



**JBA**  
consulting

# Strategic Flood Risk Assessment

Final Report

July 2013

## JBA Office

Crowmarsh Battle Barns  
100 Preston Crowmarsh  
Wallingford  
Oxfordshire  
OX10 6SL

## Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1.0 26 April 2013		Katherine Macdonald, Peter Dela (VOWH), Jon Waite (SODC), Sarah Underhay (Environment Agency)
Draft v2.0 07 June 2013	Amendments after review by the above	Katherine Macdonald, Peter Dela (VOWH), Jon Waite (SODC), Sarah Underhay (Environment Agency)
Final 3 July 2013	Amendments after review by the above	Katherine Macdonald, Peter Dela (VOWH), Jon Waite (SODC)

## Contract

This report describes work commissioned by Vale of White Horse and South Oxfordshire District Councils, by an email dated 30 January 2013. The Councils' representative for the contract was Katherine Macdonald.

## Purpose

This document has been prepared as a Strategic Flood Risk Assessment for Vale of White Horse and South Oxfordshire District Councils. 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 Vale of White Horse and South Oxfordshire District Councils.

## Acknowledgements

We would like to thank everyone who has assisted in the development of this SFRA, including: For South Oxfordshire District Council, Jon Waite, Patrick Roche, Geoff Bushell, Dave Baldwin (Monson) and Beryl Guiver. For Vale of White Horse District Council, Katherine Macdonald, Peter Dela and Alison Blyth. For the Environment Agency, Sarah Underhay, Ashley Maltman, Mike Mombrun and Lewis Purbrick. For Thames Water, Steve Dummer.

## Copyright

© Jeremy Benn Associates Limited 2013

## Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 223g if 100% post-consumer recycled paper is used and 283g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to achieve carbon neutrality.



## Executive Summary

In 2009 JBA Consulting completed an SFRA for South Oxfordshire District Council (SODC) and Vale of White Horse District Council (VOWH). A separate SFRA was completed for Didcot by HR Wallingford in 2007. Since preparation of the existing SFRAs there have been significant changes in legislation and flood risk policy, progression of the Local Plans for both Councils, along with some important updates to the flood risk mapping in the Districts. Consequently in March 2013, JBA Consulting was appointed to comprehensively review, update and combine the existing SFRAs with reference to the changes, specifically in flood policy and the best available flood risk information.

The report and accompanying maps are designed to furnish the two District Councils with enough information to carry out the Sequential Test as their Local Planning Frameworks progress and site allocations are made, enabling them to continue to fulfil their aim to locate development in areas of lowest flood risk. Available national flood risk mapping and other sources of evidence (historical records, detailed flood risk studies etc) are described. All sources of flood risk within the Districts are considered: fluvial, surface water, groundwater, sewer flooding, reservoir and other artificial sources. The impacts of climate change and adaptation measures are discussed.

Taking into account all the available information, flood risk for strategic sites and key settlements (main towns and larger villages) is discussed in further detail, along with the planning implications for each site/settlement.

General guidance is given for planners and developers to cover all types of development, including:

- Permitted development within the Flood Zones and requirements for Flood Risk Assessments (FRAs) and applying the Sequential and Exception Tests
- Taking into account other sources of flooding
- Surface water runoff and drainage
- Making development safe
- River restoration and enhancement
- Existing watercourses, defences and assets
- Developer contributions to flood risk improvements
- The WFD and water quality

The available flood risk data is being constantly updated and planners and developers should be aware that they should always use the latest information to inform their decision making, including the Sequential Test and Flood Risk Assessments, as the Local Plans continue to progress.

New legislation offers opportunities for a more integrated approach to flood risk management and development. As they are both in the relatively early stages of the site allocation process, the Councils have a real chance to make sure development provides improvements to flood risk overall and enhancements to the river environment.

# Contents

<b>Executive Summary.....</b>	<b>iii</b>
<b>Abbreviations and Definitions.....</b>	<b>iii</b>
<b>1 Introduction.....</b>	<b>1</b>
1.1 Background.....	1
1.2 Objectives .....	1
1.3 Study area .....	1
<b>2 The planning framework and flood risk policy .....</b>	<b>2</b>
2.1 Introduction .....	2
2.2 National legislation.....	2
2.3 County, District and catchment level policy .....	6
2.4 Local level.....	10
<b>3 Mapping and the risk based approach .....</b>	<b>11</b>
3.1 How flood risk is assessed .....	11
3.2 Flood risk mapping .....	12
3.3 Other flood risk evidence .....	16
<b>4 Understanding flood risk in the Districts .....</b>	<b>19</b>
4.1 Introduction .....	19
4.2 Fluvial flood risk .....	19
4.3 Fluvial defences, assets and structures .....	20
4.4 Surface water flooding.....	22
4.5 Groundwater flooding .....	22
4.6 Flooding from sewers .....	23
4.7 Flooding from reservoirs, canals and other artificial sources .....	24
4.8 The impact of climate change.....	25
<b>5 Review of potential development areas .....</b>	<b>26</b>
5.1 Introduction .....	26
5.2 South Oxfordshire District Council.....	26
5.3 Vale of White Horse District Council.....	26
5.4 Site and settlement summary sheets .....	27
5.5 Increased scope assessment .....	27
<b>6 Guidance for planners and developers .....</b>	<b>29</b>
6.1 Introduction .....	29
6.2 Permitted development in Flood Zones.....	29
6.3 Flooding from other sources.....	34
6.4 Surface water runoff and drainage .....	34
6.5 Wastewater.....	35
6.6 Making development safe.....	36
6.7 Water quality and biodiversity.....	36
6.8 River restoration and enhancement .....	36
6.9 Existing watercourses, defences and assets.....	37
6.10 Developer contributions to flood risk improvements.....	37
6.11 Climate change adaptation and mitigation .....	37
<b>7 Summary and conclusions .....</b>	<b>40</b>
<b>8 Useful documents and links .....</b>	<b>41</b>

## List of Figures

Figure 2-1: Flood Risk Regulation Requirements .....	2
--	---

Figure 2-2: Strategic planning links and key documents for flood risk .....	3
Figure 2-3: Sequential and Exception Test .....	7
Figure 3-1: Definition of Flood Zones .....	13
Figure 3-2: Risk of flooding from reservoirs (extracted from Environment Agency website) .....	16
Figure 4-1: Effect of climate change on Flood Zone 3 on the Thames .....	25
Figure 6-1: Example of a dry island between Warborough and Dorchester .....	33

## List of Tables

Table 2-1: Roles and Responsibilities in Oxfordshire.....	4
Table 2-2: Thames CFMP Key Messages by Policy Unit.....	9
Table 3-1: Flood Zone descriptions .....	13
Table 3-2: Sources of historical flood data and information .....	18
Table 5-1: Flood risk to South Oxfordshire key settlements.....	26
Table 5-2: Flood risk to Vale of White Horse strategic sites.....	27
Table 5-3: Flood risk to Vale of White Horse key settlements.....	27
Table 5-4: Matrix of vulnerability and hazard classification .....	28
Table 6-1: Identifying significant evidence of flooding from other sources.....	34

## 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.
Asset Information Management System	AIMS	Environment Agency's asset database
Areas Susceptible to Groundwater Flooding	AStGWF	National map produced by the Environment Agency showing areas susceptible to groundwater emergence.
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.
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 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 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.
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
Flood Risk Assessment	FRA	A detailed site-based investigation that is undertaken by the developer at planning application stage
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. Zone 1: Flooding predicted to occur less than once every thousand years (<0.1% Annual Event Probability) Zone 2: Flooding predicted to occur at least once every thousand years (0.1% Annual Event Probability) Zone 3: Flooding predicted to occur at least once every hundred years (1% Annual Event Probability)
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 a developing a strategy for local flood risk management that encompasses all sources of flooding (Oxfordshire 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		Larger streams and watercourses, for which the Environment Agency is the designated body responsible for flood risk management.
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.
Oxfordshire County Council	OCC	Lead Local Flood Authority covering both Districts.
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)



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.
South Oxfordshire District Council	SODC	
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
Sewage Treatment Works	STW	
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
Upper Thames Major Resource Development	UTMRD	Thames Water proposal for a large new storage reservoir to the west of Abingdon.
Uncertainty		A reflection of the (lack of) accuracy or confidence that is considered attributable to a predicted water level or flood extent
Vale of White Horse District Council	VOWH	
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

In September 2007 JBA Consulting was commissioned jointly by South Oxfordshire District Council (SODC) and Vale of White Horse District Council (VOWH) to undertake a Strategic Flood Risk Assessment (SFRA). This consisted of a Scoping Study (Level 1) with some more detailed assessment in key settlements. The SFRA was completed in June 2009. A separate SFRA was completed for Didcot by HR Wallingford in 2007.

Since preparation of the existing SFRAs there have been significant changes in legislation and flood risk policy, progression of the Local Plans for both Councils, along with some important updates to the flood risk mapping in the Districts. Consequently in March 2013, JBA Consulting was appointed to comprehensively review, update and combine the existing SFRAs with reference to the changes, specifically in flood policy and the best available flood risk information.

## 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 existing site allocations, but also sets out the procedure to be followed when assessing additional sites for development in the future. The SFRA will assist the council to make the spatial planning decisions required to inform the forthcoming Local Plans.

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 planned 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 provide the necessary interpretation of detailed technical input.

## 1.3 Study area

The study area comprises the whole of the administrative areas of South Oxfordshire District Council and Vale of White Horse District Council. The study area is illustrated in Map 1.

The River Thames is the main watercourse within the two Districts, forming part of the boundary with West Oxfordshire and the City of Oxford, and the boundary between the two Districts to the north of Didcot. To the south it forms much of the boundary between SODC and West Berkshire, Reading and Wokingham. Significant tributaries joining the Thames within or on the borders of the Districts include the Dickler, Evenlode, Cherwell (within City of Oxford), Ock and Thame. The catchment area and channel size thus increase significantly. The upstream catchment area of the Thames entering VOWH near Lechlade is 776km<sup>2</sup>, on re-entering VOWH/SODC at Kennington it is 3053km<sup>2</sup>, and on exiting the study area at Henley it is 6613km<sup>2</sup>.

