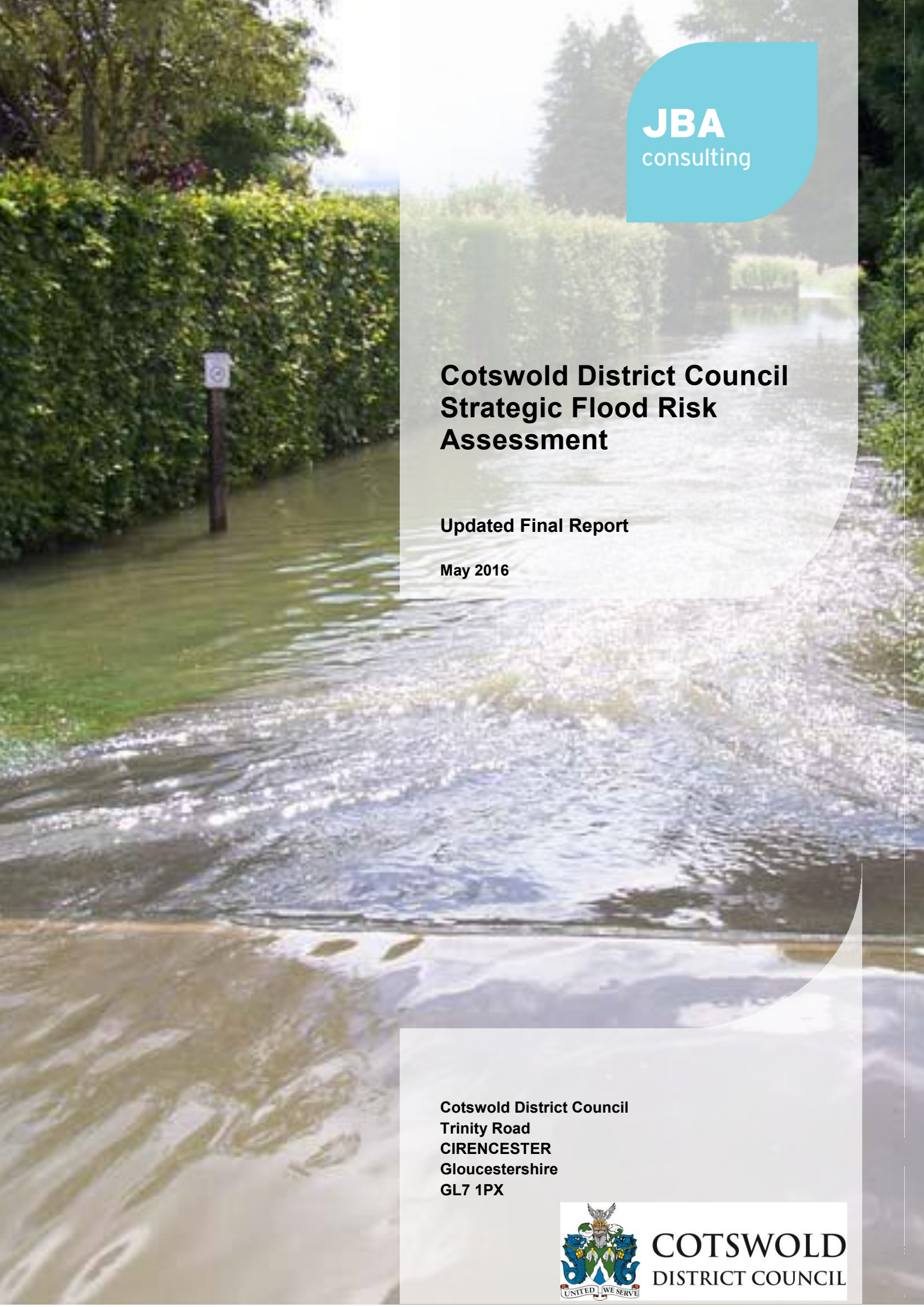

Cotswold District Council Strategic Flood Risk Assessment

Updated Final Report

May 2016

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1.0 October 2013	-	Joanne Corbett (CDC), Laurence King (CDC), Luke Newbey (EA)
Draft v2.0 May 2014	Amendments based on Environment Agency and CDC review. Updated with new modelling data, uFMfSW and NPPF Planning Practice Guidance.	Joanne Corbett (CDC), Laurence King (CDC), Luke Newbey (EA)
Final June 2014	Minor amendments based on Environment Agency and CDC review.	Joanne Corbett (CDC), Laurence King (CDC), Luke Newbey (EA)
Final July 2014	Minor amendments to Figure 2-2 based on CDC review and to Table 5-2 and 5-3.	Joanne Corbett (CDC), Laurence King (CDC), David Halkyard (CDC), Luke Newbey (EA)
Updated Final Draft v1.0 May 2016	Updates to include new Environment Agency model information for Bourton-on-the-Water and reference to new Government guidance on climate change allowances in section 6.3.5.	Joanne Corbett (CDC)
Updated Final v1.0 May 2016	Minor amendments following review by CDC	Joanne Corbett (CDC)

Contract

This report describes work commissioned by Cotswold District Council, in a letter dated 29 May 2013. The CDC representative for the contract was Joanne Corbett.

The May 2016 update was commissioned by Cotswold District Council, in an email dated 12 January 2016. The CDC representative for the contract was Joanne Corbett.

Purpose

This document has been prepared as a Strategic Flood Risk Assessment for Cotswold District Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

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

Acknowledgements

We would like to thank everyone who has assisted in the development of this SFRA, including: Joanne Corbett and Laurence King from Cotswold District Council, Sophie Robinson, Nicola Shorter, Lewis Purbrick, Ashley Maltman and Luke Newbey from the Environment Agency, Steve Dummer of Thames Water.

Front cover picture taken from the Environment Agency Report (2008) Fairford, Whelford, Kempsford & Lechlade Floods Review July 2007 - Photo 5. Fairford July 2007. Court Brook area, Snakes Lane.

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Executive Summary

Cotswold Strategic Flood Risk Assessment (SFRA) is a planning tool that will assist the councils in their selection and development of sustainable site allocations away from vulnerable flood risk areas in accordance with the National Planning Policy Framework and its associated Planning Practice Guidance on Flood Risk and Coastal Change. The purpose of this Level 2 SFRA is to provide detail on flood risk for 20 settlements (18 from the preferred development strategy of the Local plan plus 2 additional settlements), in order to carry out the sequential risk based approach on a site basis and provide an evidence base for the Exception Test. The SFRA has been completed to aid the preparation of the emerging Local Plan documents and exercises (e.g. Development Strategy Paper, Strategic Housing and Land Availability Assessment (SHLAA) and Strategic Employment and Land Availability Assessment (SELAA)). The assessment focuses on 92 potential housing sites and 34 potential economic development sites currently identified by the SHLAA and SELAA, but also contains mapping and guidance for assessing additional/windfall sites for development in the future.

Chapter 1 gives a background to the SFRA and Cotswold District, and Chapter 2 outlines the national legislation and planning framework, and national, regional and local planning flood risk guidance relevant to the SFRA.

Chapter 3 explains how we assess flood risk, and outlines the sources of national and local flood risk mapping data, information and evidence available for use in the SFRA. Advice on how they should be used and their limitations is noted.

Chapter 4 described flood risk from different sources in the District, including fluvial (flood risk from rivers), surface water, groundwater, sewers, reservoirs and other artificial sources. It also summarises the expected impact of climate change on flooding of all sources.

Chapter 5 is intended to summarise flood risk information for each of the sites in a way that can be easily utilised by CDC when carrying out their Sequential Test, highlighting those sites where constraints would exist on development as a result of flood risk. This information has also been supplied to CDC as an Excel spreadsheet to enable easy querying and sorting of the information.

Chapter 6 introduces guidance aimed at both planners and developers. The guidance should be read in conjunction with the NPPF and flood risk guidance from the Environment Agency. The guidance addresses requirements for development in each of the Flood Zones, dealing with surface water runoff and drainage, wastewater, making development safe, water quality and biodiversity, river restoration and enhancement as part of development, dealing with existing watercourses and assets, safeguarding land for future flood storage, and developer contributions to flood risk improvements.

It is important to remember that information on flood risk is being updated continuously. As CDC move forward with their Local Plan which includes site allocations, they must use the most up to date information in the Sequential Test, and developers should be aware of the latest information for use in Flood Risk Assessments.

The Flood and Water Management Act (2010), the Localism Act (2011) and the National Planning Policy Framework (2012) all offer opportunities for a more integrated approach to flood risk management and development. As they are in the relatively early stages of the site allocation process, the CDC have a real chance to make sure development provides improvements to flood risk overall and enhancements to the river environment.

Contents

List of Figures

List of Tables

Abbreviations and Definitions

Actual Risk		The risk posed to development situated within a defended area (i.e. behind defences), expressed in terms of the probability that the defence will be overtopped, and/or the probability that the defence will suffer a structural failure, and the consequence should a failure occur
Annual Event Probability	AEP	Expresses the probability of a flood event of a specific magnitude occurring in any one year. For example, the 1 in 100 year flood event is expressed as the 1% AEP; there is a 1% chance of it occurring within any given year.
Area Action Plan	AAP	Planning document to guide development in a specific area. Forms part of the Local Plan.
Area Benefiting from Defence	ABD	Those areas which benefit from formal flood defences in the event of flooding from rivers with a 1% chance in any given year or from the sea with a 0.5% chance in any given year. If the defences were not there, these areas would be flooded.
Areas Susceptible to Groundwater Flooding	AStGWF	National map produced by the Environment Agency showing areas susceptible to groundwater emergence.
Asset Information Management System	AIMS	Environment Agency's asset database
Brownfield		Brownfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has previously been developed'.
Combined sewer overflow	CSO	In combined sewerage systems, foul drainage and surface water are conveyed in the same piped system. During rainfall, when flows in the combined sewer are high, excess flow is diverted to watercourses or ground in order to reduce the risk of combined sewer flooding. CSOs can be a significant source of pollution to watercourses.
Core Strategy	CS	Term no longer used to describe a Development Plan Document setting out the long-term spatial vision, strategic objectives and policies relating to future development of an area. Where they remain, the Core Strategy forms part of the Local Plan.
Cotswold District Council	CDC	
Defended Area		An area offered a degree of protection against flooding through the presence of a flood defence structure
Development Plan Documents	DPDs	Documents that make up the Local Plan and form part of the statutory development plan for the areas. DPDs must include the Local Plan and adopted Policies Map. All DPDs are subject to public consultation and independent examination.
Flood Alleviation Scheme	FAS	Works designed to provide protection from flooding.
Flood and coastal erosion risk management Grant in Aid	FCRMGiA	Central government funding to flood risk management authorities to pay for a range of activities including schemes that help reduce the risk of flooding and coastal erosion.
Flood Estimation Handbook	FEH	Provides current methodologies for estimation of flood flows for the UK
Flood Map for Surface Water	FMfSW	National map produced by the Environment Agency showing flood risk from surface water at the 30 year and 200 year return periods.
Flood Risk Assessment	FRA	A detailed site-based investigation that is undertaken by the developer at planning application stage
Flood Risk Management		The introduction of mitigation measures (or options) to reduce the risk posed to property and life as a result of flooding. It is not just the application of physical flood defence measures
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 surface water flood risk in England.
Flood Storage Area	FSA	Area designed to store water in a flood and release it later when flood waters have subsided.
Flood Zone		Areas of land at risk from tidal or fluvial flooding as delineated by the Environment Agency. Flood Zone 1 - This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). Flood Zone 2 - This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year. Flood Zone 3 - This zone comprises land assessed as having a 1 in 100 or

		greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Floodplain		Any area of land over which water flows or is stored during a flood event or would flow but for the presence of defences
Fluvial Flooding		Flooding caused by high flows in rivers or streams exceeding the capacity of the normal river channel.
Formal Defence		A flood risk asset which is maintained by any party to fulfil a flood defence function in agreement with the Environment Agency.
Freeboard		A 'safety margin' to account for residual uncertainties in water level prediction and/or structural performance, expressed in mm
Functional Floodplain		An area of land where water has to flow or be stored in times of flood.
Greenfield		Greenfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has not previously been developed'.
Historic Flood Map	HFM	National map produced by the Environment Agency showing historical flood extents.
Informal Defence		An asset which was not designed for flood defence and is not maintained for this purpose, but forms some flood defence function.
ISIS		One-dimensional river modelling software developed by Halcrow. Capable of steady and unsteady state simulation.
Lead Local Flood Authority	LLFA	Body responsible for managing flood risk from localised sources across the County and for developing a strategy for local flood risk management that encompasses all sources of flooding (Gloucestershire County Council)
LIDAR		Light Detection and Ranging. An airborne laser mapping technique producing precise elevation data.
Local Development Framework	LDF	This term has been replaced by the term 'Local Plan'. It was used to describe a portfolio of Local Development Documents that provide a framework for delivering the spatial planning strategy for the area.
Local Plan	LP	The plan for the future development of the local area, drawn up by the local planning authority in consultation with the community. In law this is described as the development plan documents adopted under the Planning and Compulsory Purchase Act 2004. Current core strategies or other planning policies, which under the regulations would be considered to be development plan documents, form part of the Local Plan. The term includes old policies which have been saved under the 2004 Act.
Local Planning Authority	LPA	
Main River		All watercourses shown as such on the statutory main river maps held by the Environment Agency and the Department of Environment, Food and Rural Affairs, and can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel. The Environment Agency has permissive powers to carry out works of maintenance and improvement on these rivers.
Measure		A deliverable solution that will assist in the effective management (reduction) of risk to property and life as a result of flooding, e.g. flood storage, raised defence, effective development control and preparedness, and flood warning
Mitigation		The management (reduction) of flood risk
National Flood and Coastal Defence Database	NFCDD	A database, maintained by the Environment Agency, of fluvial and coastal assets. Flood defence assets are included, as are other assets with other functions such as footbridges on towpaths.
National Planning Policy Framework	NPPF	The NPPF sets out the Government's planning policies for England and how these are expected to be applied at a local level.
OfWAT		The Water Services Regulation Authority. The economic regulator of the Water Industry in England and Wales.
Ordinary Watercourses		All watercourses other than Main Rivers. The Lead Local Flood Authority is the designated body responsible for flood risk management.
Probability	1%	A measure of the chance that an event will occur. The probability of an event is typically defined as the relative frequency of occurrence of that event, out of all possible events. Probability can be expressed as a fraction, % or a decimal. For example, the probability of obtaining a six with a shake of a fair dice is 1/6, 16% or 0.166. Probability is often expressed with reference to a time period, for example, annual exceedance probability
Property Level Protection	PLP	Schemes that protect property from flooding at the property scale, for example installing flood barriers on doors, air brick covers etc.
Rapid Inundation Zone		An area immediately behind defences which, should they fail, will generate a combination of high velocities and flood depths that would cause a risk to life.

Residual Risk		The risk that inherently remains after implementation of a mitigation measure (option)
Return Period		The expected (mean) time (usually in years) between the exceedance of a particular extreme threshold. Return period is traditionally used to express the frequency of occurrence of an event, although it is often misunderstood as being a probability of occurrence.
Risk		The threat to property and life as a result of flooding, expressed as a function of probability (that an event will occur) and consequence (as a result of the event occurring)
Sewage Treatment Works	STW	
Sewer		A pipeline, usually underground, designed to carry foul sewage and/or surface water from buildings and paved areas associated with buildings in more than one curtilage (plot of land).
Site Specific Allocations	SSAs	Allocation of sites for specific or mixed-use development.
Standard of Protection	SoP	The return period to which properties are protected against flooding
Strategic Flood Risk Assessment	SFRA	The assessment of flood risk on a catchment-wide basis for proposed development in a District
Strategic Housing Land Availability Assessment	SHLAA	A technical planning document that helps to identify a supply of potentially suitable sites for housing
Strategic Employment Land Availability Assessment	SELAA	A technical planning document that helps to identify a supply of potentially suitable sites for employment
Supplementary Planning Documents	SPD	Supplementary Planning Documents or SPD support DPDs in that they may cover a range of issues, both thematic and site specific. Examples of SPD may be design guidance or development briefs. SPD may expand policy or provide further detail to policies in a DPD. They will not be subject to independent examination.
Surface Water Management Plan	SWMP	Projects to investigate local flooding issues such as flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall. Carried out through a partnership of all relevant stakeholders including local authorities, internal drainage boards, sewerage undertakers and the Environment Agency.
Sustainability Appraisal	SA	A Sustainability Appraisal is a systematic process to predict and assess the economic, environmental and social effects likely to arise from DPDs and SPDs, enabling each document to be tested and refined, ensuring that it contributes towards sustainable development.
Sustainable (Urban) Drainage System	SuDS	Current 'best practice' for new urban development that seeks to minimise the impact upon the localised drainage regime, e.g. through the use of pervious areas within a development to reduce the quantity of runoff from the site
Uncertainty		A reflection of the (lack of) accuracy or confidence that is considered attributable to a predicted water level or flood extent
updated Flood Maps for Surface Water	uFMfSW	In 2013, the Environment Agency produced the updated Flood Map for Surface Water (uFMfSW). The aim of the uFMfSW is to provide the best single source of information on surface water flooding for England and Wales that includes local information and knowledge. To meet the requirements of the Flood Risk Regulations, the uFMfSW assesses a flooding scenario as a result of rainfall with the following chance of occurring in any given year: 1 in 30 1 in 100 1 in 1000
Water Framework Directive	WFD	European Union directive designed to improve and integrate the way water bodies are managed throughout Europe

1 Introduction

1.1 Background

The existing SFRA for Cotswold District Council (CDC) was published in 2008 and is a "Level 1 SFRA". The Level 1 SFRA was prepared as a component of a wider assessment for the County of Gloucestershire. JBA was commissioned to review and amend the Level 1 SFRA and to increase the scope of the SFRA to provide further flood risk evidence to support the preparation of the Local Plan (Development Plan Document). This document replaces the Level 1 SFRA and includes, as per the Environment Agency's recommendation, further analysis of the data within the Level 1 assessment and has been supplemented where necessary with more detailed investigations.

