Cotswold District Council Level 1 Strategic Flood Risk Assessment

Final Report

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This report describes work commissioned by Joanne Corbett, on behalf of Cotswold District Council, by an instruction dated 28 August 2021. The Client's representative for the contract was Joanne Corbett. Laura Thompson and Mike Williamson of JBA Consulting carried out this work.

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Abbreviations

AEP	Annual Exceedance Probability
CC	Climate Change
CDC	Cotswold District Council
CFMP	Catchment Flood Management Plan
CSO	Combined Sewer Overflow
Defra	Department for Environment Food & Rural Affairs
DLUHC	Department for Levelling Up, Housing and Communities
EA	Environment Agency
FAS	Flood Alleviation Scheme
FCERM	Flood and Coastal Erosion Risk Management
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRCC-PPG	Flood Risk and Coastal Change planning Practice Guidance
FRMP	Flood Risk Management Plan
FRR	Flood Risk Regulations
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
GI	Green Infrastructure
HFM	Historic Flood Map
LA	Local Authority
LDP	Local Development Plan
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	Metres above Ordnance Datum
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
PFR	Property Flood Resilience
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
RBD	River Basin District
RBMP	River Basin Management Plan
RFCC	Regional Flood and Coastal Committee

RFO	Recorded Flood Outline
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water
SA	Sustainability Appraisal
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SuDS	Sustainable Drainage System
SWMP	Surface Water Management Plan
WCS	Water Cycle Study
WFD	Water Framework Directive
WwNP	Working with Natural Processes

Executive Summary

This Level 1 Strategic Flood Risk Assessment (SFRA) is an update to the previous SFRA, completed in 2016, using up-to-date flood risk information together with the most-current flood risk and planning policy available from the National Planning Policy Framework (NPPF) (2021) and Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG).

The Level 1 SFRA is focused on collecting readily available flood risk information from a number of stakeholders, the aim being to help identify the number and spatial distribution of flood risk sources present throughout the Cotswold District Council's Local Plan area to inform the application of the Sequential Test.

Cotswold District Council (CDC) requires this Level 1 SFRA to initiate the sequential risk-based approach to the allocation of land for development and to identify whether application of the Exception Test is likely to be necessary. This will help to inform and provide the evidence base for the update to the Local Plan.

The LPA provided its latest assessed sites data and information. An assessment of flood risk has been undertaken on all sites provided to assist the LPA in its decision-making process for sites to support the Local Plan.

A number of CDC's allocation sites are shown to be at varying risk from fluvial and surface water. Development consideration assessments for all assessed sites are summarised through a number of strategic recommendations within this report and the development sites assessment spreadsheet in Appendix C. The strategic recommendations broadly entail the following:

- Strategic Recommendation A – recommend for withdrawal;
- Strategic Recommendation B – Level 2 SFRA. Exception Test required for more vulnerable sites;
- Strategic Recommendation C – allocate and progress to developer-led FRA; and
- Strategic Recommendation D – development could be allocated on flood risk grounds based on the evidence of this Level 1 SFRA; LPA to make decision on allocation.

A total of 1,089 sites were screened against the latest available flood risk information, all of which were assessed as more vulnerable residential sites.

Strategic Recommendation A applies to 129 sites. Strategic Recommendation B applies to 246 sites. There are 325 sites to which Strategic Recommendation C applies. Strategic Recommendation D applies to 389 sites with all of these being in Flood Zone 1 of the Flood Map for Planning, not modelled to be at additional risk from climate change, less than 1 hectare in size, and at very low risk of surface water flooding.

See Appendix C for a full breakdown of the risk at each site and Appendix E which discusses the identified risks.

SFRA Recommendations

The main planning policy and flood risk recommendations to come out of this SFRA are outlined briefly below and are based on the fundamentals of the National Planning Policy Framework and the Flood Risk and Coastal Change Planning Practice Guidance. Section 6 of this report provides further details.

SFRA recommendation:

- No development within the functional floodplain, unless development is water compatible;
- Surface water flood risk should be considered with equal importance as fluvial/tidal risk;
- The sequential approach must be followed in terms of site allocation and site layout;
- Ensure site-specific Flood Risk Assessments are carried out to a suitable standard, where required, with full consultation required with the LPA/LLFA, the EA, Thames Water, Severn Trent and Wessex Water;
- Appropriate investigation and use of SuDS;
- Natural Flood Management techniques must be considered for mitigation;
- Phasing of development must be carried out to avoid possible cumulative impacts; and
- Planning permission for at risk sites can only be granted by the LPA following a site-specific FRA.

Included within this Level 1 SFRA, along with this main report, are:

- Discussion of relevant Planning Framework and Flood Risk Policies – Appendix A;
- Detailed interactive GeoPDF maps showing all available flood risk information together with the assessed sites – Appendix B;
- Development site assessment spreadsheet detailing the risk to each site with recommendations on development – Appendix C;
- A note on the delineation of the functional floodplain following discussion and agreement between CDC and the EA – Appendix D;
- Discussion of the strategic recommendations outlined in the site assessment spreadsheet – Appendix E;
- Key settlement summaries – Appendix F;
- Discussion of existing flood risk issues in neighbouring authorities – Appendix G;
- Cumulative Impact Assessment methodology – Appendix H; and
- Discussion of historical flood events within CDC; Appendix I.

1 Introduction

1.1 Commission

Cotswold District Council (CDC) commissioned JBA Consulting to prepare a comprehensive update to the Cotswold District Council Level 1 Strategic Flood Risk Assessment (SFRA), published July 2008, as a component of a wider assessment for the County of Gloucestershire. JBA was previously commissioned to review and amend the SFRA and replaced it with a SFRA Level 2 in 2016 to support the Local Plan (adopted 2018). CDC requires this update to bring the SFRA fully in line with the latest Government planning policy, Environment Agency (EA) guidance and flood risk information.

In June 2020 CDC agreed to undertake a partial update for the Local Plan. The update focuses only on issues that need modification within the plan period (to 2031) and does not invite consultation and examination on matters beyond the plan period.

A new project timetable was agreed by Cabinet in May 2021 and is set out in the Local Development Scheme (LDS). The LDS sets out the Council's work programme in relation to the main planning policy documents over the period 2021-2024. These documents include the Local Plan (the Development Plan for the area) and associated documents, such as Supplementary Planning Documents (SPDs). This SFRA update will inform the Regulation 18 part of the Local Plan update and replaces the draft Level 1 SFRA completed in March 2022.

1.2 Purpose of the Strategic Flood Risk Assessment

All local planning authorities should produce a Level 1 SFRA. A Level 2 SFRA may also be required depending on whether the Local Authority has plans for development in flood risk areas, identified through this Level 1 SFRA. The EA's SFRA guidance for local planning authorities (updated March 2022, at the time of writing) states:

"*Your SFRA will help your planning authority make decisions about:*

- *your local plan or spatial development strategy*
- *individual planning applications*
- *how to adapt to climate change*
- *future flood management*
- *emergency planning (the resources needed to make development safe)*
- *site masterplans and local design guidance or codes*
- *infrastructure planning*
- *community infrastructure levy and planning obligations*

You also need it to help you:

- *carry out the sequential test for the local plan or spatial development strategy, and individual planning applications*

- *do the exception test, when you're proposing to allocate land for development in flood risk areas*
- *establish if a development can be made safe without increasing flood risk elsewhere*
- *decide when a flood risk assessment will be needed for individual planning applications*
- *identify if proposed development is in functional floodplain*
- *do the sustainability appraisal of the local plan or spatial development strategy*."

1.3 Cotswold Level 1 Strategic Flood Risk Assessment

The Cotswold Level 1 SFRA has been carried out in accordance with Government's latest development planning guidance including the National Planning Policy Framework[1] (NPPF), first published March 2012 and last updated July 2021, and the accompanying flood risk and planning practice guidance, the Flood Risk and Coastal Change Planning Practice Guidance[2] (FRCC-PPG), first published 2014 and last updated August 2022. The latest SFRA guidance has also been considered, including 'How to prepare a strategic flood risk assessment[3]' guidance, September 2020, and the 'Strategic flood risk assessments a Good Practice Guide[4]' guidance, December 2021.

This SFRA makes use of the most up-to-date flood risk datasets, available at the time of submission, to assess the extent of risk, at a strategic level, to potential development sites identified by CDC which acts as the LPA. Gloucestershire County Council (GCC) acts as the Lead Local Flood Authority (LLFA) covering the Cotswold district.

The SFRA Appendix contains interactive GeoPDF maps (Appendix B) showing the existing and potential development sites overlaid with the latest, readily available, gathered flood risk information along with a Development Site Assessment spreadsheet (Appendix C) indicating the level of flood risk to each site following a strategic assessment of risk. Each site is assigned a strategic recommendation, discussed in Appendix E. This information allows the LPA to identify the strategic development options that may be applicable to each site and to inform on the application of the Sequential Test.

1 National Planning Policy Framework; Ministry of Housing, Communities & Local Government, 2021
2 Flood Risk and Coastal Change Planning Practice Guidance; Ministry of Housing, Communities & Local Government, 2021
3 How to Prepare a Strategic Flood Risk Assessment, Defra and Environment Agency, 2020
4 Strategic flood risk assessments A GOOD PRACTICE GUIDE, Report produced using Environment Agency research on 'using flood risk information in spatial planning' (2019-2020), 2021

1.4 Objectives

The aims and objectives of this Level 1 SFRA, in line with the NPPF (2021), FRCC-PPG (2022), EA SFRA guidance (2022), EA Good Practice guide (2021) and more specifically included in CDC's Brief, are to:

- Provide a sound and up to date strategic assessment of the risk to Cotswold of flooding from all sources including fluvial from main rivers (Flood Map for Planning) and ordinary watercourses, designation of functional floodplain (Flood Zone 3b), surface water (pluvial), sewer, groundwater, residual risk from reservoirs and canals, taking account of the impacts of climate change where data is available, focusing on priority areas,
- Provide a sound and up to date evidence base to inform the preparation of the new Local Plan,
- Identify the requirements for site-specific flood risk assessments, including those at risk from sources other than river flooding,
- Determine requirements for emergency planning and flood warning,
- Assess flood defence infrastructure, including defence types, Standards of Protection, condition as per T98 specifications, and associated residual risk,
- Document any current or planned EA or LLFA Flood and Coastal Erosion Risk Management (FCERM) schemes, strategies and plans,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance, storage of floodwater through appropriate Sustainable Drainage Systems (SuDS) and possible areas of critical drainage. Also, through natural flood management and the use of green infrastructure and open space for flood storage and amenity use through blue / green infrastructure. Consideration of Property Flood Resilience (PFR) measures, including retrofitting SuDS for existing communities and formulating policy for surface water management from new development i.e. restrictions to greenfield rates, percentage betterments on current, etc.,
- Similarly, consider how SuDS can contribute towards improving water quality and providing alternative water resources,
- Provide a reference and policy document to advise and inform the public and private and commercial developers of their obligations under the latest planning guidance.

1.5 Consultation

The EA's 2022 SFRA guidance recommends consultation with the following parties, external to the LPA:

- The EA;
- The LLFA;
- Emergency planners;
- Emergency services;

- Water and sewerage companies;
- Reservoir owners or undertakers, if relevant;
- Highways authorities;
- district councils; and
- Regional flood and coastal committees.

1.6 SFRA future proofing

This SFRA has been developed using the most up-to-date data and information available at the time of submission. The SFRA has been future proofed as far as possible though the reader should always confirm with the source organisation (CDC) that the latest information is being used when decisions concerning development and flood risk are being considered. The FRCC-PPG, alongside the NPPF, is referred to throughout this SFRA, being the current primary development and flood risk guidance information available at the time of the finalisation of this SFRA.

The EA's 2022 SFRA guidance states a review of a SFRA should be carried out when there are changes to:

- The predicted impacts of climate change on flood risk;
- Detailed flood modelling - such as from the EA or LLFA;
- The local plan, spatial development strategy or relevant local development documents;
- Local flood management schemes;
- Flood risk management plans;
- Local flood risk management strategies; and
- National planning policy or guidance.

The SFRA should also be reviewed after a significant flood event. It is in any authority's interest to keep the SFRA as up to date as possible.

Ideally, the SFRA should be kept as a 'live' entity and continually updated when new information becomes available. The EA requests for reports and maps to be published online and be easily updateable, when required.

This SFRA uses the EA's Flood Map for Planning (FMfP) version issued in February 2023 to assess fluvial risk across the district. The Flood Map for Planning is updated by the EA, as and when accepted new modelling data becomes available. The reader should therefore refer to the online version of the Flood Map for Planning to check whether the flood zones may have been updated since February 2023, via the following link:

Flood Map for Planning

To assess surface water risk, this SFRA uses the EA's Risk of Flooding from Surface Water (RoFSW) dataset, last updated May 2021 at the time of writing. This dataset can be updated periodically when applicable local surface water modelling is carried out that adheres to the EA's required methodology. The reader should therefore refer to the online

version of the RoFSW map to check whether the surface water flood outlines have been updated, via the following link:

Long Term Flood Risk

At the time of writing, the RoFSW is being updated and is due for release in late 2024.

2 Study area

Cotswold District Council administrative area is situated in the south of England within the county of Gloucestershire. The south of the district is bordered by Wiltshire whilst the east borders the West Oxfordshire districts. Stratford-upon-Avon and Wychavon districts border the north of the Cotswold administrative area; whilst Tewkesbury, Stroud and Cheltenham districts border the west. Cotswold is a large rural district covering 450 square miles. The largest town is Cirencester and is home to approximately 20% of the population of the district. The district is rural and sparsely populated, with numerous villages and hamlets.

The landscape is exceptionally distinctive. The Cotswolds Area of Outstanding Natural Beauty (AONB) is a national designation which affords the highest level of landscape protection and covers nearly three quarters of the district. In addition, there are locally designated Special Landscape Areas and the Cotswold Water Park (internationally important for its nature conservation). Coupled with this natural beauty the district has an abundance of built heritage and archaeology, creating a unique 'Cotswold Character'. The district has many listed buildings and a significant number of conservation areas. Several parks are listed on the English Heritage list of historic parklands. The district also has 238 scheduled ancient monuments.

The main river catchment within the Cotswold district is the Thames catchment which extends over an area of almost 13,000 km^2. The topography of the catchment is characterised by rural landscapes, rolling hills and wide, flat river floodplains with the east comprising a significantly more urban environment (Figure 2-1). The west of the district is comprised of hilly, upland areas. The nature of the topography indicates a faster, 'flashy' system in the uplands with water levels and flows responding to rainfall in a shorter time. In contrast, the flatter lower-lying parts of the lower catchment show slower responses.

The Thames is a 215-mile-long watercourse, rising in the west in Gloucestershire, flowing through the Cotswold district, Oxfordshire and Buckinghamshire. 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. The river then flows through Greater London, with the channel becoming more artificial and straightened, before reaching the Thames Estuary to the east. The Thames has a number of tributaries in its upstream phase that have the potential to be a source of risk for settlements within the Cotswolds, including 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. Historical blockage of culverts on the River Churn in the Spitalgate Lane area may have contributed to fluvial flood risk in the past. The River Churn is also recorded to have flooded 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.