## 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), 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

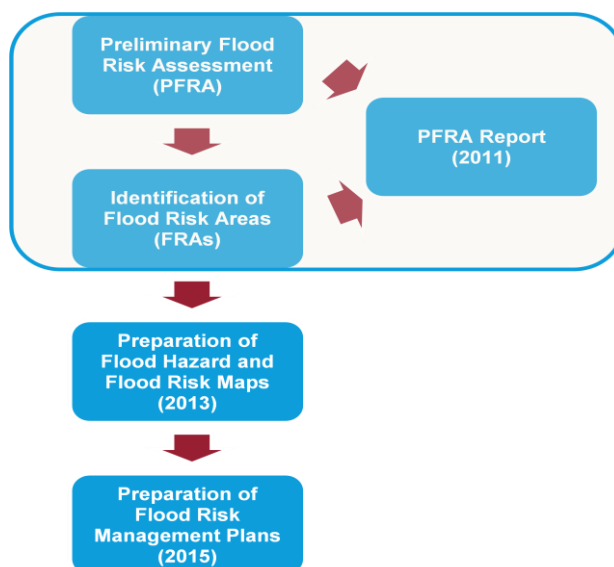
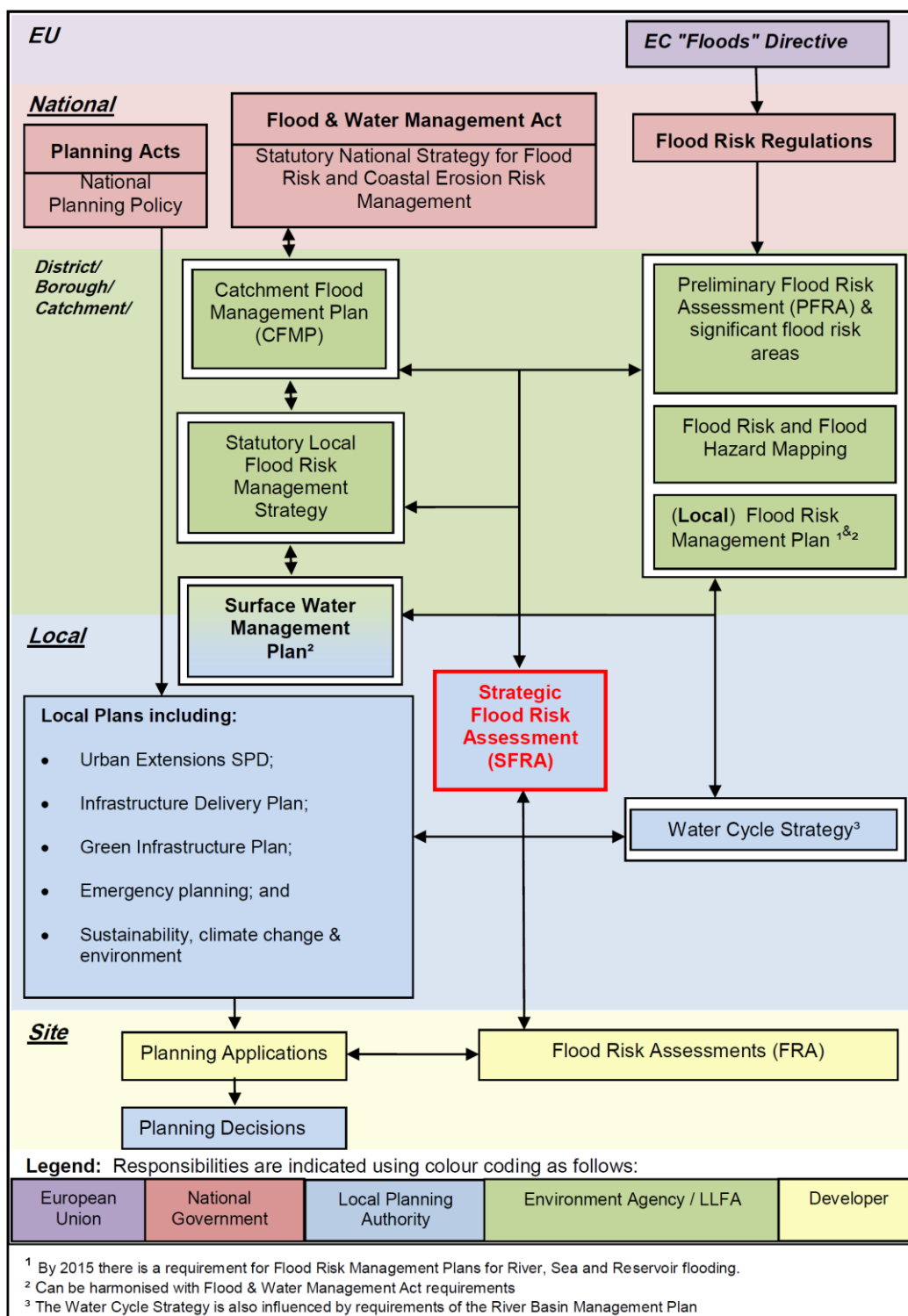


Figure 2-2: Strategic planning links and key documents for flood risk



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, Oxfordshire 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 Oxfordshire 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 Oxfordshire

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	National Statutory Strategy Reporting and supervision (overview role)	Main rivers, reservoirs Preliminary Flood Risk Assessment (per River Basin District) Identify Significant Flood Risk Area Flood Risk and Hazard Maps Flood Risk Management Plan
Lead Local Flood Authority (Oxfordshire 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 Councils	Input to National and Local Authority Plans and Strategy (e.g. Local Plan documents) Vale of White Horse Local Plan and South Oxfordshire Core Strategy	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](#)<sup>1</sup> 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 several Neighbourhood Plans in place in the Districts (see Section 2.3.5).

### 2.2.3 National Planning Policy Framework (NPPF)

The [NPPF](#)<sup>2</sup> 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. [Technical guidance to the NPPF](#)<sup>3</sup> has been produced as an interim measure, which works alongside the NPPF and sets out how the policy should be implemented.

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:

<sup>1</sup> 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>

<sup>2</sup> 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](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf)

<sup>3</sup> Department of Communities and Local Government (2012) Technical Guidance to the National Planning Policy Framework [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/6000/2115548.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf)

- “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** has been carried forward from PPS25. Details of the test are described in NPPF and the accompanying NPPF Technical Guide. This test must be performed when considering the placement of future development and for planning application proposals. The NPPF Technical Guide gives detailed instructions on how to perform the test. 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 Technical Guide.

The Environment Agency has published a technical note<sup>4</sup> which 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 Councils can use to assess whether it is necessary to revisit/update the Sequential Test. The Environment Agency recommends that the following approach is used by local planning authorities to apply the Sequential Test to planning applications located in Flood Zones 2 or 3. There are three stages to the test, these have been summarised in Figure 2-3.

## 2.2.4 Association of British Insurers (ABI): Guidelines on Planning and Insurance in Flood Risk Areas for Local Authorities in England<sup>5</sup>

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.

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 in many cases this will be

<sup>4</sup> 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](http://www.environment-agency.gov.uk/static/documents/Business/SequentialTestProcess_v3.1.pdf)

<sup>5</sup> 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>

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 Oxfordshire County Council Local Flood Risk Management (FRM) Strategy<sup>6</sup>

In fulfilling the role of LLFA, Oxfordshire County Council (OCC) 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 is ongoing at present and will include the following:

- Information on local flood risk in Oxfordshire, highlighting where problems have already occurred, or where areas fall in risk categories
- 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

### 2.3.2 Oxfordshire Preliminary Flood Risk Assessment

The regulations required Oxfordshire County Council (as the LLFA) to prepare and publish a Preliminary Flood Risk Assessment (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).

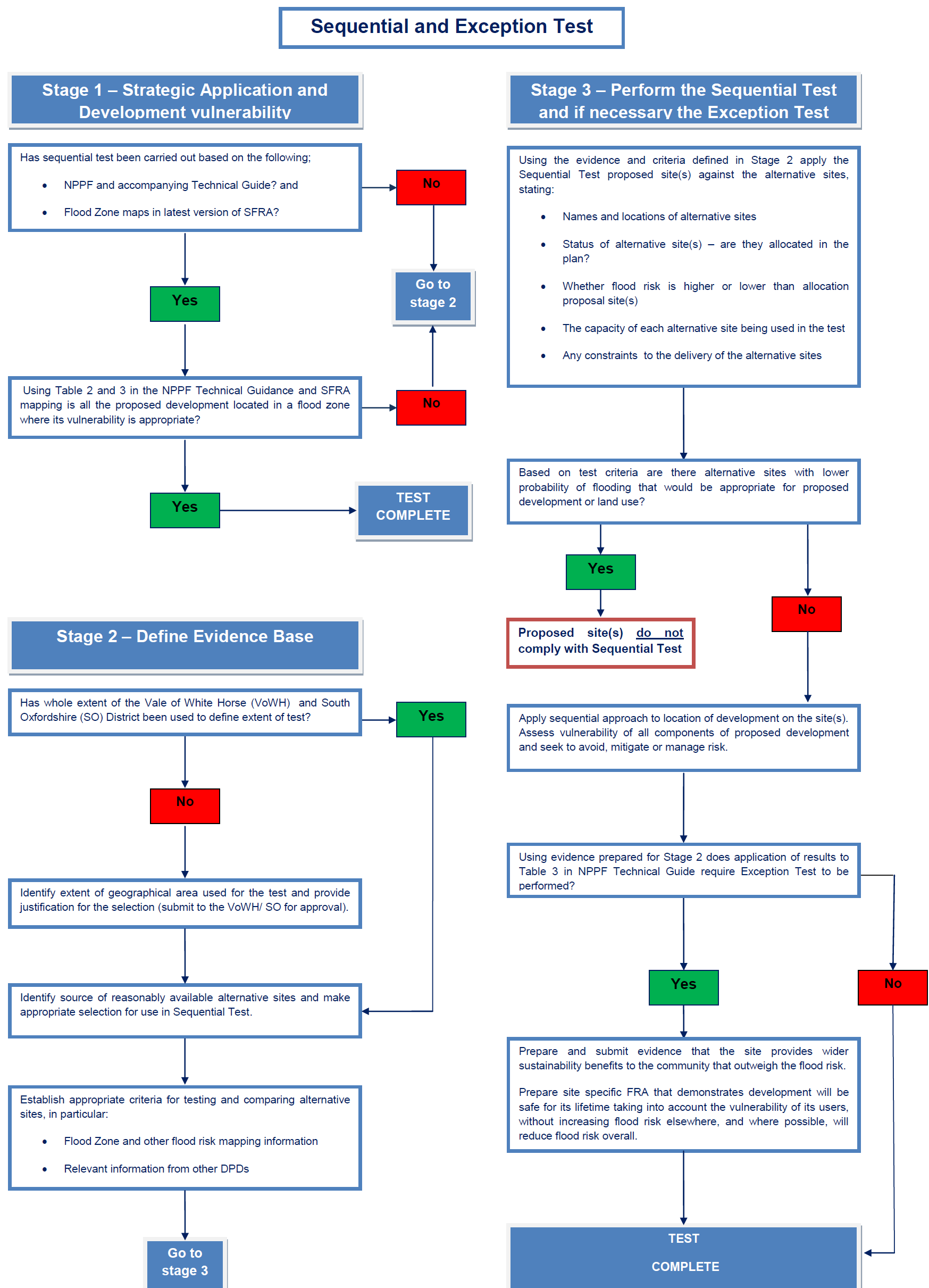
Key outputs of the Oxfordshire PFRA include<sup>7</sup>:

- 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.
- The analysis of available data predicting future flood risk suggests that the level of risk in Oxfordshire is not significant enough to propose a new indicative Flood Risk Area. However, the evidence collected demonstrates that there are flooding issues that must be addressed in the Local Flood Risk Management Strategy.

<sup>6</sup> Oxfordshire County Council Local Flood Risk Management Strategy  
<http://www.oxfordshire.gov.uk/cms/content/oxfordshire-local-flood-risk-management-strategy>

<sup>7</sup> Oxfordshire County Council (June 2011) Preliminary Flood Risk Assessment  
<http://www.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/environmentandplanning/flooding/pfra/PFRAPreliminaryreport.pdf>

Figure 2-3: Sequential and Exception Test





### 2.3.3 The Vale of White Horse Local Plan 2029<sup>8</sup>

The Vale of White Horse Local Plan 2029, once adopted, will provide a framework for future development across the Vale of White Horse District. It will replace the strategic elements of the Local Plan 2011. Up-to-date information on planning in VOWH and the Local Plan 2029 Part 1 can be found at <http://www.whitehorsedc.gov.uk/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 challenges and opportunities

'Protecting the environment and responding to climate change' is identified as a key challenge and opportunity under the Local Plan. It identifies ways to build greater resilience to the unavoidable effects of climate change, including the issues of flooding and an increased incidence of extreme weather. Under this umbrella are set out policies on:

- Responding to climate change
- Sustainable design and construction (Draft Core Policy 30)
- Flood risk (Draft Core Policy 32)
- Water quality and meeting the needs of the WFD.
- Green infrastructure (Draft Core Policy 35)
- Conservation and improvement of biodiversity (Draft Core Policy 36).

At the time of writing, all policies are currently at draft stage and are subject to amendment following public consultation. Of most relevance is:

#### Draft Core Policy 32: Flood Risk

Draft Core Policy 32 deals with flood risk from all sources and is very much in-line with the NPPF. It states that "With regard to flood risk, the sequential approach will be strictly applied across the District, in accordance with national guidance. Development within areas of flood risk from any source of flooding, including areas with a history of groundwater or surface water flooding, will only be accepted if it is demonstrated that it is appropriate at that location, and that there are no suitable and available alternative sites at a lower flood risk. Planning permission will not be granted for any development in the functional floodplain (Flood Zone 3b) except water-compatible uses and essential infrastructure.

For all developments over 1 hectare and/or development in any area of flood risk from rivers (Flood Zone 2 or above) or other sources, developers must carry out a full Flood Risk Assessment (FRA) demonstrating that the proposed development will not increase flood risk.

Unless it is shown not to be feasible, all developments will be expected to incorporate sustainable drainage systems or techniques to limit surface water runoff from new development, and reduce the existing rate of run-off."