The increased scope SFRA also includes updates with reference to the following key changes that have occurred since the Level 1 SFRA was completed (2008):

- Changes to legislation, both relating to flood risk and planning policy, including the Flood and Water Management Act (2010), the National Planning Policy Framework (NPPF) (2012), and the Localism Act (2011); and new powers and responsibilities bestowed on Gloucestershire County Council as the Lead Local Flood Authority under the Flood and Water Management Act (2010) and their dependencies therefore with the District Council's local development and forward planning role.
- Changes to technical guidance, for example the Consultation on SuDS Regulations and Standards (2011), National SuDS Guidance (Defra, pending), and recently updated NPPF Planning Practice Guidance (March 2014) replacing the PPS25 Technical Guidance.
- Progression of the District Local Plan, e.g. consultation on the second issues and options Paper (December 2010) and Preferred Development Strategy Consultation Paper (May 2013).
- Potentially improved knowledge of flood risk through modelling studies e.g. of the upper River Thames, River Churn defence assessments, the availability of the updated Flood Map for Surface Water; and flood events that have occurred since 2008.

The purpose of this SFRA is to provide detail on flood risk for 19 settlements, in order to carry out the sequential risk based approach on a site basis and provide an evidence base for the Exception Test. This SFRA has been completed to aid the preparation of the emerging Local Plan documents and exercises (e.g. Development Strategy Paper, Strategic Housing and Land Availability Assessment (SHLAA) and Strategic Employment and Land Availability Assessment (SELAA)).

1.2 Objectives

The SFRA is a planning tool that will assist the councils in their selection and development of sustainable site allocations away from vulnerable flood risk areas. The assessment focuses on the current potential housing and economic development sites as identified by the SHLAA and SELAA, but also contains mapping and guidance for assessing additional/windfall sites for development in the future. The SFRA will assist the council to make the spatial planning decisions required to inform the forthcoming Local Plan.

The National Planning Policy Framework (NPPF) reinforces the responsibility of Local Planning Authorities (LPAs) to ensure that flood risk is managed effectively and sustainably as an integral part of the planning process, balancing socio-economic needs, existing framework of landscape and infrastructure, and flood risk. To this end, the key objectives of the SFRA are:

- To investigate and identify the extent and severity of flood risk from all sources to the area at present and in the future.
- To present data on flood risk for potential new developments, as an evidence base for use in the Local Plan.
- To provide a planning tool with a straightforward ‘risk-based’ approach to development control within the LPAs, providing clarity to both planners and developers.
- To take an interactive approach with stakeholders to present technical data in a clear and useable manner.

1.3 Study area

The study area comprises the whole of the administrative area of Cotswold District Council. The study area is illustrated in Figure 1-1.

Cotswolds is a large rural district covering 450 square miles. The largest town is Cirencester and is home to 25% of the population of the District. The District is rural and sparsely populated, with numerous villages and hamlets. The landscape is exceptionally distinctive. The Cotswolds Area of Outstanding Natural Beauty (AONB) is a national designation which affords the highest level of landscape protection, and covers nearly three quarters of the District. In addition there are locally designated Special Landscape Areas and the Cotswold Water Park (internationally important for its nature conservation). Coupled with this natural beauty the District has an abundance of built heritage and archaeology, creating a unique 'Cotswold Character'. The District has a large number of listed buildings and a significant number of conservation areas. A number of parks are listed on the English Heritage list of historic parklands. The District also has 266 scheduled ancient monuments. The challenge for the Council is to ensure growth is managed in a sustainable way, whilst protecting the areas natural and built environment.

The existing adopted Local Plan (2006) applies a strategy of restraint with a presumption against new build open market housing beyond Cirencester and the nine most sustainable settlements in the District. The area has an aging and overall increasing population, and high property values. A suitable level of growth is needed to strengthen employment functions at key settlements and support the provision of workspace in rural locations. Due to the District's environmental and heritage constraints it can be difficult to find sites for future development; and adds pressure to CDC to provide viable locations for development.

1.3.1 Geology

The geology of the Cotswold District is complex and is dominated by limestones of the Jurassic age. The limestones within the Great Oolite Group and Inferior Oolite Group cover the majority of the District towards the north-western and central extents and have a significant influence on the topography, drainage and soils of the Cotswolds. Geology information can be viewed on the British Geological Society website (http://mapapps2.bgs.ac.uk/geoindex/home.html).

Much of the upland areas of the Cotswolds comprises of the Great Oolite Group and demonstrates a greater variety in formations than the Inferior Oolite Group. An area of Lias Group mudstones dominates to the north east. Towards the south and east of the District in the Upper Thames Valley, the Jurassic limestones of the Great Oolite Group are succeeded by a succession of mudstones including the Oxford clay. These form the broad valleys around the main rivers and streams which flow eastwards.

Sand and gravel drift deposits are mainly associated with the tributaries of the River Thames including the Rivers Churn, Coln, Leach, Windrush and Evenlode and within the Cotswold Water Park towards the south. Here, superficial deposits are thick and extensive. Further drift deposits can be found towards the north east of the District, overlying the Lias Group mudstones.

Away from the escarpment the drainage is almost entirely south eastwards via the tributaries of the Thames; namely the Rivers Churn, Coln, Leach, Windrush and Evenlode. Where they join the Thames, superficial deposits are thick and extensive. The valleys of the Churn, Coln, Leach and their tributaries tend to be narrow and meandering because they are incised into the limestones of the Inferior Oolite and Great Oolite. They contain narrow tracts of superficial deposits. In contrast, the Windrush and the Evenlode lie in broader shallow valleys cut into soft Lias mudstones, and may be flanked by more substantial expanses of terrace deposits and alluvium. In addition, in the case of the Evenlode, which drains the Vale of Moreton, there are broad tracts of till and associated sand and gravel deposits left behind by an ice sheet during the last Ice Age.

There are aquifers within the District (Great Oolite) that are confined by overlying geology (Oxford Clay). Groundwater levels within these confined aquifers may be artesian (above ground level) however the groundwater is prevented from reaching the surface by the overlying impermeable geology.

1.3.2 Topography

The topography of the District is influenced by the interbedded nature of the limestones and clays of the Inferior and Great Oolite Group. Towards the western extent of the District the

landscape is characterised by a steep scarp face with incised valleys marking the edge of the Cotswold Hills. Here, elevations are in excess of 300m AOD with the Inferior Oolite rocks forming the main upland area. To the east and south west of the escarpment, the topography of the District becomes rather more undulating, reflecting the regional dip of the Inferior and Great Oolite beds. Towards the south and south eastern extents of the District, valleys of those such as the Evenlode, Windrush and Coln are typically much broader and shallower cut into the underlying softer Lias mudstones. Here, elevations ranging from approximately 165m AOD in the headwaters to 82m AOD as the watercourses approach the flatter, wider floodplains of the River Thames.

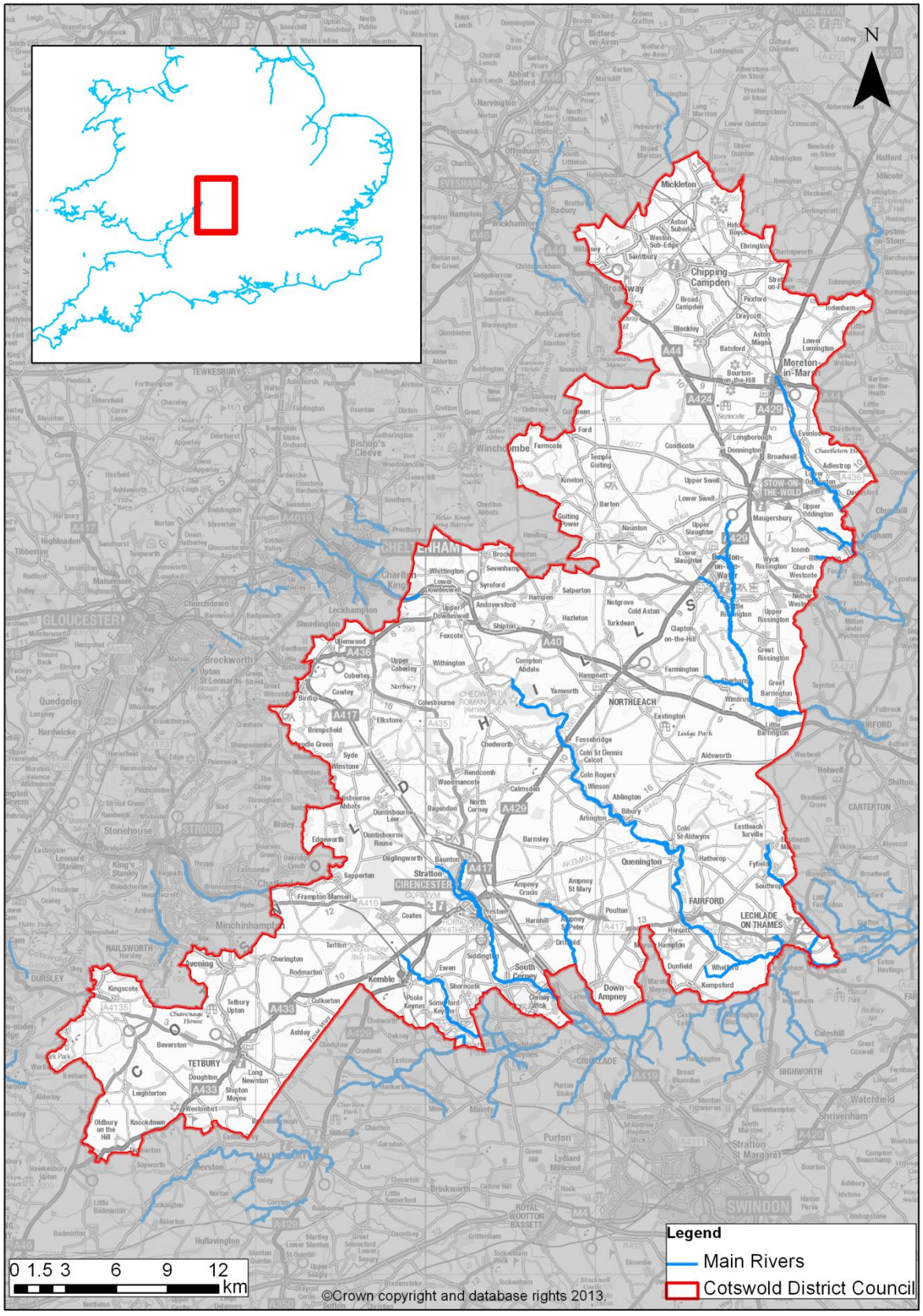


Figure 1-1: Study Area

2 The planning framework and flood risk policy

2.1 Introduction

The overarching aim of planning policy on development and flood risk is to ensure that flood risk is taken into account at all stages of the planning process. The purpose of this section of the report is to highlight the main changes to the planning framework and flood risk responsibilities since the previous SFRA was published in 2009.

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

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of catchment flood management plans (CFMPs), shoreline management plans (SMPs), and surface water management plans (SWMPs) and water cycle strategies.

2.2 National legislation

2.2.1 Flood Risk Regulations (2009) and Flood and Water Management Act (2010) Background

The Flood Risk Regulations transpose the EC Floods Directive into UK law and place responsibility upon all Lead Local Flood Authorities (LLFAs) to manage local flood risk. The Flood and Water Management Act (FWMA) received Royal Assent in April 2010. The FWMA aims to create a simpler and more effective means of managing the risk of flood and coastal erosion and implements Sir Michael Pitt's recommendations following his review of the 2007 floods.

Figure 2-1 sets out the requirements and timescales for implementing the requirements of the Directive.

Figure 2-1: Flood Risk Regulation Requirements

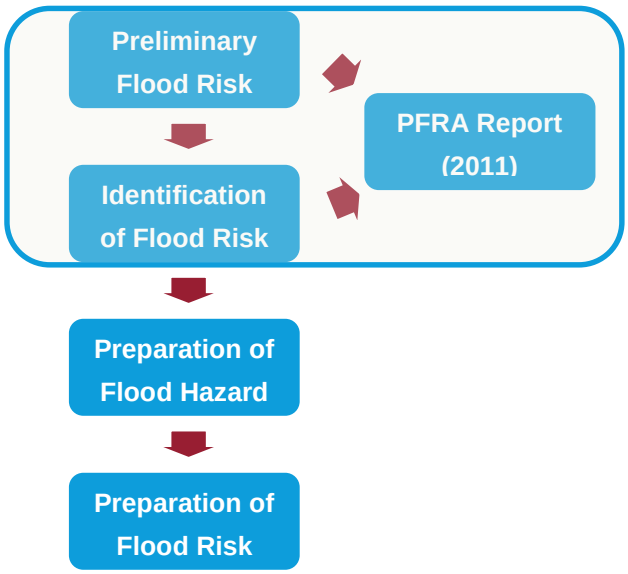
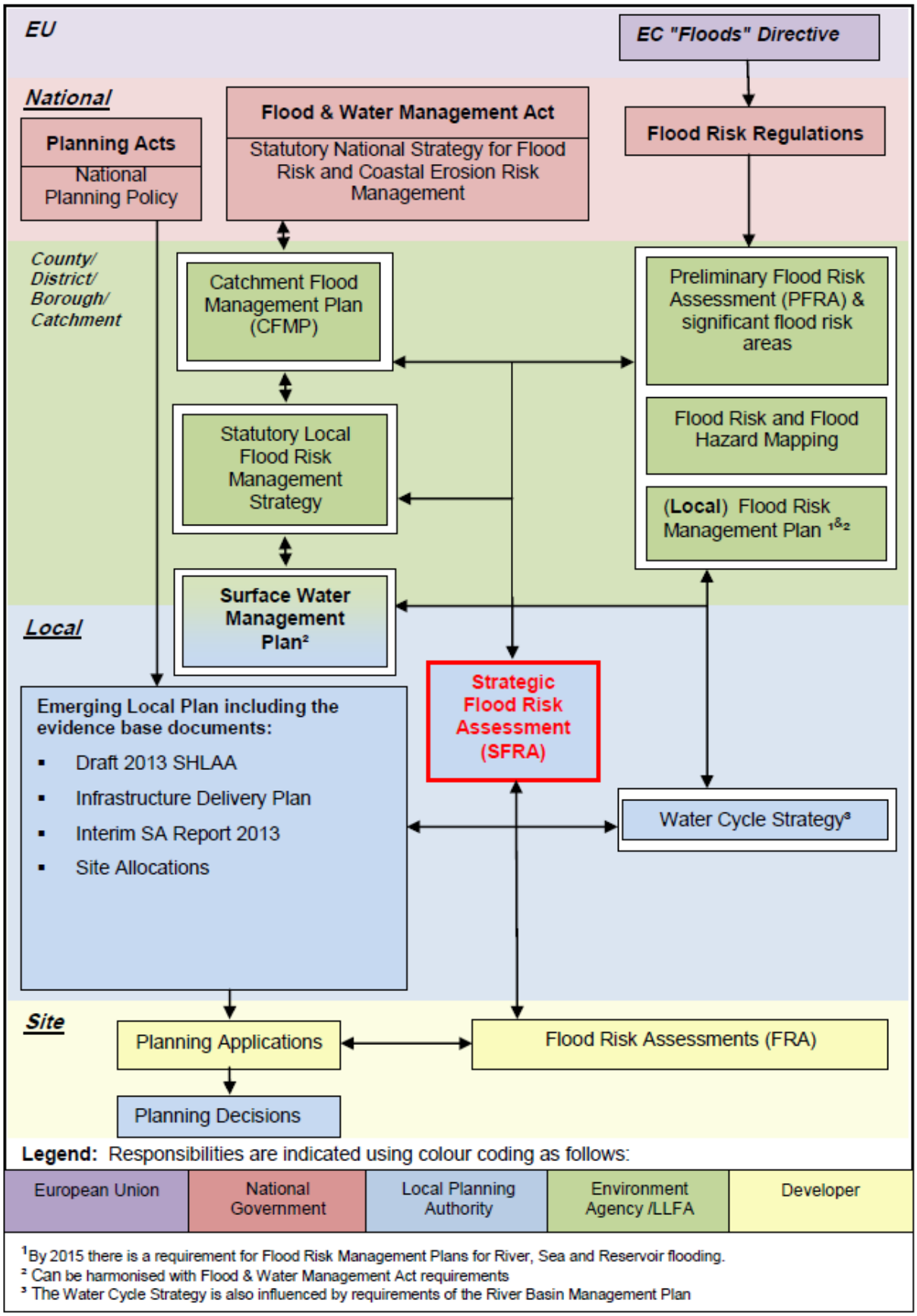


Figure 2-2: Strategic planning links and key documents for flood risk



The FWMA also calls for the establishment of a SuDS Approving Body (SAB) to be set up in county, county borough or unitary local authorities. The SAB will be responsible for approving, adopting and maintaining drainage plans and SuDS schemes that meet new national standards

for design, construction, operation and maintenance. SAB approval of drainage systems for new and redeveloped sites will be required before construction can commence. A clear timetable for implementation of the new responsibilities for SABs and national standards is still pending. The responsibilities of the SAB are likely to rest with the LLFA (in this case, Gloucestershire County Council), although there is flexibility in the FWMA if it considered more effective for another body to take on the role.

The new and emerging responsibilities in Gloucestershire under the Flood and Water Management Act and the Flood Risk Regulations are summarised in Table 2-1.

Table 2-1: Roles and Responsibilities in Cotswolds

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	National Flood Risk Management Strategy (with Defra), Reporting and supervision (overview role), Strategic Engagement with other Risk Management Authorities, national scale flood risk mapping	Permissive powers to carry out maintenance and flood defence works on main rivers Work in partnership with other risk management authorities Consenting authority for works on or near main rivers Statutory consultee on planning proposals in areas at risk of flooding from main river Operates flood warning service for areas at risk of flooding from main river Produces and delivers a risk based programme of detailed flood modelling Reservoir regulator.
Lead Local Flood Authority (Gloucestershire County Council)	Input to national strategy. Formulate and implement local flood risk management strategy.	Surface water, groundwater, other sources of flooding Prepare and publish a PFRA Identify Flood Risk Areas Prepare Flood Hazard and Flood Risk Maps Prepare Flood Risk Management Plans SuDS Approval Body (future)
District Borough and City CDC	Input to National and Local Authority Plans and Strategy (e.g. Local Plan documents) Cotswolds District Council Local Plan	Ordinary watercourse Delegated powers from LLFA for flood investigation, consents and enforcement.

2.2.2 Localism Act

The purpose of this Act, which was given Royal Assent on 15 November 2011, is to shift power from central government back to the councils, communities and individuals. This Act allows councils to establish their own development plans to take account of local employment, housing and other land used in the plan making process.