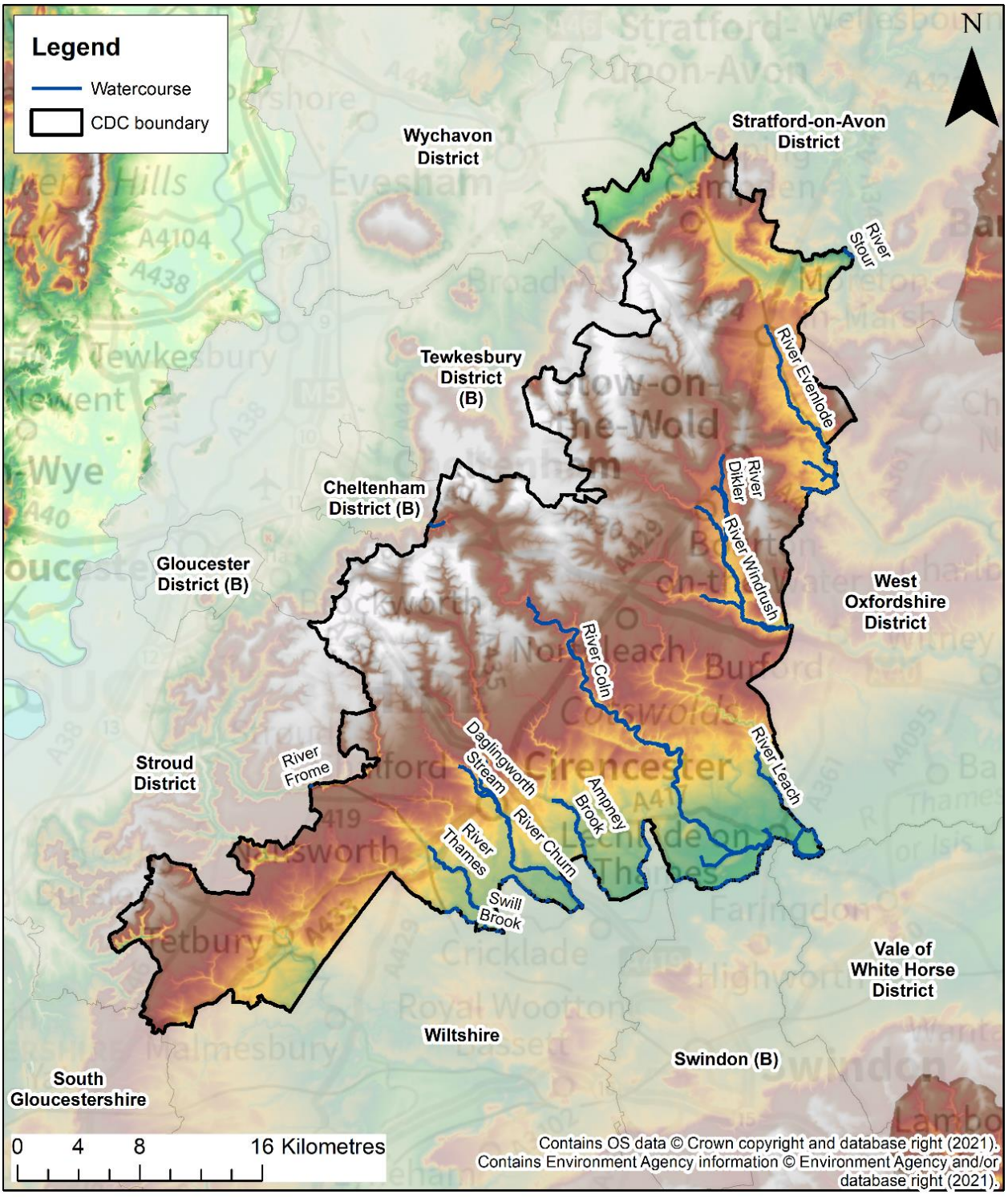

Figure 2-1 Cotswold district and neighbouring authorities

2.1 Geology and topography

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

The geology of the Cotswold district is complex and is dominated by limestones of the Jurassic age. The limestones within the Great Oolite Group and Inferior Oolite Group cover the majority of the district towards the north-western and central extents and have a significant influence on the topography, drainage and soils of the Cotswolds. Geology information can be viewed on the British Geological Society website here.

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

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

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

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

2.2 Main rivers

Main rivers are generally major watercourses for which the EA has permissive powers to carry out maintenance, improvement, or construction work to manage flood risk. The EA also regulate development or works in, on, over, under or within 8 metres of fluvial main river watercourses under the Environmental Permitting (England and Wales) Regulation 2016. This also includes within the floodplain if works do not have planning permission and require quarrying or excavation within 16 metres of any main river, flood defence or culvert. The range of activities subject to regulation are listed online via:

Flood risk activities: environmental permits

Whilst the EA has permissive powers to undertake works, the maintenance of main rivers is primarily the responsibility of riparian owners.

The main rivers of note in terms of flood risk and flood risk management activities in Cotswold include:

- River Thames
- River Coln
- River Churn
- Ampney Brook
- River Windrush
- River Evenlode
- River Dickler

2.3 Ordinary watercourses

Ordinary watercourses are any watercourse that is not designated main river. These watercourses can vary in size considerably and can include rivers, streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 2014) and passages, through which water flows. Ordinary watercourses do not always contain flowing water all year long; there may be times where the watercourses run dry, particularly over prolonged dry spells. Such watercourses can be described as ephemeral watercourses.

Ordinary watercourses come under the regulation of the LLFA, which has permissive powers to carry out works, should this be deemed necessary, and have regulatory control over certain development activities within the watercourse channel. However, the responsibility for the maintenance of ordinary watercourses lies with the riparian owner. A riparian owner is anyone who owns a property where there is a watercourse within or adjacent to the boundaries of their property; they are responsible for watercourses or culverted watercourses passing through their land.

3 Understanding flood risk

3.1 Sources of flooding

Flooding is a natural process and can happen at any time in a wide variety of locations. It constitutes a temporary covering of land not normally covered by water and presents a risk when human or environmental assets are present in the area that floods. Assets at risk from flooding can include housing, transport and public service infrastructure (including vulnerable services such as hospitals and schools), commercial and industrial enterprises, agricultural land and environmental and cultural heritage. Flooding in Cotswold can occur from many different and combined sources such as fluvial (from main rivers and ordinary watercourses), surface water, groundwater, sewers or indirectly from infrastructure failure.

Different types and forms of flooding present a range of different risks and the flood hazards of speed of inundation, depth and duration of flooding can vary greatly. With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging.

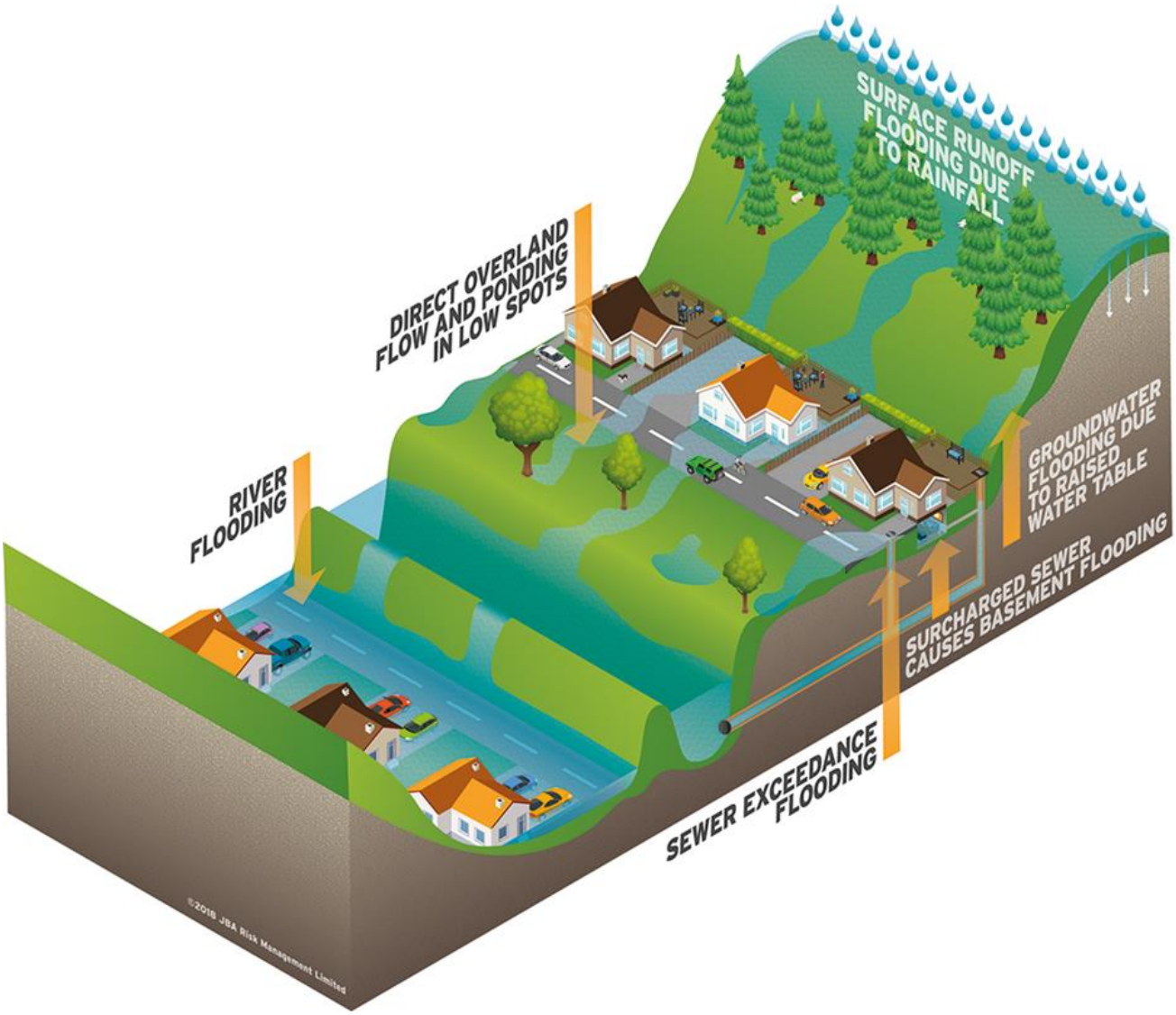

Figure 3-1 Flooding from all sources

3.1.1 Rivers

River flooding is the inundation of floodplains from rivers and watercourses; the inundation of areas outside the floodplain due to the influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts or flood channels/corridors.

River flooding is associated with the exceedance of channel capacity during higher flows or as a result of blockage (residual risk). The process of flooding from a watercourse depends on a number of characteristics associated with the catchment including geographical location and variation in rainfall; steepness of the channel and surrounding floodplain; and infiltration and rate of runoff associated with urban and rural catchments.

The EA's Flood Map for Planning (Rivers and Sea) (Section 4.1.1) is used to assess flood risk from rivers in this Level 1 SFRA. The impacts from climate change on river flooding has been modelled for this SFRA (Section 4.8) and the modelled outputs have also been used

to assess future flood risk across the district. The Flood Map for Planning and climate change outputs are presented on the SFRA Maps in Appendix B.

3.1.2 Surface water

Surface water or pluvial flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. In these instances, the volume of water from rural land can exceed infiltration rates in a short amount of time, resulting in the flow of water over land. Within urban areas, this intensity can be too great for the urban drainage network resulting in excess water flowing along roads, through properties and ponding in lower areas or natural depressions. Areas at risk of pluvial flooding can, therefore, lie outside of the fluvial flood zones.

Pluvial flooding within the urban areas of Cotswold will typically be associated with events equal to or greater than the 1 in 30 year (3.3% AEP) design standard of new sewer systems. Some older sewer and highway drainage networks will have a lower capacity than is required to mitigate for the 3.3% AEP event. There is also residual risk associated with these networks due to possible network failures, blockages or collapses.

There are certain locations, generally within the urban areas, where the probability and consequence of pluvial flooding are more prominent due to the complex hydraulic interactions that exist in the urban environment. Urban watercourse connectivity, surface water or combined sewer capacity and the location and condition of highway gullies all have a major role to play in surface water flood risk.

Surface water flood risk should be afforded equal standing in importance and consideration as fluvial and groundwater flood risk, given the increase in rainfall intensities due to climate change and the increase in impermeable land use due to development. It should be acknowledged that once an area is flooded during a large rainfall event, it is often difficult to identify the route, cause and ultimately the source of flooding without undertaking further site-specific and detailed investigations.

The EA's Risk of Flooding from Surface Water (RoFSW) map (Section 4.2) is used to assess surface water flood risk in this Level 1 SFRA. The RoFSW map is presented on the SFRA Maps in Appendix B.

Section 5.7 provides guidance on SuDS options for developers.

3.1.3 Groundwater

Groundwater water flooding occurs when the water table rises after prolonged rainfall to emerge above ground level remote from a watercourse. It is most likely to occur in low-lying areas underlain by permeable rock (aquifers) and groundwater recovery areas, after pumping for mining or industry has ceased. Warmer, wetter winters due to climate change may have significant impacts on groundwater levels.

Groundwater flooding is caused by the emergence of water from beneath the ground, either at point or diffuse locations. The occurrence of groundwater flooding is usually local and unlike flooding from rivers, does not generally pose a significant risk to life due to the slow

rate at which the water level rises. However, groundwater flooding can cause significant damage to property, especially in urban areas and can pose further risks to the environment and ground stability.

There are several mechanisms that increase the risk of groundwater flooding including prolonged rainfall, high in-bank river levels, artificial structures, groundwater rebound and mine water rebound. Properties with basements or cellars or properties that are located within areas deemed to be susceptible to groundwater flooding are at particular risk. Development within areas that are susceptible to groundwater flooding will generally not be suited to infiltration SuDS; however, this is dependent on detailed site investigation and risk assessment at the FRA stage.

JBA's 5m Groundwater Flood Risk Map (Section 4.3) is used to assess potential risk from groundwater in this Level 1 SFRA and is presented on the SFRA Maps in Appendix B.

3.1.4 Sewers

Flooding from the sewer network can occur when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes blocked, or it cannot discharge due to a high water level in the receiving watercourse. Pinch points and failures within the drainage network may also restrict flows. Water then begins to back up through the sewers and surcharge through manholes, potentially flooding highways and properties. It must be noted that sewer flooding in 'dry weather' resulting from blockage, collapse or pumping station mechanical failure (for example), is the sole concern of the drainage undertaker.

Combined sewers spread extensively across urban areas serving residential homes, business and highways, conveying waste and surface water to treatment works. Combined Sewer Overflows (CSOs) provide an EA consented overflow release from the drainage system into local watercourses or surface water systems during times of high flows. Some areas may also be served by separate waste and surface water sewers which convey wastewater to treatment works and surface water into local watercourses or combined sewers.

Severn Trent Water (STW), Thames Water (TW) and Wessex Water (WW) are the water companies responsible for the management of the public sewer drainage network across the district.

3.1.5 Reservoirs

A reservoir can usually be described as an artificial or non-natural lake where water is stored for use. The risk of flooding associated with reservoirs is residual (Section 3.2.3.2) and is associated with failure of reservoir outfalls or dam breaching. This risk is reduced through regular inspection and maintenance by the operating authority. Reservoirs in the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

The EA's Reservoir Flood Map (RFM) shows the locations at risk from reservoir flooding (Section 4.5.1).

3.1.6 Canals

The risk of flooding from a canal is considered to be residual and is dependent on a number of factors. As canals are manmade systems that are heavily controlled, it is unlikely they will respond in the same way as a natural watercourse during a storm event. Flooding is more likely to be associated with residual risks, similar to those associated with river defences, such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure as highlighted in Table 3-1. Canals can also have a significant interaction with other sources, such as watercourses that feed them and minor watercourses or drains that cross underneath.

Table 3-1 Canal flooding

Potential Mechanism	Significant Factors
Leaking causing erosion and rupture of canal lining leading to breach	Embankments Sidelong ground Culverts Aqueduct approaches
Collapse of structures carrying the canal above natural ground level	Aqueducts Large diameter culverts Structural deterioration or accidental damage
Overtopping of canal banks	Low freeboard Waste weirs
Blockage or collapse of conduits	Culverts

Section 4.6 discusses the potential risks from canals in Cotswold.

3.2 Likelihood and consequence

Flood risk is a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model as shown below. This is a standard environmental risk model common to many hazards and should be the starting point of any assessment of flood risk. However, it should be remembered that flooding could occur from many different sources and pathways, and not simply those shown in the illustration below.

The principal flood sources in Cotswold include fluvial and surface water; the most common pathways are rivers, drains, sewers, overland flows; and the receptors include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation, i.e. flood defence, measures have little or no effect on sources of flooding, but they can block or impede pathways or remove receptors.

3.2.1 Likelihood

The likelihood of flooding is expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% AEP (Annual Exceedance Probability) event indicates the flood level that is expected to be reached on average once in a hundred years, i.e., it has a 1 in 100 (1%) chance of occurring in any one year, not that it will occur once every one hundred years. Table 3-2 provides an example of the flood probabilities used to describe the flood zones as defined in the FRCC-PPG and as used by the EA in its Flood Map for Planning (Rivers and Sea).