#### Appendix A of the Local Plan Strategic Site Development Templates

This appendix refers to the following strategic sites:

- Harwell Oxford Campus, Harwell
- Crab Hill, Wantage
- Monks Farm, Grove
- Land South of Park Road, Faringdon
- Valley Park, Harwell Parish, West of Didcot

<sup>8</sup> Vale of White Horse District Council (2013) Local Plan 2029 [http://www.whitehorsedc.gov.uk/sites/default/files/2013-03-14\\_FinalLocalPlanPartOneReduced.pdf](http://www.whitehorsedc.gov.uk/sites/default/files/2013-03-14_FinalLocalPlanPartOneReduced.pdf) PLEASE NOTE: At the time of writing this report, the Local Plan was in public consultation.

### 2.3.4 South Oxfordshire Core Strategy (Part of the Local Plan)<sup>9</sup>

This adopted document describes the framework for development for South Oxfordshire for 2027. The strategy is a key document within the South Oxfordshire Local Plan. The strategy sets out what physical, social and green infrastructure is needed and how and by what means it will be delivered. The following sections specifically relate to flood risk management and related matters within the District. Up-to-date information on planning in SODC and the Core Strategy can be found at <http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy>.

#### Objective 3: Environment and Design

Objective 3: Environment and Design recognises that any new builds take into account climate change, including minimising the risks and effects of flooding.

#### The Environment

This chapter covers the Council's vision and objectives with regard to:

- Water quality - paragraph 14.11 describes the response to the needs of the WFD.
- Flood Risk Management - although there is no dedicated policy on flood risk, paragraphs 14.12 and 14.13 describe the approach to flood risk management, referring to the SFRA, and stating that "The Strategic Housing Land Availability Assessment shows that there is enough zone 1 land available in the District to meet our future greenfield allocation needs in our towns and villages. We will not therefore need to look at zone 2 or 3 land for the built element of greenfield allocations or carry out any exception testing."

#### Quality development

This chapter covers the Council's vision and objectives with regard to:

- Sustainable design and construction (Policy CSQ2)
- Climate change adaption - this section sets out the need to adapt to climate change in design and paragraph 15.24 recommends the use of SuDS to help cope with intense rainfall events.
- Design - this section mentions that new development in South Oxfordshire District should link to or provide green infrastructure where available (Policy CSQ3)

#### Green infrastructure and biodiversity

- Green infrastructure - Policy CSG1 refers directly to Green infrastructure indicating that the core strategy is aiming to increase the use of green infrastructure within South Oxfordshire and improve existing assets including Conservation Target Areas in accordance with the standards set out in the South Oxfordshire Green Infrastructure Strategy and Didcot Natural Greenspaces Study.
- Biodiversity - Policy CSB1 sets of an aim to increase the net biodiversity in the District.

### 2.3.5 Thames Catchment Flood Management Plan (CFMP)

The **Thames CFMP**<sup>10</sup> is a high level policy document produced by the Environment Agency covering the whole of the River Thames catchment (fluvial only). It aims to set policies for sustainable flood risk management for the whole catchment covering the next 50 to 100 years. The CFMP was adopted in 2008. The CFMP messages are split into various policy units. Four of these policy units apply to the Districts, and the selected policies and management approaches are detailed in Table 2-2.

Table 2-2: Thames CFMP Key Messages by Policy Unit

CFMP policy unit	SFRA key settlements	Selected policy and flood risk management approach
Abingdon	Abingdon	P5 – reduce the risk – lower the probability of exposure to flooding and/or the magnitude of the consequences of a flood and hence the risk

<sup>9</sup> South Oxfordshire District Council (December 2012) Core Strategy <http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy/core-strategy/adopted-core-strategy>

<sup>10</sup> Environment Agency (2008) Thames Catchment Flood Management Plan <http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geth1209bqyl-e-e.pdf>

Ock	Faringdon, Grove & Wantage, Kingston Bagpuize & Southmoor, Shrivenham, Stanford in the Vale, Watchfield	P6 - take action to increase the frequency of flooding to deliver benefits locally and/or reduce the risk elsewhere
Sandford to Cookham	Benson, Cholsey, Crowmarsh Gifford, Goring, Henley on Thames, Kennington, Milton, Radley, Steventon, Sutton Courtenay, Wallingford, Woodcote.	P4 – accept the risk – but in the longer term take action to ensure that risk does not increase from current level
Swindon	Shrivenham, Watchfield.	P4 – accept the risk – but in the longer term take action to ensure that risk does not increase from current level
Thame	Berinsfield, Chalgrove, Chinnor, Horspath, Thame, Watlington, Wheatley	P3 - accept the risk – our current scale of actions is sufficient to manage the current risk and future increases will be acceptable
Upper Thames	Botley, Kingston Bagpuize & Southmoor.	P6 – take action to increase the frequency of flooding to deliver benefits locally and/or reduce the risk elsewhere

### 2.3.6 Critical drainage areas and surface water management

Defra's Surface Water Management Plan Technical Guidance<sup>11</sup> indicates that the Lead Local Flood Authority (Oxfordshire County Council) have the leadership role in Surface Water Management Plans (SWMPs), although they can delegate it to lower tier councils where appropriate. SWMPs can be carried out at a variety of levels, from the District-wide strategic level to settlements or specific areas. The triggers for requiring a SWMP are:

- There is evidence of historic surface water flooding.
- Significant development or redevelopment poses a risk to existing drainage networks, or an opportunity to resolve known problems.
- Surface water flood risk mapping identifies significant risks.
- Known drainage issues cannot be resolved by a single organisation (for example the Local Authority, Environment Agency or Water Company). A joint strategy needs to be developed in a partnership.

No critical drainage areas have so far been identified by the LLFA, or the lower tier Councils, and as such no SWMPs are currently planned for the two Districts.

## 2.4 Local level

### 2.4.1 Neighbourhood Plans

Another requirement of the FWMA is for councils to provide technical advice and support on neighbourhood's development proposals. The Act enables local people to decide on the location of new housing and business developments through the use of neighbourhood plans.

#### Vale of White Horse Neighbourhood Plans

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

- Faringdon Neighbourhood Plan - undergoing informal consultation with the community, which closed in 9 May 2013.

<sup>11</sup> Defra (March 2010) Surface Water Management Plan Technical Guidance  
<http://www.defra.gov.uk/publications/files/pb13546-swmp-guidance-100319.pdf>  
 2013s6892 VOWH&SODC SFRA Final Report

- Drayton Neighbourhood Plan - the neighbourhood area was approved in February 2013. The Parish Council are preparing the plan and undertaking community consultation events.
- Longworth Neighbourhood Plan - The Parish Council has submitted an application to designate the neighbourhood area. The consultation closes on 22 July 2013.
- Great Coxwell Neighbourhood Plan - the Parish Council has submitted an application to designate the neighbourhood area. The consultation closes on 22 July 2013.

Up-to-date information on Neighbourhood Plans in the district can be found at [www.whitehorsedc.gov.uk/neighbourhoodplans](http://www.whitehorsedc.gov.uk/neighbourhoodplans).

### South Oxfordshire Neighbourhood Plans

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

- Thame Neighbourhood Plan - waiting to be made by the Council
- Woodcote Neighbourhood Plan - out for pre-submission consultation
- Benson Neighbourhood Plan - Plan area designated
- Chalgrove Neighbourhood Plan - Plan area designated
- Dorchester on Thames Neighbourhood Plan - Plan area awaiting designation
- Henley-Harpsden Neighbourhood Plan - Plan area awaiting designation
- Sonning Common Neighbourhood Plan - Plan area under review

Up-to-date information on Neighbourhood Plans in the district can be found at <http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy/neighbourhood-plans>.

## 3 Mapping and the risk based approach

### 3.1 How flood risk is assessed

#### 3.1.1 Definitions

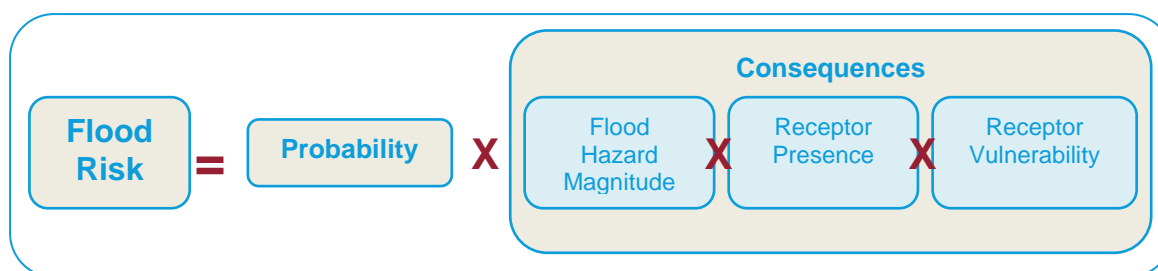
A flood is formally defined in the Flood and Water Management Act<sup>12</sup> as

*"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 exceedence probability (%) (the probability that a certain magnitude of flood will be exceeded in any one year).

<sup>12</sup> Flood and Water Management Act (2010) <http://www.legislation.gov.uk/ukpga/2010/29/contents>  
2013s6892 VOWH&SODC SFRA Final Report



**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 Zones, but should be refined by the SFRA to take into account the probability of flooding, other sources of flooding and the impact of climate change.

The 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 Flood risk mapping

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

- Flood Map
- Flood Map for Surface Water (30 year, 200 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.

### 3.2.1 Flood Map

The Flood Map is made up of a suite of GIS layers, including Flood Zone 2 and 3, Defences, Areas Benefiting from Defences and Flood Storage Areas.

The Flood Zones describe the land that would flood from rivers if there were no defences present (Map 2). 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.

A concept diagram showing the classification of 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

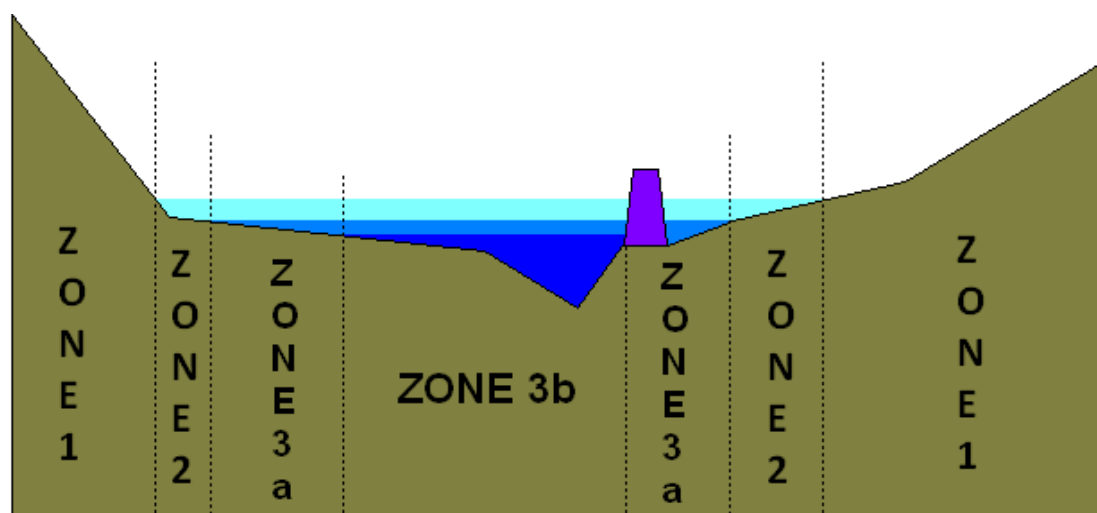


Table 3-1: Flood Zone descriptions

	Probability	Description	Suitable Development*
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	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	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year.	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 and essential infrastructure that has to be there is permitted. Essential infrastructure should pass the Exception Test and 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 should always be used, and can be viewed at <http://www.environment-agency.gov.uk/homeandleisure/37837.aspx>.

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

### 3.2.2 Functional floodplain

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 the Districts and Environment Agency, the following definition of the functional floodplain was agreed:

- Use the 1 in 20 year modelled flood extent wherever hydraulic models are available, with the exception of the Oxford area (Thames Wolvercote to Kennington 2006) where the 1 in 25 year modelled flood extent should be used.
- Elsewhere, take a precautionary approach and assume that Flood Zone 3a represents the functional floodplain

The combined extent is shown in Map 3.

Flood Zones 3a and 3b are collectively referred to as Flood Zone 3.

