					1.75	L
EC3	Gunnels Wood Industrial Zones	Y				Y	Y	Y							1.5	L
EC3	Gunnels Wood Industrial Zones	Y				Y	Y	Y							1.5	L
EC6	Pin Green Employment Area	Y				Y	Y	Y							1.5	L
HO1/1	Bedwell Crescent neighbourhood centre	Y				Y	Y	Y							1.5	L

Site Ref.	Site Name	Flood Risk from Rivers (Flood Zones)				Updated Flood Map for Surface Water			Historic Records		Susceptibility to Groundwater Flooding		Flood Response Measures		Total	Overall Risk
		FZ 1	FZ 2	FZ 3a	FZ 3b	High	Medium	Low	Historic Flood Map	Flooding Database	Medium	High	FWA	FAA		
Weightage		0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5				
HO1/2	Bragbury End sports ground car park	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	Y	4	H
HO1/3	Burwell Road neighbourhood centre	Y				Y	Y	Y							1.5	L
HO1/4	Dunn Close garage court	Y				Y	Y	Y							1.5	L
HO1/5	Ex-play centre, Scarborough Avenue	Y						Y							0.5	L
HO1/6	Former Pin Green school playing field	Y						Y							0.5	L
HO1/7	Fry Road day nursery	Y													0	NR
HO1/8	Ken Brown car showroom	Y				Y	Y	Y							1.5	L
HO1/9	Kenilworth neighbourhood centre	Y						Y							0.5	L
HO1/10	Land at Eliot Road	Y													0	NR
HO1/11	Land West of North Road (Rugby Club)	Y				Y	Y	Y							1.5	L
HO1/12	Marymead neighbourhood centre	Y				Y	Y	Y							1.5	L
HO1/13	Scout hut, Drakes Drive	Y						Y							0.5	L
HO1/14	Shephall Centre and adj. amenity land	Y													0	NR

Site Ref.	Site Name	Flood Risk from Rivers (Flood Zones)				Updated Flood Map for Surface Water			Historic Records		Susceptibility to Groundwater Flooding		Flood Response Measures		Total	Overall Risk
		FZ 1	FZ 2	FZ 3a	FZ 3b	High	Medium	Low	Historic Flood Map	Flooding Database	Medium	High	FWA	FAA		
Weightage		0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5				
HO1/15	Shephall View	Y					Y	Y							1	L
HO1/16	The Glebe neighbourhood centre	Y				Y	Y	Y							1.5	L
HO1/17	The Hyde neighbourhood centre	Y				Y	Y	Y		Y					1.75	L
HO1/18	The Oval neighbourhood centre	Y				Y	Y	Y							1.5	L
HO2	Stevenage West	Y				Y	Y	Y							1.5	L
HO3	North of Stevenage	Y				Y	Y	Y							1.5	L
HO4	South East of Stevenage	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	4.75	H
HO12	Gypsy Traveller Site	Y				Y	Y	Y							1.5	L
TC3	Centre West Major Opportunity Area	Y				Y	Y	Y							1.75	L
TC4	Station Gateway Major Opportunity Area	Y				Y	Y	Y							1.5	L
TC6	Northgate Major Opportunity Area	Y				Y	Y	Y							1.5	L
TC2	Southgate Park Major Opportunity Area	Y				Y	Y	Y		Y					1.5	L
TC7	Marshgate Major Opportunity Area	Y				Y	Y	Y							1.5	L

Site Ref.	Site Name	Flood Risk from Rivers (Flood Zones)				Updated Flood Map for Surface Water			Historic Records		Susceptibility to Groundwater Flooding		Flood Response Measures		Total	Overall Risk
		FZ 1	FZ 2	FZ 3a	FZ 3b	High	Medium	Low	Historic Flood Map	Flooding Database	Medium	High	FWA	FAA		
Weightage		0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5				
TC5	Central Core Major Opportunity Area	Y				Y	Y	Y							1.5	L
TC11	New Convenience Retail Provision	Y	Y	Y		Y	Y	Y						Y	2.5	M
HC1/1	Poplars	Y				Y	Y	Y							1.5	L
HC1/2	Bedwell	Y				Y	Y	Y							1.5	L
HC1/3	The Glebe	Y				Y	Y	Y							1.5	L
HC1/4	The Hyde	Y				Y	Y	Y		Y					1.75	L
HC1/5	Marymead	Y				Y	Y	Y							1.5	L
HC1/6	Oaks Cross	Y				Y	Y	Y							1.5	L
HC1/7	The Oval	Y				Y	Y	Y							1.5	L
HC1/8	Roebuck	Y				Y	Y	Y		Y					1.75	L
HC1/9	Canterbury Way	Y				Y	Y	Y							1.5	L
HC1/10	Chells Manor	Y				Y	Y	Y							1.5	L
HC1/11	Filey Close	Y				Y	Y	Y							1.5	L

Site Ref.	Site Name	Flood Risk from Rivers (Flood Zones)				Updated Flood Map for Surface Water			Historic Records		Susceptibility to Groundwater Flooding		Flood Response Measures		Total	Overall Risk
		FZ 1	FZ 2	FZ 3a	FZ 3b	High	Medium	Low	Historic Flood Map	Flooding Database	Medium	High	FWA	FAA		
Weightage		0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5				
HC1/12	Hydean Way	Y						Y							0.5	L
HC1/13	Mobbsbury Way	Y				Y	Y	Y							1.5	L
HC1/14	Popple Way	Y						Y							0.5	L
HC1/15	Rockingham Way	Y						Y							0.5	L
HC3	The Health Campus	Y	Y	Y		Y	Y	Y						Y	2.5	M
HC5	New health, social and community facilities	Y					Y	Y				Y			1	L
HC9	Former Barnwell East secondary school	Y				Y	Y	Y							1.5	L

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