NOTE: Paragraph 078 of the FRCC-PPG states: - *"flood zones shown on the Flood Map for Planning do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding*.

The Flood Map for Planning can be accessed online via:

Flood map for planning

Table 3-2 NPPF flood zones[5]

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively. Land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding) LPAs should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the EA. (Not separately distinguished from Zone 3a on the Flood Map for Planning)

3.2.2 Consequence

The consequences of flooding include fatalities, property damage, disruption to lives and businesses, with severe implications for people (e.g. financial loss, emotional distress, health problems). Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation measures etc.).

Flood risk is then expressed in terms of the following relationship:

Flood risk = Probability of flooding x Consequences of flooding

3.2.3 Risk

Flood risk is not static; it cannot be described simply as a fixed water level that will occur if a river overtops its banks or from a high spring tide that coincides with a storm surge. It is therefore important to consider the continuum of risk carefully. Risk varies depending on the severity of the event, the source of the water, the pathways of flooding (such as the

5 Table 1: Flood Zones, Paragraph 001 of the Flood Risk and Coastal Change Planning Practice Guidance, August 2022

condition of flood defences) and the vulnerability of receptors as mentioned above. It is also clear that risk will increase with climate change.

3.2.3.1 Existing risk

This is the risk 'as is' considering any flood defences that are in place for extreme flood events (typically these provide a minimum Standard of Protection (SoP). Hence, if a settlement lies behind a fluvial flood defence that provides a 1 in 100-year SoP then the actual risk of flooding from the river in a 1 in 100-year event is generally low. However, the residual risk may be high in that the impact of flood defence failure would likely have a major impact.

Existing risk describes the primary, or prime, risk from a known and understood source managed to a known SoP. However, it is important to recognise that risk comes from many different sources and that the SoP provided will vary within a river catchment. Hence, the existing risk of flooding from the river may be low to a settlement behind the defence but moderate from surface water, which may pond behind the defence in low spots and is unable to discharge into the river during high water levels.

3.2.3.2 Residual risk

Defended areas remain at residual risk as there is a risk of defence failure during significant flood events. Areas behind flood defences are at particular risk from rapid onset of fast-flowing and deep-water flooding, with little or no warning if defences are overtopped or breached.

Whilst the actual risk of flooding to a settlement that lies behind a fluvial flood defence that provides a 1 in 100-year SoP may be low, there will always be a residual risk from flooding if these defences overtopped or failed that must be considered. Because of this, it is never appropriate to use the term "flood free".

Developers must be able to demonstrate that development will be safe for the lifespan of the development. To that end, Paragraph 042 of the FRCC-PPG states:

" Where residual risk from flood risk management infrastructure affects large areas, the Strategic Flood Risk Assessment will need to indicate the nature, severity and variation in risk within this area, and provide guidance for residual risk issues to be covered in site-specific flood risk assessments. Where necessary, local planning authorities should use information on identified residual risk to state in strategic policies their preferred mitigation strategy for ensuring development will be safe throughout its lifetime in relation to urban form, risk management and where flood mitigation measures are likely to have wider sustainable design implications".

Residual flood risk from breach or overtopping of defences must be managed for any new development. Detailed mitigation must be agreed through site-specific FRAs or through Level 2 SFRAs where it would be necessary to demonstrate site allocations would be safe for their lifetime.

3.3 Climate change

Following on from the UK Climate Projections 2009 (UKCP09), the UK Climate Projections 2018 (UKCP18) delivered a major upgrade to the range of UK climate projection tools designed to help decision-makers assess their risk exposure to our changing climate.

The UKCP18 project used cutting-edge climate science to provide updated observations and climate change projections up to the year 2100 across the UK. The project builds upon UKCP09 to provide the most up-to-date assessment of how the climate of the UK may change over the 21st century.

UKCP18 updates the projections over land and provides a set of detailed future climate projections for the UK at a 12km scale. Models of high impact events such as from localised heavy rainfall in summer the months were created. UKCP18 enables the UK to adapt to the challenges and opportunities presented by climate change.

In relation to flood risk and climate change in the planning system, the NPPF states:

"All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property." (para 161).

Local plans should do this by safeguarding land from development that is required, or likely to be required, for current or future flood management; and to seek opportunities for the relocation of development, including housing, to more sustainable locations from areas where climate change is expected to increase flood risk.

The likely impacts of climate change are well documented and will have a significant impact on flood risk across the Cotswold district. Increases in duration and intensity of extreme rainfall events as a result of climate change will increase flood risk from multiple sources. Section 4.8 discusses the EA climate change allowances and the impacts of climate change for Cotswold.

4 Flood risk in Cotswold

4.1 Flood risk from rivers

Figure 4-1 shows the EA's Flood Map for Planning (Rivers and Sea), which identifies a number of areas across the Cotswold district that are at risk of flooding from rivers. Several of these areas are located within Flood Zone 3 and therefore identified as being at high risk of flooding from rivers. An extensive area of Flood Zone 3 is located along the River Churn, which passes through Cirencester and South Cerney. Other key areas include the areas located adjacent to the River Thames, which runs along the southern border of the district, the River Dikler, the River Windrush and the River Evenlode.

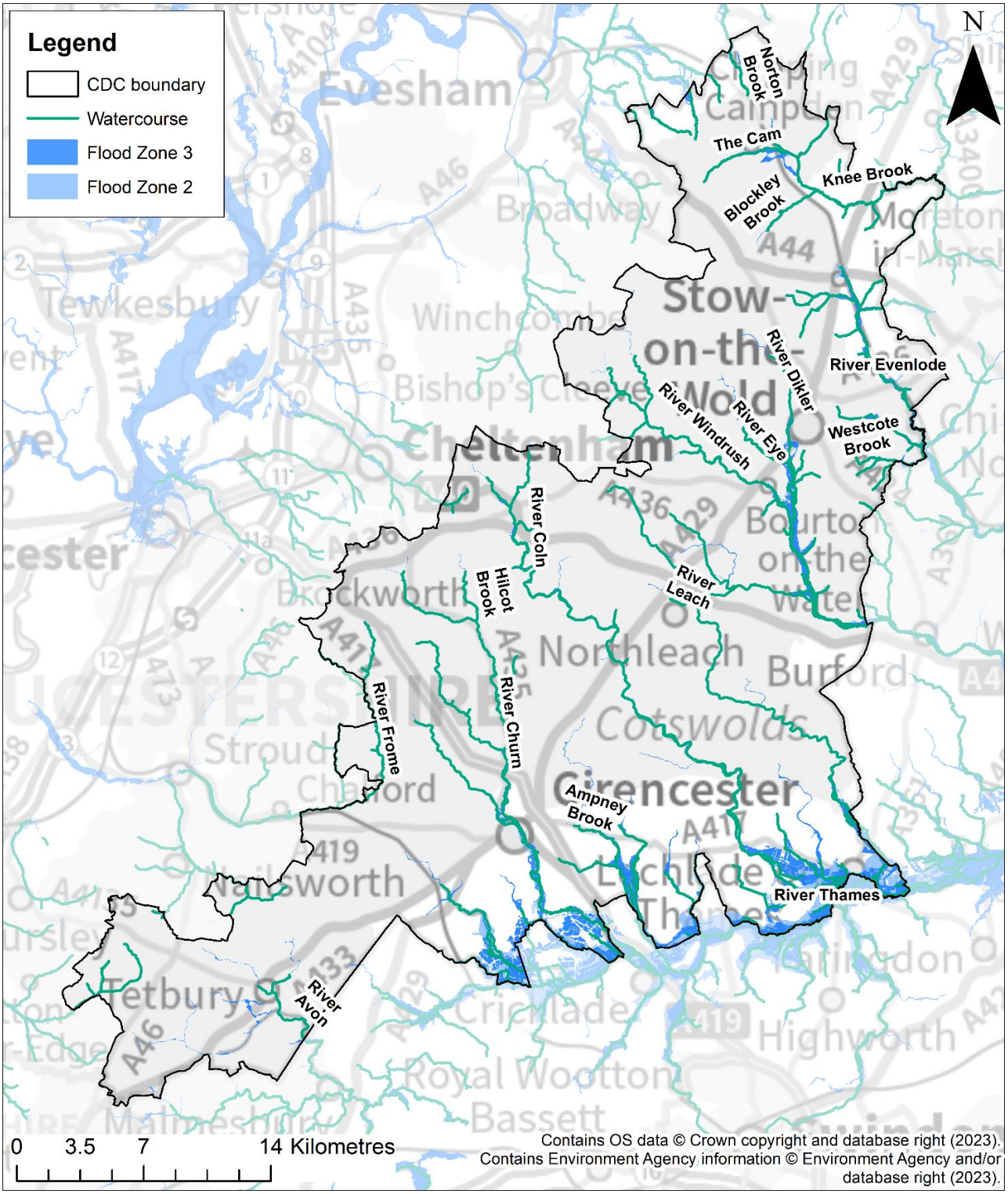

Figure 4-1 Risk of Flooding from Rivers within CDC

4.1.1 EA Flood Map for Planning (Rivers and Sea)

The SFRA Maps in Appendix B present the EA's Flood Map for Planning, which shows the fluvial coverage of Flood Zones 2 and 3 across the study area at a more detailed scale.

The Flood Map for Planning is the main dataset used by planners for predicting the location and extent of flooding from rivers. This is supported by the CFMPs and FRMPs along with a number of detailed hydraulic river modelling reports which provide further detail on flooding mechanisms.

The Flood Map for Planning provides the flooding from rivers flood extents for the 1 in 100 year (1% AEP) flood event (Flood Zone 3) and the 1 in 1000 year (0.1% AEP) flood event (Flood Zone 2). Flood zones were originally prepared by the EA using a methodology based on the national digital terrain model (NextMap), derived river flows from the Flood Estimation Handbook (FEH) and two-dimensional flood routing. Since their initial release, the EA has regularly updated its flood zones with detailed hydraulic model outputs as part of its national flood risk mapping programme.

The Flood Map for Planning is precautionary in that it does not take account of flood defence infrastructure (which can be breached, overtopped or may not be in existence for the lifetime of the development) and therefore, represents a worst-case scenario of flooding. The flood zones do not consider sources of flooding other than from rivers or the sea and do not take account of climate change. As directed by the FRCC-PPG, this SFRA subdivides Flood Zone 3 into Flood Zone 3a and Flood Zone 3b, also known as the functional floodplain (Section 4.1.2).

This SFRA uses the Flood Map for Planning issued in February 2023 to assess the risk from river flooding within identified priority areas. The Flood Map for Planning is updated by the EA, as and when new modelling data becomes available. The reader should therefore refer to the online version of the Flood Map for Planning to check whether the flood zones may have been updated since February 2023: Flood Map for Planning

The EA also provides a 'Risk of Flooding from Rivers and Sea Map'. This map shows the EA's assessment of the likelihood of flooding from rivers and the sea, at any location and is based on the presence and effect of all flood defences, predicted flood levels and ground levels. This dataset is not used in the assessment of flood risk for planning applications but is a useful source of information to show the presence and effects of flood risk management infrastructure. This dataset is further discussed in Section 4.1.3.

4.1.2 Functional floodplain (Flood Zone 3b)

The functional floodplain forms a very important planning tool in making space for flood waters when flooding occurs. Development should be directed away from these areas.

Table 1, Paragraph 078 of the FRCC-PPG defines Flood Zone 3b as:

"…land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:

land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or

land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding)".

Paragraph 078 also explains that:

"Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency."

The Environment Agency's Flood Zone 3a extent was incorporated into Flood Zone 3b as a conservative approach where there was no available detailed modelling. The extent of the functional floodplain is assessed and agreed upon by the LPA, the LLFA and the EA, based on their local knowledge. A technical note is provided in Appendix D which explains the methodology and datasets used in creating the functional floodplain outline.

4.1.3 EA Risk of Flooding from Rivers and Sea map

This Risk of Flooding from Rivers and Sea map (RoFRS) shows the likelihood of flooding from rivers and the sea based on the presence and effect of all flood defences, predicted flood levels and ground levels and is shown on the Appendix B maps. The RoFRS map splits the likelihood of flooding into four risk categories:

- High – greater than or equal to 1 in 30 (3.3% AEP) chance in any given year;
- Medium – less than 1 in 30 (3.3% AEP) but greater than or equal to 1 in 100 (1% AEP) chance in any given year;
- Low – less than 1 in 100 (1% AEP) but greater than or equal to 1 in 1000 flood event (0.1% AEP) chance in any given year; and
- Very Low – less than 1 in 1000 (0.1% AEP) chance in any given year.

The RoFRS map is included on the SFRA maps to act as a supplementary piece of information to assist the LPA in the decision-making process for site allocation.

This dataset is not suitable for use with any planning application, nor should it be used for the sequential testing of site allocations. The EA's Flood Map for Planning should be used for all planning purposes, as per the FRCC-PPG.

4.2 Surface water flood risk

The Risk of Flooding from Surface Water is shown in Figure 4-2 and illustrates that there are numerous areas of surface water flood risk scattered across the Cotswold district. Surface water risk largely follows the topography similar to that of fluvial watercourses. Areas to the north of the district appear at highest risk of surface water flooding, including Chipping Campden, Moreton-in-Marsh, Evenlode and Bourton-on-the-Water. Other key areas at high risk of surface water flooding include Cirencester and Lechlade-on-Thames.

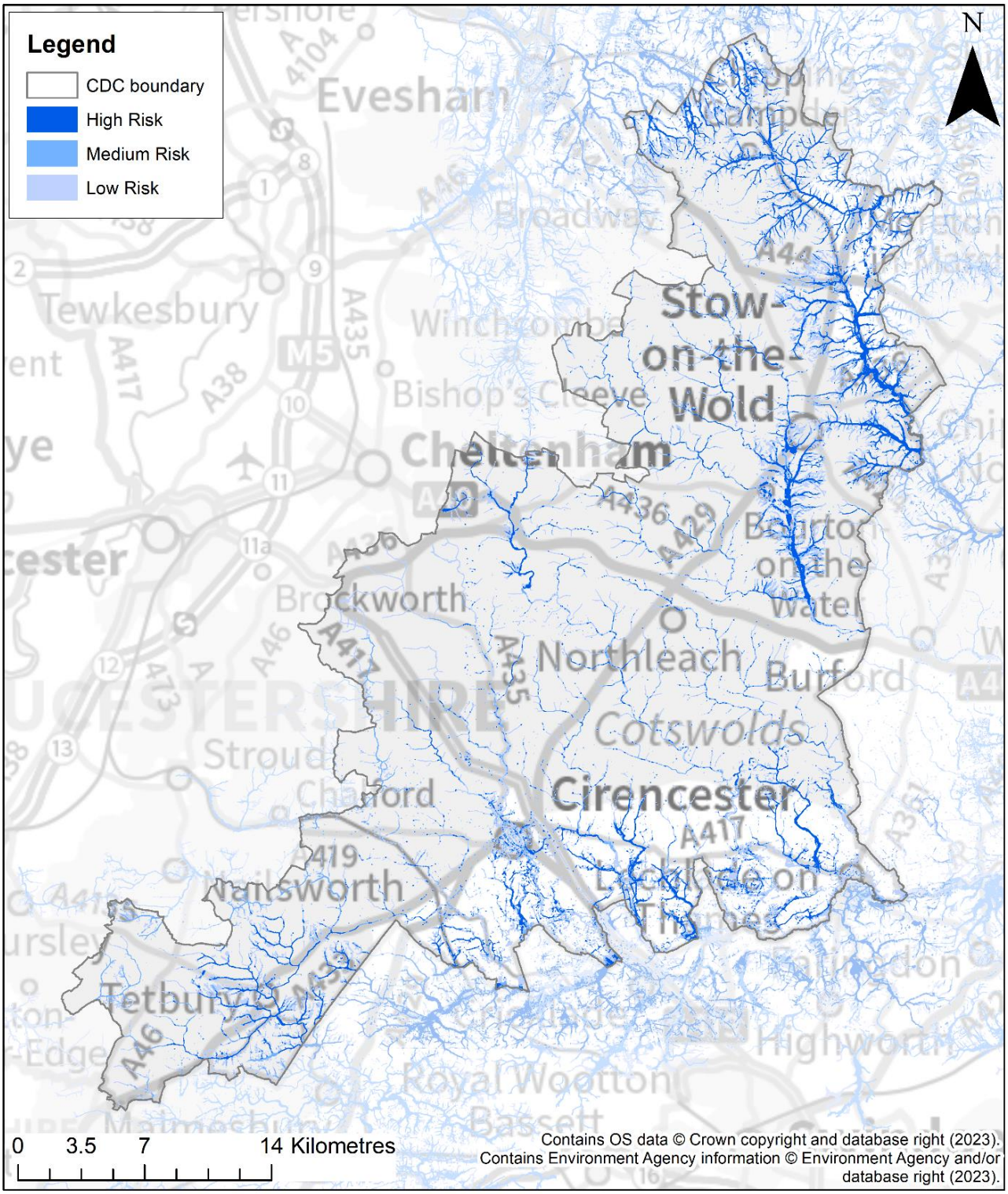

Figure 4-2 Risk of Flooding from Surface Water within CDC

4.2.1 Risk of Flooding from Surface Water dataset

The Risk of Flooding from Surface Water (RoFSW) is the third-generation national surface water flood map, produced by the EA, aimed at helping to identify areas where localised, flash flooding can cause problems even if the Main Rivers are not overflowing. The RoFSW, used in this SFRA to assess risk from surface water, has proved extremely useful

in supplementing the EA Flood Map for Planning by identifying areas in Flood Zone 1, which may have critical drainage problems.