### 3.2.3 Climate change

The Flood Map supplied by the Environment Agency does not include a layer for climate change impact. Some sensitivity testing was undertaken in 2007 to determine the impact of a 20% increase in flows to represent climate change (as recommended by the NPPF Technical Guidance on the Flood Zones), and it was found that on most watercourses the impact was relatively minor.

It was agreed between the Districts and Environment Agency that the SFRA should:

- Use the 1 in 100 year plus 20% climate change modelled flood extent wherever hydraulic models are available.
- Elsewhere, take a precautionary approach and assume that the Flood Zone 2 outline represents Flood Zone 3 with climate change.

The combined extent is shown in Map 4.

### 3.2.4 Surface water mapping

As part of the PFRA, the Lead Local Flood Authority has stated that the Environment Agency's **Flood Map for Surface Water (FMfSW)** should be used for assessing surface water risk in Oxfordshire (termed 'locally agreed' surface water information). The SFRA will therefore use this same information, in line with the PFRA.

The FMfSW 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 FMfSW 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 FMfSW 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.

Two rainfall events, one with a 1 in 30 and the other with a 1 in 200 chance of occurring in any year, are modelled and mapped.

The FMfSW is provided to Councils for use in SFRA but is not publicly available. The 200 year FMfSW is shown in Map 5. The 30 year layer has not been shown for clarity.

It should be noted that the FMfSW is currently undergoing an update. New mapping has been produced (the Updated Flood Map for Surface Water) and is currently under review by the Environment Agency and the LLFA, but is not yet available for use in the SFRA or to the public. It should be available publicly on the Environment Agency website by the end of 2013.

### 3.2.5 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 in identifying where, for example, further studies may be useful.

The Areas Susceptible to Groundwater Flooding data for the Districts is shown in Map 6.

### 3.2.6 Sewer flood risk mapping

The sewer flooding register provided by Thames Water, is a register held by water companies on the location of properties at risk of foul 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 area is shown in Map 7. 'Overloaded sewers' is the Ofwat definition of flooding due to excessive flows in sewers. Thames Water 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.

The incidents recorded will relate to incidents of flooding due to a wide range of storm return periods, and may include repeated incidents at a single property. Where improvements have been made by Thames Water to rectify a known flooding problem, the affected properties are taken off the register.

Given that only ten years of incidents have been provided, it is reasonable to assume that there are significantly more properties at risk of sewer flooding, but which haven't experienced the rainfall or other conditions to cause flooding during this period. Thames Water do not make available data with any more detailed location information, citing data protection reasons. 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, more reliance 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.



### 3.2.7 Historic Flood Map

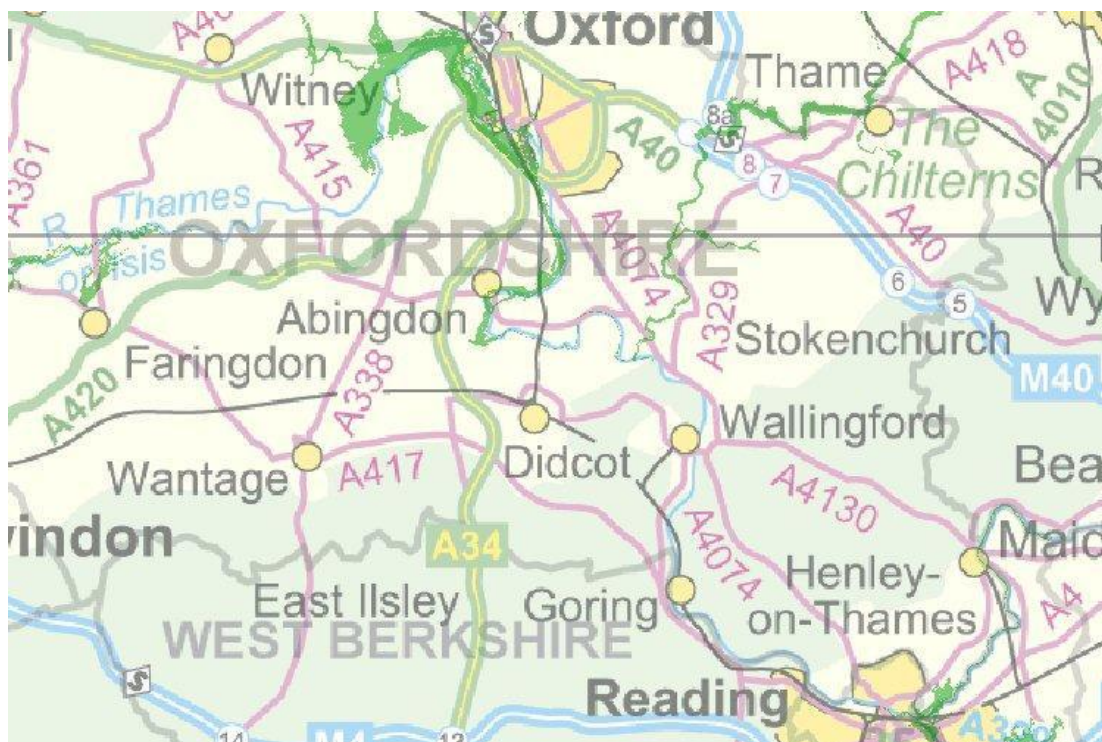
The Environment Agency maintains and updates a **Historic Flood Map (HFM)**, which shows the combined extents of known flooding from rivers, the sea, and groundwater. Events are only included where there is enough information to map them. The layer contains no attributes about the date of the event, or the mechanism of flooding. The HFM is shown in Map 8a.

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.

### 3.2.8 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<sup>3</sup> were meant to be included within this study.

This dataset was not available to the SFRA but it can be viewed on the Environment Agency website under [Risk of Flooding from Reservoirs](#)<sup>13</sup>, and is shown in Figure 3-2.



© Environment Agency copyright and database rights 2013. © Ordnance Survey Crown copyright. All rights reserved. Environment Agency, 100026380.

Figure 3-2: Risk of flooding from reservoirs (extracted from Environment Agency website)

### 3.3 Other flood risk evidence

### 3.3.1 Hydraulic modelling

The Environment Agency has carried out various detailed flood risk mapping studies, which include hydrological assessments and hydraulic models of specific reaches of river. The following studies were available at the time of writing:

- River Thames (Poole Keynes to St Johns), 2000
- River Thames (St Johns to Shifford), 2011

<sup>13</sup> Environment Agency, Risk of flooding from Reservoirs map <http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=en&topic=reservoir>

- River Thames (Shifford to Eynsham) and Windrush (A40 to Thames Confluence), 2011
- River Thames (Eynsham to Sandford), 2000
- River Thames (Wolvercote to Kennington), 2006
- River Thames (Sandford to Whitchurch), 2000
- River Thames (Whitchurch to Henley), 2000
- River Thames (Mapledurham to Sonning), 2011
- River Thames (Henley to Hurley), 2002
- River Ock (Frilford to A34), 2007
- River Ock (A34 to Thames confluence), 2009
- Stert (Harcourt Way to Thames confluence), 2009
- Northfield and Littlemore Brooks, 2011
- Letcombe Brook, 2009
- Moor Ditch (Didcot to Thames confluence), 2007
- Bradford's Brook, 2009
- River Cherwell (Thrupps Bridge to Thames Confluence), 2006
- River Cole EDA (A419 to South Marston Brook), 2011

The Environment Agency's ongoing modelling and mapping programme includes the following planned projects:

- Ewelme Brook, Benson – 2014/15
- Assendon Stream – 2013/14
- Chalgrove Brook, Watlington – 2013/14

As part of the 2007/9 SFRAs, JBA Consulting and HR Wallingford carried out hydraulic modelling of many of the ordinary watercourses in the Districts to provide further information on flood risk in key settlements/potential development areas. The following watercourses were modelled:

- Ewelme Brook, Benson (JBA)
- Assendon Stream and Harpsden Court Stream, Henley-on-Thames (JBA)
- Baldon Brook/Garsington Stream, Northfield Brook/Littlemore Brook and Toot Baldon Ditch/Sandford Brook, Oxford Fringe (JBA)
- Black Ditch, Cuttle Brook and River Thame, Thame (JBA)
- Bradford's Brook/Mill Brook, Wallingford (JBA)
- Larkhill Stream/Wildmoor Brook, River Ock and River Stert/Penn Stream, Abingdon (JBA)
- Woodhill Brook, Wantage/Grove (JBA)
- Moor Ditch and Hakkas Brook, Didcot (HR Wallingford)

### 3.3.2 Topographical data

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

The Environment Agency holds a large number of channel surveys, covering many of the watercourses within the Districts. For some channels only scanned paper drawings are available, for others the data is stored in EEBY format, making import into hydraulic models simpler.

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.

### 3.3.3 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 are shown in Map 9.

### 3.3.4 Flood history

Records of local flooding incidents have been collected from a range of sources. 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?
Environment Agency	Groundwater flooding 2000/1	GIS layer of incidents of groundwater flooding at the property level.	2007
Environment Agency	Groundwater flooding 2004-2013	GIS layer of incidents of groundwater flooding at the property level.	2013
Environment Agency	Groundwater flood locations 2001	GIS layer identifying flow paths of groundwater flooding incidents during the 2001 event.	2007
Environment Agency	Previous FRA reports	FRAs for sites in Didcot - Great Western Park, Ladygrove North, Didcot Power Station Plot 9 and Unit 6, Hawkesworth, Southmead Industrial Estate	2007
SODC	Requests for sandbags	Record of incidents where the District Council were notified, normally to request sandbags. Properties can appear more than once if they have multiple incidents.	2007, updated 2008/9 and 2013
SODC	Monsoon Flood Investigation reports	Several reports into incidents of flooding.	Various
VOWH	Flood Management Database	Records incidents of flooding from all sources, where the District Council have been contacted, normally to provide sandbags.	2007, updated 2008/9 and 2013
VOWH	2007 flood grant claimants	GIS layer of location of claimants of flood grants for properties flooded internally after the 2007 event.	2007
VOWH	Frank Graham & Partners (1986). Land Drainage / Flood Study – Abingdon	Study of Stert and Penn Stream, looking at feasibility of flood alleviation scheme.	2007
VOWH	Parish Council Survey	Results of questionnaire to Parish Councils on flooding	2007
Didcot SFRA	Data collection report	Flood history review of Didcot	2007

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 within the Districts since 1800 is provided in Appendix A.

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

Map 8b summarises the historic flooding information compiled by the Didcot SFRA in 2007.

## 4 Understanding flood risk in the Districts

### 4.1 Introduction

This section assesses flood risk in the Districts 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.

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.

Of 58,749 existing properties within South Oxfordshire, 3356 (6%) are within Flood Zone 2 and 1866 (3%) are within Flood Zone 3. Of 50,931 properties within the Vale, 3183 (6%) are within Flood Zone 2 and 2228 (4%) are within Flood Zone 3.

Fluvial risk is present on both main rivers (which are the responsibility of the Environment Agency) and ordinary watercourses (which are the responsibility of the Councils and riparian owners). The following sections briefly describe fluvial flood risk in the two Districts by watercourse. Map 2 and the GIS layers provided with this report should be referred to for further detail.

#### 4.2.1 Fluvial flood risk by watercourse

##### River Thames

With one of the largest catchment areas in the UK, flooding on the Thames and its larger tributaries is relatively predictable, with lead times being in the order of days rather than hours. There have been many floods over the last century or so, notably 1894, 1947, 1977, 1979, 2000, 2003, 2007 and 2012.

The upper reach of the Thames has a wide rural floodplain and does not pose a high risk to property. The middle reach of the Thames has a substantial history of flooding of urban areas. Outside of the urban areas, the floodplain remains extensive, but less so than the Upper Thames, being typically less than 1km wide. This narrows to around 500m between Goring and Reading, as the river cuts through the Chilterns, with land rising steeply to both banks.

In Botley, whilst the majority of at risk properties are to the left bank within the City of Oxford jurisdiction, the Botley Road area has suffered fluvial flooding in all of the events mentioned above.

In Abingdon, significant areas of residential and town centre development are within the floodplain. Fluvial flooding was experienced in 1894, 1947, 1979, 2000, 2007 and 2012.