In order for councils to achieve sustainable development practices, Provision 110 of the Act[1] was introduced to encourage cooperation during the planning process. This duty to cooperate requires Local Authorities to "engage constructively, actively and on an ongoing basis in any process by means of which development plan documents are prepared so far as relating to a strategic matter".

There are Neighbourhood Plans proposed within the District (see Section 0).

2.2.3 National Planning Policy Framework (NPPF)

The NPPF[2] was introduced in 2012 with its stated aim to simplify the planning system and to make it more accessible. It superseded Planning Policy Statement 25: Development and Flood Risk (PPS25). The NPPF also promotes the need for sustainable growth and protection of the environment and provides guidance to help local planning authorities prepare local plans. These local plans require strategic flood risk assessments that will help to develop policies on flood risk management with advice from the Environment Agency and other relevant bodies such as the LLFAs.

[1] Localism Act (2011) Section 110: Duty to cooperate in relation to planning of sustainable development. http://www.legislation.gov.uk/ukpga/2011/20/section/110

[2] Department of Communities and Local Government (2012) National Planning Policy Framework https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

The Planning Practice Guidance for Flood Risk and Coastal Change[3], a living web-based document first published in April 2014, works alongside the NPPF and sets out how the policy should be implemented in terms of flood risk.

The NPPF states that "inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. For these purposes:

- “areas at risk of flooding” means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency;
- “flood risk” means risk from all sources of flooding - including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources."

The Sequential Test and Exception Test have been carried forward from PPS25. Details of the test are described in NPPF and the accompanying NPPF Planning Practice Guidance. This test must be performed when considering the placement of future development and for planning application proposals. The NPPF Planning Practice Guidance gives a process for how to perform the tests as part of the preparation of the Local Plan (Diagram 1-3). These instructions on how to perform the test should be used with the following information from the SFRA:

- Identify the geographical area to be assessed, including a justification;
- Assess the sites chosen (including alternatives) on the Flood Zone maps that are provided with this assessment;
- Establish the risk of flooding from other sources using the maps in this SFRA; and
- Follow the instructions given in the NPPF Planning Practice Guide.

The Environment Agency has published a technical note[4] which also provides guidance on how to apply the Sequential Test as per the NPPF and in relation to the allocation of land, individual planning applications, windfall sites, renewable energy projects, redevelopment of an existing single property and change of use.

The Sequential Test is used to direct all new development (through the site allocation process) to locations at the least risk of flooding, giving highest priority to Flood Zone 1. An increased scope SFRA provides further flood risk evidence which the CDC can use to assess whether it is necessary to revisit/update the Sequential Test.

2.2.4 Association of British Insurers (ABI): Guidelines on Planning and Insurance in Flood Risk Areas for Local Authorities in England[5]

The National Flood Forum and the ABI have published guidance which aims to help local authorities in England when producing local plans and helps them deal with the planning application process in flood risk areas. The main guidelines are:

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

2.2.5 Water Framework Directive

The Water Framework Directive (WFD) is designed to improve and integrate the way water bodies are managed throughout Europe. In the UK, much of the implementation work will be undertaken by competent authorities. It came into force on 22 December 2000, and was put into UK law (transposed) in 2003.

[3] Department of Communities and Local Government (2014) Planning Practice Guidance for Flood Risk and Coastal Change http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

[4] Environment Agency (2012) Demonstrating the flood risk Sequential Test for Planning Applications version 3.1 http://www.environment-agency.gov.uk/static/documents/Business/SequentialTestProcess_v3.1.pdf

[5] Association of British Insurers and National Flood Forum (April 2012) Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England

Under this Directive, many of the parties listed in Table 2-1 have a specific statutory duty to protect and address water quality issues within the area, and this will be considered as part of flood risk management or development proposals. For example, removing culverts, creating riparian zones or creating open space for water.

2.3 County, District and catchment level policy

2.3.1 Gloucestershire First Edition Surface Water Management Plan[6]

In October 2008, Defra launched a call for expressions of interest for local authorities to undertake a first edition SWMP (FESWMP), with the aim of testing the emerging SWMP guidance. Gloucestershire County Council (GCC) was successful in its bid to undertake a FESWMP. The 2007 flood events identified areas of flood risk within Gloucestershire. The aims of the SWMP were to

- To test the national SWMP guidance and report back to Defra;
- To improve understanding of the extent and likelihood of surface water flooding across the whole county by undertaking an SWMP scoping study;

The SWMP identified within CDC that surface water was an issue. The worst affected areas included Moreton-in-Marsh, Fairford and Whelford. The exact source of flooding was not necessarily clear, but the perceived sources listed include overwhelmed sewers, road gullies or blocked drains combined with fluvial sources.

Sewer flooding within Cotswold District was identified within the SWMP as an issue in nine areas where properties were flooded internally. These included Fairford, South Cerney, Ampney St Mary, Upper and Lower Slaughter, Moreton-in-Marsh, Bourton-on-the-Water and Quenington. Records also describe that areas were affected externally by overloaded sewers resulting in flooding to gardens and open spaces. In addition, the cause of flooding was perceived to be from fluvial flooding affecting the sewer system where high levels in receiving watercourses impedes the free discharge from sewers.

The FESWMP produced surface water mapping which was then used in the Preliminary Flood Risk Assessment (PFRA).

2.3.2 Gloucestershire Preliminary Flood Risk Assessment (PFRA)

The regulations required Gloucestershire County Council (as the LLFA) to prepare and publish a PFRA on past and future flood risk from local sources of flooding. The Regulations also require the LLFA to identify significant Flood Risk Areas. The PFRA reports on significant past and future flooding from all sources except Main River and Reservoir (covered by Environment Agency).

Key outputs of the Gloucestershire PFRA include[7]:

- The PFRA was a broad-scale assessment of flood risk from local sources (surface runoff, groundwater and ordinary watercourses) across the county. Existing available data was gathered from a variety of sources. Incidents of past flooding from local sources were investigated.
- Surface water modelling undertaken to inform a First Edition Surface Water Management Plan for Gloucestershire (this was also used as the locally agreed surface water information for the PFRA).
- The analysis of available data predicting future flood risk suggests that the level of risk in Gloucestershire is not significant enough to propose a new indicative Flood Risk Area at a European scale. However, the evidence collected demonstrates that there are local flooding issues that must be addressed in the Local Flood Risk Management Strategy.

[6] Gloucestershire First Edition Surface Water Management Plan Pilot A partnership study initiated by the Department for the Environment, Food and Rural Affairs to test the national SWMP Guidance, Final Pilot Report, March 2010

[7] Gloucestershire County Council (November 2011) Preliminary Flood Risk Assessment http://www.gloucestershire.gov.uk/extra/article/109983/Preliminary-Flood-Risk-Assessment

2.3.3 Gloucestershire County Council Local Flood Risk Management (FRM) Strategy[8]

In fulfilling the role of LLFA, Gloucestershire County Council (GCC) has new roles and responsibilities, duties and powers to enable it to manage flood risk from localised sources across the County and a duty to develop, maintain, apply and monitor a strategy for local flood risk management that encompasses all sources of flooding.

In general terms the Flood and Water Management Act (2010) requires Risk Management Authorities to act consistently with the Local FRM Strategy when undertaking flood risk management functions, except for water companies who will need to have regard to it.

The Strategy includes the following:

- Information on local flood risk in Gloucestershire, highlighting where problems have already occurred, or where areas are most vulnerable to local flooding
- Clarification of which authority is responsible for what in relation to the prevention and management of flooding
- Detail on the measures that will be undertaken to manage flood risk
- Clarification on how work is prioritised
- Measures that communities can undertake to improve flood resilience, as it is not possible to stop all flooding

Seven of the 21 parishes/ wards highlighted as vulnerable to local flooding are within Cotswold District Council, these include:

- Chipping Campden
- Cirencester
- Fairford
- Lechlade
- Moreton in Marsh
- Northleach with Eastington
- Weston Subedge

Specific measures have been identified within the LFRMS relating to further defence, resilience and alleviation measures in specific settlement areas. Appendix A discusses where these measures relate to one of the 19 settlements referred to in this SFRA.

[8]Gloucestershire County Council Local Flood Risk Management Strategy available at http://www.gloucestershire.gov.uk/CHttpHandler.ashx?id=56193&p=0

2.3.4 Catchment Flood Management Plans (CFMPs)

A CFMP is 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.

Cotswold District Council is covered by four CFMPs: The Thames CFMP covers the majority of the District; the Severn CFMP covers the northern tip of the District, the Bristol Avon CFMP covers the southern tip of the District and a small section of the south western border is covered by the Severn Tidal Tributaries CFMP, see Figure 2-3.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Policy Units'. These policies are intended to cover the full range of long term flood risk management options in the catchment that can be applied to different locations. Within any CFMP six standard flood risk management policies have been applied:

- Policy 1 – Areas of little or no flood risk where we will continue to monitor and advise.
- Policy 2 – Areas of low to moderate risk where we can generally reduce existing flood risk management actions.
- Policy 3 – Areas of low to moderate risk where we are generally managing existing flood risk effecively.
- Policy 4 – Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.
- Policy 5 – Areas of moderate to high risk where we can generally take further action to reduce flood risk.
- Policy 6 – Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

Severn CFMP

The policy unit selected within CDC for the Severn catchment is Policy 3 - continue with existing or alternative actions to manage flood risk at the current level. This may mean for the catchment that the level of flood preparedness (flood warning, flood proofing and flood resilience) should be increased and promoted in this area, and promotion of Environmental Stewardship Schemes will have the beneficial effects of decreasing run-off. Close communication between the Environment Agency Development Control and Local Planning Authority is required to ensure that development does not occur in areas of flood risk. The application of the Sequential Test to new development is therefore vital.

Thames, Severn Tidal Tributaries and Bristol Avon CFMPs

The policy unit selected for each of these CFMPs is Policy 6 – take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.CDC should seek to protect the natural floodplain from inappropriate development. In addition, it should promote resistance and resilience of existing development at risk of flooding, as for many of the settlements within CDC flood defence works may not prove feasible.

Figure 2-3 Catchment Management Flood Plans (CFMP)[9]

2.3.5 Cotswold District Council Local Plan

The District Council is producing a new Local Plan to replace the Cotswold District Local Plan, adopted in 2006. Once the new Local Plan is adopted, this will provide a framework for future development across Cotswold District. Up-to-date information on planning in Cotswold District and the Local Plan can be found at http://www.cotswold.gov.uk/residents/planning-building/planning-policy/.

The Local Plan together with any Development Planning Documents (DPDs), and any neighbourhood plans prepared by the community will make up the 'development plan' for the District. All planning applications will be determined in accordance with the development plan, taken as a whole, unless material considerations indicate otherwise. The following policies and references relate to the management of flood risk within the District.

Key issues to be addressed

Climate change and flood risk have been highlighted as key issues to be addressed within the district. This is carried through in 'The Vision' for Cotswold District and where Cotswold District aims to create an environment that adapts to climate change and avoids flood risk by:

- Enabling development in the most sustainable locations that incorporates sustainable transport options, have good accessibility to work, services and facilities, and are not liable to flooding
- Designing new developments to ensure that they are capable of meeting the impacts of climate change.[10]

[9] Figure taken from the Level 1 SFRA Volume 1 Cotswold District Council (Sept 2008) - Figure 6.1

[10] Cotswold District Council (May 2013) Local Plan Consultation Paper Preferred Development Strategy available at http://www.cotswold.gov.uk/residents/planning-building/planning-policy/

Table 2-2 lists the settlements considered within the Local Plan: Preferred Development Strategy Consultation Paper (May 2013).

Table 2-2: Settlements proposed within the Local Plan

Andoversford	Moreton-in-Marsh
Blockley	Naunton ***
Bourton-on-the-Water	Northleach
Chipping Campden	Siddington*
Cirencester *	South Cerney
Down Ampney**	Stow-on-the-Wold
Fairford	Tetbury
Kemble	Upper Rissington
Lechlade	Weston Subedge** *
Mickleton	Willersey
* Cirencester and Siddington have been grouped together in the SFRA due to their proximity.	
**Down Ampney - Included in the SFRA but not the Preferred Development Strategy (May 2013). Substantial development opportunities have since been put forward for review in the draft SHLAA; and combined with Down Ampney's potential as a sustainable location, as noted in the 2nd Issues and Options Paper (2010) and Evidence Paper it was considered pragmatic and appropriate to include this settlement in the SFRA	
** *Weston Subedge and Naunton - Locations requested for inclusion in the SFRA by the Principal Engineer for West Oxfordshire and Cotswold District Councils.	

A review of the draft SHLAA/SELAA, incorporating a 'call for sites,' in the summer 2013, provided the initial 'draft' of potential sites for development, in line with identified settlements. These sites were further assessed through the SHLAA / SELAA process and community engagement in 2014, and are contained within this SFRA.

2.4 Local level

2.4.1 Localism Act [11]

The Localism Act gives communities new powers to plan the future of their areas through neighbourhood planning. A neighbourhood plan can establish general planning policies for the development and use of land in a neighbourhood. Once completed, a neighbourhood plan will become part of the development plan, which the council uses to decide planning applications in the local area.

Neighbourhood Plans[12]

Neighbourhood plans and development orders must meet certain important legal and policy requirements before they can come into force. For example, they must be in general conformity with the strategic policies of the local plan, have regard to national policy and be compatible with EU law and other legislative requirements. Neighbourhood plans and orders should not promote less development than set out in the local plan or undermine its strategic policies.

The following list describes the neighbourhood plans for the Cotswold and their status at the time of producing the SFRA:

- Stow-on-the-Wold - In July 2012, Stow-on-the-Wold Town Council approached CDC to have their Parish designated as a 'Neighbourhood Area'. Following the statutory consultation period, CDC designated this area on 6th September.
- Tetbury Town Council, with the support of Tetbury Upton Parish Council, has submitted proposals to designate a Neighbourhood Area. The consultation period has now closed.
- Lechlade on Thames - In August 2013, Lechlade-on-Thames Town Council approached CDC to have their parish areas designated as a Neighbourhood Area, the first formal step in developing a Neighbourhood plan. Following the statutory consultation period, CDC designated this area on 7th October 2013.
- Fairford - Fairford Town Council has submitted proposals to designate a Neighbourhood Area. The proposed area includes all of Fairford and two parcels of land currently in

[11] http://www.local.gov.uk/web/guest/local-flood-risk-management/-/journal_content/56/10180/3572110/ARTICLE#flood management

[12] Cotswold District Council Neighbourhood plans

Kempsford, but due to transfer to Fairford in 2015, following the Community Governance Review.

Up-to-date information on Neighbourhood Plans in the district can be found at http://www.cotswold.gov.uk/residents/communities/neighbourhood-planning/neighbourhood-plans-in-force-or-development/.

3 Mapping and the risk based approach

3.1 How flood risk is assessed

3.1.1 Definitions

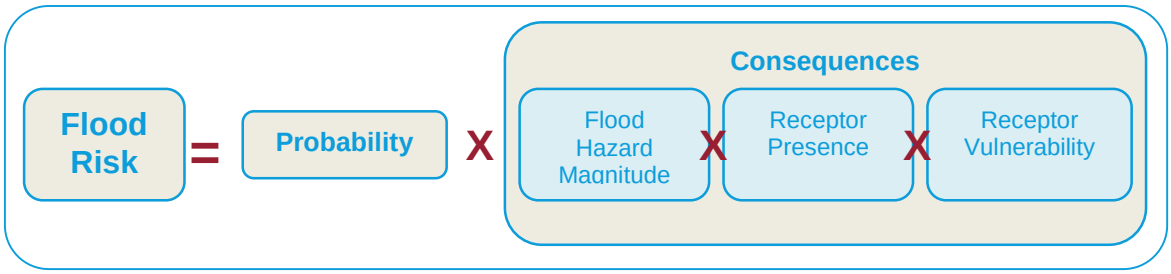
A flood is formally defined in the Flood and Water Management Act[13] as

"including cases where land not normally covered by water becomes covered by water and can be the result of water emanating from a number of sources".

Flood risk can be described as the combination of the statistical probability of a flood occurring and the scale of its potential consequences, whether inland or on the coast, and includes consideration of development located outside of the river and tidal flood risk areas. Thus it is possible to define flood risk as:

Flood risk = (probability of a flood) x (scale of the consequences)

On that basis it is useful to express the definition as follows:



The **probability** of flooding can be expressed as a return period in years (the average time between years with at least one larger flood), or as an annual exceedance probability (%) (the probability that a certain magnitude of flood will be exceeded in any one year).

Increasing the probability or chance of a flood being experienced increases the flood risk. In situations where the probability of a flood being experienced increases gradually over time, for example due to the effects of climate change, then the magnitude of the flood risk will increase.

The severity of the consequences can increase the flood risk:

- **Flood hazard magnitude:** If the direct hazard posed by the depth of flooding, velocity of flow, the speed of onset, rate of rise in flood water or duration of inundation is increased (for example due to the effects of climate change), then the consequences of flooding, and therefore risk, is increased. New development can potentially increase the hazard if it causes an increase in surface runoff flows.
- **Receptor presence:** The consequences of a flood will be increased if there are more receptors affected. Additionally, if there is new development that increases the probability of flooding or increased density of infrastructure then consequences will also be increased.
- **Receptor vulnerability:** If the vulnerability of the people, property or infrastructure is increased then the consequences are increased. For example, old people or children are more vulnerable if they are caught up in a flood event.

3.1.2 Using SFRA risk information

The SFRA contains information that should be used for planning in advance of flooding. It also provides information on the effects of flood events (due to failure or overtopping of defences). The SFRA flood risk data should be updated following flood events.

The NPPF sets out a sequential approach to steer new development to areas with the lowest probability of flooding. This is initially based on the Flood Map for Planning (Rivers and Sea)

[13] Flood and Water Management Act (2010) http://www.legislation.gov.uk/ukpga/2010/29/contents

(see Section 3.2) but should be refined by the SFRA to take into account the probability of flooding, other sources of flooding and the impact of climate change.

A number of national mapping products were provided by the Environment Agency through their DataShare website, including:

- Flood Map for Planning (Rivers and Sea)
- Flood Map for Surface Water (1 in 30 year, 1 in 200 year)
- Updated Flood Map for Surface Water (1 in 30 year, 1 in 100 year, 1 in 1000 year)
- Areas Susceptible to Surface Water Flooding
- Areas Susceptible to Ground Water Flooding
- Historic Flood Map
- Detailed River Network v3
- Defences
- Areas Benefiting from Defences
- Flood Storage Areas

The data was downloaded in February and March 2013.

