



3.5 Sewer flood risk mapping

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

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

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

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

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

3.6 Historic Flood Map

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

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

3.7 Risk of flooding from reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Maps (NRIM) study. All reservoirs with an above ground storage capacity of 25,000 m³ were meant to be included within this study.

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

3.8 Other flood risk evidence

3.8.1 Hydraulic modelling

Existing Environment Agency detailed hydraulic models include:

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

¹⁷ Environment Agency, Risk of flooding from Reservoirs map <http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=reservoir#x=357683&y=355134&scale=2>
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- River Thames (Main River Limit to St John's) - 1D/2D ISIS-TUFLOW model, completed 2014.
- River Windrush at Bourton-on-the-Water - 1D/2D ISIS-TUFLOW model, completed 2015.

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

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

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

3.8.2 Topographical data

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

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

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

3.8.3 Assets and infrastructure

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

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

The available flood defence data is shown in Map 1.

3.8.4 Flood history

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

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

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



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

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

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



4 Understanding flood risk in the District

4.1 Introduction

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

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

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

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

Guidance on the planning implications is given in Chapter 6.

4.2 Fluvial flood risk

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

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

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

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

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

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

4.2.1 Fluvial flood risk by watercourse¹⁹

Main rivers

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

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

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



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

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

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

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

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

Ordinary watercourses

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

4.3 Fluvial defences, assets and structures

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

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

4.3.1 Flood defence structures and raised defences

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

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

4.3.2 Culverts

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



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

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

Table 4-2: Notable Culverts in the District

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

4.3.3 Local flood alleviation schemes (FAS)

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

Table 4-3: Completed Local Flood Alleviation Schemes ²⁰

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

Table 4-4: Ongoing Local Flood Alleviation Schemes ²¹

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

²⁰ see Note 18

²¹ see Note 18



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

4.4 Surface water flooding

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

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

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

Surface water flooding is a problem throughout the District with reported incidents referring to runoff from hills and drains being unable to cope with storm water. In the July 2007 event, surface water was the most frequently cited source of flooding throughout the district²².

4.5 Groundwater flooding

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

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

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

²² Cotswold District Council (2007) First Phase Draft Report 18 February 2008 Report no: 0001-NE02933-WXR-03 2016s3821 Cotswold SFRA Update Final (May 2016)