Between Abingdon and Wallingford, various settlements lie within or at the edge of the floodplain, including Sutton Courtenay, Appleford, Long Wittenham, Clifton Hampden, Burcot and Shillingford. Wallingford has experienced fluvial flooding to a relatively small number of properties in 1894, 1947, 1968, 2003 and 2007. Tributaries joining the Thames between Abingdon and Wallingford include the Ginge, Moor Ditch / Ladygrove Ditch, Thame and Bradford Brook / Mill Brook. Amongst these, flood risk is most notable on the Ginge at Steventon, with 161 properties at risk from a 100 year event.

Through Goring, Whitchurch and Mapledurham, the floodplain is typically well defined, with only a small number of properties at risk. The Thames then exits the study area as it passes through Reading. Downstream, back in the SODC area, the entire hamlet of Sonning Eye, and part of Playhatch are in the floodplain, with flooding having been recorded in 1947, 2003 and 2007.

Approximately six riverside properties in Shiplake experienced fluvial flooding in 2007, with a larger number at risk within Zones 2 and 3. At Henley, whilst the floodplain is relatively narrow, some flooding to property was reported in 1947, 1990, 2000 and 2003, though not in 2007 or 2012.

### River Cole and tributaries

The River Cole is a tributary of the Upper Thames, forming part of the western boundary of Vale of White Horse District Council. The Tuckmill Brook tributary flows between Shrivenham and Watchfield, with some properties in Northford Close and Lake Road at risk.

### River Ock and tributaries

The River Ock catchment contains a large number of small watercourses, draining a mainly clay catchment between the oolitic limestones (to north) and chalk (to south). In its lower reaches it represents a flood risk to a large number of properties in Abingdon. Flooding was recorded in 1947, 1979, 1992, 2003, 2007 and 2012.

In the upper reaches, its floodplain impacts on parts of several villages, notably Stanford in the Vale (Frogmore Brook), Charney Bassett and Lyford (Ock) and Wantage, Grove and East Hanney (Letcombe Brook). Historic flood events are mapped for the Ock from Charney Bassett downstream.

### River Thames and tributaries

The Thames originates to the north and east of Aylesbury, but flows into the SODC area immediately to the north of Thame. Historic flood outlines are mapped for 1992 and 1993, but no serious property flooding resulted.

In contrast to the majority of the study area, the Thames CFMP has selected the policy: "accept the flood risk - reduce existing flood risk management actions." For the Thames catchment, this would effectively mean allowing increased flooding in undeveloped areas. The Environment Agency anticipate that any flood relief solutions required within the catchment would be localised and would not impact on the wider catchment.

### Other watercourses

Numerous other watercourses (both main river and ordinary watercourses) within the Districts pose a flood risk to small numbers of properties. Where these impact upon the key settlements, they are discussed in Appendix B.

## 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** GIS layers are provided alongside the Flood Map which define national Defences, Areas Benefiting from Defences (ABD) and Flood Storage Areas. These datasets do not identify any assets within either District.

The Environment Agency has provided 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 Map 9, and summarised below.

### 4.3.1 Flood defence structures and raised defences

There are 152 'flood defence structures' in SODC and 195 in VOWH. The vast majority of these are point structures such as flood arches, weirs, locks 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 a small number of minor embankments. Most are privately or Local Authority maintained.

There are 6 'raised defences (man-made)' in SODC and 13 in VOWH. Again these are mostly minor embankments rather than formal flood defences. It does include the embankments of a flood storage area at Tilsley Park in Abingdon and the embankments of Farmoor Reservoir. Farmoor Reservoir is not a flood storage area. It may have an impact on reducing flows in the Thames in some flood events, but its operating regime is not specifically designed to do so.

The **Oxford Flood Risk Management strategy**<sup>14</sup> has been adopted by the Environment Agency to tackle flood risk in Oxford. It includes recommendations for the 'Western Conveyance Channel' to divert flood water around the west and south of Oxford. If built, this would impact

<sup>14</sup> Environment Agency (2010) Oxford Flood Risk Management Strategy <http://www.environment-agency.gov.uk/homeandleisure/floods/127355.aspx>  
2013s6892 VOWH&SODC SFRA Final Report



on a corridor of land within VOWH. The Environment Agency are looking to safeguard this land against development and have requested this to be included in the Local Plan.

#### 4.3.2 Non flood defence structures

There are over 800 'non-flood defence structures' in SODC and over 1300 in VOWH. These include features such as railway embankments, bunds, sheet piling which may affect water level, and also bridges and footbridges. Some of the larger embankments include the railway embankment at Kennington and the railway crossing of the Thames south of Radley. Inspection of LIDAR data and model results indicate that neither of these is likely to have a significant defensive impact, and therefore that any "residual risk" is nominal.

Whilst some minor embankments within the Districts may offer a degree of protection to some areas, historic flood outlines indicate that they are not operating as effective flood defence structures.

#### 4.3.3 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 Districts have a low proportion of culverted watercourse, but where they do exist they can be problematic. Responsibility for maintenance of culverts can be difficult to determine between riparian owners, District and County Councils and the Environment Agency.

All culverts recorded on the Environment Agency's AIMS database are shown on Map 9. The AIMS database only includes culverts on main rivers. The Councils do not keep a formal record of culverts or other assets on ordinary watercourses, however additional culverts of interest have been marked on Map 9, and Council Drainage teams can be contacted for further information on culvert locations.

Notable culverts in the districts include:

- River Stert, Abingdon - Culverted through Abingdon town centre
- Radley Park Ditch, Abingdon - Culverted from the south end of Chilton Close to Radley Road
- Ladygrove Brook, Didcot - Culverted under the Ladygrove Estate.
- Mill Brook, Wallingford - Flows into the head of this culvert were reversed in the 1970s, directing all natural flows into the Bradford's Brook. Only local surface water sewers and highway drainage connect into this culvert.
- Assendon Stream, Henley - The course of Assendon Stream enters a culvert along Fair Mile, but is not recorded on AIMS. A crude route plan was obtained from Oxfordshire County Council. This culvert was found to be in poor condition during the last flood in 2000/1.
- Wheatley Brook, Wheatley - Culverted from west to east under the High Street to Crown Square. Takes high natural flows from surrounding land.
- Town Ditch, Henley - Runs from upper Henley through the town centre between Hart Street and Friday Street. Takes highway drainage and spring flows.

This is by no means an exhaustive list, and risk from culverts should be assessed on a local basis, particularly on ordinary watercourses.

#### 4.3.4 Local flood alleviation schemes

The Councils provided details of schemes carried out on Ordinary Watercourses, funded under the Flood and Coastal Erosion Risk Management Grant in Aid scheme (FCRMGA).

SODC have carried out works at Chalgrove, Roke, Tiddington, Wheatley, Clifton Hampden, East Hagbourne, Nuneham Courtney, Sydenham, Towersey, Thame, Pyrton and Chinnor since 2009, with work at Berrick Salome, Sandford-on-Thames ongoing. Further work at Wheatley is planned in 2013/14. Most of this work is watercourse or culvert improvements, but includes a Property Level Protection (PLP) scheme at Thame.

VOWH has completed schemes at Longcot and East Hanney, and a PLP scheme at Cumnor Road (Oxford), since 2010. A scheme to improve a culvert at Appleton is ongoing and work at Farm Road Abingdon due to start in 2013.

#### 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 5) predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. If the FMfSW indicate 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.

A review of the local flooding history, PFRA, and discussions with Council drainage teams has been undertaken to assess where there are known surface water flooding problems in the Districts. Changes to legislation in recent years means surface water flooding is being recorded as a specific cause of flooding more effectively, so most of the known events are in the last 10 years. The following settlements have suffered surface water flooding problems in recent years:

- Wheatley and Horspath - July and October 2012.
- Berrick Salome/Roke, Chalgrove, Kidlington, Thame, Tiddington and Wheatley (among others mostly in South Oxfordshire District) - June 2008.
- Nuneham Courtenay - January 2003, August 2004, October 2006, July 2007.
- Abingdon, Appleton, Ashbury, Buckland, Charney Bassett, Childrey, Chinnor, Cumnor, Denchworth, Drayton, East Challow, East Hanney, East Hendred, Eaton, Faringdon, Fernham, Fyfield, Frilford, Goosey, Grove, Kingston Lisle, Letcombe Regis, Longcot, Milton, Netherton, Shrivenham, Southmoor, Stanford in the Vale, Sutton Courtney, Uffington, Wantage, West Hendred, Woodcote, Wootton - July 2007.

The July 2007 event was a major incident with flooding occurring from all sources over the course of the event, but the above settlements were specifically recorded as being affected by surface water flooding by the PFRA and the VOWH July 2007 Flooded Properties spreadsheet. There are other more isolated surface water incidents recorded

Many of these areas have received Flood and Coastal Erosion Risk Management Grant in Aid (FCRMGiA) funded flood alleviation works since the events.

#### 4.5 Groundwater flooding

Groundwater flooding can occur, after prolonged periods of high winter rainfall, when the regional water table rises above the land surface and inundates limited areas of low lying ground. It occurs in the unconfined parts of aquifers (where strata comes to the surface). It is often differentiated from fluvial flooding by the clarity of the flood waters.

Amongst the general population there is a poor understanding of groundwater flooding, however, on the basis of experience gained from the two events this century we are now in a better position to predict which areas are likely to experience groundwater flooding.

This type of flooding is particularly disruptive because it can continue for weeks and even months before groundwater levels recede. The consequences of groundwater flooding include, groundwater seeping into dwelling foundations, supercharging of storm/foul sewers, road flooding and road surface damage.

A Defra report into groundwater flooding<sup>15</sup> identified the Environment Agency's Thames West Area (which includes the Districts) as having had the second highest number of groundwater flooding incidents from hard rock aquifers for all Environment Agency regions in 2000/1 (77 incidents) and 2003 (20 incidents). It indicates that the majority of incidents are coincidental

<sup>15</sup> Defra (2004) Strategy for Flood and Coastal Erosion Management: Groundwater Flooding Scoping Study (LDS23)  
2013s6892 VOWH&SODC SFRA Final Report

with the chalk aquifer. It notes that there were no groundwater flooding incidents reported on the oolitic limestones found to the north and west of the Vale area. However, the Environment Agency have observed groundwater flooding at the head waters of the River Thames from Oolitic limestones, although they have not received reports of properties experiencing groundwater flooding. Due to the nature of the flow within Oolitic limestones the duration of the flooding experienced is likely to be shorter than that from the Chalk.

The Environment Agency supplied locations of 62 groundwater flooding reports since 2000, 33 in South Oxfordshire and 29 in the Vale of White Horse. These are shown on Map 6. Fifteen of these incidents were recorded in the winter of 2012/13. In addition, polylines were provided representing flow paths of groundwater flooding paths during the 2000/1 event.

Groundwater flooding also occurs in combination with main rivers. In particular, some areas of Oxford, including South Hinksey, in VOWH District, have suffered basement flooding when groundwater in alluvial gravels has risen, driven by river flooding in the River Thames.

Notable areas that suffer from groundwater-related flooding problems are:

- Assendon Stream: According to the Parish Flooding Survey (2010), approximately 14 properties are estimated to have flooded on the Assendon Stream in 2001 (an ephemeral groundwater fed ordinary watercourse), which flows through Middle Assendon, Lower Assendon, and Henley, before entering a long culvert through Henley. The flood was especially notable on the Assendon Spring because the watercourse is normally dry. Prior to 2001, the stream had last flowed in 1969.
- Harpsden, Henley-on-Thames: A normally dry valley, similar to Assendon Stream (2 incidents in Environment Agency database).
- Ewelme Brook from Ewelme village to east end of Benson: Environment Agency identified as a groundwater flow path, and 1 recorded incident.
- Headwaters of the Stert Brook at Kingston Blount - Environment Agency identified as a groundwater flow path, but no recorded incidents.
- Cumnor and Botley - identified by the council as suffering from groundwater flooding associated with the River Thames gravels. Environment Agency recorded 3 incidents.
- South Hinksey - identified by the council as suffering from groundwater flooding associated with the River Thames gravels.
- Chilton - identified by the council as suffering from groundwater flooding during 2012/13. Environment Agency recorded 1 incident.
- Blewbury - an area close to the edge of the chalk aquifer, where numerous springs flow, forming the streams of the Vale of White Horse. Due to the exceptionally high groundwater levels in 2012-2013 spring heads were observed higher up the valleys as at Blewbury and groundwater could be seen seeping out of the ground over a wide areas as at Hagbourne around the A417.
- Appleford - according to the Environment Agency a couple of properties were flooded in 2013, probably caused by raised ground water levels in gravels which were unable to discharge naturally due to flooding in the River Thames nearby.