This national data is supplemented by various sources of more detailed local data, as described through the following sections.

The following sections describe the evidence base provided by available national flood risk mapping and other locally available flood risk information, to support the application of the Sequential approach using the SFRA.

3.2 NPPF Fluvial Flood Zones

3.2.1 Flood Map for Planning (Rivers and Sea) (Flood Zone 2 and 3a)

The Flood Map for Planning (Rivers and Sea), as provided by the Environment Agency, is made up of a suite of GIS layers, including Flood Zone 2 and 3a, Defences, Areas Benefiting from Defences and Flood Storage Areas.

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

For planning purposes under the NPPF, a more detailed breakdown of risk within the Flood Zones is required, and the SFRA is required to define Flood Zone 3b (also known as Functional Floodplain) and Flood Zone 3a with climate change, as described in the following sections.

3.2.2 Functional floodplain (Flood Zone 3b)

The 'functional floodplain' is defined as an area of land where water has to flow or be stored in times of flood. This forms Flood Zone 3b in terms of the NPPF. Following discussion between CDC and Environment Agency, the following definition of the functional floodplain was agreed:

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

The extent is shown in the Map 1.

3.2.3 Climate change (Flood Zone 3a plus climate change)

The Flood Map supplied by the Environment Agency does not provide any indication of the impact of climate change on the Flood Zones.

As advised in the NPPF, It was agreed between CDC and Environment Agency that the SFRA should:

- Use the 1 in 100 year plus 20% climate change modelled flood extent wherever suitable hydraulic models are available[14].
- Elsewhere, take a precautionary approach and assume that the current Flood Zone 2 outline (1 in 1000 year flood extent) represents a future Flood Zone 3a taking into account climate change.

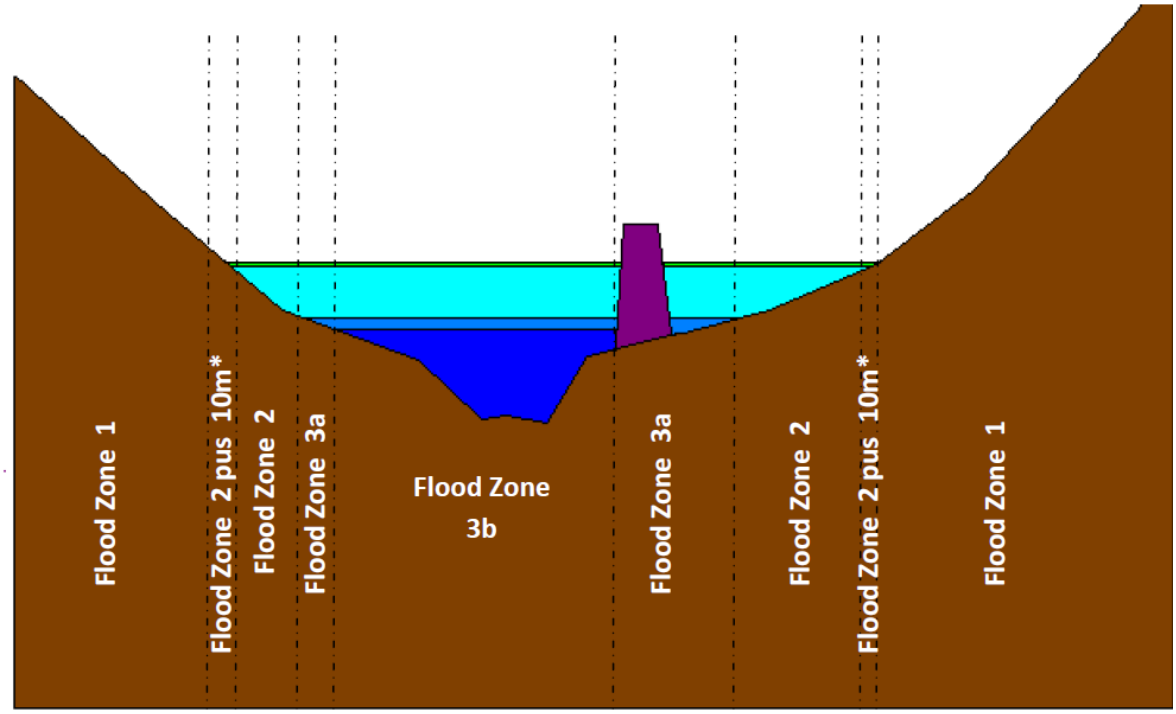
The combined extent, Flood Zone 3a plus climate change, is shown in Map 1. There is no direct guidance for this Zone under the NPPF however it suggests that the impact of climate change must be taken into account when considering location and potential future flood risks to developments and land uses.

There are no available modelled outlines for Flood Zone 2 with climate change and consideration of this is not a requirement of NPPF. However, as a broad-brush indicator of areas that might be at risk, CDC has requested that a 10m buffer be added onto Flood Zone 2.

3.2.4 Appropriate development in the Flood Zones

A concept diagram showing the classification of NPPF Flood Zones graphically is included in Figure 3-1 below. Table 3-1 includes a description and discussion of appropriate development. A fuller discussion of Flood Zones and their relation to planning policy can be found in the NPPF and the technical guidance.

Figure 3-1: Definition of Flood Zones



* Flood Zone 2 plus 10m is shown for information only

[14] Contact with the Environment Agency should be made at the earliest opportunity to ascertain the availability of the most up to date models.

Table 3-1: Flood Zone descriptions

	Probability	Description	Suitable Development under NPPF
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).	All uses of land
Zone 2 plus 10m buffer		Information only - CDC requested that The previous SFRA recommended that an additional 10m buffer should be placed around Flood Zone 2 to provide an indication of climate change impact.	Not applicable
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.1% – 0.5%) in any year.	Water compatible, less vulnerable and more vulnerable uses of land and essential infrastructure are appropriate. The highly vulnerable uses are only appropriate if the Exception Test is passed.
Zone 3a plus climate change		The likely extent of Flood Zone 3a in the future taking into account the effects of climate change.	Not applicable
Zone 3a	High	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1.0%) or a 1 in 200 or greater annual proability of flooding from the sea (>0.5%) in any year.	Water compatible and less vulnerable uses of land are appropriate. More vulnerable and essential infrastructure should only be permitted if the Exception test is passed. Highly vulnerable uses should not be permitted.
Zone 3b	Function Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes.	Water compatible uses of land are appropriate. Essential infrastructure should only be permitted if the Exception Test is passed. If the Exception Test is passed essential infrastructure should be designed and constructed to meet a number of flood risk related targets. Less vulnerable, more vulnerable and highly vulnerable uses should not be permitted

New development should, whenever possible, be placed in Flood Zone 1. The Flood Zones are indicative of the potential undefended floodplain. Allocating sites in Flood Zone 1 means that future development is not reliant on fluvial or coastal flood defences. This negates the requirement of committing future generations to costly long term expenditure, which becomes unsustainable in light of the effects of climate change.

However, developers should be aware that the runoff from development on Flood Zone 1 land can potentially cause an increase in the probability of flooding. Information in the SFRA should be used to address this issue.

The most up to date version of the Flood Map for Planning (Rivers and Sea) should always be used, and can be viewed on the Environment Agency's website[15]

If it has not been possible for all future development to be situated in Flood Zone 1, or away from areas at flood risk from other sources, then a more detailed assessment is needed to understand the implications of locating proposed development in Flood Zones 2 or 3. It may be necessary to apply the Exception Test (see Table 3-1), in which case the scope of the SFRA must be expanded to take into account the 'actual' and 'residual' risk considering the presence

[15] Flood Map for Planning (Rivers and Sea) http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=floodmap&utm_source=Poster&utm_medium=FloodRisk&utm_campaign=FloodMonth13.

of flood risk management infrastructure and its effect on the frequency, impact, speed of onset, depth and velocity of flooding.

3.2.5 Updating the Flood Zone mapping

Into the future, the Environment Agency's Flood Zone 3a and 2 are updated quarterly with any new detailed hydraulic modelling information, and planners and developers should always refer to the most up to date issue.

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

3.3 Surface water mapping

The updated Flood Map for Surface Water (uFMfSW) is a national level broad-scale map indicating areas that are likely to be at risk from surface water flooding. It is not suitable for identifying individual properties at risk. According to the accompanying information, the type of flooding shown by the uFMfSW fits with the definition in the Flood and Water Management Act (2010) and shows:

The flooding that takes place from the 'surface runoff' generated by rainwater (including snow and other precipitation) which:

(a) is on the surface of the ground (whether or not it is moving), and

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

The uFMfSW will pick out natural drainage channels, rivers, low areas in floodplains, and flow paths between buildings, but it will only indicate flooding caused by local rainfall. It does not show flooding that occurs from overflowing watercourses, drainage systems or public sewers caused by catchment-wide rainfall events or river flow. It has been subject to a review by LLFAs who were able to incorporate local data and information if available.

The uFMfSW was provided to CDC for use in the SFRA and is publically available on the Environment Agency's website under Risk of Flooding from Surface Water[16]. Three rainfall events, with return periods of 1 in 30 years, 1 in 100 years and 1 in 1000 are modelled and mapped. All are shown on Map 2.

3.4 Groundwater mapping

Areas Susceptible to Groundwater Flooding (AStGWF) is a strategic scale map showing groundwater flooding susceptibility on a 1km square grid. It was developed specifically by the Environment Agency for use by Lead Local Flood Authorities (LLFAs) for use in Preliminary Flood Risk Assessment (PFRA) as required under the Flood Risk Regulations. It is not available publicly.

This data has used the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map and thus covers consolidated aquifers and superficial deposits. It does not take account of the chance of flooding from groundwater rebound. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge. The susceptible areas are represented by one of four area categories showing the proportion of each 1km square that is susceptible to groundwater emergence. It does not show the likelihood of groundwater flooding occurring.

In common with the majority of datasets showing areas which may experience groundwater emergence, this dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The data should not be interpreted as identifying areas where groundwater is actually likely to flow or pond, thus causing flooding, but may be of use to identifying where, for example, further studies may be useful.

The Areas Susceptible to Groundwater Flooding data for the Districts is shown in Map 2.

[16] Environment Agency, Risk of Flooding from Surface Water map http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=ufmfsw#x=357683&y=355134&scale=2

3.5 Sewer flood risk mapping

The sewer flooding registers are held by water companies on the location of properties at risk of foul, combined and/or surface water sewer related flooding problems showing the number of properties flooded by 'overloaded sewers' within the Districts over the past ten years by postcode sector area. 'Overloaded sewers' is the Ofwat definition of flooding due to excessive flows in sewers. Water companies do not make publicly available figures for other causes of flooding including blockages, collapses and equipment failure, presumably because such problems should be rectified in a relatively short time and so should be unlikely to recur.

Thames Water, Severn Trent and Wessex Water were contacted to provide their sewer flooding registers. Severn Trent and Wessex Water had no records of flooding on their registers for Cotswold. Thames Water provided information on the number of properties recorded on their sewer flooding register based on postcode sectors (e.g. GL7 1), which has been translated into a GIS layer and is shown on Map 2.

The incidents recorded relate to incidents of internal and external flooding caused by a range of storm return periods up to 1 in 20 year. Thames Water did not provide data on properties flooded by events larger than a 1 in 20 year. Properties are only recorded once on the register, even if they have been flooded multiple times. Where improvements have been made by Thames Water to rectify a known flooding problem, the affected properties are taken off the register.

It is reasonable to assume that there may be more properties at risk of sewer flooding, but do not appear on the register. Comparison of the sewer flooding register data with locally reported sewer flooding issues suggests that it does not tell the whole story.

Therefore in the case of sewer flooding, an emphasis should be placed on locally gathered knowledge and information on sewer flooding incidents when assessing flood risk for development. The analysis of surface water flooding can also help to indicate likely locations at risk of sewer flooding, since in extreme floods the importance of above ground flow routes is arguably as or more significant than underground piped drainage systems.

3.6 Historic Flood Map

The Environment Agency maintains and updates a Historic Flood Map (HFM), which shows the combined extents of known flooding from rivers, the sea, and groundwater. Events are only included where there is enough information to map them. The layer contains no attributes about the date of the event, or the mechanism of flooding. The HFM is shown in the Map

It is worth noting that HFM outlines are used to define Flood Zone 2, where they are more extensive than the modelled Flood Zone 2 and where there is an appropriate level in confidence in the source and extents of the historic event.

3.7 Risk of flooding from reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Maps (NRIM) study. All reservoirs with an above ground storage capacity of 25,000 m^3 were meant to be included within this study.

This dataset can be viewed on the Environment Agency website under Risk of Flooding from Reservoirs[17].

3.8 Other flood risk evidence

3.8.1 Hydraulic modelling

Existing Environment Agency detailed hydraulic models include:

- River Churn - 1D/2D ISIS-TUFLOW model, last updated 2011.
- River Frome - (does not affect any of CDC's settlements)
- River Stour - (does not affect any of CDC's settlements)

[17] Environment Agency, Risk of flooding from Reservoirs map http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=reservoir#x=357683&y=355134&scale=2

- River Thames (Main River Limit to St John's) - 1D/2D ISIS-TUFLOW model, completed 2014.
- River Windrush at Bourton-on-the-Water - 1D/2D ISIS-TUFLOW model, completed 2015.

There were a number of modelling studies commissioned following the 2007 flood events within the District. The following modelling reports were held by CDC and made available to this study:

- Chipping Campden Flood Risk Management Study (December 2009)
- Weston Sub Edge Flood Study (December 2009)
- Morton in Marsh Flood Risk Management Study (December 2009)
- Naunton Flood Study (December 2009)
- Lechlade Flood Study (December 2009)
- Andoversford Flood Study (December 2009)
- Willersley Flood Study (December 2009)

CDC did not have digital copies of the hydraulic models and outputs that informed these studies. Attempts were made as part of the SFRA to obtain these outputs from the consultants that carried out the studies. The information from the models and reports has been used where appropriate to inform the SFRA.

3.8.2 Topographical data

A range of topographical data is available in the District, which has been used in the assessment of risk for the SFRA, and also can be used by future FRAs.

The Environment Agency and CDC hold channel survey and CCTV survey data where they have been carried out as part of various flood risk studies.

Digital terrain data is available for some watercourses in the form of LIDAR data, and full coverage of the area at a lower resolution is available from the Flood Map for Surface Water DTM.

3.8.3 Assets and infrastructure

In early February 2013, the Environment Agency launched its new flood and coastal risk asset inventory, in England and Wales. The new Asset Information Management System (AIMS) now replaces the National Flood and Coastal Defence Database (NFCDD).

The Environment Agency supplied GIS files of flood defences and structures extracted from AIMS. This database includes both structures owned or maintained by the Environment Agency, by the Districts and by third parties.

The available flood defence data is shown in Map 1.

3.8.4 Flood history

Records of local flooding incidents have been collected from a range of sources and used to inform the SFRA. These sources of information are summarised in Table 3-2.

Table 3-2: Sources of historical flood data and information

Source	Data	Description	When provided/ updated?
CDC	A Cotswold District Council Level 1 SFRA FINAL.PDF		2007
CDC	Flood Risk Management Studies	Various Flood Risk Management Studies looking into flooding mechanisms and looking at feasibility of flood alleviation schemes. Areas investigated include Andoversford, Chipping Campden, and Lechlade, Morton in Marsh, Naunton, WestonSubLedge and Willersley.	2009
CDC	Flood information from 2012 event	Excel spreadsheets describing the properties affected during flood event November - December 2012	2012
CDC	Review of Summer 2007	A detailed report describing the flood	2008

Source	Data	Description	When provided/ updated?
	floods Phase 1 Hyder.pdf	mechanisms of the July 2007 flood event across Cotswold District	
Environment Agency	Flood Review Reports	The Environment Agency prepared flood reviews to further investigate the extent of flooding, and opportunities for improvement. Areas investigated include: Buscot and Kelmscott; Fairford, Whelford; Kempsford & Lechlade; Lower Cotswolds; River Churn and Ampney Brook; and the Upper Cotswolds	2008
Environment Agency (Thames West)	Groundwater flooding database	An excel spreadsheet of incidents of groundwater flooding from 2000- 2013	2013
GCC	Historic Flood Map	A GIS layer showing areas of Historic flooding	2013
GCC	Locally agreed Surface Water information from PFRA	Surface water mapping	2013
Thames Water	Cotswold SFRA.xlsx	An excel file describing the number of flood incidents within CDC based on postcode sector	2013

The Chronology of British Hydrological Events (http://www.dundee.ac.uk/geography/cbhe/) provides a wealth of historical references to floods within the Districts. However, the majority of references do not give sufficient information to map the flood extents. A full listing of all events in the District is provided in Appendix A.

A further internet search was carried out for references to flooding in CDC beyond those already listed above, or identified on the Environment Agency Historic Flood Map. The results are summarised in Appendix A.

4 Understanding flood risk in the District

4.1 Introduction

This section assesses flood risk in Cotswold District from all sources, now and in the future. It makes use of all the data and information described in Chapter 3. It assesses flood risk from all sources, providing enough information for the councils to perform the Sequential Test.

The maps provided with this report should be referred to for information:

- Map 1 Fluvial Flood Risk: Flood Zone 3b, 3a, 3a plus climate change and 2, Historical Flood Map, flood depth and hazard mapping (where available), AIMS flood defence and asset data.
- Map 2 Flood Risk from Other Sources: Flood Map for Surface Water, Areas Susceptible to Groundwater Flooding, Sewer Flooding Register

Each map is in the form of a GeoPDF, with a drop down menu to choose the layer you want to view. Each map has an 'index map' of the whole District, which can be clicked on to open a more detailed map of an individual settlement.

Guidance on the planning implications is given in Chapter 6.

4.2 Fluvial flood risk

Fluvial flooding is flooding caused by high flows in rivers or streams exceeding the capacity of the river channel and spilling onto the floodplain, usually after a period of heavy rainfall.

The Environment Agency completed a study to identify the level of risk within Cotswolds. Table 4-1 describes the communities at risk, ranked by number of properties with a likelihood of flooding.