NOTE: EA guidance on the use of the RoFSW states: *"This dataset is not suitable for identifying whether an individual property will flood. It should not be used with basemapping more detailed than 1:10,000 as the data is open to misinterpretation if used as a more detailed scale. Because of the way the map has been produced and the fact that it is indicative, the map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence."*

The RoFSW includes surface water flood outlines, depths, velocities and hazards for the following events:

- 1 in 30 year event (3.3% AEP) – high risk;
- 1 in 100 year event (1% AEP) – medium risk; and
- 1 in 1000 year event (0.1% AEP) – low risk.

The outlines of the RoFSW are presented on the SFRA maps in Appendix B.

The EA produced a guidance document, updated in April 2019[6], explaining the methodology applied in producing the map.

Note: The national map of surface water flood risk is, at the time of writing, undergoing a significant update. However, the updated map is unlikely to made available until late-2024.

4.2.1.1 Locally agreed surface water information

EA guidance, from within the FWMA[7], on using surface water flood risk information recommends that CDC, as LLFA, should:

"…review, discuss, agree and record, with the Environment Agency, Water Companies, Internal Drainage Boards and other interested parties, what surface water flood data best represents their local conditions. This will then be known as locally agreed surface water information".

At the time of writing, locally agreed surface water information either consists of:

- The RoFSW map; or
- Compatible local mapping if it exists i.e. from a SWMP; or
- A combination of both these datasets for defined locations in the LLFA area.

GCC have not developed SWMP's that cover the Cotswold district. CDC should consider the RoFSW to be its locally agreed surface water flood information as this is the latest, most robust surface water flood map available for the administrative area, at the time of writing.

6 What is the Risk of Flooding from Surface Water map? EA, 2019
7 Flood and Water Management Act, 2010

4.3 Groundwater flood risk

This SFRA assesses groundwater flood risk through JBA's 5m Groundwater Flood Map, which provides a general broadscale assessment of the groundwater flood hazard. The good practice guide to producing SFRAs[8], developed by the EA and published December 2021, recommends the use of this dataset in SFRAs. The map is categorised by grid code where each code is explained in Table 4-1.

Table 4-1 Groundwater flood hazard classification of JBA Groundwater Flood Map

Groundwater head difference (m)*	Grid Code	Class label
0 to 0.025	4	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	3	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	2	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event. There is a risk of flooding to subsurface assets but surface manifestation of groundwater is unlikely.
>5	1	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.

8 Strategic flood risk assessments A GOOD PRACTICE GUIDE, Report produced using Environment Agency research on 'using flood risk information in spatial planning' (2019-2020), 2021

Groundwater head difference (m)*	Grid Code	Class label
N/A	0	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.		

Figure 4-3 shows the groundwater flood risk across CDC. Please refer to Table 4-1 for grid code definitions. The main areas within grid code 4 are to the south of the district, along the River Thames. Other key areas within grid code 4 include Bourton-on-the-Water, Chipping Campden, Moreton-in-Marsh and the surrounding areas of Stow-on-the-Wold. Areas categorised as grid code 3 are located throughout the district with notable locations within this risk category being Broad Campden, South Cerney and Cirencester.

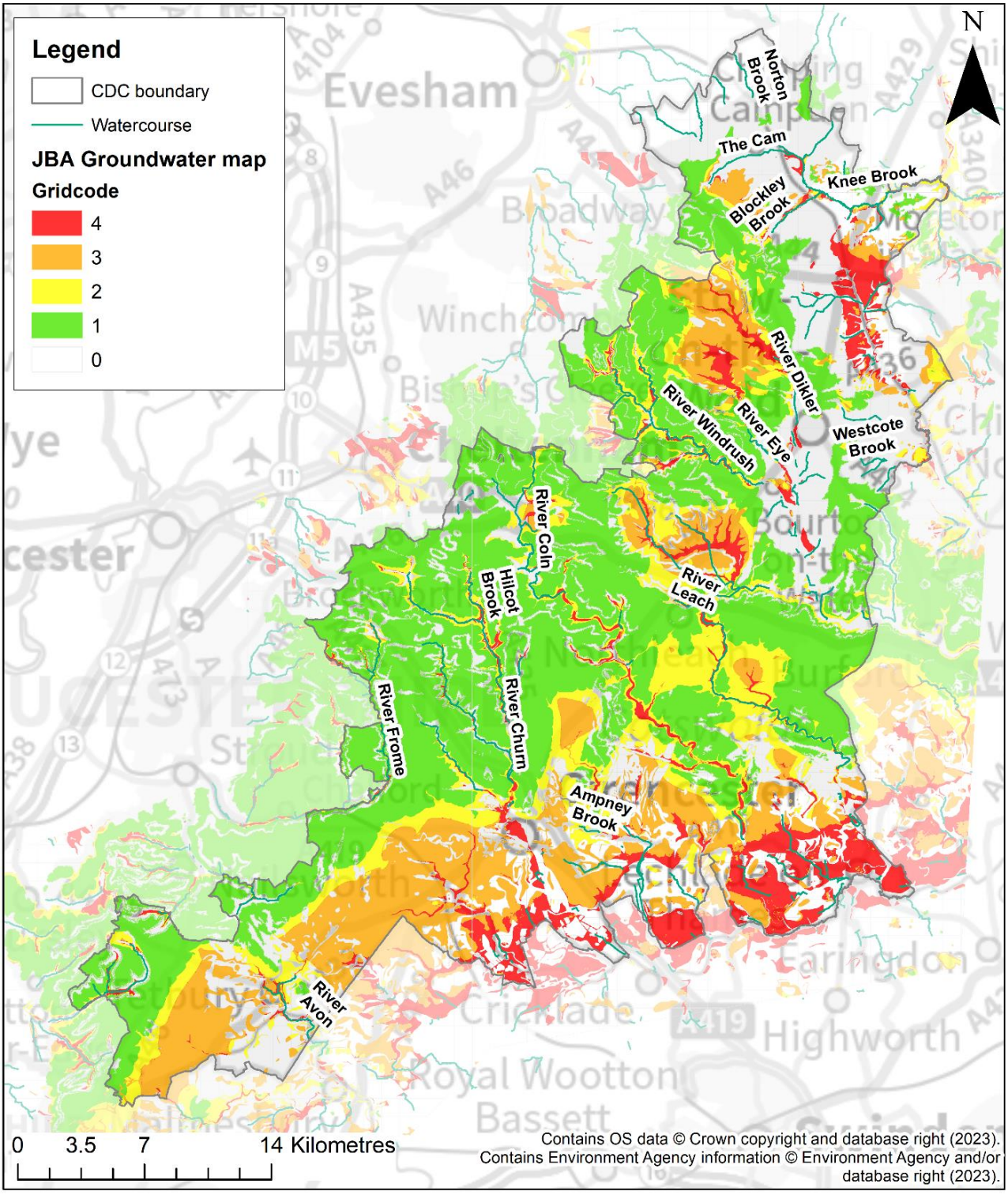

Figure 4-3 Risk of Flooding from Groundwater within CDC

It is important to ensure that future development is not placed at unnecessary risk therefore groundwater flood risk should be considered on a site-by-site basis in development planning.

Groundwater flood risk should be considered particularly when determining the acceptability of SuDS schemes as a way of managing surface water drainage. Developers should

consult with the LPA, the LLFA and the EA at an early stage of any site-specific groundwater assessment.

The JBA 5m Groundwater Flood Map is shown on the SFRA Maps in Appendix B.

4.4 Flood risk from sewers

According to the GCC Level 1 SFRA (2008), the risk of sewer flooding to Cotswold district is medium to low with the exception of the GL7 5 postcode area where there is a high level of risk.

4.5 Flood risk from reservoirs

The EA is the enforcement authority for the Reservoirs Act 1975 in England and Wales, with the FWMA amending this Act. All large reservoirs must be regularly inspected and supervised by reservoir panel engineers. Local authorities are responsible for coordinating emergency plans for reservoir flooding and ensuring communities are well prepared. The LPA should work with other members of the Gloucestershire Local Resilience Forum (GLRF) to develop these plans. See Section 5.9.1.1 for more information on the GLRF.

Paragraph 046 of the FRCC-PPG states that, in relation to development planning and reservoir dam failure:

"the local planning authority will need to evaluate the potential damage to buildings or loss of life in the event of dam failure, compared to other risks, when considering development downstream of a reservoir. Local planning authorities are also advised to consult with the owners/operators of raised reservoirs, to establish constraints upon safe development."

4.5.1 Reservoir Flood Map (RFM)

The EA has produced Reservoir Flood Maps (RFM) for all large reservoirs that they regulated under the Reservoirs Act 1975 (reservoirs that hold over 25,000 cubic metres of water). The FWMA updated the Reservoirs Act and targeted a reduction in the capacity at which reservoirs should be regulated from 25,000m^3 to 10,000m^3. This reduction is, at the time of writing, yet to be confirmed meaning the requirements of the Reservoirs Act 1975 should still be adhered to.

In November 2021, the EA published the RFM guidance 'Reservoir flood maps: when and how to use them[9]', which provides information on how the maps were produced and what they contain.

To view the RFM, the Defra Data Services Platform can be used to search for specific reservoirs at:

Reservoir Flood Maps

9 Reservoir flood maps: when and how to use them – Environment Agency, 2021.

The EA provided a GIS file of the RFM covering Cotswold. The RFM shows that there are 23 large-raised reservoirs which have the potential to impact the Cotswold district in the event of a breach during a dry-day scenario. A dry-day, as opposed to a wet-day scenario, assumes the water level in a reservoir is lower than the spillway level and the upstream and downstream watercourses are at normal levels.

The RFM extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. It is worth considering that reservoirs within the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

If development is proposed downstream of a reservoir, there will need to be an assessment of whether work is needed to improve the design or maintenance of the reservoir. Together with the reservoir undertakers, the LPA should look to avoid an intensification of development within the risk areas and/or ensure that reservoir undertakers can assess the cost implications of any reservoir safety improvements required due to changes in land use downstream of these assets.

The LPA will need to evaluate:

- The potential damage to buildings or loss of life in the event of dam failure compared to other risks;
- How an impounding reservoir will modify existing flood risk in the event of a flood in the catchment is location within and/or whether emergency draw-down of the reservoir will add to the extent of flooding; and
- Emergency planning requirements with appropriate officers to ensure safe sustainable development.

4.6 Flood risk from canals

The risks associated with flooding from canals are dependent on the potential failure location with the consequence of flooding higher where floodwater could cause the greatest harm due to the presence of local highways and adjacent property.

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

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

4.7 Cumulative impacts assessment

The NPPF states that strategic policies…

"…*should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards*" (para 160).

Previous policies have relied on the assumption that if each individual development does not increase the risk of flooding, the cumulative impact will also be minimal. However, if there is a lot of development occurring within one catchment, particularly where there is flood risk to existing properties or where there are few opportunities for mitigation, or proposed developments of less than 10 dwellings that are not referred to the LLFA for consultation under the Town and Country Planning (Development Management Procedure) Order (DMPO) 2015, the cumulative impact may be to change the flood response of the catchment.

Consideration should be given to the following:

- The importance of phasing development,
- Cross boundary impacts i.e. there should be dialogue between CDC and neighbouring authorities (Tewkesbury district, Wychavon district, Stratford-on-Avon district, West Oxfordshire district, Wiltshire, Cheltenham district, Gloucester district, South Gloucestershire, Stroud district, Swindon, Vale of White Horse district) upstream and downstream of the district on flood risk management practices and development;
- Leaving space for floodwater by safeguarding land through the Local Plan and utilising greenspace for flood storage and slowing the flow (see Sections 4.7.3 and 4.10.4);
- Ensuring floodplain connectivity; and
- SuDS and containment of surface water onsite as opposed to directing elsewhere (see Section 5.7).

When allocating land for development, consideration should be given to the potential cumulative impact of the loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing all new development complies with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory there should not be any increase in flood risk downstream.

Strategic solutions may include upstream flood storage, integrated major infrastructure/Flood Risk Management schemes, new defences and watercourse improvements as part of regeneration and enhancing green infrastructure, with opportunities for Working with Natural Processes and retrofitting of SuDS to existing development.

Through the Local Plan, CDC should consider the following strategic solutions:

- Use of sustainable flood storage and mitigation schemes to store water and manage surface water runoff in locations that provide overall flood risk reduction as well as environmental benefits;
- In areas where flood risk is being managed effectively, there will be a need in the future to keep pace with increasing flood risk as a result of climate change;
- Assessment of long-term opportunities to move development away from the floodplain and to create blue/green river corridors throughout the CDC area;
- Identification of opportunities to use areas of floodplain to store water during high flows, to reduce long-term dependence on engineered flood defences located both within and outside the CDC area;
- Safeguarding the natural floodplain from inappropriate development;
- Where possible, changes in land management should look to reduce runoff rates from development whilst maintaining or enhancing the capacity of the natural floodplain to retain water. Land management and uses that reduce runoff rates in upland areas should be supported;
- Development should maintain conveyance of watercourses through hamlets and villages to help reduce the impact of more frequent flood events and to improve the natural environment and WFD targets;
- Use of this SFRA to inform future development and minimise flood risk from all sources;
- Implementation of upstream catchment management i.e. slow the flow and flood storage schemes could be implemented in upper catchments to reduce risk downstream and across neighbouring authority boundaries; and
- Promotion and consideration of SuDS at the earliest stage of development planning through Schedule 3 of the FWMA, when implemented.

According to the NPPF, the LPA should work with neighbouring authorities to consider strategic cross-boundary issues and infrastructure requirements. Local authorities also have a duty to cooperate whereby councils work together on strategic matters and produce effective and deliverable policies on strategic cross boundary matters.

The FWMA requires all RMAs to cooperate with relevant authorities regarding exercising flood and coastal risk management. Cotswold district is represented by the English Severn and Wye Regional Flood and Coastal Committee (RFCC) where cross-boundary resources, projects and data are shared between neighbouring authorities.

4.7.1 Hydrological linkages and cross boundary issues

The main watercourses within the Cotswold district all originate from within the CDC authority boundary. Therefore, major land use changes within neighbouring catchments are unlikely to have a significant impact on flow regimes and flood risk. However, a number of watercourses that originate from within the Cotswold district enter into neighbouring catchments and local authority boundaries. Development control and responsible land

management across the Cotswold district is crucial to ensuring sustainable development within neighbouring authority boundaries.

Figure 4-4 illustrates fluvial hydraulic linkages for the catchments in and around the authority area of CDC. The River Windrush and River Evenlode enter the West Oxfordshire district from CDC; upstream land use changes in the CDC area could have an effect on flood risk along these watercourses. In addition, the River Coln and River Leach enter the Vale of White Horse district; and the River Thames and River Churn flow into Wiltshire. Close partnerships between CDC and the surrounding authorities will need to be maintained.