## 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.

Many sewers in the county are over 100 years old and little is known about their capacity and state of repair. Since 1980, the Sewers for Adoption guidelines have meant that most new 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). Sewer flooding is therefore a problem that could occur in many locations across the Districts.

The Thames Water sewer flooding register (Map 7) is only available at a 5 digit postcode level. A review of the local flooding history, PFRA, and discussions with Council drainage teams have been undertaken to assess where there are known sewer flooding problems in the Districts. Notable areas where sewer flooding is an issue are:

- South Hinksey and Botley have a history of sewer flooding problems, in combination with other sources. Thames Water has put in a scheme which was completed in December 2012<sup>16</sup>, which was crucial to allowing development to go ahead in Botley. However the area experienced sewer/surface water flooding at end of November 2012, for which Thames Water blamed 'operational reasons'.
- The Manor Road area of Wantage also has a history of sewer flooding incidents<sup>17</sup>, particularly in the last few years.

Other sewer flooding incidents are more isolated, or difficult to distinguish from surface water events. The Vale of White Horse Flooding Database records 42 incidents of flooding related to sewers.

## 4.7 Flooding from reservoirs, canals and other artificial sources

### 4.7.1 Reservoirs

Within the Districts, Farmoor is the most notable reservoir, though numerous smaller reservoirs exist. Farmoor is the only reservoir within the Districts which the Environment Agency identifies as falling under the terms of the Reservoir Act. Reservoirs covered by this act are subject to a high level of regulation and inspection, and are therefore considered to have a low risk of failure.

The risk of inundation to VOWH and SODC 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. The mapping for the Districts shows a significant inundation area from Farmoor reservoir that follows the Thames valley as far as Abingdon, plus several other smaller areas in the Thame and upper Thames catchment (see Figure 3-2). However, the extents of the flooding appear to be within the bounds of the Flood Zones.

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.

### 4.7.2 Canals

The only canal in either District is the Wilts and Berks Canal, which is currently derelict but with plans for restoration by the Wilts and Berks Canal Trust. It originally linked the Thames at Abingdon with the Kennet & Avon Canal near Melksham.

Although derelict, the canal still receives surface water from drains and runoff from the surrounding land, so there is a risk of overtopping if the outlet is overwhelmed or not operating correctly. For example two properties were threatened by flooding at East Challow in the winter of 2012/13 when the outlet from the canal was blocked and surface water drainage filled the canal to capacity.

<sup>16</sup> Water projects online, Botley Sewer Renewal

[http://www.ukwaterprojects.com/case\\_studies/2012/Thames\\_Botley\\_2012.pdf](http://www.ukwaterprojects.com/case_studies/2012/Thames_Botley_2012.pdf)

<sup>17</sup> Herald Series (March 2013) Firm promises to stop the sewage

[http://www.heraldservices.co.uk/news/10310538.Firm\\_promises\\_to\\_stop\\_the\\_sewage/](http://www.heraldservices.co.uk/news/10310538.Firm_promises_to_stop_the_sewage/)



## 4.8 The impact of climate change

The impact of climate change on fluvial flooding has been examined by comparing Flood Zone 3 with the modelled 100 year + 20% climate change outline (where available) (Map 4). This indicates that the impacts of a 20% increase in flows on flood extents will be relatively minor in many areas, but more significant in others. Figure 4-1 illustrates the impacts on Flood Zone 3 on the River Thames as modelled at Burcot, Dorchester and the Wittenhams.

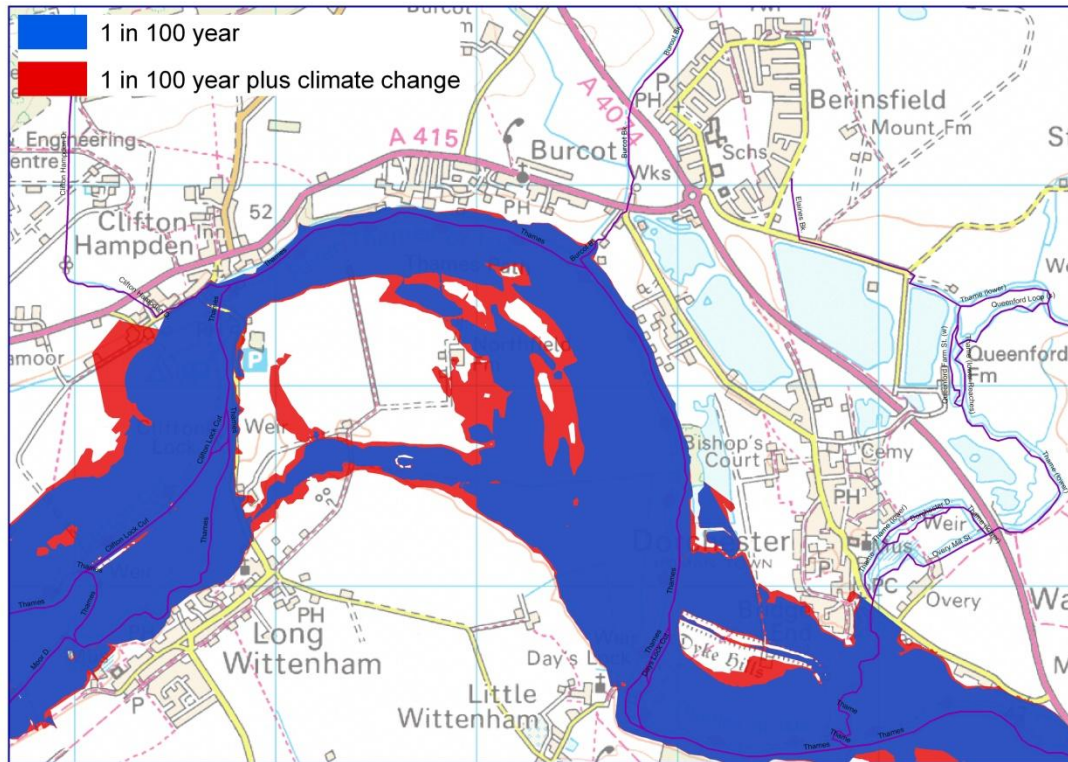


Figure 4-1: Effect of climate change on Flood Zone 3 on the Thames

On minor watercourses, the change to Flood Zone 3 when the 20% increase in flow is applied has been tested in some sample locations and is in most cases very minor, particularly where there is no LIDAR data available.

It should be noted however that even where extent does not increase significantly for a particular event, climate change is still likely to increase the frequency and severity of flooding.

Increased rainfall intensity in the future is likely to increase the likelihood and frequency of surface water flooding. Any locations where surface water or sewer flooding are an issue should consider the impact of climate change on rainfall intensity as outlined in the NPPF Technical Guidance.

Climate change is also likely to result in wetter winters, which may result in more frequent groundwater flooding problems in areas which are already susceptible.

## 5 Review of potential development areas

### 5.1 Introduction

Both Councils have a strong policy of locating development sequentially in areas of lowest flood risk. In VOWH this is covered by Core Policy 32: Flood Risk in the Local Plan, and in SODC it is covered by paragraphs 14.12 and 14.13 on Flood Risk Management in the Core Strategy.

This section, along with the detailed information contained in Appendix B, should provide enough information to enable them to do this and carry out the Sequential Test as outlined in the NPPF Technical Guidance.

Vale of White Horse has identified several strategic sites, Larger Villages and Main Towns. South Oxfordshire has identified one strategic site plus several Larger Villages and Main Towns. The following sections summarise what is known about flood risk from all sources for each of these areas.

### 5.2 South Oxfordshire District Council

At the time of production of the SFRA, South Oxfordshire District Council had just adopted their Core strategy and were about to start work on a Site Allocations DPD.

They identified 12 larger villages (Berinsfield, Benson, Chalgrove, Cholsey, Chinnor, Crowmarsh Gifford, Goring-on-Thames, Nettlebed, Sonning Common, Wheatley, Watlington, Woodcote) and four main towns (Didcot, Henley-on-Thames, Wallingford and Thame) as key settlements for investigation in this SFRA. They also intend to allocate homes at Bayswater Farm.

The SFRA has therefore examined flood risk in and around these settlements.

#### 5.2.1 Summary of key settlements and sites

Table 5-1: Flood risk to South Oxfordshire key settlements

Key settlement	Fluvial		Surface water	Groundwater	Sewer
	Flood Zone 3	Flood Zone 2			
Bayswater Farm	Y	Y	Medium	Low	Low
Benson	Y	Y	Low	High	Low
Berinsfield	Y	Y	Medium	Medium	Low
Chalgrove	Y	Y	High	Medium	Low
Chinnor	N	N	Medium	Medium	Low
Cholsey	Y	Y	Medium	Low	Low
Crowmarsh Gifford	Y	Y	Medium	Medium	Low
Didcot	Y	Y	Medium	Low	Low
Goring-on-Thames	Y	Y	Low	Medium	Low
Henley-on-Thames	Y	Y	Low	High	Low
Horspath	N	N	High	Medium	Low
Nettlebed	N	N	Low	Low	Low
Sonning Common	N	N	Low	Low	Low
Thame	Y	Y	Medium	Low	Low
Wallingford	Y	Y	Medium	Medium	Low
Watlington	Y	Y	Medium	High	Low
Wheatley	Y	Y	High	Low	Low
Woodcote	N	N	Low	Low	Low

Note, this table refers to both the existing village, and the surrounding land.

### 5.3 Vale of White Horse District Council

#### 5.3.1 Summary of strategic sites



Table 5-2: Flood risk to Vale of White Horse strategic sites

Strategic site	Fluvial		Surface water	Ground-water	Sewer
	Flood Zone 3	Flood Zone 2			
Land at Park Road, Faringdon	Immediately adjacent to site.	Immediately adjacent to site	Low	Low	Low
Crab Hill, Wantage	Yes. Tiny area intersects at A417 bridge.	Yes. Tiny area intersects at A417 bridge.	Medium	Low	Low
Valley Park, Didcot	Yes, small area to north of site	Yes, small area to north of site	Medium	Medium to high	Low
Harwell Campus, Harwell	No	No	Medium	Low	Low
Monks Farm, Grove	Yes.	Yes.	Medium	High	Low

### 5.3.2 Summary of key settlements

Table 5-3: Flood risk to Vale of White Horse key settlements

Key settlement	Fluvial		Surface water	Groundwater	Sewer
	Flood Zone 3	Flood Zone 2			
Abingdon	Y	Y	Medium	Low	Low
Botley	Y	Y	High	High	High
Kingston Bagpuize with Southmoor	Y	Y	Medium	Low	Low
Shrivenham and Watchfield	Y	Y	Medium	Low	Low

## 5.4 Site and settlement summary sheets

Flood risk from all sources has been described in more detail and mapped for each key settlement and strategic site. 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:

- Fluvial flood risk summary, Flood Zone map, source of Flood Zone information, flood defences.
- Surface water flood risk summary and Flood Map for Surface Water map
- Groundwater flood risk summary
- Sewer flood risk summary
- Reservoir flood risk summary (where applicable)
- Effects of climate change
- Available survey and detailed modelling
- Implications for development

## 5.5 Increased scope assessment

The NPPF Technical Guidance states that where there is a flood risk to an allocated site, the scope of the SFRA must be increased to provide a more detailed assessment of flood risk to inform the Exception Test if necessary.

As the majority of potential development areas have only been identified at the settlement level for the two Districts, it is not possible or necessary to increase the scope for most of them. However there are two exceptions, Monks Farm, a strategic site in VOWH, and Abingdon.

### 5.5.1 Monks Farm

The Letcombe Brook flows through the centre of the Monks Farm strategic site. The council have allocated the site in the Local Plan, but with the proviso that all development is situated in Flood Zone 1.

After discussion with the Environment Agency, it was decided that the SFRA should increase its scope for this site to clearly define the areas of high flood risk in this allocation, and therefore, to carry out a sequential approach to directing all development.

This additional information has been included in an extended summary sheet for Monks Farm, which can be found in Appendix B.2.3.