Table 4-1: Communities at risk in CDC, ranked by number of properties with a likelihood of flooding [18]

Community at Risk	Significant Risk
Cirencester*	253
St John Priory	122
Somerford Keynes	68
Bourton-on-the-Water*	57
Lechlade*	36
Fairford*	35
South Cerney*	30
Moreton-in-Marsh*	29
Whelford	14
Bledington	8

*** Principal Settlement identified in the current Local Plan (adopted 2006)**

Fluvial risk is present on both main rivers (which are the responsibility of the Environment Agency and riparian owners) and ordinary watercourses (which are the responsibility of the Councils and riparian owners). Map 1 and 2 provided with this report should be referred to for further detail of the watercourses in Cotswolds.

4.2.1 Fluvial flood risk by watercourse[19]

Main rivers

The Environment Agency has permissive powers to carry out maintenance and improvement works on these rivers. There are 16 main rivers in the Cotswold District. The location of these main rivers have been described in further detail in Appendix B, where they flow through one of the key 19 settlements listed in Table 2-2.

[18] Table adapted from the Environment Agency (2012) Communities at Fluvial Flood Risk - Cotswold District - It should be noted that Communities have been defined as areas of instances of 10 or more properties within flood zone 3 (100 year flood plain). Properties at risk have been defined using the National Flood Risk Assessment data (NAFRA), which works out the likelihood of flooding from rivers and the sea. The assessment takes into account the type, location and condition of flood defences, and the chance of these defences overtopping or failing during flooding.

[19] Cotswold District Council (2008) Strategic Flood Risk Assessment for Local Development Framework Level 1 Volume 1 - FINAL

The **River Thames** has its source upstream of Kemble, and continues as an ordinary watercourse in the Cotswold District at Thames Head (ST 9804 9947), very soon being classed as a main river less than 1km downstream. It is a source of risk for a number of settlements along its course including Lechlade, and the Thames has many tributaries even at this upstream phase, such as the **River Churn, River Coln**, and **Ampney Brook**.

The **River Churn** flows through Cirencester, where it is the main source of flood risk to properties and roads in Cirencester, South Cerney and Siddington. Historically blockage of culverts on the **River Churn** in the Spitalgate Lane area may have contributed to fluvial flood risk. The **River Churn** has also affected several residential properties at Watermoor, South Cerney and Cerney Wick.

The **River Coln** rises as several minor rivers in the hills north of Withington. It is classed as a main river from Chedworth Woods onwards. From here it winds its way south eastwards through Bibury, Coln St Aldwyns and Fairford and past the Cotswold Water Park before flowing into the **River Thames**. The main areas described as being at risk in Fairford are Milton Street and the A417. Reports describe the A417 as a major overland flow route.

Moreton in Marsh is at fluvial flood risk from the **River Evenlode**. As the watercourse flows through Moreton in Marsh it has been prone to blockages from debris and silt in the past, for example Queen Victoria Culvert. The Environment Agency has a monitoring and maintenance scheme in place and replaced the trash screen at Queen Victoria Park.

Bourton-on-the-Water is at risk of flooding from the **River Windrush** and the **River Dickler**. High levels within these watercourses impede the discharge of local drains and sewers during heavy rainfall (2007 event) and in turn have been reported to affect properties.

Ordinary watercourses

Where these impact upon the key settlements, they are discussed in Appendix B. Most of the minor rivers (or ordinary watercourses) in the District form upstream portions of main rivers and have the same name.

4.3 Fluvial defences, assets and structures

The Flood Zones do not take into account the effect of flood defences and assets on flood risk. Three 'national' GIS layers are provided alongside the Flood Map which defines Defences (recognised formal defences with a standard of protection of 1% or greater annual probability), Areas Benefiting from Defences (ABD) and Flood Storage Areas. These datasets are broadscale and do not identify any assets within the District.

The Environment Agency has also provided more detailed local data from its AIMS system, which is a database of all known assets on main rivers. The data is in GIS format and includes points (e.g. for individual structures like weirs and bridges) and lines (e.g. for embankments or walls). This information is shown on the Map 1, and summarised below.

4.3.1 Flood defence structures and raised defences

The AIMS dataset describes 226 structures. The vast majority of these are point structures such as weirs and bridges that affect or control water levels in the event of a flood, rather than what would be considered a formal flood defence scheme.

There are 361 'flood defences' listed in CDC. The vast majority of these are classified as bank protections and walls. There are thirty embankments identified. The descriptions vary and include earth embankment, flood bund, raised bank protection, raised earth embankment, raised earth/masonry embankment and raised stone wall. Most are privately or Local Authority maintained. There is a flood storage area (FSA) identified at Cotswold Water Park.

4.3.2 Culverts

Culverts may frequently increase flood risk, both due to blockages, either of the culvert itself or trash screens, or where they are hydraulically inadequate due to under-capacity or condition. In general the District has a low proportion of culverted watercourse as it is relatively rural, but where they do exist they can be problematic in flooding terms and ecological terms, often contributing towards Water Framework Directive compliance issues. Responsibility for maintenance of culverts can be difficult to determine between riparian owners, CDC and GCC and the Environment Agency.

All culverts recorded on the Environment Agency's AIMS database are shown on Map 1. The AIMS database only includes culverts on main rivers. CDC do not keep a formal record of culverts or other assets on ordinary watercourses, however the CDC Drainage team can be contacted for further information on culvert locations.

Table 4-3 describes notable culverts in the Cotswold District.

Table 4-2: Notable Culverts in the District

Settlement	Culvert description
Andoversford	Culvert under TH White site
Chipping Campden	Guild Twin culvert, Blind Lane/Dyer's Lane culverts
Cirencester	Culverts under Spitalgate
Lechlade	Butlers Court
Moreton-in-Marsh	East Street, Swan Close, Queen Street The culvert which passes under High Street, the A429, Budgens and the railway.
Northleach	Culvert under old prison and West End
South Cerney	Lower Mill, Upper Mill and School Lane.
Weston Subedge	Friday Street, Manor Farm and Parson Street
Willersey	Timms Green, Broadway Road, Collin Lane, Willow Road

4.3.3 Local flood alleviation schemes (FAS)

The Environment Agency provided details of schemes carried out on watercourses. These schemes are predominantly funded under the Flood Defence Grant in Aid scheme (FDGiA) or by the Regional Flood and Coastal Committee's Local Levy, see Table 4-3 and Table 4-4.

Table 4-3: Completed Local Flood Alleviation Schemes [20]

Name	Description	Source	Delivery Date	Lead RMA
Somerford Keynes FAS	Bunds, a wall, drainage ditch, trash screen, spill weir and pumping station	Fluvial	1998	Environment Agency
Bourton-on-the-Water	Grass bank, bunds flood storage area, drainage ditch network and upgrade and replacement of some culverts	Fluvial	2010	CDC
Bledington	Bund	Fluvial	2011	Environment Agency
Cirencester - Kingsmeadow culvert	Rehabilitation of damaged culvert	Surface Water	2012	CDC
Cirencester (excluding Watermoor) and South Cerney	Local improvements from the River Churn Flood Risk Management Strategy	Fluvial	2013	Environment Agency
Cirencester (Watermoor only)	Construction of flood wall, kerbs and embankments to protect properties from Daglingworth Stream	Fluvial	2013	Environment Agency
Naunton	Property Level Protection	Fluvial	2012	CDC

Table 4-4: Ongoing Local Flood Alleviation Schemes [21]

Name	Description	Source	Delivery Date	Lead RMA
Fairford FAS (excluding Courtbrook)	Low walls, bunds and throttle to limit flow	Fluvial	2013	Environment Agency
Fairford FAS (Courtbrook only)	Property Level Protection	Fluvial	2013	Environment Agency
Northleach	Repairs to culvert	Fluvial	2013	CDC
Northleach	Construction of the	Fluvial	2013	CDC

[20] see Note 18

[21] see Note 18

Name	Description	Source	Delivery Date	Lead RMA
	balancing pond			
Moreton-in -Marsh	Construction of flood relief culvert/ ditch	Surface Water	2013	CDC
Churn Strategy Review	Reviewing the Churn Strategy and confirming the next phase of works, which will focus on the maintenance and renewal of existing flood defence assets	Fluvial	2014	Environment Agency
St John' s Priory, Lechlade	Initial assessment to investigate options	Fluvial	2013	Environment Agency
Lechlade	Construction of flood relief culvert	Surface Water	2013	CDC
Moreton-in-Marsh	Property Level Protection	Fluvial	2014	CDC

4.4 Surface water flooding

Flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours, and usually occurs in lower lying areas often where the drainage system is unable to cope with the volume of water. Of course surface water flooding problems are inextricably linked to issues of poor drainage or drainage blockage by debris, and sewer flooding.

The Flood Map for Surface Water (Map 2) predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. If the FMfSW indicates a risk to a site allocation or settlement this has been discussed in further detail in Appendix B. It should be noted that because of its broad-scale nature, wherever possible, these mapped outlines should be used in conjunction with other sources of local flooding information to confirm the presence of a surface water risk.

The geology and topography of the District contribute to the rainfall response within the District and therefore the likelihood and nature of surface water flooding, see section 1.3. In light of this, surface water flooding is a significant problem, posing risk to Flood Zone 1 in addition to high and medium fluvial flood risk areas. In addition, areas with an abundance of impervious surfaces may also be at risk of surface water flooding, especially when local intense rainstorms occur. Any site-specific FRA would need to adequately assess the risk from surface water flooding.

Surface water flooding is a problem throughout the District with reported incidents referring to runoff from hills and drains being unable to cope with storm water. In the July 2007 event, surface water was the most frequently cited source of flooding throughout the district[22].

4.5 Groundwater flooding

In comparison to fluvial and tidal flooding, the understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. The risks and mechanisms of groundwater flooding have traditionally been poorly reported. However, under the Flood and Water management Act (2010), the LLFA now has powers to undertake risk management functions in relation to groundwater flood risk.

The Great Oolite aquifers in the District are not considered to be a major risk of flooding directly from groundwater emergence. In the north west of the District the Oolites are unconfined and receive direct recharge from rainfall. Spring lines are well-developed at the boundary with the underlying Lias Clays and provide significant baseflow to rivers, and properties located near springs may experience flooding problems. Local changes in groundwater levels may occur due to abstraction and this should be considered in more detailed studies. Further south the Oolites are confined and flood risk is low.

The Areas Susceptible to Groundwater Flooding (ASGWF) mapping from the Environment Agency shows the main areas at risk of groundwater emergence as the superficial deposits in the main river valleys (particularly the River Thames alluvial gravels), and the drift deposits in the north-east of the District which are underlain by less permeable mudstones. These deposits

[22] Cotswold District Council (2007) First Phase Draft Report 18 February 2008 Report no: 0001-NE02933-WXR-03

tend to have a shallow water table and are drained by the surface watercourses running through them. When water levels in these watercourses are high, less groundwater is able to drain away, leading to water-logging and groundwater emergence.

The Environment Agency's records of groundwater flooding reports broadly correspond with the ASGWF. There are several incidents recorded in the Cirencester and Siddington areas, and a few isolated incidents on the Great Oolite, probably related to springs.

4.6 Flooding from sewers

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

Since 1980, the Sewers for Adoption guidelines have meant that most new surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems.

This means that even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in a given year). Existing sewers can also become overloaded as new development adds to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep).

Thames Water has identified nine areas where properties were flooded internally by sewers in the 2007 event (Fairford, South Cerney, Ampney St Peter, Ampney St Mary, Upper and Lower Slaughter, Moreton-in-Marsh, Bourton-on-the-Water, Quenington). However, it recognises that there were many other areas where sewers caused flooding to gardens and open spaces[23].

In the winters of 2012/13 and 2013/14, sewer flooding problems have been experienced in South Cerney and Cirencester. The surface water sewer network in Cirencester is prone to surcharging when there are high river levels in the River Churn. This affected the Spitalgate/Trafalgar Road area. Some properties have been affected by foul sewer flooding. Sewer flooding has also been highlighted as a problem in recent years in combination with high river levels and surface water flooding at Lechlade and Fairford.

4.7 Flooding from reservoirs, canals and other artificial sources

4.7.1 Reservoirs

The risk of inundation to Cotswold District as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Maps (NRIM) study[24]. The reservoir register for Cotswold District Council is detailed in Table 4-5.

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is very difficult to estimate, but it is less likely than flooding from rivers or surface water. It may not be possible to seek refuge from floodwaters upstairs as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure. The Environment Agency maps represent a credible worst case scenario. In these circumstances it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

The Environment Agency maps show there is a risk to Cirencester by a breach or failure of a The Lake at Cirencester Park (shown in Figure 4-1). Flood water would flow south east through the town affecting the A419 and roughly following Sheep Street, Querns Lane, Trinity Road and Watermoor Road before joining the River Churn floodplain.

[23] Hyder (2008) Review of Summer 2007 floods Phase 1 Hyder

[24] Environment Agency "What's on your back yard"? - Risk of flooding from Reservoirs

Table 4-5: Reservoir Register for Cotswold District Council

Reservoir	Situation	NGR	Year Built	Dam Type	Max Height (m)	Capacity (m3)	Surface Area (m2)
Cirencester Park - The Mansion	Cirencester	SP 01750 01750	1736	Unknown	2	38326	34200

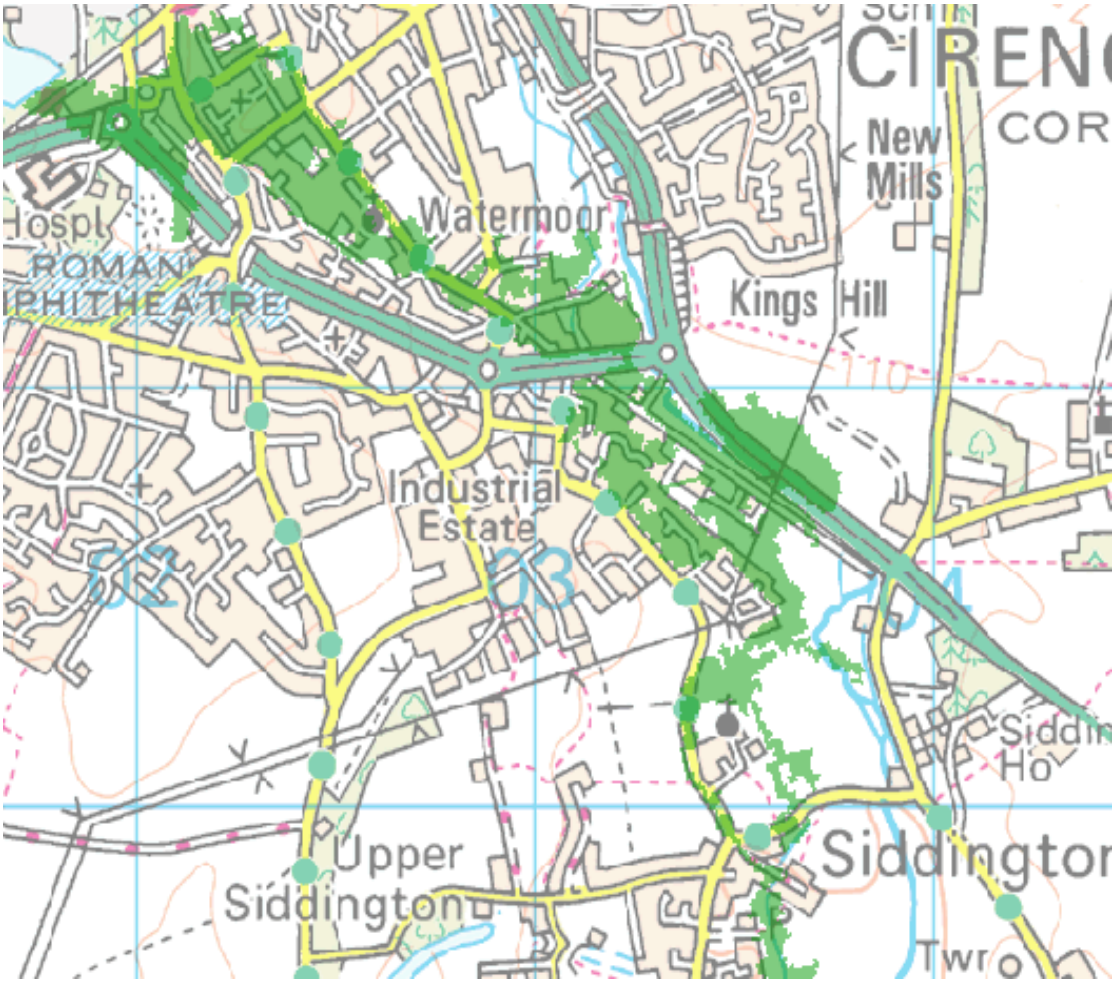


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Figure 4-1 Risk of flooding from reservoirs

4.7.2 Canals

There is one canal located within the District. The Thames and Severn Canal is located at the northern extent of the District and runs parallel to the River Frome for much of its length. There are no records of breach or overtopping of this canal in the District. The Canal and River Trust has indicated that there are no raised sections of canals within the Cotswold District.

At present canals do not have a level of service for flood recurrence (i.e. there is no requirement for canals to be used in flood mitigation), although the Canal and River Trust, as part of its function, will endeavour to maintain water levels to control the risk of flooding from canals to adjacent properties. It is important, however, that any development proposed adjacent to a canal be investigated on an individual basis regarding flooding issues and should be considered as part of any FRA.

4.8 The impact of climate change[25]

4.8.1 Fluvial flooding

On larger main rivers in wider valleys such as the River Churn and the River Thames, the estimated increase in flow under climate change scenarios has been modelled. The effect tends to be a noticeable increase in the mapped flood extent. Smaller watercourses in Cotswold (e.g. River Cam, Blockley Brook, and upper River Windrush) tend to be in areas of steeper topography with quite confined floodplains, and in these cases increases in flow do not result in a significant increase in flood extent. Even where no model is available, the difference between Flood Zone 3 and Flood Zone 2 can give a good indication of the impact of an increase in flows due to climate change on extent (a 100 year plus climate change event would usually be between these two in magnitude).

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

The impact of an event with a given probability is also likely to become more severe, for example depths, velocities, hazard and therefore risk to people will increase. Although qualitative statements can be made as to whether extreme events are likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of these changes locally. Further details regarding the uncertainties in predicting the impacts of climate change can be found in

- Environment Agency (2011) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities. September 2011
- UK Climate Projections (UKCP09)

4.8.2 Surface water

Climate change is predicted to increase rainfall intensity in the future by up to 30%. This will increase the likelihood and frequency of surface water flooding, particularly in impermeable urban areas, and areas that are already susceptible such as Moreton in Marsh and Fairford.