Were the above strategic solutions not considered in upstream development planning, the following issues may occur:

- Reduction in upstream floodplain storage capacity; and
- Increase in impermeable areas leading to a reduction in rainfall infiltration and subsequent increased runoff.

The need for consistent regional development policies controlling runoff or development in floodplains within contributing districts is therefore crucial as this would have wider benefits for neighbouring local authorities as well as Cotswold district. This should be carried out by the successful implementation of the Sequential Test.

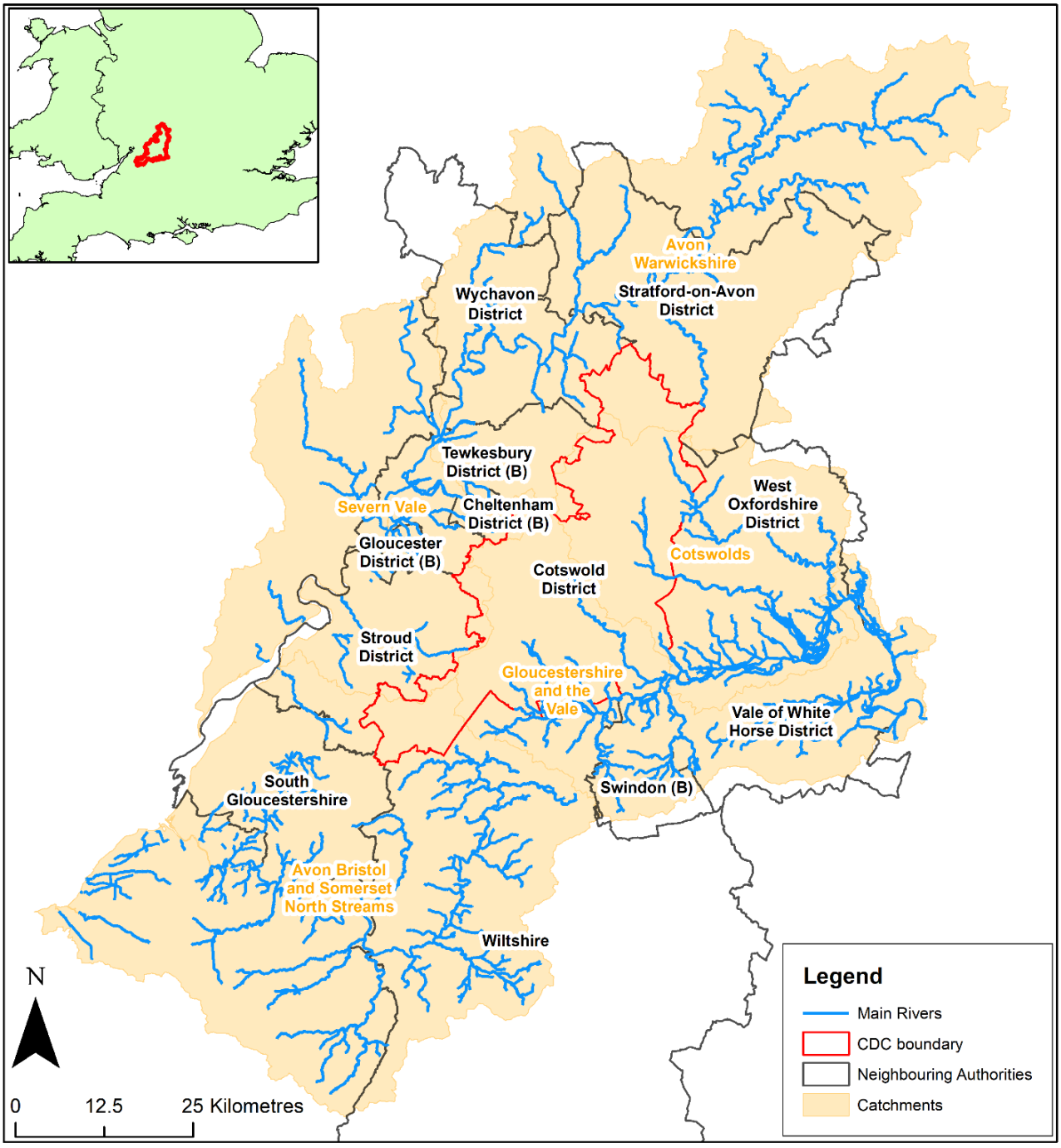

Figure 4-4 Hydrological linkages for catchments in and around the Cotswold district

4.7.2 Cumulative impact of development and strategic solutions

This section provides a summary of the catchments with the highest flood risk and development pressures and then makes recommendations for local planning policy based on these.

4.7.2.1 Introduction

Under the NPPF, strategic policies and their supporting SFRAs, are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 160), rather than just to or from individual development sites.

When allocating land for development, consideration should be given to the potential cumulative impact of the loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments comply with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory they should not increase flood risk downstream.

Catchments within the study area that have the potential to influence existing flood risk issues in neighbouring Local Authorities were identified, as well as catchments in the study area that may be influenced by development in catchments in neighbouring Local Authorities. Historic flood incidents, the current and potential increases in surface water flood risk to properties and cross boundary issues in each catchment were assessed to identify the catchments at greatest risk.

Local planning policies can also be used to identify areas where the potential for development to increase flood risk is highest and identify opportunities for such new development to positively contribute to decreases in flood risk downstream.

4.7.2.2 Strategic solutions

Cotswold District Council has a vision for the future management of flood risk and drainage in the district. This concerns flood risk management, alongside wider environmental and water quality enhancements. Strategic solutions may include upstream flood storage, integrated major infrastructure/ FRM schemes, new defences and watercourse improvements as part of regeneration and enhancing green infrastructure, with opportunities for natural flood management and retrofitting sustainable drainage systems.

The strategic policy vision from the Catchment Flood Management Plan (CFMP) and River Basin Management Plan (RBMP) focuses on safeguarding the floodplain from inappropriate development and encouraging collaboration and creating new partnerships to reduce the risk of flooding and to enhance the natural environment. Within Cotswold district, strategic solutions encourage development to:

- Consider Flood Risk Management potential social, environmental and economic benefits to local communities to improve the natural and built environments;
- Work closely with county and district planners, and other organisations where relevant, to avoid inappropriate development in areas of flood risk and ensure development does not increase flood risk elsewhere;

- Support sustainable flood resilient development through avoiding development in existing and future areas at risk of flooding and coastal erosion and managing other land elsewhere to avoid increasing the risks, through the encouragement of the implementation of SuDS;
- Address flood risk through improved engagements with wider partners and key communities, increasing public awareness on the effects of climate change and how to manage/mitigate the risks;
- Ensure CDC is using the 'Locally Agreed Surface Water Information' to support spatial planning;
- Ensure downstream properties are protected from an increase, and preferably seek a decrease, in flood risk due to development. This should also account for climate change;
- Identify land that could be allocated for future water attenuation schemes, and areas which could be flooded without high risk of damages to properties or injury to use for conveyance and storage of stormwater; and
- Minimise future culverting of watercourses and seek to 'daylight' existing culverts where possible.

The Thames CFMP gives an overview of the flood risk in the River Thames catchment and sets out plans for sustainable flood risk management across nine sub areas. Cotswold District Council occupies the Upper Thames; sub area 1. This sub area covers large expanses of open undeveloped floodplain with villages and market towns. The preferred policy is Policy Option 6, which uses sustainable flood storage and mitigation schemes to store water and manage surface water runoff in locations that provide overall flood risk reduction as well as environmental benefits.

4.7.2.3 Assessment of cross-boundary issues

Figure 4-6 shows the catchments in the Cotswold district mapped against the topography and the direction that they drain. This shows that although the majority of the cross-boundary catchments drain out of the district, some located towards the northeast drain into the Cotswold district from neighbouring authorities. This means that development in neighbouring authorities to the northeast are more likely to have an impact on flood risk within the Cotswold district, whereas development within Cotswold district is more likely to impact neighbouring authorities to the south and west.

The neighbouring Local Authorities that contain catchments which drain into Cotswold district include:

- Tewkesbury district
- Wychavon district
- Stratford-on-Avon district
- West Oxfordshire district
- Wiltshire

Growth in neighbouring authorities was considered in the cumulative impact assessment outlined below. There were three brownfield sites with the potential for development found

within West Oxfordshire that are located within the Cornwell Brook and tributaries catchment that drains into the east of Cotswold district. The total area of the potential development sites only occupies around 0.4% of the catchment. In the remaining neighbouring authorities, there are no significant development sites on catchments draining into Cotswold district. If appropriate drainage strategies and SuDS are adopted, new development in West Oxfordshire district can be mitigated to reduce the effects on flood risk in Cotswold district.

The neighbouring Local Authorities that catchments located within the Cotswold district drain into, shown in Figure 4-5, include:

- Cheltenham district
- Gloucester district
- South Gloucestershire
- Stratford-on-Avon district
- Stroud district
- Swindon
- Tewkesbury district
- Vale of White Horse district
- West Oxfordshire district
- Wiltshire
- Wychavon district

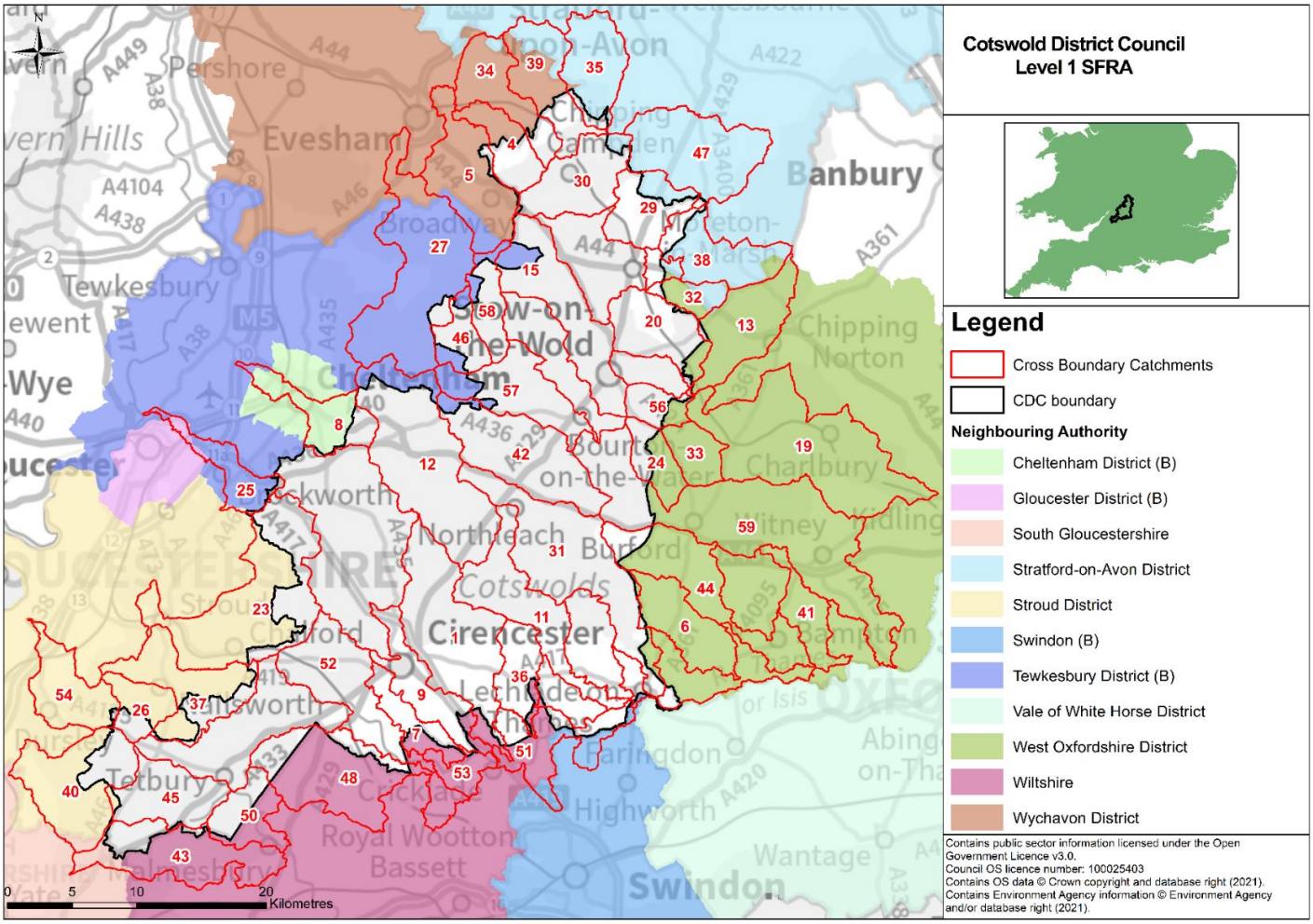

Figure 4-5 Cross boundary catchments that drain out of the district into neighbouring Local Authorities

Consequently, there are a number of catchments and sub-catchments that exist within the Cotswold district where future development may impact flood risk in the neighbouring Local Authorities outlined above, particularly where there are existing flood risk issues. Appendix G summarises which catchments drain out of the Cotswold district, and any downstream existing flood risk issues that have the potential to be exacerbated. The sources of data used to inform the existing flood risk issues to properties in neighbouring Local Authorities can be found in Appendix H.

Apart from the districts outlined below, the Local Plans for the remaining neighbouring Local Authorities are being reviewed alongside their evidence bases (i.e., SFRAs, Sustainability Appraisals, etc.) and therefore, their up-to-date flood risk and drainage policies are not yet formalised. However, it is very likely that to ensure compliance with the NPPF, appropriate sustainable drainage and flood risk policies will be proposed. Below summarises the relevant drainage and flood risk policies relating to the Local Plans for the neighbouring authorities with adopted Local Plans.

Cheltenham, Gloucester and Tewkesbury Joint Core Strategy 2011-2031

The Joint Core Strategy (JCS) for Cheltenham, Gloucester and Tewkesbury was adopted 11 December 2017. The majority of policies for the individual districts are contained within the JCS. The following policies are relevant to the district's flood risk and drainage strategy:

- INF2: Flood Risk Management
- INF3: Green Infrastructure
- SD3: Sustainable Design and Construction

Stroud district Local Plan 2011-2031

Stroud district's Local Plan was adopted 19 November 2015, and the following policies are relevant to the district's flood risk and drainage strategy:

- CP6: Infrastructure and developer contributions
- CP14: High Quality Sustainable Development
- ES1: Sustainable Construction and Design
- ES3: Maintaining Quality of Life within our Environmental Limits
- ES4: Water resources, quality, and flood risk

Swindon Local Plan 2011-2026

Swindon's Local Plan was adopted 26 March 2015, and the following policies are relevant to the district's flood risk and drainage strategy:

- EN6: Flood Risk

Vale of White Horse district Local Plan 2011-2031

Vale of White Horse district's Local Plan Part 1 was adopted in December 2016, with Part 2 being adopted 9 October 2019, and the following policies are relevant to the district's flood risk and drainage strategy:

- Core Policy 14: Strategic Water Storage Reservoirs
- Core Policy 42: Flood Risk
- Core Policy 37: Design and Local Distinctiveness
- Core Policy 40: Sustainable Design and Construction
- Core Policy 45: Green Infrastructure
- Development Policy 30: Watercourses

West Oxfordshire district Local Plan 2011-2031

West Oxfordshire district's Local Plan was adopted 26 March 2015, and the following policies are relevant to the district's flood risk and drainage strategy:

- OS2: Locating development in the right places
- OS3: Prudent use of natural resources
- OS4: High quality design
- EH7: Flood risk

It is recommended that Cotswold District Council consults neighbouring authorities to identify and review potential cross-boundary issues.

Policy recommendations with regards to managing the cumulative impact of development have been made further in the section of the report. This will help to ensure there is no incremental increase in flood risk both within and downstream of Cotswold district. The catchments within the Cotswold district are shown in Figure 4-5. The direction of catchment drainage in or out of the Cotswold district for catchments that straddle neighbouring Local Authority boundaries is shown in Figure 4-6.