### 5.5.2 Abingdon

In Abingdon, redevelopment of the town centre is ongoing within a flood risk area. This has been the subject of separate report to carry out the Sequential and Exception Test<sup>18</sup>.

Hazard maps for the River Stort in central Abingdon were prepared as part of the 2007 SFRA to inform the allocation of sites within the town centre. These are shown in Map 10 to Map 13.

Table 5-4 makes suggestions for how the hazard classifications and vulnerability classes could be used to locate development appropriately within Flood Zone 3.

Table 5-4: Matrix of vulnerability and hazard classification

Hazard classification	Vulnerability				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Not classified	Suitable	Suitable	Suitable	Suitable (but see note 1)	Suitable (but see note 1)
Low (Danger to none)	Suitable	Suitable	Suitable	Suitable (but see note 1)	Suitable (but see note 1)
Moderate (Danger for some)	Possibly Suitable	Possibly Suitable	Suitable (but see note 2)	Suitable	Suitable (but see note 1)
Significant (Danger for most)	Not suitable	Not suitable	Possibly Suitable (but see note 2)	Suitable	Suitable
Extreme (Danger for all)	Not suitable	Not suitable	Not suitable	Suitable	Suitable

Notes:

1. Consider reserving areas of lower hazard for higher vulnerability classes.
2. Safe internal or external escape routes must be provided.

There are proposals to improve flood storage at Tilsey Park on the River Stort, but these are currently still at an options testing stage.

<sup>18</sup> JBA (2010) Sequential and Exception Test for Bury Street and the Charter Area, Abingdon Town Centre. Report on behalf of Vale of White Horse District Council  
<http://www.whitehorsedc.gov.uk/sites/default/files/Sequential%20and%20exception%20test%20for%20Bury%20Street%20and%20Charter%20Area,%20Abingdon.pdf>  
 2013s6892 VOWH&SODC SFRA Final Report

## 6 Guidance for planners and developers

### 6.1 Introduction

Planners and developers should follow the [Environment Agency Flood Risk Standing Advice](#)<sup>19</sup> as a starting point when considering applications for new development. This section will summarise guidance for the Councils on the appropriate planning response for all development in Flood Zones 1, 2, 3a and 3b (from large strategic sites to small windfall sites) and provide guidance for developers in what should be included within an appropriate Flood Risk Assessment. It should be read with reference to Map 2, 3 and 4 which show the location of the Flood Zones.

Table 3 of the NPPF Technical Guide highlights 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, see Figure 2-3. Further detail is provided in the [NPPF Technical Guidance](#).

### 6.2 Permitted development in Flood Zones

#### 6.2.1 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.

#### Developments >1ha in Flood Zone 1

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

- Assess risk from other sources of flooding which are not considered within the Flood Zone maps.
- Recommend mitigation measures in response to any identified flood risk.
- Assess the impact of a proposed development upon surface water drainage following an increase in impermeable area, including the potential impact upon areas and receiving watercourses downstream, and recommend the approach to control surface water discharge.
- Demonstrate the ability to meet the following drainage requirements to avoid increasing flood risk elsewhere:
  - Greenfield discharge rates
  - Attenuation up to the 1% annual probability event plus climate change
  - Consider the use of SuDS

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.

Further information on the details to be provided within the FRA can be found in the [Environment Agency's FRA Guidance Note 1](#)<sup>20</sup>, [CIRIA report C624](#)<sup>21</sup>, and [PPS 25 Practice Guide](#)<sup>22</sup>.

<sup>19</sup> Environment Agency Flood Risk Standing Advice <http://www.environment-agency.gov.uk/research/planning/82584.aspx>

<sup>20</sup> Environment Agency, FRA Guidance Note 1 <http://www.environment-agency.gov.uk/research/planning/82584.aspx>

<sup>21</sup> CIRIA report C624

<sup>22</sup> PPS 25 Practice Guide

## Developments <1ha

If a site within Flood Zone 1 site 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 outlined in [Environment Agency's FRA Guidance Note 1](#)<sup>20</sup>.

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.

### 6.2.2 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. Depending on the type of development proposed, a Flood Risk Assessment may be required, see Table 3 Flood risk vulnerability and flood zone 'compatibility' within the NPPF Technical Guide. 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:

- Consideration of all sources of flooding (e.g. surface water, sewer, and groundwater), not just fluvial flood risk, for the lifetime of the development.
- Demonstration of the ability to avoid increasing flood risk elsewhere through the addition of hard surfaces, to control the potential impact new development may have on the surface water run-off regime. To control the effect of new development on potential depth and speed of flooding to adjacent and surrounding property and to meet the following drainage requirements:
  - Greenfield discharge rates
  - Attenuation up to the 1% annual probability event plus climate change
  - Use of SuDS
- An assessment of the effect of climate change on flood risk.
- Recommendations of mitigation measures in response any identified flood risk.
- Demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account. This includes flood defences, flood resilient and resistant design, escape/evacuation, effective flood warning and emergency planning) are acceptable

Any proposed development will be required to provide evidence that the Sequential Test, and if required the Exception Test, have been passed, see Figure 2-3. 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](#)<sup>20</sup>, [CIRIA report C624](#)<sup>21</sup>, and the [PPS 25 Practice Guide](#).

### 6.2.3 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.

[agency.gov.uk/static/documents/Utility/FRAGuidanceNote1\\_v3.1.pdf](https://www.agency.gov.uk/static/documents/Utility/FRAGuidanceNote1_v3.1.pdf)

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

22 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](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7772/pps25guideupdate.pdf)

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

The FRA should:

- Consider all sources of flooding (e.g. surface water, sewer, and groundwater), not just fluvial flood risk.
- Demonstrate the ability to meet the following drainage requirements to avoid increasing flood risk elsewhere:
  - Greenfield discharge rates
  - Attenuation up to the 1% annual probability event plus climate change
  - Use of SuDS
  - Assess the effect of climate change on flood risk.
- Consider the residual risks behind defences, if present.
- 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.
- 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 outside of the floodplain.
  - The site is designed sequentially. Relocate existing development to land in zones with a lower probability of flooding. Ensure mitigation measures are provided in response to flood risk and
  - Safe access and egress from the proposed development to safe ground can be assured.

Further information on the details to be provided within the FRA can be found in the [Environment Agency’s FRA Guidance Note 3](#)<sup>23</sup> and the NPPF Technical Guidance.

#### 6.2.4 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 built within the functional floodplain should:

- Remain operational and safe for users in times of flood;
- Result in no net loss of floodplain storage;

<sup>23</sup> Environment Agency, FRA Guidance Note 3

- Not impede water flows; and
- Not increase flood risk elsewhere.

The NPPF Technical Guidance recommends that Local Planning Authorities define the functional flood plain in discussion with the Environment Agency. This was done at project meetings for this SFRA.

Flood Zone 3b should be considered as the 1 in 20 year flood extents where these have been modelled and mapped, with the exception of the Oxford area (Thames Wolvercote to Kennington 2006) where the 1 in 25 year modelled flood extent should be used. 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 3).

The Councils 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 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 6.2.6)

#### 6.2.5 Dry islands

Both Districts contain numerous isolated areas of Flood Zone 1 where land rises above the Flood Zone 3 level (see Figure 6-1). These areas require special consideration as they can present hazards in terms of access and egress in a flood event.

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. The Councils 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.<sup>24</sup>

<sup>24</sup> 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>  
2013s6892 VOWH&SODC SFRA Final Report



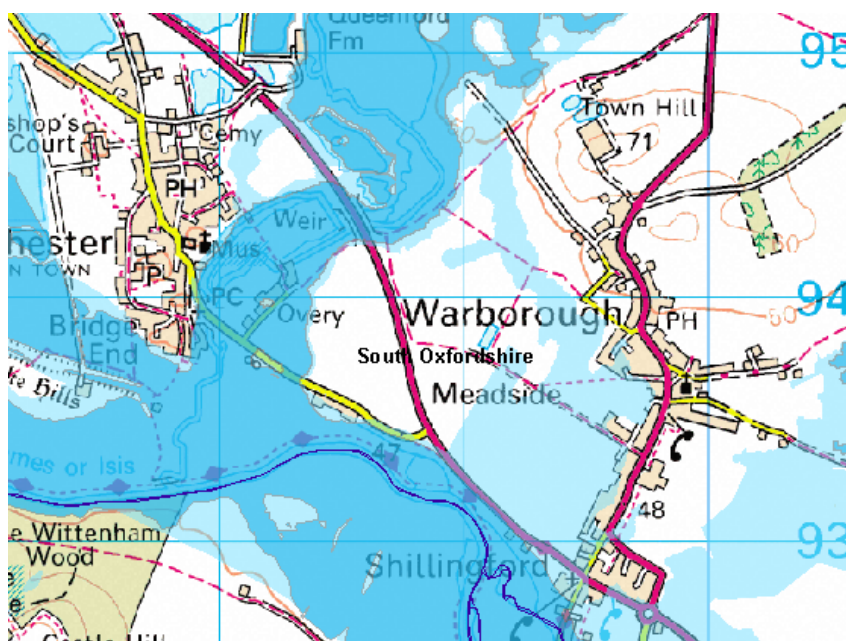


Figure 6-1: Example of a dry island between Warborough and Dorchester

#### 6.2.6 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.

#### 6.2.7 Planning policies for existing settlements within Flood Zones 2 and 3

Below are recommendations for specific policies within Flood Zones 2 and 3 which could be applied following a Sequential Test. There is an opportunity for both SODC and VOWH to incorporate these policies into the Site Allocations and Development Policies and the Local Plan 2029 Part 2 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.

**Residential Infill:** Residential infill (for example construction of a new property in the garden of an existing property) will be required to pass the Sequential Test within established residential areas in Flood Zones 2 and 3.

**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.

## 6.3 Flooding from other sources

Planners and developers should use the evidence and maps presented in this SFRA, along with other records, to identify where there is significant evidence of other sources flooding at all sites, including those in Flood Zone 1. Recommended criteria for identifying significant evidence of flooding from other sources, using this SFRA, are:

Table 6-1: Identifying significant evidence of flooding from other sources

Source of Flooding	Sources of Evidence	Criteria for evidence of "significant risk"
Historic flooding	Map 8	Any reliable evidence of historic flooding at or adjacent to the site.
Minor watercourses	Appendix B	Proximity to the watercourse
Surface water	Map 5 and Appendix B	Predicted surface water depths greater than 0.3m at or adjacent to the site.
Groundwater	Map 6 and Appendix B	Risk in highest category on AStGWF map, supported by evidence of groundwater events in the local area.
Sewer	Appendix B.	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 <a href="#">Risk of Flooding from Reservoirs</a> <sup>13</sup> ,	Within flood envelope on Environment Agency reservoir maps

In considering allocations or applications for development on sites with a risk of other sources flooding, planners should:

- Provide a detailed assessment of the risk from that source, for example using hydraulic modelling, surface water modelling or groundwater investigations as appropriate.
- Sequentially design the site to locate the built element of the development away from the source of flood risk.
- Ensure that the development will not make flooding any worse, and if possible reduce the level of flood risk, e.g. by preserving surface water flow routes.
- Consider the effect of climate change on flooding from other sources.
- Ensure that suitable mitigation measures against flooding from other sources are included in the development.
- Substitute less vulnerable development types for those incompatible with the degree of flood risk.

## 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 a speculative stage. Any locations where surface water or sewer flooding are an issue should 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.

Redevelopment of brownfield sites offers the opportunity to remove connectivity to foul or combined sewerage systems, with consequent benefits for reducing sewer flooding and the potential of pollution from combined sewer overflows (CSOs).

#### 6.4.1 Runoff rates

The design philosophy for greenfield sites requires that site drainage be limited to the greenfield runoff rate, up to the 1 in 100 year design event. Guidance on calculating greenfield runoff rates is given in the [Defra/EA guide to preliminary rainfall runoff management for developments](#)<sup>25</sup>.

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.

#### 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.

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.

Oxfordshire County Council will become a SuDS Approval Body (SAB) by the enactment of Schedule 3 of the Flood and Water Management Act 2010, which is likely to be from April 2014. This means that all new development which has surface water drainage implications will potentially require SAB approval and need to conform to National and Local Standards. In the interim Oxfordshire County Council has taken a pro-active stance to its role and, relative to many other Lead Local Flood Authorities, has been actively involved in assessing the suitability of SuDS schemes for new development, working with colleagues in Highways, Development Control, City and District Councils and developers.