4.8.3 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows (such as the River Churn), is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible. However, warmer drier summers may counteract this effect by drawing down groundwater levels more during the summer months, meaning that lower levels are experienced at the start of winter and it takes longer for recharge to occur.

[25] Environment Agency (2011) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities. September 2011.

5 Review of potential development areas

5.1 Introduction

At the time of production of the SFRA, CDC identified 20 settlements for the SFRA to assess, 18 from the preferred development strategy of the Local Plan and an additional two requested by the Council's Principal Engineer. For the purposes of the SFRA, Cirencester and Siddington have been grouped together due to their proximity. The SFRA has therefore examined flood risk in and around these settlements. Table 5-1 lists the settlements identified.

Table 5-1: Settlements assessed by the SFRA

Andoversford	Moreton-in-Marsh
Blockley	Naunton ***
Bourton-on-the-Water	Northleach
Chipping Campden	Siddington*
Cirencester *	South Cerney
Down Ampney**	Stow-on-the-Wold
Fairford	Tetbury
Kemble	Upper Rissington
Lechlade	Weston Subedge** *
Mickleton	Willersey
* Cirencester and Siddington have been grouped together in the SFRA due to their proximity.	
**Down Ampney - Included in the SFRA but not the Preferred Development Strategy (May 2013). Substantial development opportunities have since been put forward for review in the draft SHLAA; and combined with Down Ampney's potential as a sustainable location, as noted in the 2nd Issues and Options Paper (2010) and Evidence Paper it was considered pragmatic and appropriate to include this settlement in the SFRA	
** *Weston Subedge and Naunton - Locations requested for inclusion in the SFRA by the Principal Engineer for West Oxfordshire and Cotswold District Councils.	

A review of the draft SHLAA/SELAA in early 2014 identified potential sites for development, contained within this SFRA. The SFRA has assessed flood risk at the potential sites for development.

5.2 Settlement summary sheets and maps

Flood risk from all sources has been described in more detail for each key settlement. This information is provided in a 'summary sheet' format in Appendix B. Each summary sheet also gives further information about the implications for development. The following information is provided for each site:

- Description of flood risk in terms of sources, pathways and receptors
- Historic Flooding
- Fluvial flood risk summary, source of Flood Zone information, flood defences and flood warning.
- Surface water flood risk summary
- Groundwater flood risk summary
- Sewer flood risk summary
- Reservoir flood risk summary (where applicable)
- Effects of climate change
- Available survey and detailed modelling
- Suitability of SuDS
- Implications for potential development sites (if applicable)

Maps showing the available flood risk information are provided with this report:

- Map 1 - Fluvial Flood Risk: Flood Zone 3b, 3a, 2 and 2 plus the 10m buffer zone , Historical Flood Map, flood depth and hazard mapping (where available), AIMS flood defence and asset data.
- Map 2 Flood Risk from Other Sources: Flood Map for Surface Water, Areas Susceptible to Groundwater Flooding, Sewer Flooding Register

Each map is in the form of a GeoPDF, with a drop down menu to choose the layer you want to view. Each map has an 'index map' of the whole District, which can be clicked on to open a more detailed map of an individual sustainable settlement.

5.3 Site flood risk hierarchy

There are 126 potential development sites considered in this SFRA. A flood risk hierarchy table has been compiled below assessing each site against key flood indicators, and is intended to help CDC carry out their Sequential Test. It has also been supplied to CDC as an Excel spreadsheet to enable easy querying and sorting of the information.

Table 5-2 shows flood risk to potential housing sites, and Table 5-3 shows flood risk to potential economic sites:

Vulnerability classification: Exact land use for each site is not known at this stage. For the purposes of this assessment it has been assumed that housing sites will be 'More Vulnerable' and employment sites will be 'Less Vulnerable'. If 'Highly Vulnerable' uses are proposed at more detailed planning stage they will have to be treated as per Table 3 of the NPPF Planning Practice Guidance.

Flood risk mapping: The percentage of the site within the different Flood Zones, uFMfSW 100 year and Historic Flood Map has been noted and colour coded. Where a site falls within 8m of any watercourse this has also been noted, in order to highlight sites that fall outside the Flood Zones but which may still be at risk from an ordinary watercourse.

Hazard and depth: Where models are available, the maximum hazard category on the site and the maximum depth are noted.

Comments on constraints: In order to aid CDC in carrying out the Sequential Test, the final column in Table 5-2 and Table 5-3 notes:

- Potential sites where intersection with a Flood Zone represents a constraint to development under the NPPF in terms of certain types of development not being permitted, or the Exception Test being required. It should be noted that for many sites these constraints only affect a relatively small area, and sequential site planning to ensure the built environment is all within Flood Zone 1 may be able to overcome these constraints.
- Potential sites which were not in the fluvial Flood Zones but where flood risk from other sources is present
- Potential sites where no flood risk indicators were identified.

Table 5-2: Flood risk to potential housing development sites

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Andoversford	A_2	More										No constraints
Andoversford	A_3A	More										No constraints
Blockley	BK_11	More										No constraints
Blockley	BK_5	More	10% to 50%	10% to 50%	10% to 50%	10% to 50%	10% to 50%	Yes				More Vulnerable use not permitted in FZ3b. Exception Test required for More Vulnerable use in FZ3a. Sequential planning of the site would be necessary.
Blockley	BK_14A	More	10% to 50%	10% to 50%	10% to 50%	10% to 50%	10% to 50%	Yes				More Vulnerable use not permitted in FZ3b. Exception Test required for More Vulnerable use in FZ3a. Sequential planning of the site would be necessary.
Blockley	BK_14B	More	< 10%	< 10%	< 10%	< 10%	10% to 50%	Yes				More Vulnerable use not permitted in FZ3b. Exception Test required for More Vulnerable use in FZ3a. Sequential planning of the site would be necessary.
Blockley	BK_8	More										No constraints
Bourton-on-the-Water	B_20	More										No constraints
Bourton-on-the-Water	B_32	More					< 10%					Flood risk from other sources
Broad Campden	R_432	More					10% to 50%	Yes				Flood risk from other sources
Broad Campden	R_484	More					< 10%	Yes				Flood risk from other sources
Chipping Campden	CC_23B	More										No constraints
Chipping	CC_23C	More										No constraints

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Campden												
Chipping Campden	CC_23E	More										No constraints
Chipping Campden	CC_38A	More					< 10%					Flood risk from other sources
Chipping Campden	CC_40	More					< 10%					Flood risk from other sources
Chipping Campden	CC_41	More					10% to 50%					Flood risk from other sources
Chipping Campden	CC_43	More					< 10%					Flood risk from other sources
Chipping Campden	CC_44	More					10% to 50%					Flood risk from other sources
Chipping Campden	CC_48	More					< 10%					Flood risk from other sources
Chipping Campden	CC_51	More										No constraints
Chipping Campden	CC_52	More					< 10%					Flood risk from other sources
Chipping Campden	CC_53	More					< 10%					Flood risk from other sources
Cirencester	C_101A	More										No constraints
Cirencester	C_173	More					< 10%					Flood risk from other sources
Cirencester	C_174	More					< 10%					Flood risk from other sources
Cirencester	C_17	More					< 10%					Flood risk from other sources
Cirencester	C_39	More					10% to 50%					Flood risk from other sources
Cirencester	C_76	More					< 10%					Flood risk from other sources
Cirencester	C_82	More					< 10%					Flood risk from other sources
Cirencester	C_84B	More					< 10%					Flood risk from other sources
Cirencester	C_89	More		< 10%	10% to 50%	> 50%	< 10%	Yes		Significant	0.506	Significant flood risk. Exception Test required in FZ3a for More Vulnerable use.

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Cirencester	C_97	More					< 10%					Flood risk from other sources
Cirencester	C_111	More					< 10%					Flood risk from other sources
Cirencester	C_75	More					< 10%					Flood risk from other sources
Down Ampney	DA_1A	More										No constraints
Down Ampney	DA_2	More										No constraints
Down Ampney	DA_5A	More										No constraints
Down Ampney	DA_5C	More					< 10%					Flood risk from other sources
Down Ampney	DA_8	More										No constraints
Down Ampney	DA_9	More					< 10%					Flood risk from other sources
Fairford	F_32	More										No constraints
Fairford	F_35B	More										No constraints
Fairford	F_44	More					< 10%					Flood risk from other sources
Fairford	F_46	More										No constraints
Kemble	K_1B	More										No constraints
Kemble	K_2	More					< 10%					Flood risk from other sources
Kemble	K_5	More					< 10%					Flood risk from other sources
Lechlade	L_18B	More				< 10%			< 10%			Exception Test required in FZ2 for Highly Vulnerable use
Lechlade	L_19	More	< 10%	< 10%	< 10%	10% to 50%	< 10%	Yes	10% to 50%	Low	0.252	More Vulnerable use not permitted in FZ3b. Sequential planning of the site would be necessary.
Mickleton	MK_4	More					< 10%					Flood risk from other sources
Moreton-in-Marsh	M_12A	More					< 10%					Flood risk from other sources
Moreton-in-Marsh	M_14A	More					10% to 50%					Flood risk from other sources

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Moreton-in-Marsh	M_14B	More					10% to 50%	Yes				Flood risk from other sources
Moreton-in-Marsh	M_14C	More			10% to 50%	10% to 50%	10% to 50%	Yes	10% to 50%			Exception Test required in FZ2 for Highly Vulnerable use
Moreton-in-Marsh	M_19A	More					< 10%	Yes				Flood risk from other sources
Moreton-in-Marsh	M_19B	More			< 10%	< 10%	10% to 50%	Yes	< 10%			Exception Test required in FZ2 for Highly Vulnerable use
Moreton-in-Marsh	M_21	More					10% to 50%	Yes				Flood risk from other sources
Moreton-in-Marsh	M_29	More			> 50%	> 50%	> 50%		> 50%			Exception Test required in FZ2 for Highly Vulnerable use
Moreton-in-Marsh	M_51	More										No constraints
Moreton-in-Marsh	M_56	More			> 50%	> 50%	10% to 50%		> 50%			Exception Test required in FZ2 for Highly Vulnerable use
Moreton-in-Marsh	M_57	More										No constraints
Moreton-in-Marsh	M_60	More					10% to 50%	Yes				Flood risk from other sources
Northleach	N_13B	More					< 10%					Flood risk from other sources
Northleach	N_14B	More					< 10%					Flood risk from other sources
Northleach	N_1A	More					< 10%					Flood risk from other sources
Northleach	N_8	More					< 10%					Flood risk from other sources
Siddington	SD_3	More					< 10%					Flood risk from other sources
South Cerney	SC_13A	More		< 10%	< 10%	< 10%	< 10%			Low	0.144	Exception Test required in FZ3a for More Vulnerable use.
Stow-on-the-Wold	S_14	More										No constraints
Stow-on-the-Wold	S_20	More										No constraints
Stow-on-the-	S_22B	More					< 10%	Yes				Flood risk from other sources

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Wold												
Stow-on-the-Wold	S_34A	More										No constraints
Stow-on-the-Wold	S_34B	More										No constraints
Stow-on-the-Wold	S_46	More					< 10%					Flood risk from other sources
Stow-on-the-Wold	S_8A	More										No constraints
Tetbury	T_24B	More					< 10%					Flood risk from other sources
Tetbury	T_31B	More					< 10%					Flood risk from other sources
Tetbury	T_38	More										No constraints
Tetbury	T_51	More					10% to 50%					Flood risk from other sources
Tetbury	T_61	More					< 10%					Flood risk from other sources
Upper Rissington	UR_2	More										No constraints
Willersey	W_1A	More					< 10%					Flood risk from other sources
Willersey	W_1B	More										No constraints
Willersey	W_4	More					10% to 50%	Yes				Flood risk from other sources
Willersey	W_4B	More					10% to 50%	Yes				Flood risk from other sources
Willersey	W_5	More										No constraints
Willersey	W_7A	More					< 10%					Flood risk from other sources
Willersey	W_8A	More					10% to 50%	Yes				Flood risk from other sources
Willersey	W_8B	More					10% to 50%	Yes				Flood risk from other sources
Willersey	W_9	More					> 50%	Yes				Flood risk from other sources
Willersey	W_10	More					10% to 50%	Yes				Flood risk from other sources

Table 5-3: Flood risk to potential economic development sites

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course	Historic Flood Map	Hazard Category (where available)	Max Depth (m) (where available)	Local evidence	Comments on constraints (e.g. development not permitted/Exception Test required)
Bourton-on-the-Water	BOW_E1	Less			< 10%	< 10%	10% to 50%	Yes					Exception Test required in FZ2 for Highly Vulnerable use
Bourton-on-the-Water	BOW_E3	Less					< 10%						Flood risk from other sources
Bourton-on-the-Water	BOW_E4	Less											No constraints
Chipping Campden	CCN_E1	Less					< 10%	Yes					Flood risk from other sources
Chipping Campden	CCN_E3A	Less			< 10%	< 10%	< 10%						Exception Test required in FZ2 for Highly Vulnerable use
Chipping Campden	RUR_E19	Less					< 10%						Flood risk from other sources
Cirencester	CIR_E10	Less						Yes					No constraints
Cirencester	CIR_E11	Less	< 10%	< 10%	< 10%	< 10%	10% to 50%	Yes		Significant	0.399		Less vulnerable development not permitted in Flood Zone 3b. Sequential planning of the site would be necessary.
Cirencester	CIR_E12	Less					< 10%						Flood risk from other sources
Cirencester	CIR_E13	Less					< 10%						Flood risk from other sources

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course	Historic Flood Map	Hazard Category (where available)	Max Depth (m) (where available)	Local evidence	Comments on constraints (e.g. development not permitted/Exception Test required)
Cirencester	CIR_E14	Less	< 10%	< 10%	10% to 50%	> 50%	10% to 50%						Less vulnerable development not permitted in Flood Zone 3b. Sequential planning of the site would be necessary.
Cirencester	CIR_E20	Less					< 10%						Flood risk from other sources
Cirencester	CIR_E4A	Less											No constraints
Cirencester	CIR_E5	Less					< 10%						Flood risk from other sources
Cirencester	CIR_E6	Less											No constraints
Lechlade	LEC_E1	Less					< 10%	Yes					Flood risk from other sources
Lechlade	LEC_E2A	Less											No constraints
Moreton-in-Marsh	MOR_E11	Less						Yes					No constraints
Moreton-in-Marsh	MOR_E4	Less			< 10%	< 10%	10% to 50%		< 10%				Exception Test required in FZ2 for Highly Vulnerable use
Moreton-in-Marsh	MOR_E5	Less					10% to 50%						Flood risk from other sources
Moreton-in-Marsh	MOR_E6	Less											No constraints
Moreton-in-Marsh	MOR_E7	Less					10% to 50%	Yes					Flood risk from other sources
Moreton-in-Marsh	MOR_E8	Less					10% to 50%						Flood risk from other sources
Moreton-in-	MOR_E9A	Less											No constraints

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course	Historic Flood Map	Hazard Category (where available)	Max Depth (m) (where available)	Local evidence	Comments on constraints (e.g. development not permitted/Exception Test required)
Marsh													
Northleach	NOR_E3A	Less					< 10%						Flood risk from other sources
South Cerney	RUR_E12	Less		> 50%	> 50%	> 50%	< 10%			Low	0.661		Significant flood risk. Exception Test required in FZ3a for More Vulnerable use.
South Cerney	RUR_E13	Less	< 10%	< 10%	< 10%	> 50%	10% to 50%	Yes	> 50%	Moderate	0.750		Less vulnerable development not permitted in Flood Zone 3b. Sequential planning of the site would be necessary.
Stow-on-the-Wold	STW_E1	Less											No constraints
Stow-on-the-Wold	STW_E7	Less											No constraints
Stow-on-the-Wold	STW_E9	Less											No constraints
Tetbury	TET_E1	Less					< 10%						Flood risk from other sources
Tetbury	TET_E2	Less											Flood risk from other sources
Tetbury	TET_E4	Less					< 10%						Flood risk from other sources
Willersey	WIL_E1C	Less					< 10%						Flood risk from other sources

6 Guidance for planners and developers

6.1 Introduction

In terms of planning for future development, the preparation of Strategic Flood Risk Assessments (SFRA) has become essential evidence that is required to help support Local Plans. Planners and developers should follow the NPPF Planning Practice Guidance and Environment Agency Flood Risk Standing Advice[26] as a starting point when considering applications for new development. In addition, developers should engage with the Local Authority in the early stage of planning, as CDC has specific guidance with regards to any site >5 hectares concerning the assessment of risk from surface water.

This section will summarise guidance for CDC on the appropriate planning response for all development in Flood Zones 1, 2, 3a and 3b (from large strategic sites site allocations to small windfall sites) and provide guidance for developers on what should be included within an appropriate Flood Risk Assessment. Flood Zone 3a plus climate change and Flood Zone 2 plus 10m buffer should be used to assess the impact of climate change on the NPPF Flood Zones. It should be read with reference to Map 1 and 2 which show the available flood mapping information for different sources of flood risk.

Table 3 of the NPPF Planning Practice Guide provides further detail of the type of development considered appropriate for each Flood Zone, where development is not permitted, and where development is allowed only when the Exception Test is passed.

6.2 Identifying areas at risk of flooding

When presented with a site for development, planners and developers should use the evidence and maps presented in this SFRA, along with other evidence (see Section 3.8) to identify any risk of flooding (from all sources). Table 6-1 gives some guidelines on sources of evidence and criteria for identifying a significant level of risk.

Table 6-1: Identifying areas at risk of flooding from all sources

Source of flooding	Sources of evidence	Criteria for identifying risk
Fluvial	Environment Agency Flood Zones Environment Agency Historic Flood Map CDC/GCC records Anecdotal evidence	Within Flood Zone 2 or 3.
Minor watercourses (not included in Flood Zone maps)	Detailed River Network CDC/GCC records Anecdotal evidence	Within 8m of the watercourse Local evidence of historic flooding from the watercourse.
Surface water	Environment Agency Flood Map for Surface Water CDC/GCC records Anecdotal evidence	Predicted surface water depths greater than 0.3m at the site on the Flood Map for Surface Water 200 year. Local evidence of surface water flooding in the area.
Groundwater	Environment Agency Areas Susceptible to Groundwater Flooding CDC/GCC records Anecdotal evidence	Risk in highest category on AStGWF. Local evidence of groundwater flooding problems in the area.
Sewer	Thames Water Sewer Flooding Register Map CDC/GCC records Anecdotal evidence	Local evidence of sewer flooding to existing properties on or near the site. Sewer flooding records provided by Thames Water are not detailed enough to identify site-specific risks. However, Thames Water will comment on larger planning applications, and on Local Plans.
Flooding from reservoirs, canals and other artificial sources	Environment Agency reservoir flood plans - can be viewed on the Environment Agency website under Risk of Flooding from Reservoirs[17],	Within flood envelope on Environment Agency reservoir flooding maps. Within 8m of a canal or other waterbody.