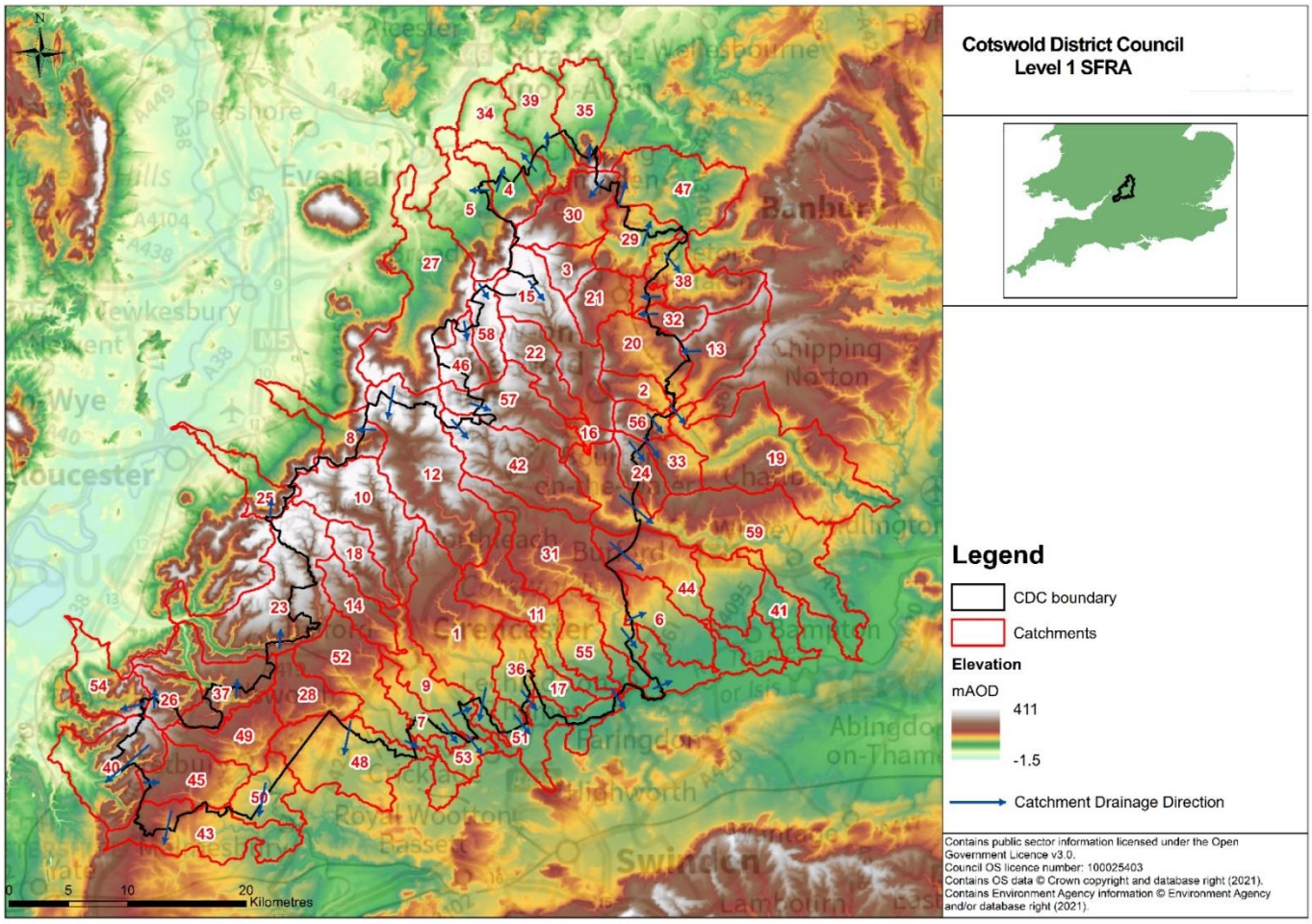

Figure 4-6 River Catchments and the direction of catchment drainage in or out of Cotswold district

4.7.2.4 Cumulative Impact Assessment

A cumulative impact assessment (CIA) was undertaken for this SFRA. To assess which catchments are at the highest risk of flooding and where the cumulative impact of development may have the biggest effect, historic flood risk and areas that are most sensitive to increases in flood risk were assessed. The methodology for the CIA is discussed in Appendix H. The policy recommendations are listed further on in this section. The results of the CIA can be summarised to give a rating of low, medium or high risk for each catchment. The rating of each catchment in each of these assessments was combined to give an overall ranking. The average scores for the rating of each of the sub catchments was combined to give the rating of the overall catchment. The highest overall

ranked catchments are shown in Table 4-2 and a map of the catchment ratings is shown in Figure 4-7.

Table 4-2 Highest ranked catchments

Catchment	Number of historic flood events	Sensitivity to increases in flood flows*	% area of development sires within catchment**	Potential to impact neighbouring local authority?	Potential for neighbouring local authority to impact flood risk?	Total Score
Churn (Baunton to Cricklade)	25	249%	2.5%	Yes	No	9
Coln (from Coln Rogers) and Thames (Coln to Leach)	21	237%	0.4%	Yes	No	8
Daglingworth Stream (Source to Churn)	11	340%	0.04%	No	No	7
Evenlode (Compton Bk to Bledington Bk) and 4 Shires	5	100%	3.3%	No	Yes	7
Evenlode (Source to Four Shires S) and Longborough Stream	10	219%	2.3%	No	No	7
Tetbury Avon - unnamed trib to conf Sherston Avon	1	346%	0%	Yes	No	7

Catchment	Number of historic flood events	Sensitivity to increases in flood flows*	% area of development sires within catchment**	Potential to impact neighbouring local authority?	Potential for neighbouring local authority to impact flood risk?	Total Score
Windrush (Slade Barn Stream to Dikler)	9	126%	0%	No	Yes	7

*This is the measure of the increase in the number of properties at risk of surface water flooding in a 1 in 100-year event to a 1 in 1,000-year event. It is an indicator of where local topography makes an area more sensitive to increases in flood risk that may be due to any number of reasons, including climate change, new development etc. It is not an absolute figure or prediction of the impact that new development will have on flood risk.

**This is the measure of the area of development sites within each catchment taken as a percentage of the total area in each catchment.

***The final divides the Total Scores up into different bands to assign a rating of high, medium or low. A score of >7 = High, 4-6 = Medium and 0-3 = Low.

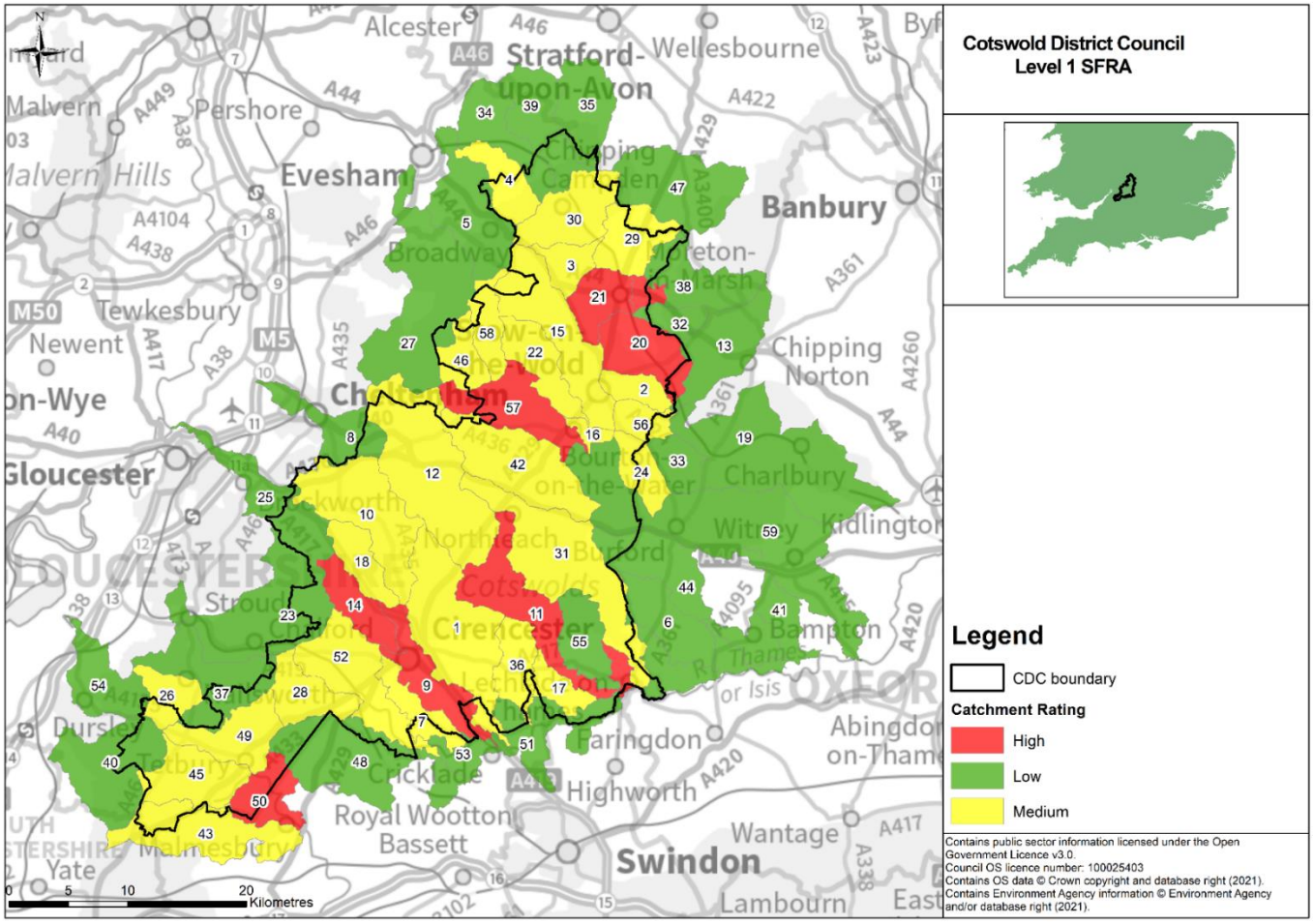

Figure 4-7 Map of the results of the CIA for each of the catchments

4.7.2.5 Recommendations from the Cumulative Impact Assessment

The CIA supports a tiered approach, with bespoke policy depending on the location of the development. Specific policy recommendations relate to:

- High risk urban catchments (Policy Recommendation 1)
- High risk rural catchments (Policy Recommendation 2)

The remaining medium and low risk catchments in the district are assigned different policy recommendations:

- All catchments council-wide including ones at lower risk (Policy Recommendation 3)

Policies 1 and 2 relate to the high risk ‘red’ catchments seen in Table 4-7, whereas Policy 3 relates to all other ‘yellow’ and ‘green’ catchments within Cotswold District Council administrative area. More details regarding the Policies can be seen below.

Policy Recommendation 1 – High risk urban catchments

Mapping of these catchments can be found in Figure 4-7. High-risk catchments are detailed within Table 4-2.

- Churn (Baunton to Cricklade)
- Daglingworth Stream (Source to Churn)

Cirencester town centre falls within both the Churn (Baunton to Cricklade) and the Daglingworth Stream (Source to Churn) catchments, which received a high-risk rating in the cumulative impact analysis.

All new development (other than minor extensions) within this catchment should:

- Consider site specific Flood Risk Assessments to demonstrate what measures can be put in place to contribute to flood risk reduction downstream. This could be through SuDS, natural flood management techniques, green infrastructure, and green-blue corridors.
- Look to maintain existing key blue and green spaces including those identified in the Green and Blue Infrastructure Strategy, particularly where there is an environmental or climate change mitigation value, and consider creating additional blue and green infrastructure, combing these with the existing network, unless other development pressures outweigh the need for maintaining existing blue/green areas. Key green spaces within high-risk urban catchments should be identified to protect from future development.
- Produce a Green and Blue Infrastructure Management and Maintenance Plan to set out the effective management of green and blue infrastructure assets so they can continue to deliver the long-term benefits they were designed to provide.
- Incorporate Surface Water Drainage Strategies consistent with local planning requirements for all developments in this catchment, regardless of development size.

Policy Recommendation 2 - High risk rural catchments

Mapping of these catchments can be found in Figure 4-7. High-risk catchments are detailed within Table 4-2.

- Coln (from Coln Rogers) and Thames (Coln to Leach)
- Evenlode (Compton Bk to Bledington Bk) and 4 Shires
- Evenlode (Source to Four Shires S) and Longborough Stream
- Tetbury Avon - unnamed trib to conf Sherston Avon
- Windrush (Slade Barn Stream to Dikler)

Opportunities within rural catchments should be explored to:

- Promote environmental land management practices to attenuate surface water runoff, through methods such as cover crops, riparian borders, and infiltration techniques, to alleviate potential issues downstream.
- Promote community resilience in rural areas where immediate assistance following serious flood events might not be possible.

The LPA should work closely with the EA and GCC as LLFA to identify areas of land that should be safeguarded for the future use of natural flood management features.

Policy Recommendation 3 - Applicable across the district to minimise cumulative impacts

This policy applies to all catchments that received a medium-risk or low-risk catchment rating in the CIA.

All new development in these catchments should:

- Incorporate green and blue infrastructure into development plans, through both maintaining current green and blue spaces and also creating additional infrastructure to promote recreation, water management, biodiversity and climate change mitigation.
- Integrate Surface Water Drainage Strategies in accordance with local requirements for all major and non-major developments. These should consider all sources of flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere.

4.7.3 Safeguarding land for flood storage

Where possible, the LPA may look to allocate land designed for flood storage functions through the local plan. Such land can be explored by using this SFRA to assess the flood risk within the priority areas and to ascertain what benefit could be gained by leaving at risk areas undeveloped.

Paragraph 161 of the NPPF states:*to avoid where possible, flood risk to people and property, the LPAs should manage any residual risk by*:

'safeguarding land from development that is required, or likely to be required, for current or future flood management'.

Applicable locations may include any current greenfield sites:

- That are considered to be large enough to store floodwater to achieve effective mitigation (modelling would be required);
- With large areas of their footprint at high or medium surface water flood risk (based on the RoFSW);
- Within the functional floodplain (Flood Zone 3b);
- With large areas of their footprint at risk from Flood Zone 3a; and
- That are large enough and within a suitable distance to receive floodwater from a nearby development site using appropriate SuDS techniques which may involve pumping, piping or swales/drains.

Brownfield sites could also be considered, though this would entail site clearance of existing buildings, conversion to greenspace and contaminated land assessments.

4.8 Climate change

NPPF para 8 states that mitigating and adapting to climate change is an important objective that is key to delivering sustainable development that should be delivered through local plans.

In relation to flood risk and climate change in the planning system, the NPPF states:

"*New development should be planned for in ways that:*

a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure". (Para 154).

The Level 1 SFRA should be the starting point for any LPA to assess the effects of climate change on flood risk across the local plan area. Section 4.8.2 details the climate change modelling carried out as part of this regional SFRA.

Along with the NPPF, FRCC-PPG and EA guidance, the LPA should refer to the Royal Town Planning Institute and Town & Country Planning Association's new edition of their joint guidance: 'The Climate Crisis – a guide for local authorities on planning for climate change[10]' when preparing the local plan.

4.8.1 EA climate change allowances

The EA previously revised the climate change allowances for peak river flow allowances in July 2021 and for peak rainfall allowances in May 2022, for use in FRAs and SFRAs and will, at the time of writing, use these revised allowances when providing advice. These updates are based on the release of UKCP18.

Climate change guidance is continually evolving therefore developers should refer to the climate change allowances on Government's website[11] to ensure those outlined below are the most up-to-date available.

4.8.1.1 Peak river flow allowances

Developers should refer to the online peak river flow map[12] for the latest climate change allowances to ensure those outlined in Table 4-3 are the most up-to-date available. Peak river flow allowances show the anticipated changes to peak flow by management catchment which are sub-catchments of river basin districts. The Cotswolds, Gloucestershire and the Vale, Avon Warwickshire, Avon Bristol and North Somerset Streams and Severn Vale management catchments are present in CDC, as shown on Figure 4-8. Both the central and higher central allowances for the 2080s epoch are required to be assessed for SFRAs, as advised by the EA. See Section 4.8.2 for the assessment of climate change for this Level 1 SFRA.