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

- [Susdrain website](#)<sup>26</sup> - online community for delivering sustainable drainage
- CIRIA documents - there are several CIRIA guides relating to SuDS, most notably The SuDS Manual<sup>27</sup>, although this is currently undergoing an update. The Susdrain website is a good guide to the available documentation.
- [Environment Agency SuDS guidance](#)<sup>28</sup> - Environment Agency advice for developers
- [Interim Code of Practice for Sustainable Drainage Systems](#)<sup>29</sup>

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

### 6.5 Wastewater

Major developments must carry out wastewater capacity checks and should liaise with Thames Water at an 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.

<sup>25</sup> 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>

<sup>26</sup> Susdrain website <http://www.susdrain.org/>

<sup>27</sup> CIRIA (2007) The SuDS Manual (C697)

<sup>28</sup> Environment Agency SuDS guidance <http://www.environment-agency.gov.uk/business/sectors/39909.aspx>

<sup>29</sup> 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](http://www.environment-agency.gov.uk/static/documents/Business/icop_final_0704_872183.pdf)

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.

## 6.6 Making development safe

### 6.6.1 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. 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 [PPS25 practice guide](#)<sup>22</sup>, 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, raising flood levels, non-return valves.
- 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 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](#)<sup>30</sup>.

### 6.6.2 Safe access and egress

For development in Flood Zone 3 it is necessary to provide safe access and egress during a flood.

'Safe' access should remain dry for 'more' and 'highly vulnerable' uses and should preferably be dry for other uses such as 'less vulnerable' land use classifications.. 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.

The developer will be asked (if this is not already included in the FRA) to review the acceptability of the proposed access using the 'Flood Risk to People' FD 2320 calculator. In this instance it needs to be demonstrated that depths and velocities of flood water will be acceptable to the 'risks to some' category of this calculator.

## 6.7 Water quality and biodiversity

All development should assess the impact of site drainage on the 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.

## 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, the Councils 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.

<sup>30</sup> 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](http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf)  
2013s6892 VOWH&SODC SFRA Final Report

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<sup>31</sup>. 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 Land Drainage Consent from the Environment Agency (in the case of Main rivers) or from the District Councils 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.

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.

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<sup>32</sup>.

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

## 6.10 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 the Districts, 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 the development.

## 6.11 Climate change adaptation and mitigation

An important part of the SFRA analysis process is the consideration of future climate change and the increased impact that development may have as a result of that climate change. When reviewing development plans it is important to understand not only the current predicted flood risk to a site but also the flood risk for the life time of the development. For residential development the analysis is undertaken based on a development lifetime of 100 years. The

<sup>31</sup> 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](http://www.environment-agency.gov.uk/static/documents/1_GETH1106BLNE-e-e(1).pdf)

<sup>32</sup> CIRIA (2010) Culvert Design and Operation Guide. CIRIA report C689  
2013s6892 VOWH&SODC SFRA Final Report



focus has been on new development however the key features apply equally to retro-fit of adaptation and mitigation measures to existing development.

### 6.11.1 Adaptation

The UK Climate Change Impacts Programme (UKCCIP) report [Identification of Adaptation Options](#)<sup>33</sup> presents a framework for identifying and appraising adaptation measures.

Adaptation options can be grouped into four categories, which are discussed below:

#### No-regrets options

No-regrets options are adaptive measures that deliver benefit whatever the extent of future climate change. Those relevant to the SFRA include the following examples:

- Avoiding building in high-risk areas (e.g. flood plains) when locating development (Sequential Test)
- Reducing water usage in new development
- Building/designing property and buildings to minimise over-heating in summer months through the use of green space and running water.
- Reducing the consequences of flooding (increasing resilience) through the use of water-resistant materials for floors, walls and fixtures, and the siting of electrical controls, cables and appliances at a higher than normal level.

Such options will require investments but overall are at least cost neutral when the immediacy of the targeted risks and realised benefits are considered.

#### Low-regrets options

Low-regret adaptation options include actions or activities that directly target the consequences of climate change but have a low relative cost. Those relevant to the SFRA include:

- Building extra climate headroom in new developments to allow for further modifications (e.g. increased drainage and increased finished floor level)
- Restricting the type and extent of development in flood-prone areas
- Promoting the creation and preservation of space (e.g. verges, agricultural land, and green urban areas, including roofs) in support of additional temporary storage of runoff or flood water.
- Sharing in developing and operating additional water storage facilities (e.g. Community groups, Local Flood Risk Management partnership working arrangements to identify and implement measures).
- Improving the flood resilience of critical infrastructure, when it is renewed (such as electricity sub stations).

Both no- and low-regrets options have merit in that they are directed at maximising the return on investment when certainty of the associated risk is low.

#### Win-Win options

Win-win adaptation options are measures that have the desired result in terms of minimising the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits.

- Flood management that includes creating or re-establishing flood plains which increase flood management capacity and support biodiversity and habitat conservation objectives;
- Improving preparedness and contingency planning to deal with risks (including climate);
- Green roofs and green walls which have multiple benefits in terms of reducing building temperature and rainfall runoff from buildings, and increased green spaces within urban areas, but also reduces energy use for both heating and cooling.
- Flood mitigation measures that also contribute to improved water quality within the catchment (e.g. SuDS measures that improve the quality of discharges to the watercourses)

<sup>33</sup>UK Climate Change Impacts Programme, Identifying adaptation options [http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ID\\_Adapt\\_options.pdf](http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ID_Adapt_options.pdf)



### Flexible or adaptive management options

Flexible or adaptive management adaptation options involve putting in place incremental adaptation options, rather than undertaking large-scale adaptation in one fell swoop. Measures are introduced through an assessment of what is appropriate today, but are designed to allow for incremental change, including changing tack, as knowledge, experience and technology evolve.

Examples of flexible or adaptive management adaptation options that are relevant to the SFRA include:

- Delay implementing specific adaptation measures while improving understanding of risk
- Introducing progressive withdrawal from areas at risk of flooding and creation or re-establishment of floodplains consistent with risks and development lifetimes
- Progressive development and investments in adaptation measures consistent with projected changes in climate (e.g. progressive investments in defence maintenance and level rising to maintain status quo).

Flexible or adaptive management options are perhaps the most important to plan ahead of time and should be a key feature of any local flood risk management plan. By identifying this type of opportunity early on it is possible to invest in a flexible plan of action and avoid repetition of work each time the scheme or measure is reviewed. Such measures also allow for careful financial management of the funding which should spread the whole life cost across a number of different funding streams as they become available.

#### 6.11.2 Mitigation measures

New development and re-development present an important opportunity to 'design-in' capacity for climate change mitigation into new development. The key opportunity is to build in additional capacity into systems to counter the predicted effects of climate change. This form of adaptation linked to new development is particularly important in densely developed urban areas, where it is possible to gradually introduce measures that contribute to a reduction in the overall effects of climate change in subsequent planning cycles and periods of redevelopment.

By requiring sites to mitigate today for the effects of 100 years of climate change it has the additional benefit of introducing local capacity in the present day systems. The mitigation schemes that include provision for the level of service, which will be required in 100 years, will provide an augmented level of service under present day conditions.

## 7 Summary and conclusions

The existing South Oxfordshire and Vale of White Horse SFRA (2009) and Didcot SFRA (2007) have been updated to reflect changes in policy and legislation, and bring the planning context and flood risk information up to date.

The SFRA provides general advice for planners and developers on:

- Sources of flood risk mapping and other evidence to inform the Sequential Test
- Summarises 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 Councils as potential development areas at the time of writing.

It is important to remember that information on flood risk is being updated continuously. This is particularly true now that the Councils 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 have been carried out, this will also affect the definition of the functional floodplain (Flood Zone 3b) and the climate change outline. The Flood Map for Surface Water is currently undergoing an update and should be released and available to the public by the end of 2013.

As the Councils move forward with their Local Plans and Site Allocations DPDs, 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 both in the relatively early stages of the site allocation process, the Councils 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)

Vale of White Horse planning website

<http://www.whitehorsedc.gov.uk/services-and-advice/planning-and-building/planning-policy>

Vale of White Horse Neighbourhood plans

[www.whitehorsedc.gov.uk/neighbourhoodplans](http://www.whitehorsedc.gov.uk/neighbourhoodplans).

South Oxfordshire planning website

<http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy>

South Oxfordshire Neighbourhood Plans

<http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy/neighbourhood-plans>.

JBA (2010) Sequential and Exception Test for Bury Street and the Charter Area, Abingdon Town Centre. Report on behalf of Vale of White Horse District Council

<http://www.whitehorsedc.gov.uk/sites/default/files/Sequential%20and%20exception%20test%20for%20Bury%20Street%20and%20Charter%20Area,%20Abingdon.pdf>

### Lead Local Flood Authority flood risk management documents

Oxfordshire County Council Local Flood Risk Management Strategy website

<http://www.oxfordshire.gov.uk/cms/content/oxfordshire-local-flood-risk-management-strategy>

Oxfordshire County Council (June 2011) Preliminary Flood Risk Assessment

<http://www.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/environmentandplanning/flood/pfra/PFRApreliminaryreport.pdf>

### 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](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf)

Technical Guidance to the National Planning Policy Framework, Department of Communities and Local Government (2012)

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/6000/2115548.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf)

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

## Environment Agency resources and guidance

Environment Agency website, Flood information

<http://www.environment-agency.gov.uk/homeandleisure/floods/default.aspx>

Environment Agency, Risk of flooding from reservoirs map

[http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&p=map&textonly=off&lang=\\_e&topic=reservoir](http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&p=map&textonly=off&lang=_e&topic=reservoir)

Environment Agency, Flood Map (Risk of flooding from rivers and the sea)

[http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&p=map&textonly=off&lang=\\_e&topic=floodmap](http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&p=map&textonly=off&lang=_e&topic=floodmap)

Environment Agency Flood Risk Standing Advice

<http://www.environment-agency.gov.uk/research/planning/82584.aspx>

Environment Agency, FRA Guidance Note 1

[http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote1\\_v3.1.pdf](http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote1_v3.1.pdf)

Environment Agency, FRA Guidance Note 3

[http://www.environment-agency.gov.uk/static/documents/Utility/FRAGuidanceNote3\\_v3.1.pdf](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://www.environment-agency.gov.uk/static/documents/Business/SequentialTestProcess\\_v3.1.pdf](http://www.environment-agency.gov.uk/static/documents/Business/SequentialTestProcess_v3.1.pdf)

Environment Agency SUDS guidance

<http://www.environment-agency.gov.uk/business/sectors/39909.aspx>

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](http://www.environment-agency.gov.uk/static/documents/1_GETH1106BLNE-e-e(1).pdf)

Environment Agency (2010) Oxford Flood Risk Management Strategy

<http://www.environment-agency.gov.uk/homeandleisure/floods/127355.aspx>

Environment Agency (2008) Thames Catchment Flood Management Plan

<http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/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=/contentmanagemet/contentdisplay.aspx&contentfileid=1417](http://www.ciria.org/service/AM/ContentManagerNet/Search/SearchRedirect.aspx?Section=Search1&content=product_excerpts&template=/contentmanagemet/contentdisplay.aspx&contentfileid=1417)

CIRIA (2007) The SuDS Manual (C697) (can be purchased at [www.ciria.org](http://www.ciria.org))

CIRIA (2010) Culvert Design and Operation Guide. CIRIA report C689 (available free by registering at [www.ciria.org](http://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](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](http://www.ukcip.org.uk/wordpress/wp-content/PDFs/ID_Adapt_options.pdf)



Offices at

**Atherstone**

**Doncaster**

**Edinburgh**

**Haywards Heath**

**Limerick**

**Newcastle upon Tyne**

**Newport**

**Saltaire**

**Skipton**

**Tadcaster**

**Thirsk**

**Wallingford**

**Warrington**

Registered Office

**South Barn**

**Broughton Hall**

**SKIPTON**

**North Yorkshire**

**BD23 3AE**

t: +44(0)1756 799919

e: [info@jbaconsulting.com](mailto:info@jbaconsulting.com)

Jeremy Benn Associates Ltd

**Registered in England**

**3246693**



**Visit our website**

[www.jbaconsulting.com](http://www.jbaconsulting.com)