[26] **Environment Agency Flood Risk Standing Advice**

6.3 Permitted development in Flood Zones

6.3.1 Flood Zone 1

All development (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water-compatible development) is allowed in Flood Zone 1. All development proposals should consider the following about the sites:

- Their vulnerability to flooding from other sources as well as from fluvial flooding.
- Their potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff.
- Their potential impact on other sources of flood risk such as the groundwater regime (specifically underground development) and the overland flow routes for surface water.
- Their potential impact on watercourses including those not considered in the Flood Zones.
- Developments should be set back from watercourses, seeking a minimum of 8 metres wide undeveloped strip from the top of bank.
- Their access and egress, it should be noted for sites where access and egress routes are located in Flood Zone 2 and/ or 3, the site will be considered to be in that Flood Zone.

Developments greater than one hectare 1ha in Flood Zone 1

A detailed FRA must be undertaken by a suitably qualified professional. It should:

- Assess risk from all sources of flooding (e.g. fluvial, surface water, sewer, and groundwater) for the lifetime of the development (accounting for climate change. Provide a detailed assessment of the risk using hydraulic modelling, surface water modelling or groundwater investigations as appropriate.
- Recommend mitigation measures in response to any identified flood risk:
    - Sequentially design the site to locate the built element of the development away from the source of flood risk, see section 6.3.7.
    - Substitute less vulnerable development types for those incompatible with the degree of flood risk, see Section 6.3.8. Appropriate space should be allocated within the site for SuDS.
- Assess the impact of proposed development upon surface water drainage following any increase in impermeable area. This should include the potential impact upon areas and receiving watercourses downstream, and recommend the approach to control surface water discharge.
- Demonstrate that a proposed development can reduce flood risk elsewhere through the addition of SuDS, to control the potential impact new development may have on the surface water run-off regime, see Section 0. The following minimum drainage requirements should be adhered to:
    - Surface water run-off rates are attenuated to greenfield run-off rates. Higher rates would need to be justified and the risks quantified. Developers should strive to reduce run-off rates for existing developed sites. Early liaison with CDC and the Environment Agency should be undertaken to consider viable options for onsite drainage.
    - Attenuation up to the 1% annual probability event plus climate change.
    - Consideration of the existing groundwater regime.
- Developers should also be able to demonstrate that a proposed development does not adversely impact on the local groundwater regime.
- It is recommended that the FRA should propose a schedule to monitor groundwater levels from the conception to the completion of a proposed development. This schedule should ideally include a scheme for monitoring groundwater levels for a year post development to ensure that there is no alteration to the groundwater regime.[27]

[27] Note: This measure is not compulsory, but in areas where sites are potentially vulnerable to ground water flooding an assessment of this risk will need to be considered. CDC has recommended this approach.

Further information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance Note 1[28], CIRIA report C624[29], and PPS 25 Practice Guide[30].

Developments less than one hectare in Flood Zone 1

CDC should be consulted directly for developments <1ha in Flood Zone 1. The Environment Agency is only statutory consultee for sites greater than 1 ha. If a site within Flood Zone 1 has been identified by the SFRA as having a known drainage problem, or has experienced flooding from other sources, then a detailed FRA is required (as above).

For those proposed developments where there is not a known drainage issue then a detailed FRA is not required. Nevertheless, the proposed development should include the appropriate application of sustainable drainage techniques so as to maintain, or preferably reduce the existing runoff and flood risk in the area, see Section 0.

Developers should also be able to demonstrate through an appropriate assessment that a proposed development does not adversely impact on the local groundwater regime.

6.3.2 Flood Zone 2

Flood Zone 2 is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure, following application of the Sequential Test. Highly vulnerable development is only allowed where the Exception Test is passed. A Flood Risk Assessment is required for all development. Planners and developers are to be aware that a FRA should be appropriate to the scale and size of the development and undertaken by a suitably qualified professional. The following should be included within a FRA for developments within Flood Zone 2:

- Assess risk from all sources of flooding (e.g. fluvial, surface water, sewer, and groundwater) for the lifetime of the development (accounting for climate change. Provide a detailed assessment of the risk using hydraulic modelling, surface water modelling or groundwater investigations as appropriate.
- Recommend mitigation measures in response to any identified flood risk, such as:
    - Sequentially design the site to locate the built element of the development away from the source of flood risk, see section 6.3.7.
    - Substitute less vulnerable development types for those incompatible with the degree of flood risk, see Section 6.3.8. Appropriate space should be allocated within the site for SuDS.
    - Floor levels should be situated above the 1 in 100-year plus climate change predicted maximum level with a minimum freeboard of 300mm, see 6.6.2.
    - Demonstration that flood resilience/ resistance and emergency escape measures have been incorporated where appropriate. This includes flood defences, flood resilient and resistant design, effective flood warning and emergency planning are acceptable, see 6.6.2.
- Assess the impact of proposed development upon surface water drainage following any increase in impermeable area. This should include the potential impact upon areas and receiving watercourses downstream, and recommend the approach to control surface water discharge.
- Demonstrate that a proposed development ensures flood risk is not increased elsewhere through the addition of SuDS, to control the potential impact new development may have on the surface water run-off regime see Section 0. The following minimum drainage requirements should be adhered to:
    - Surface water run-off rates are attenuated to greenfield run-off rates. Higher rates would need to be justified and the risks quantified. Developers should strive to

28 Environment Agency, FRA Guidance Note 1 http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote1_v3.1.pdf

29 CIRIA (2004) Development and Flood Risk: Guidance for the Construction Industry. Report C624 http://www.ciria.org/service/AM/ContentManagerNet/Search/SearchRedirect.aspx?Section=Search1&content=product_excerpts&template=/contentmanagernet/contentdisplay.aspx&contentfileid=1417

30 Department of Communities and Local Government (2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7772/pps25guideupdate.pdf

reduce run-off rates for existing developed sites. Early liaison with CDC and the Environment Agency should be undertaken to consider viable options for onsite drainage.

- Attenuation up to the 1% annual probability event plus climate change.
- Consideration of the existing groundwater regime.

- For large developments (>1 ha), it is recommended that the FRA should propose a schedule to monitor groundwater levels from the conception to the completion of a proposed development. This schedule should ideally include a scheme for monitoring groundwater levels for a year post development to ensure that there is no alteration to the groundwater regime. [31]
- For smaller developments (<1 ha), developers should also be able to demonstrate through an appropriate assessment that a proposed development does not adversely impact the local groundwater regime.
- Basements should not be used for habitable purposes in Flood Zone 2. Where basements are permitted for commercial use, access points should be situated 300mm above the 1 in 100-year plus climate change flood level, see Section 6.6.1.
- Demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures) are taken into account. People (including those with restricted mobility) should be able to remain safe inside a new development in the 1 in 1000-year; and rescue and evacuation of people from a development is practicable up to a 1 in 1000-year event, see Section 6.6.3.
- The proposed development should be set back from the watercourse with a minimum strip of 8m of undeveloped buffer zone to allow for maintenance, see Section 6.9.

Any proposed development will be required to provide evidence that the Sequential Test, and if required the Exception Test, have been passed. A preliminary FRA, using data from the SFRA, PFRA and any necessary further modelling work (where detailed modelling has not already been provided as part of the SFRA), will be required to ascertain the level of flood risk for Sequential Test purposes. It is strongly recommended that the Sequential Test, and, if necessary, the Exception Test be satisfied before the FRA detailing design and mitigation measures is commenced.

Further information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance Note 3[28], CIRIA report C624[29], and the PPS 25 Practice Guide.

6.3.3 Flood Zone 3a

Water-compatible uses and less vulnerable development are allowed in this Flood Zone, following application of the Sequential Test. Highly vulnerable development is not permitted, and essential infrastructure and more vulnerable development need to pass the Exception Test. Essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

Where, due to wider sustainable development reasons, there are no other suitable sites available in lower risk zones then an assessment of the residual risk within Flood Zone 3 is required. For developments to proceed; it must also be shown that the development will not increase flood risk elsewhere through a loss of storage or conveyance. Flood risk must be reduced or kept at current levels.

A detailed FRA must be undertaken by a suitably qualified professional. It is required to provide evidence that the Sequential Test, and if required the Exception Test, have been passed. A preliminary FRA, using data from the SFRA, PFRA and any necessary further modelling work (where detailed modelling has not already been provided as part of the SFRA), will be required to ascertain the level of flood risk for Sequential Test purposes.

It is strongly recommended that the Sequential Test, and, if necessary, the Exception Test be satisfied before the FRA detailing design and mitigation measures is commenced. The Sequential Test will already have been applied to adopted site allocations. In the case of windfall sites, developers should speak to the local planning authority to confirm whether developer or planning

[31] Note: This measure is not compulsory, but in areas where sites are potentially vulnerable to ground water flooding an assessment of this risk will need to be considered. CDC has recommended this approach.

authority will undertake the sequential test. However, there will be a presumption against development within Flood Zone 3a and 3b.

The following should be included within a FRA for developments within Flood Zone 3a:

- Assess risk from all sources of flooding (e.g. fluvial, surface water, sewer, and groundwater) for the lifetime of the development (accounting for climate change. Provide a detailed assessment of the risk using hydraulic modelling, surface water modelling or groundwater investigations as appropriate.
- Proposed developments located in proximity to formal defences, water retaining structures (reservoirs or canals) will require a detailed breach and overtopping analysis to ensure that the residual risk can be managed for the lifetime of the development. The nature of the breach analysis should be discussed with the Environment Agency and CDC as required, see Section 6.9.
- Recommend mitigation measures in response to any identified flood risk, such as:
    - Floor levels should be situated above the 1 in 100-year plus climate change predicted maximum level with a minimum freeboard of 300mm, see 6.6.2.
- Any new 'More Vulnerable' development, particularly involving the creation of new residential units, will require dry access and egress up to the 1 in 100 year flood event, with an allowance for climate change over the lifetime of the development, see Section 6.6.3.
    - Demonstration that flood resilience/ resistance and emergency escape measures have been incorporated where appropriate. This includes flood defences, flood resilient and resistant design, effective flood warning and emergency planning are acceptable, see 6.6.2.
    - Sequentially design the site to locate the built element of the development away from the source of flood risk, see section 6.3.7.
    - Substitute less vulnerable development types for those incompatible with the degree of flood risk see Section 6.3.8. Appropriate space should be allocated within the site for SuDS.
- Ensure that flood risk is reduced overall, for example that:
    - Flood flow routes are preserved
    - Floodplain storage capacity is not reduced, and where necessary is compensated for on a level for level basis using land on the edge of the floodplain and above the 1% annual probability (1 in 100) with an allowance for climate change flood extent.
- Assess the impact of proposed development upon surface water drainage following any increase in impermeable area. This should include the potential impact upon areas and receiving watercourses downstream, and recommend the approach to control surface water discharge.
- Demonstrate that a proposed development can reduce flood risk elsewhere through the addition of SuDS, to control the potential impact new development may have on the surface water run-off regime see Section 0. The following minimum drainage requirements should be adhered to:
    - Reduce surface water runoff, where this is not feasible at a minimum greenfield discharge rates should be met.[32]
    - Attenuation up to the 1% annual probability event plus climate change.
    - Consideration of the existing groundwater regime.
- For large development (>1 ha), the FRA should propose a schedule to monitor groundwater levels from the conception to the completion of a proposed development. This schedule should include a scheme for monitoring groundwater levels a year post development to ensure that there is no alteration to the groundwater regime.

[32] Note: for some sites it may not be feasible to meet this requirement in highly constrained brownfield sites. In these circumstances, early liaison with CDC and the Environment Agency should be undertaken to consider viable options for onsite drainage.

- For smaller developments (<1 ha), developers should also be able to demonstrate through an appropriate assessment that a proposed development does not adversely impact the local groundwater regime.
- Basements should not be used for habitable purposes in Flood Zone 3. Where basements are permitted for commercial use, access points should be situated 300mm above the 1 in 100-year plus climate change flood level, see Section 6.6.1.
- The proposed development should be set back from the watercourse with a minimum strip of 8m of undeveloped buffer zone to allow for maintenance.

Further information on the details to be provided within the FRA can be found in the Environment Agency's FRA Guidance Note 3[33] and the NPPF Planning Practice Guidance.

6.3.4 Flood Zone 3b – the Functional Floodplain

The functional flood plain is defined as "land where water has to flow or be stored in times of flood." Only water-compatible uses are allowed in this Flood Zone. Essential infrastructure can be permitted after the Exceptions Test is passed. Essential Infrastructure is defined as essential transport infrastructure (including mass evacuation routes); and strategic utility infrastructure (including electricity generating power stations, grid and primary stations). However, utility infrastructure may not be appropriate, considering the events at the Mythe Treatment Works, Castlemeads electricity sub-station and the near flooding of the Waltham electricity sub-station. Therefore essential infrastructure built within the functional floodplain should:

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

Flood Zone 3b should be considered as the 1 in 20 year flood extents where these have been modelled and mapped. Where the 1 in 20 year extents have not been mapped, a precautionary approach should be followed and Flood Zone 3 should be considered as equivalent to the functional floodplain (see Map 1).

CDC should be seeking risk reduction on any sites within Flood Zone 3b. When such land comes up for redevelopment, planning applications should strive for:

- Removal of buildings, culverts and other structures, and restoration of the functional floodplain, including linkage between the watercourse and floodplain.
- Changing the land use to a less vulnerable classification.
- Changing the layout and form of the development (e.g. reducing the building footprint).
- Preserving flow routes.
- Improving conveyance/storage, e.g. replacing solid building with floodable structures.
- Sequential approach to design of site (see Section 6.3.7)

6.3.5 Taking account of climate change

At all stages of the development process it is important to understand not only the current flood risk to a site but also the flood risk for the lifetime of the development, taking into account the future impact of predicted climate change.

Flood Zone 3a plus climate change (Map 1) is based on existing information (see section 3.2.3 for more details on how the Flood Zone 3a plus climate change was produced) and provides a starting point for applying the Sequential Test. However, more detail using up to date recommended allowances will be required for any site-specific FRA.

An FRA must demonstrate that the impact of climate change on the development has been taken into account and, if appropriate, mitigated against. Government guidance on assessing climate change in flood risk assessments (released in January 2016) can be found at:

[33] Environment Agency, FRA Guidance Note 3
http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote3_v3.1.pdf

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The guidance provides a range of climate change allowances which are dependent on location (by river basin) and timescale of development (termed 'epoch'). Different allowances are given for different epochs but it is envisaged that the '2070-2115' epoch will be appropriate for most developments (Table 6-2).

The guidance also gives several categories (termed 'central', 'higher central' and 'upper end') to test depending on the vulnerability of the development and the Flood Zone within which it is located (summarised in Table 6-3). For example for 'more vulnerable' development in Flood Zone 3a, FRAs should use the higher central and upper end estimates to assess a range of allowances.

When carrying out an FRA, it may be necessary to carry out new or additional modelling to properly test these climate change allowances. It is advisable to contact the Environment Agency to establish what is expected for any particular site, and whether any new modelling is available.

Table 6-2: Climate change allowances (% increase in river flow)

River basin district	Allowance category	Total potential change anticipated for the '2080s' (2070 to 2115)
Thames	Upper end	70%
	Higher central	35%
	Central	25%
Severn	Upper end	70%
	Higher central	35%
	Central	25%

Table 6-3: Using peak river flow allowances in FRAs

	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Flood Zone 2	Higher central/upper end	Higher central/upper end	Central/higher central	Central	None
Flood Zone 3a	Upper end	Development not permitted	Higher central/upper end	Central/higher central	Central
Flood Zone 3b	Upper end	Development not permitted	Development not permitted	Development not permitted	Central

6.3.6 Dry islands

Environment Agency guidance is that dry-islands, areas of land totally surrounded by Flood Zone 3a, should, for spatial planning purposes, be considered as Flood Zone 3a. Dry islands within Flood Zone 2 should be treated as Flood Zone 1. CDC should follow this guidance and treat them as such when carrying out the Sequential Test.

Any development planned in a Flood Zone 3a island areas must therefore pass the Exception Test and have a detailed flood risk assessment with emphasis on safe access and egress. It may also be appropriate to consider the size of the dry-island, and the duration for which access to a site is expected to be compromised. Where a dry island forms between the floodplains of two or more rivers, it may be appropriate to consider the joint probability of both watercourses being in flood at the same time.

Any new "More Vulnerable" or "Highly Vulnerable" development, particularly involving the creation of new residential units, will require dry access and egress up to the 1 in 100 year flood event, with an allowance for climate change over the lifetime of the development. Further guidance on spatial planning within dry-islands is provided in the "Flood Risk to People" report.[34]

[34] http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=12016

6.3.7 Sites within more than one Flood Zone

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. In particular large development proposals may include a variety of land uses of varying vulnerability to flooding.

Where a site covers more than one Flood Zone, the sequential approach should be applied within development sites to design the site layout to reduce flood risk as much as possible.

A sequential, risk-based approach should be applied to try to locate more vulnerable land use to higher ground, while more flood-compatible development (e.g. recreational space) can be located in more high risk areas subject to appropriate management.

Low-lying waterside areas, or areas along known surface water flow routes, can be used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives.

Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

6.3.8 Policies for existing settlements within Flood Zones 2 and 3

Below are recommendations for specific flood risk management policies within Flood Zones 2 and 3 which could be applied in order to reduce flood risk overall. There is an opportunity for CDC to incorporate these policies into site allocations and Development Management policies within the Local Plan respectively:

Reducing vulnerability: On change of use of sites, opportunities should be taken to reduce vulnerability to flooding, by promoting less vulnerable and water compatible land uses.

Layout and footprint: On redevelopment of a site, opportunities should be taken to reduce the building footprint, thus improving floodplain storage and flow paths. Also, opportunities should be considered for the allocation of SuDS to be included with the revised footprint.

Extensions: Extensions to existing properties should not be permitted in Flood Zone 3a, unless their design is flood resilient.