10 The Climate Crisis – a guide for local authorities on planning for climate change | The Royal Town Planning Institute and Town & Country Planning Association | January 2023
11 Flood risk assessments: climate change allowances | Environment Agency | May 2022
12 Peak river flow map | Environment Agency

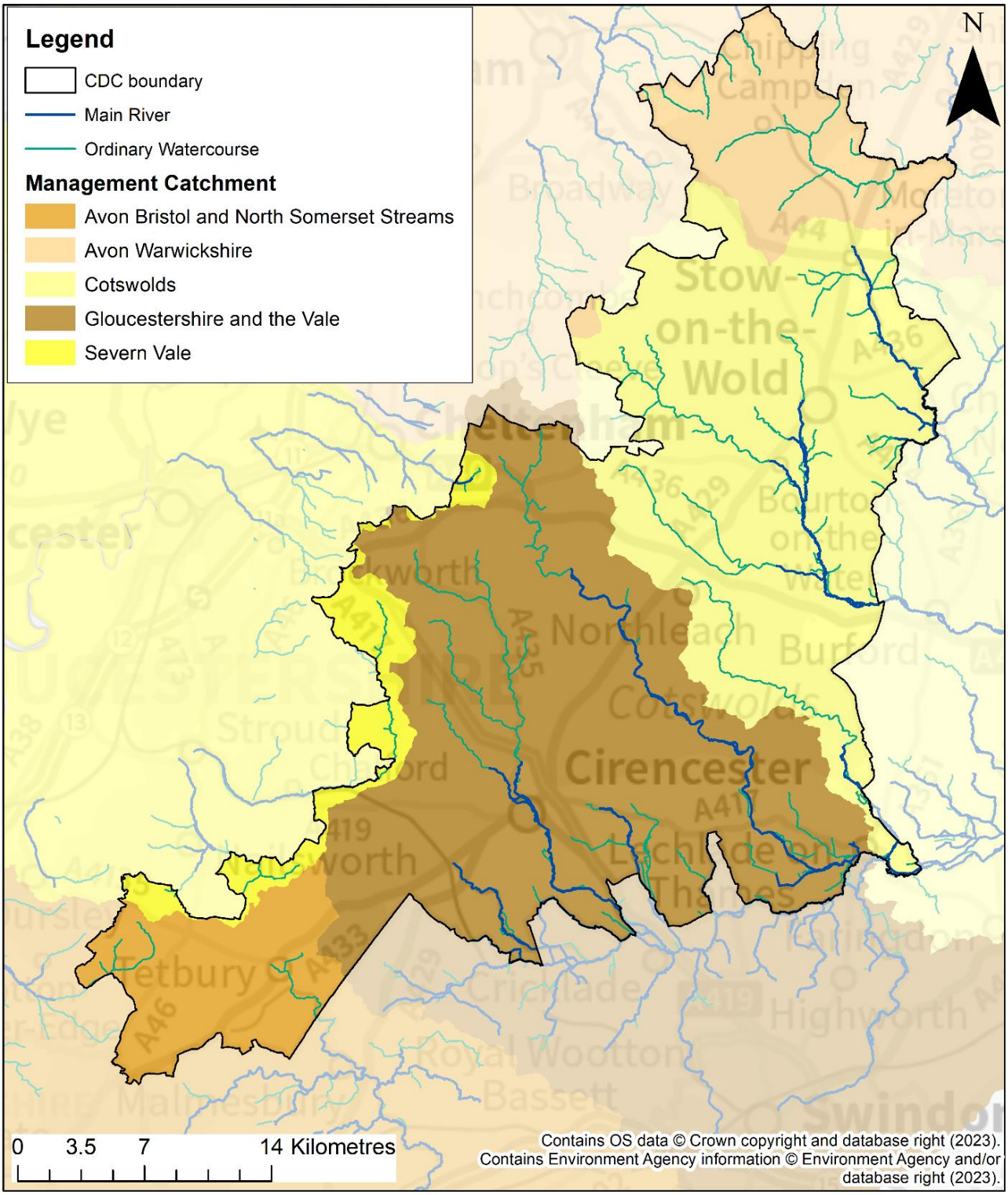

Figure 4-8 Management Catchments within the CDC boundary

Table 4-3 Recommended peak river flow allowances for the management catchments covering Cotswold district

Management catchment	Allowance Category	Total potential change anticipated for peak river flows (based on a 1981 to 2000 baseline)		
		2020s (2015-2039)	2050s (2040-2069)	2080s (2070-2125)
Cotswolds	Upper end	31%	43%	82%
	Higher central	17%	21%	43%
	Central	11%	13%	30%
Gloucestershire and the Vale	Upper end	33%	43%	84%
	Higher central	17%	19%	41%
	Central	11%	11%	26%
Avon Warwickshire	Upper end	22%	31%	59%
	Higher central	12%	14%	32%
	Central	7%	8%	21%
Avon Bristol and North Somerset Streams	Upper end	27%	38%	71%
	Higher central	15%	19%	39%
	Central	10%	12%	26%
Severn Vale	Upper end	34%	52%	94%
	Higher central	20%	28%	53%
	Central	14%	19%	37%

4.8.1.2 Peak rainfall intensity allowances

Increases in rainfall intensities lead to increases in surface water flood risk and the risk of sewer and drainage systems becoming overwhelmed. Developers should refer to the online peak rainfall allowances map[13] which shows anticipated changes in peak rainfall intensity per management catchment (see Table 4-4).

The EA guidance states, for FRAs and SFRAs, the upper end allowances should be used for both the 1% and 3.3% AEP events for the 2070s epoch.

13 Peak rainfall allowances map | Environment Agency

Table 4-4 Peak rainfall intensity allowances in small and urban catchments for England

Return period	Allowance Category	Total potential change anticipated for peak rainfall intensities (based on a 1961 to 1990 baseline)	
		2050s	2070s
3.3%	Upper end	+35%	+40%
	Central	+25%	+30%
1%	Upper end	+40%	+50%
	Central	+25%	+35%

4.8.2 Climate change data in Cotswold district

To represent the increased flood risk resulting from climate change on flooding from rivers, peak river inflows were uplifted respectively according to the EA allowances listed in the tables above. The hydraulic models of the watercourses outlined in Table 4-5 were updated in accordance with the EA peak river flow allowances to produce flood extents to support the SFRA. The 100-year and 1000-year modelled present day and climate change enhanced flood extents (where available) are presented on the SFRA Maps in Appendix B.

A climate changed enhanced Flood Zone 3a extent has been produced for both the 30% and 43% climate change uplift factors. This combines any available detailed modelling with the EA's Flood Zone 2 outline in areas of no detailed modelling. Similarly, a climate changes enhanced Flood Zone 3b has been produced using the 43% uplifted 30-year outline where available, combined with the EA's Flood Zone 3a outline in areas of no detailed modelling. These layers are presented on the SFRA maps in Appendix B.

Table 4-5 Modelled climate change allowances

Watercourse	Management catchment	Central allowance modelled	Higher central allowance modelled
Bledington Brook	Cotswolds	30%	43%
Churn	Gloucestershire and the Vale	30%	43%
Daglingworth Stream	Gloucestershire and the Vale	30%	43%
Thames	Cotswolds	30%	43%
Windrush	Cotswolds	30%	43%

For some watercourse, namely the Churn, the higher central allowance was unable to be successfully modelled due to issues with the model simulations becoming unstable. Where this is the case, the central allowance modelled outputs have been mapped. There were also some instances where the 1000-year flood event or the climate change enhance 1000-

year flood event was unable to be modelled. These have been flagged in the Data Gaps summary in Section 6.2.

4.9 Historic risk

GCC, as LLFA, is required, under the FWMA, to maintain and update its historic flood incidents database as and when any locally significant flood incidents occur. The LLFA has a statutory responsibility to investigate and report upon any 'significant' flood events.

The LFRMS (2014) identified that the district has a long history with flooding, with flood events occurring throughout the last 80 years. Notable flood events occurred in the Summer of 2007 and the winter of 2012, due to heavy rainfall causing both surface water and fluvial flooding.

As many of these incidents are at the property level and considered as sensitive information, they will only be shown at the smaller scale of the whole authority. Figure 4-9 shows GCC, CDC and the relevant water companies recorded historic flood incidents within CDC, which includes multiple sources of flooding. The historic (compiled) dataset that was provided by the LLFA includes flooding of property, gardens to property, highways and footpaths.

Appendix I details historic flooding information for CDC and summarises impacted roads and businesses.

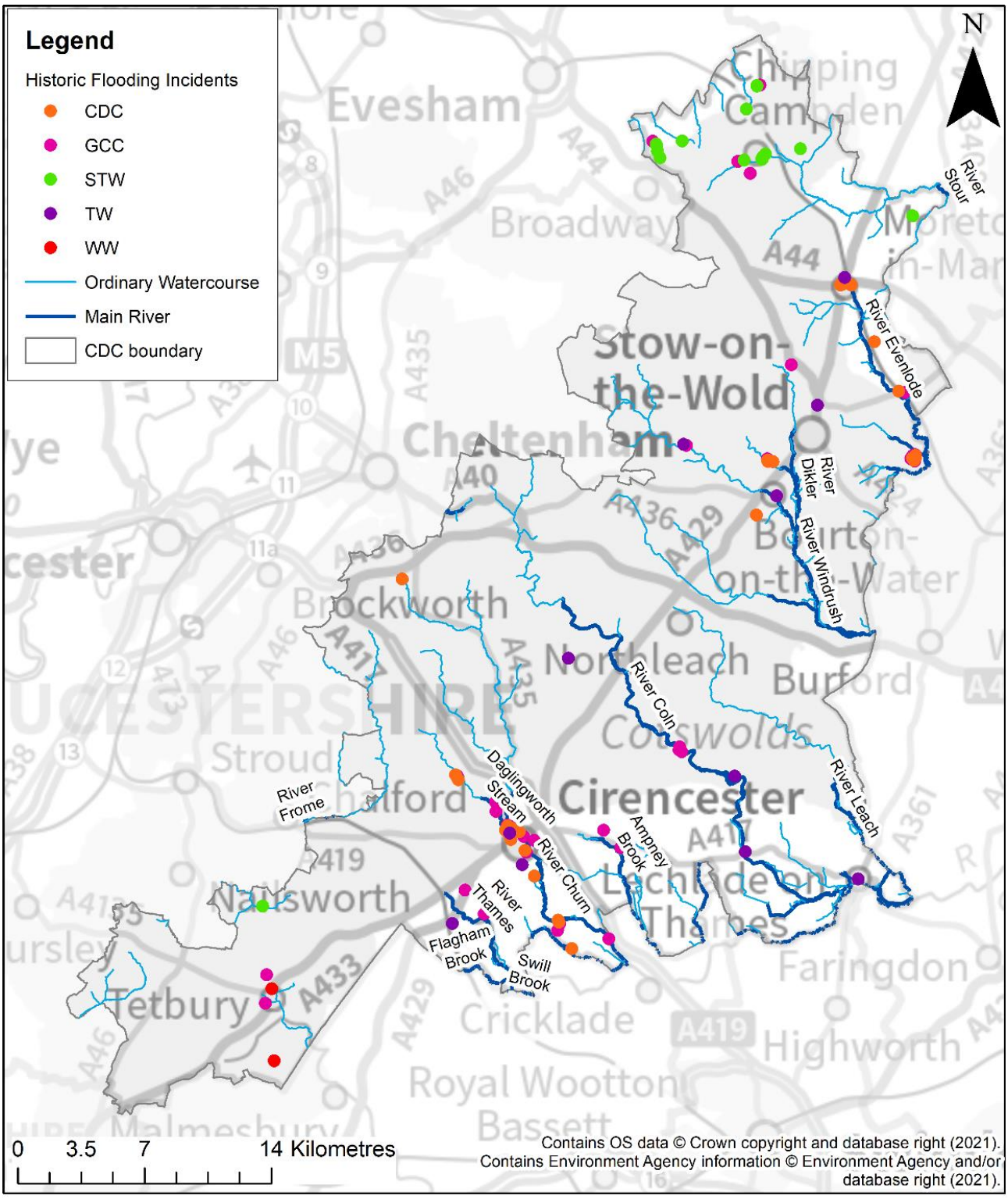

Figure 4-9 CDC, GCC and water company historic flood incidents

4.9.1 Historic surface water flooding

The LFRMS states that the Summer 2007 flooding was caused in part from fluvial sources, however also as a result of surface water overloading the drainage systems. This was an extended intense rainfall event following a relatively dry Spring. Approximately 5,000 homes and businesses were recorded as having been flooded during this event.

4.9.2 Historic groundwater flooding

The 2014 SFRA stated that generally there are limited records of groundwater flooding within the district. There are several incidents recorded in the Cirencester and Siddington areas, and a few isolated incidents on the Great Oolite, most likely related to springs.

4.9.3 EA Historic Flood Map and Recorded Flood Outlines

The Historic Flood Map (HFM) is a spatial dataset showing the maximum extent of all recorded historic flood outlines from river, sea and groundwater and shows areas of land that have previously been flooded across England. Records began in 1946 when predecessor bodies to the EA started collecting information about flooding incidents. The HFM accounts for the presence of defences, structures, and other infrastructure where such existed at the time of flooding. It includes flood extents that may have been affected by overtopping, breaches or blockages. It is also possible that historic flood extents may have changed and that some areas would not flood at present i.e., if a flood defence has been built.

The HFM does not contain any information regarding the specific flood source, return period or date of flooding, nor does the absence of the HFM in an area mean that the area has never flooded, only that records of historic flooding do not exist. The Recorded Flood Outlines (RFO) dataset however does include details of flood events. The difference between the two datasets is that the HFM only contains flood outlines that are ‘considered and accepted’ by the EA following adequate verification using certain criteria.

In relation to CDC, the HFM and RFO show areas of historic flooding around Fairford, South Cerney, Kemble, Somerford Keynes, Cirencester, Lechlade-on-Thames, Bourton-on-the-Water, Bledington and Moreton-in-Marsh.

The HFM and RFO datasets are shown on the SFRA maps in Appendix B.

4.10 Flood risk management

The aim of this section of the SFRA is to identify existing Flood Risk Management (FRM) assets and proposed FRM schemes. The location, condition and design standard of existing assets will have a significant impact on actual flood risk mechanisms. Whilst future schemes in high flood risk areas carry the possibility of reducing the probability of flood events and reducing the overall level of risk. Both existing assets and future schemes will have a further impact on the type, form and location of new development or regeneration.

4.10.1 EA inspected assets (Spatial Flood Defences)

The EA maintains a spatial dataset called the Spatial Flood Defences dataset. This national dataset contains such information as:

- Asset type (flood wall, embankment, high ground, demountable defence, bridge abutment);
- Flood source;
- Design Standard of Protection (SoP);

- Asset length;
- Asset age;
- Asset location; and
- Asset condition.

This dataset does not include flood defence assets on non-main rivers. See Table 4-6 for condition assessment grades using the EA's Condition Assessment Manual[14] (CAM).

The design standard of protection (SoP) for a flood defence is a measure of how much protection a flood defence gives. If the SoP is 100, the defence is designed to protect against a flood with the probability of occurring once in 100 years (1% AEP event).

Table 4-6 EA flood defence condition assessment grades

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no impact on performance
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce the performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very Poor	Severe defects resulting in complete performance failure.

Table 4-7 Major flood defences within Cotswold district

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Condition grade
Somerford Keynes	2 embankments	Fluvial	River Thames	50 (2)	N/A
South Cerney	3 embankments 1 wall	Fluvial	River Churn	5 (3) N/A (1)	2 (3) 3 (1)
Cirencester	4 embankments 3 walls	Fluvial	River Churn	5 (1) N/A (6)	1 (2) 2 (1) 3 (3) N/A (1)
Fairford	2 embankments 5 walls	Fluvial	River Coln	N/A (7)	1 (3) N/A (4)
Bourton-on-	3	Fluvial	River	75 (4)	1 (1)

14 Environment Agency. (2012). Visual Inspection Condition Grades. In: EA Condition Assessment Manual. Bristol: Environment Agency. P9.