Residential development above shops: Residential developments above shops in Flood Zone 3 should demonstrate that dry access and egress will be maintained. Where this is not feasible, safe access should be ensured. Where safe access cannot be achieved, the production of a Flood Emergency Plan needs to be undertaken (this will be reviewed by CDC Emergency Planners).

6.4 Surface water runoff and drainage

A FRA should consider how surface water will be managed on the development site. A preliminary drainage strategy should be fully outlined in the FRA, even at an outline application stage. Drainage strategies must consider the impact of climate change on rainfall intensity as outlined in the NPPF Technical Guidance.

Site drainage should be to SuDS infiltration systems where practicable. Where it is not practicable to drain the entire site to infiltration systems, appropriate assessments should be carried out for green and brownfield developments.

Opportunities for developing an Integrated Water Management Strategy across development site boundaries should be explored, and a catchment led approach should be adopted. An integrated approach to controlling surface water drainage can lead to a more efficient and reliable surface water management system as it enables a wider variety of potential flood mitigation options to be used. In addition to controlling flood risk, integrated management of surface water has potential benefits, including improved water quality and a reduction of water demand through rain-water recycling and reuse.

Integrated drainage systems may be considered suitable for catchments where other development is being planned or constructed, and where on-site measures are set in isolation of the systems and processes downstream.

6.4.1 Runoff rates

The design philosophy for greenfield sites requires that surface water run-off rates are attenuated to greenfield run-off rates. Higher rates would need to be justified and the risks quantified. Developers should strive to reduce run-off rates for existing developed sites. Guidance on calculating greenfield runoff rates is given in the Defra/EA guide to preliminary rainfall runoff management for developments[35].

The Environment Agency will expect, where practicable, that the developer should design drainage of a brownfield site such that there is a reduction in flows from the previous usage. [36]

6.4.2 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner and to endeavour to mimic the local natural drainage.

There are many different SuDS techniques which can be implemented. The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography, geology (soil permeability), and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined, and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential. Additionally, for infiltration SuDS it is imperative that the water table is low enough and a site specific infiltration test is undertaken. Where sites lie within or close to source protection zones further restrictions may be applicable, and guidance should be sought from the Environment Agency.

FRAs should consider the long-term maintenance and ownership of SuDS.

Gloucestershire County Council will become a SuDS Approval Body (SAB) by the enactment of Schedule 3 of the Flood and Water Management Act 2010, although a confirmed date for this enactment has yet to be announced. On enactment, all new development which has surface water drainage implications will potentially require SAB approval and need to conform to National and Local Standards.

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

- Susdrain website[37] - online community for delivering sustainable drainage
- CIRIA documents - there are several CIRIA guides relating to SuDS, most notably The SuDS Manual[38], although this is currently undergoing an update. The Susdrain website is a good guide to the available documentation.
- Environment Agency SuDS guidance[39] - Environment Agency advice for developers
- Interim Code of Practice for Sustainable Drainage Systems[40]
- Cotswold District Council Strategic Flood Risk Assessment Level 1[41]

Connection of surface water drainage to an existing surface water sewer should only be considered as a last resort. The sewerage undertaker should be consulted at an early stage to ensure that sufficient capacity is available in the existing drainage system.

6.5 Wastewater

Major developments and those upstream of areas where sewer flooding is known to be a problem must carry out wastewater capacity checks and should liaise with the sewerage undertaker at an

[35] Defra/ Environment Agency (2005) Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1. http://archive.defra.gov.uk/environment/flooding/documents/research/sc030219.pdf

[36] Note: for some sites it may not be feasible to meet this requirement in highly constrained brownfield sites. In these circumstances, early liaison with CDC and the Environment Agency should be undertaken to consider viable options for onsite drainage.

[37] Susdrain website http://www.susdrain.org/

[38] CIRIA (2007) The SuDS Manual (C697)

[39] Environment Agency SuDS guidance http://www.environment-agency.gov.uk/business/sectors/39909.aspx

[40] National SuDS Working Group (2004) Interim Code of Practice for Sustainable Drainage Systems. http://www.environment-agency.gov.uk/static/documents/Business/icop_final_0704_872183.pdf

[41] Cotswold District Council (2008) Strategic Flood Risk Assessment for Local Development Framework Level 1 Volume 1 - FINAL available at http://consult.cotswold.gov.uk/portal/fp/cs/sfra/sfra1?tab=files

early stage to prevent an increase in sewer flooding and/or spills from combined sewer overflows (CSOs) further down the wastewater system as a result of the development.

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

The Cotswold Water Cycle Study should be referred to for more information on wastewater capacity.

6.6 Making development safe

6.6.1 Basements

Basement dwellings are classified as 'Highly Vulnerable' according to the National Planning Policy Framework - Planning Practice Guide (Table 2)[42]. As such basement dwellings should not be permitted within Flood Zone 3a and must pass the Exception Test should they be proposed within Flood Zone 2. Basements dwellings should be discouraged within areas at risk of fluvial, surface water or groundwater flooding.

Where basements are permitted however, basement access points should be situated at a minimum of 300 mm above the 100 year plus climate change flood level. The basement must have unimpeded access and waterproof construction to avoid seepage during flooding conditions. In addition, it is important with proposals for subterranean development that there is no adverse impact on the groundwater regime. Therefore where basement developments are proposed, an assessment of existing and potential groundwater levels at the site should be undertaken, including monitoring of groundwater levels from the conception to the completion of a proposed development. Groundwater levels should also be monitored for a year post development.

6.6.2 Flood resistance and resilience

Resistance and resilience measures are measures which reduce the impact of flooding or increase the ability of people or buildings affected to recover from flooding. However these measures should not be used to justify development in inappropriate locations. These measures are particularly relevant where minor developments (such as domestic extensions) are allowed in flood risk areas. Further useful guidance is provided in the Planning Practice Guidance for Flood Risk and Coastal Change, which describes the possible measures:

- Flood resistance measures are used to prevent water from entering a building, e.g. flood barriers across doorways and airbricks; non-return valves and raising flood levels.
- Flood resilience measures are used when water is designed to enter the building, but cause minimal damage and can be quickly returned to use after a flood, e.g. raising electrical sockets, tiled floors.

The measures chosen will depend on the nature of the flood risk, and obviously development vulnerable to sewer flooding will require a different approach to one, for example at risk from flooding of the River Thames.

Further guidance is available in the Department of Communities and Local Government's document, Improving the flood performance of new buildings[43].

6.6.3 Safe access and egress

For development in Flood Zone 3 it is necessary to provide safe access and egress during a flood. Within Flood Zone 3, 'safe' access should remain dry for 'more vulnerable' uses. Dry escape for residential dwellings should be up to the 1% annual probability event (100 year return period) taking into account climate change for fluvial flood risk.

Access should preferably be dry for 'less vulnerable' land use classifications, but if this is not possible the FRA needs to demonstrate that depths and velocities of flood water will be no greater than the 'risks to some' category of the 'Flood Risk to People' FD 2320 calculator.

[42] Department for Communities and Local Government (March 2012) Technical Guidance to the National Planning Policy Framework available at http://www.communities.gov.uk/documents/planningandbuilding/pdf/2115548.pdf

[43] Department of Communities and Local Government (2007) Improving the Flood Performance of New Buildings: Flood Resilient Construction http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf

Within Flood Zone 2, people (including those with restricted mobility) should be able to remain safe inside a new development in the 1 in 1000-year; and rescue and evacuation of people from a development should be practicable up to a 1 in 1000-year event. Where safe access and egress cannot be achieved a Flood Emergency Plan needs to be produced (and be assessed by Cotswold DC Emergency Planners).

6.7 Water quality and biodiversity

All development should assess the impact of site drainage on the Water Framework Directive (WFD) status of the waterbody the water will drain into. The assessment should consider both water quality and quantity as a change to one or both of these may have a detrimental impact on the waterbody which will need to be mitigated for. For example SuDS schemes can alter the discharge runoff rate into watercourses and consideration needs to be given to the impact of this change on the physical structure of the watercourse and its ecology.

An impact assessment should also be carried out if the floodplain habitat currently depends on periodic inundation, for example water meadows.

The Cotswold Water Cycle Study should be referred to for more information on water quality.

6.8 River restoration and enhancement

All new development close to rivers and culverts should consider the opportunity presented to improve and enhance the river environment. As a minimum, CDC and developers should aim to set back development 8m from the river, providing a buffer strip to 'make space for water' and allow additional capacity to accommodate climate change. The 8m buffer should not contain any built environment including roads, lighting and fencing.

Developments should look at opportunities for river restoration, de-culverting and river enhancement as part of the development. Restoration can take place on various scales, from small enhancement measures to full river restoration. Options include backwater creation, in-channel and bank habitat enhancement, removal of structures e.g. weirs, removal of toe-boarding, restoration of banks and reinstatement of meanders.

When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river. Advice on river restoration, de-culverting and providing other environmental enhancements on development sites is available from the Environment Agency[44]. Early consultation is recommended.

Any modifications made as part of a proposed opening up and/ or restoration of river channels and corridors should be designed by suitable professionals and a full flood risk assessment of the impact of the modifications will be required to be carried out.

6.9 Existing watercourses, defences and assets

Permanent or temporary works within or adjacent to a watercourse require a Flood Defence Consent from the Environment Agency (in the case of Main rivers) or from CDC who act on behalf of the LLFA for ordinary watercourses.

Proposed developments which are adjacent to Environment Agency assets must demonstrate a minimum clearance of 8m from these assets to permit maintenance and renewal.

Developers should consult Map 1 to determine the location of defences. The FRA should consider the mechanisms of potential failure, the standard of protection, the worst case scenario breach and the residual risk. Parameters for the breach should be discussed with the Environment Agency prior to the building of a hydraulic model.

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

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

maintenance free, but there is an obligation to the riparian owner to undertake maintenance when required.

There should be a presumption against further culverting and building over culverts. All new developments with culverts running through the site should seek to de-culvert rivers for flood risk management and conservation benefit. Wherever possible, existing watercourses and drainage channels should be retained, offering risk management authorities benefits in terms of maintenance, future upgrading, biodiversity and pollution prevention. The CIRIA (2010) Culvert Design and Operation Guide provides guidance in this area[45].

Where a culvert is present, the FRA must consider risk from the culvert being both 0% blocked and 75% blocked.

6.10 Safeguarding land for future flood storage

The Environment Agency is currently undertaking a 5 year review of the Churn Flood Risk Management Strategy. One of the flood risk management options discussed by the Strategy is a flood storage area (FSA) just upstream of Cirencester on land between Baunton and the Abbey Way bridge.

The review shows that implementation of this proposed scheme only becomes economically viable if the predicted impacts of climate change are recognised, so this option is currently due to be reviewed with a view of potential implementation in 2030 (beyond the plan period of the Local Plan). The existing floodplain in this area is already classed as Functional Floodplain (Flood Zone 3b) and therefore most forms of development would not be permitted currently. Planners should be aware however that the land required for a FSA in the future would extend beyond the existing floodplain. There are various other areas on the River Churn currently under discussion for use as water meadows and flow control.

CDC and the Environment Agency have agreed that the findings of the Strategy review should be taken into account and that any land highlighted as a potential flood storage area in the future should be 'safe-guarded' from development.

6.11 Developer contributions to flood risk improvements

Major development offers a unique opportunity to reduce the level of flood risk, both to the development area, and also to existing communities downstream. Changes to legislation mean that it is now much easier for developers to contribute towards the cost of flood risk improvements.

Without allocated sites, location specific recommendations on developer contributions or strategic options cannot be made at this stage. In the case of CDC, there are no large strategic alleviation schemes planned, but improvements tend to be small scale channel and culvert improvements works, generally funded at the moment by FCRMGiA. Developers can be asked to make direct contributions to flood alleviation schemes affecting the communities close to developments.

7 Summary and conclusions

The scope of the Cotswold District SFRA has been increased to reflect changes in policy and legislation, to bring the planning context and flood risk information up to date and to aid the development of the Local Plan.

The SFRA provides general advice for planners and developers on:

- Sources of flood risk mapping and other evidence to inform the Sequential Test
- Flood risk from each source of flooding in the Districts
- What is required from a Flood Risk Assessment
- Other issues that need to be considered when carrying out development close to watercourses.

It also provides more specific flood risk information and advice for each of the strategic sites and key settlements under consideration by the Council as potential development areas at the time of writing.

[45] CIRIA (2010) Culvert Design and Operation Guide. CIRIA report C689

It is important to remember that information on flood risk is being updated continuously. This is particularly true now that the Council have taken responsibility for carrying out and recording flood investigations under the FWMA. The Environment Agency has a rolling programme of flood modelling and mapping studies, and updates to the Flood Map are made quarterly. Where new mapping studies are carried out, this will also affect the definition of the functional floodplain (Flood Zone 3b) and the climate change outline (see section 3.2.5).

As CDC move forward with their Local Plan which includes site allocations, they must use the most up to date information in the Sequential Test, and developers should be aware of the latest information for use in Flood Risk Assessments.

The Flood and Water Management Act (2010), the Localism Act (2011) and the National Planning Policy Framework (2012) all offer opportunities for a more integrated approach to flood risk management and development. As it is in the relatively early stages of the site allocation process, CDC have a real chance to make sure development provides improvements to flood risk overall and enhancements to the river environment.

8 Useful documents and links

District Council planning policy documents (including Local Plan and Core Strategy)

Cotswold Planning Website

http://www.cotswold.gov.uk/nqcontent.cfm?a_id=4714&tt=cotswold

Cotswold Neighbourhood Plans

http://www.cotswold.gov.uk/nqcontent.cfm?a_id=14210&tt=cotswold

Cotswold Review of Summer 2007 floods Phase 1 (Hyder)

http://www.cotswold.gov.uk/nqcontent.cfm?a_id=3131&cx=012408004195912917261%3Aamu9ei-rrcq&cof=FORID%3A11&ie=UTF-8&q=Cotswold+Review+of+Summer+2007+floods+Phase+1+%28Hyder%29&sa=Search

Lead Local Flood Authority flood risk management documents

Gloucestershire County Council Local Flood Risk Management Strategy website

http://www.gloucestershire.gov.uk/CHttpHandler.ashx?id=56202&p=0

Gloucestershire County Council (November 2011) Preliminary Flood Risk Assessment

http://www.gloucestershire.gov.uk/extra/article/109983/Preliminary-Flood-Risk-Assessment

Legislation and government guidance

Localism Act (2011) Section 110: Duty to cooperate in relation to planning of sustainable development

http://www.legislation.gov.uk/ukpga/2011/20/section/110

Flood and Water Management Act (2010)

http://www.legislation.gov.uk/ukpga/2010/29/contents

National Planning Policy Framework, Department of Communities and Local Government (2012)

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

Planning Practice Guidance for Flood Risk and Coastal Change, Department of Communities and Local Government (2014)

http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

Defra (March 2010) Surface Water Management Plan Technical Guidance

http://www.defra.gov.uk/publications/files/pb13546-swmp-guidance-100319.pdf

Department of Communities and Local Government (2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7772/pps25guideupdate.pdf

Department of Communities and Local Government (2007) Improving the Flood Performance of New Buildings: Flood Resilient Construction

http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf

Environment Agency resources and guidance

Environment Agency website, Flood information

https://www.gov.uk/browse/environment-countryside/flooding-extreme-weatherhttp:/www.environment-agency.gov.uk/homeandleisure/floods/default.aspx

Environment Agency, Flood Map for Planning (Rivers and Sea)

http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=floodmap&utm_source=Poster&utm_medium=FloodRisk&utm_campaign=FloodMonth13

Environment Agency, Risk of Flooding from Surface Water map

http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=ufmfsw#x=357683&y=355134&scale=2

Environment Agency, Risk of Flooding from Reservoirs map

http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=reservoir#x=357683&y=355134&scale=2

Environment Agency Flood Risk Standing Advice

https://www.gov.uk/flood-risk-standing-advice-frsa-for-local-planning-authorities

Environment Agency, FRA Guidance Note 1

http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote1_v3.1.pdf

Environment Agency, FRA Guidance Note 3

http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote3_v3.1.pdf

Environment Agency (2012) Demonstrating the flood risk Sequential Test for Planning Applications version 3.1

http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/static/documents/Business/SequentialTestProcess_v3.1.pdf

Environment Agency SUDS guidance

http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/business/sectors/39909.aspx

Environment Agency (2006) Building a better environment: A guide for developers

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289894/LIT_2745_c8ed3d.pdf

Environment Agency (2010) Oxford Flood Risk Management Strategy

https://www.gov.uk/government/publications/oxford-flood-risk-management-scheme

Environment Agency (2008) Thames Catchment Flood Management Plan

http://webarchive.nationalarchives.gov.uk/20140328084622/http://cdn.environment-agency.gov.uk/geth1209bqyl-e-e.pdf

Other resources and guidance

Association of British Insurers and National Flood Forum (April 2012) Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England

http://www.planningofficers.org.uk/downloads/pdf/ABI%20%20NFF%20Guidance%20on%20Insurance%20and%20Planning%20for%20Local%20Planning%20Authorities.pdf

CIRIA (2004) Development and Flood Risk: Guidance for the Construction Industry. Report C624

http://www.ciria.org/service/AM/ContentManagerNet/Search/SearchRedirect.aspx?Section=Search1&content=product_excerpts&template=/contentmanagernet/contentdisplay.aspx&contentfileid=1417

CIRIA (2007) The SuDS Manual (C697) (can be purchased at www.ciria.org)

CIRIA (2010) Culvert Design and Operation Guide. CIRIA report C689 (available free by registering at www.ciria.org)

Defra (2004) Strategy for Flood and Coastal Erosion Management: Groundwater Flooding Scoping Study (LDS23)

Defra/Environment Agency (2005) Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1

http://archive.defra.gov.uk/environment/flooding/documents/research/sc030219.pdf

Defra/Environment Agency (2006) Flood Risks to People Phase 2. R&D Technical Report FD2321/TR2

http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=12016

National SuDS Working Group (2004) Interim Code of Practice for Sustainable Drainage Systems

http://www.environment-agency.gov.uk/static/documents/Business/icop_final_0704_872183.pdf

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

UK Climate Change Impacts Programme, Identifying adaptation options
http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ID_Adapt_options.pdf

Offices at

Coleshill
Doncaster
Edinburgh
Haywards Heath
Limerick
Newcastle upon Tyne
Newport
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
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