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Condition grade
the-Water	embankments 1 wall		Windrush		2 (3)
Number in brackets = number of assets					

Table 4-7 highlights the main locations within the area that have significant FRM assets which are located in Somerford Keynes, South Cerney, Cirencester, Fairford and Bourton-on-the-Water.

There are 14 embankments with varying design standards, that have been assessed at condition grades 2 or 3 meaning the condition is rated as 'Good' or 'Fair' according to the EA's Condition Assessment Manual (as discussed in Table 4-6) meaning that there are some assets where defects could reduce performance of the structure.

Along the majority of the Main Rivers within CDC's authority area, there are only areas of high ground offering protection from fluvial flooding, with no formal defences. The condition grade of the majority of these defences is stated as 2/3, which means 'Good/Fair', as per the EA's Condition Assessment Manual meaning there could be defects that could reduce the performance of the asset or the defects are only minor and would not compromise performance.

The Spatial Flood Defences dataset is shown on the Interactive Maps in Appendix B.

As well as the ownership and maintenance of a network of formal defence structures, the EA carries out a number of other flood risk management activities that help to reduce the probability of flooding, whilst also addressing the consequences of flooding. These include:

- Maintaining and improving the existing flood defences, structures and watercourses;
- Enforcement and maintenance where riparian owners unknowingly carry out work that may be detrimental to flood risk;
- Identifying and promoting new flood alleviation schemes (FAS), were appropriate;
- Working with local authorities to influence the location, layout and design of new and redeveloped property and ensuring that only appropriate development is permitted relative to the scale of flood risk;
- Operation of Floodline Warnings Direct and warning services for areas within designated Flood Warning Areas (FWA) or Flood Alert Areas (FAA). EA FWAs are shown on the SFRA Maps in Appendix B;
- Promoting awareness of flooding so that organisations, communities and individuals are aware of the risk and therefore sufficiently prepared in the event of flooding; and
- Promoting resilience and resistance measures for existing properties that are currently at flood risk, or may be in the future as a result of climate change (Property Flood Resilience - see Section 5.8.5).

4.10.2 GCC assets and future Flood Risk Management schemes

The LLFA owns and maintains a number of assets throughout the district which includes culverts, bridge structures, gullies, weirs and trash screens. The majority of these assets lie along ordinary watercourses within smaller urban areas where watercourses may have been culverted or diverted, or within rural areas. All these assets can have flood risk management functions as well as an effect on flood risk if they become blocked or fail. In most cases responsibility lies with the riparian/landowner. Notable culvert features within CDC can be found in Table 4-8.

Table 4-8 Notable culvert features within CDC

Settlement	Culvert description
Andoversford	Culvert under Station Road
Chipping Campden	Guild Twin culvert, Blind Lane/Dyer's Lane culverts
Cirencester	Culverts under Spitalgate Lane
Lechlade	Butlers Court
Moreton-in-Marsh	Swan Close, Queen Street The culvert which passes under High Street, the A429, Co-op and the railway. The culvert beneath the A44
Northleach	Culvert under old prison and West End
South Cerney	Lower Mill, Upper Mill and School Lane.
Weston-sub-Edge	B4632, Manor Farm and Parsons Lane
Willersey	Campden Lane, Broadway Road, Collin Lane, Willow Road

GCC (as the LLFA), under the provisions of the FWMA, has a duty to maintain a register of structures or features that have a significant effect on flood risk, including details of ownership and condition as a minimum. The Asset Register should include those features relevant to flood risk management function including feature type, description of principal materials, location, measurements (height, length, width, diameter) and condition grade. The Act places no duty on the LLFA to maintain any third-party features, only those for which the authority has responsibility as land/asset owner.

The LLFA should carry out a strategic assessment of structures and features on the FRM Asset Register to inform capital programme and prioritise maintenance programme. Critical assets (i.e. culverts in poor condition) to be prioritised for designated works.

At the time of writing, there are no current proposed future Flood Risk Management schemes within CDC.

4.10.3 Water company assets

The sewerage infrastructure within CDC's administrative area may have a risk of localised flooding associated with the existing drainage capacity and sewer system. Wessex Water,

Severn Trent and Thames Water are responsible for the management of the adopted sewerage system for their areas. This includes surface water and foul sewerage. There may however be some private surface water sewers in the area as only those connected to the public sewer network that were transferred to the water companies under the Private Sewer Transfer in 2011 are likely to have been constructed since this transfer date. Surface water sewers discharging to watercourses were not part of this transfer and would therefore not be under the ownership of WW, ST or TW, unless adopted under a Section 104 adoption agreement.

Water company assets include Wastewater Treatment Works, Combined Sewer Overflows, pumping stations, detention tanks, sewer networks and manholes.

4.10.4 Natural Flood Management/Working with Natural Processes

Natural flood management (NFM) or Working with Natural Processes (WwNP) is a type of nature-based flood risk management used to protect, restore and re-naturalise the function of catchments and rivers to reduce flood and coastal erosion risk. WwNP has the potential to provide environmentally sensitive approaches to minimising flood risk, to reduce flood risk in areas where hard flood defences are not feasible and to increase the lifespan of existing flood defences.

A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes in order to store or slow down floodwaters before they can damage flood risk receptors (e.g. people, property, infrastructure, etc.). WwNP involves taking action to manage flood and coastal erosion risk by protecting, restoring and emulating the natural regulating functions of catchments, rivers, floodplains and coasts.

The EA is actively encouraging the implementation of WwNP measures within catchments and coastal areas in order to assist in the delivery of environmental protection and national policies. The implementation of WwNP will continue to become a fundamental component of the flood risk management tool kit due to climate change.

4.10.4.1 Evidence base for WwNP to reduce flood risk

The EA has produced a WwNP evidence base which includes three interlinked projects:

- Evidence directory;
- Mapping the potential for WwNP; and
- Research gaps.

The evidence base can be accessed online via:

Working with natural processes to reduce flood risk

The evidence base can be used by those planning projects which include WwNP measures to help understand:

- Their potential FCRM benefits and multiple benefits;
- Any gaps in knowledge;
- Where it has been done before and any lessons learnt; and

- Where in a catchment they might be most effective.

A guidance document sits alongside the evidence directory and the WwNP maps which explains how to use them to help make the case for implementing WwNP when developing business cases.

4.10.4.2 Mapping the potential for WwNP

National maps for England make use of different mapping datasets and highlight the potential areas for tree-planting (for three different types of planting), runoff attenuation storage, gully blocking and floodplain reconnection. The maps can be used to signpost potential areas for WwNP and do not take into account issues such as landownership and drainage infrastructure, but they may well help start the conversation and give indicative estimates of, for example, additional distributed storage in upstream catchments.

These maps are intended to be used alongside the evidence directory to help practitioners think about the types of measure that may work in a catchment and the best places in which to locate them. There are limitations with the maps, however it is a useful tool to help start dialogue with key partners. The maps are provided as spatial data for use in GIS and also interactive GeoPDF format, supported by a user guide and a detailed technical guide.

The WwNP types are listed in Figure 4-10.

WWNP Type	Open data licence details
Floodplain reconnection	• Risk of Flooding from Rivers and Seas (April 2017) • Data derived from the Detailed River Network, which is not displayed, rescinding the licence requirements for displaying the dataset (to be superseded by OS Water Network but not available for project in time). • Constraints data
Run-off attenuation features	• Data derived from Risk of Flooding from Surface Water (Depth 1 percent annual chance and Depth 3.3 percent annual chance) (October 2013). The original data is not displayed, due to licensing restrictions.[2] • Constraints data • Gully blocking potential (a subset of run-off attenuation features on steeper ground) • Data derived from OS Terrain 50 (2016) to classify each run-off attenuation feature based on median slope.
Tree planting (3 categories)	• Floodplain: Flood Zone 2 from Flood Map for Planning (April 2016) and new constraints layer • Riparian: 50m buffer OS water features from Section 2.2.3 with constraints layer • Wider catchment woodland: - Based on slowly permeable soils. - BGS Geology 50,000 Superficial and Bedrock layers (both V8, 2017). Used with new science to derive new 100m gridded open data. This new layer can be used to signpost areas of SLOWLY PERMEABLE SOILS and can be checked in more detail on the BGS portal. - To the north of the line of Anglian glaciation, the presence of till-diamicton has been shown to be a strong predictor of slowly permeable soils. - To the south of this line, particular bedrock geologies have shown a similarly strong spatial relationship to the presence of slowly permeable soils.

Figure 4-10 WwNP measures and data

The WwNP datasets are included on the SFRA Maps in Appendix B and should be used to highlight any sites or areas where the potential for WwNP should be investigated further as a means of flood mitigation:

- Floodplain Reconnection:

- Floodplain Reconnection Potential – areas of low or very low probability based on the Risk of Flooding from Rivers and Sea dataset (see Section 4.1.3) which are in close proximity to a watercourse and that do not contain properties, are possible locations for floodplain reconnection. It may be that higher risk areas can be merged, depending on the local circumstances.

- Runoff Attenuation Features (Run-off attenuation features are based on the premise that areas of high flow accumulation in the RoFSW) maps are areas where the runoff hydrograph may be influenced by temporary storage if designed correctly):
  - Runoff Attenuation Features 1% AEP
  - Runoff Attenuation Features 3.3% AEP
- Tree Planting
  - Floodplain Woodland Potential and Riparian Woodland Potential – woodland provides enhanced floodplain roughness that can dissipate the energy and momentum of a flood wave if planted to obstruct significant flow pathways. Riparian and floodplain tree planting are likely to be most effective if close to the watercourse in the floodplain, which is taken to be the 0.1% AEP flood extent (Flood Zone 2) and within a buffer of 50 metres of smaller watercourses where there is no flood mapping available. There is a constraints dataset that includes existing woodland; and
  - Wider Catchment Woodland Potential – slowly permeable soils have a higher probability of generating 'infiltration-excess overland flow' and 'saturation overland flow'. These are best characterised by gleyed soils, so tree planting can open up the soil and lead to higher infiltration and reduction of overland flow production.

Limitations

The effectiveness of WwNP measures is site-specific and depends on many factors, including the location and scale at which they are used. It may not always be possible to guarantee that these measures alone will deliver a specified standard of defence. Consequently, flood risk management measures should be chosen from a number of options ranging from traditional forms of engineering through to more natural systems. The research gaps that need to be addressed to move WwNP into the mainstream are identified in the evidence directory.

The key locations within Cotswold district that are considered to have significant potential for WwNP schemes include:

- Chipping Campden
- Moreton-in-Marsh
- South Cerney
- Somerford Keynes
- Siddington

An interactive map of nature-based flood risk management projects and potential projects can be found at: JBA Trust Mapping

4.10.5 EA flood risk management activities and Flood and Coastal Erosion Risk Management (FCERM) Research and Development

The FCERM Research and Development Programme is run by the EA and Defra and aims to serve the needs of all flood and coastal operating authorities in England. The strategic objectives for research include:

- better understand future flood and coastal erosion risk
- prepare for the scale and frequency of future incidents
- optimise the management of FCERM infrastructure
- improve responsibility and funding for flood and coastal risk
- understand the potential of new technology and innovation
- increase resilience to flood and coastal erosion risk

Completed and ongoing research can be researched online via: FCERM research and development projects

4.10.6 Summary of risk

The risk across the district is varied:

- The main fluvial risk comes from the River Thames and its tributaries towards the south of the district, and also along the River Windrush to the north;
- Surface water risk is spread across the district, with areas to the north being of particular risk, around Chipping Campden;
- Groundwater risk is located primarily towards the south of the district around the River Thames; and
- The only area within CDC at reservoir flood risk is around Cirencester.

5 Development and flood risk

5.1 Introduction

This section of the SFRA summarises the sequential approach and the application of the sequential and exception tests for identifying the suitability of potential development sites in the local plan. The information and guidance provided in this chapter (supported by the SFRA Maps in Appendix B, the sites screening spreadsheet in Appendix C, and the sites screening assessment commentary in Appendix E) can be used by the Council to inform the local plan and provide the basis from which to apply the sequential approach in the development allocation and development management process.

5.2 Sequential approach

The FRCC-PPG provides the basis for the sequential approach. It is this approach, integrated into all stages of the development planning process, which provides the opportunities to reduce flood risk to people, property, infrastructure and the environment to acceptable levels. Land at the lowest risk of flooding from all sources should be considered for development, following the requirements of the sequential test.

The approach is based around the FRM hierarchy, in which actions to avoid, substitute, control and mitigate flood risk is central. For example, it is important to assess the level of risk to an appropriate scale during the decision-making process, (starting with this Level 1 SFRA). Once this evidence has been provided, positive planning decisions can be made and effective FRM opportunities identified.

Figure 5-1 illustrates the FRM hierarchy with an example of how this may translate into the LPA's development management decisions and actions.

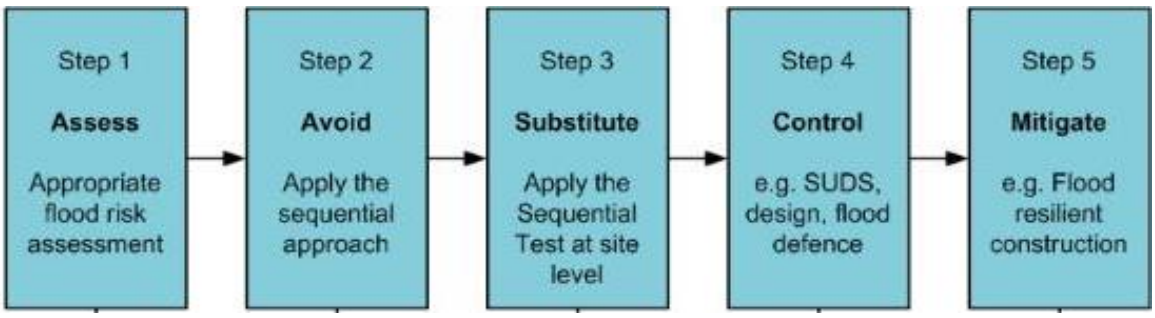

Figure 5-1 Flood risk management hierarchy

There are two different aims in carrying out the sequential test depending on what stage of the planning system is being carried out, i.e. LPAs allocating land in local plans or determining planning applications for development. The LPA will apply the sequential test to strategic allocations for inclusion in the local plan using the whole local planning authority area to increase the possibilities of accommodating development which is not exposed to flood risk, both now and in the future. For other developments, such as windfall developments, developers must supply evidence to the LPA, with a suitable planning application, that the development has passed the test.

This Level 1 SFRA provides the basis for applying the sequential test. However, the LPA may decide to perform the test as part of the Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of Strategic Housing Land or Employment Land Availability Assessments.

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development and the flood zone it is proposed for. Table 2 of the FRCC-PPG[15] defines the flood risk vulnerability and flood zone 'incompatibility' of different development types to flooding, as shown in **Error! Reference source not found.**.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	X	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	X	X	X	✓ *

Figure 5-2 FRCC-PPG flood risk vulnerability and flood zone 'incompatibility'

5.3 The sequential test for local plan preparation

The FRCC-PPG, para 024, states the aim of the sequential test is:

"…*to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account."*

The LPA should seek to avoid inappropriate development in areas at risk of all sources of flooding by directing development away from areas at highest risk and ensuring that all

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development does not increase risk and where possible can help reduce risk from flooding to existing communities and development.

At a strategic level, this should be carried out through the Local Plan using this Level 1 SFRA by:

1. Applying the sequential test and if the sequential test is passed, applying and passing the exception test, if required;
2. Safeguarding land from development that is required for current and future flood management (i.e. using potential for WwNP data as a starting point);
3. Using opportunities offered by new development to reduce the causes and impacts of flooding through effective mitigation i.e., SuDS;
4. Identifying where flood risk is expected to increase with climate change so that existing development may be made sustainable in the long term through Property Flood Resilience measures; and
5. Seeking opportunities to facilitate the relocation of development including housing to more sustainable locations, where feasible.

Figure 5-3 presents Diagram 2 of the FRCC-PPG (para 026) which illustrates the sequential test process for plan preparation. The Test can be applied using the information provided in this Level 1 SFRA. This is a stepwise process, but a challenging one, as a number of the criteria used are qualitative and based on experienced judgement. The process must be documented, and evidence used to support decisions recorded.

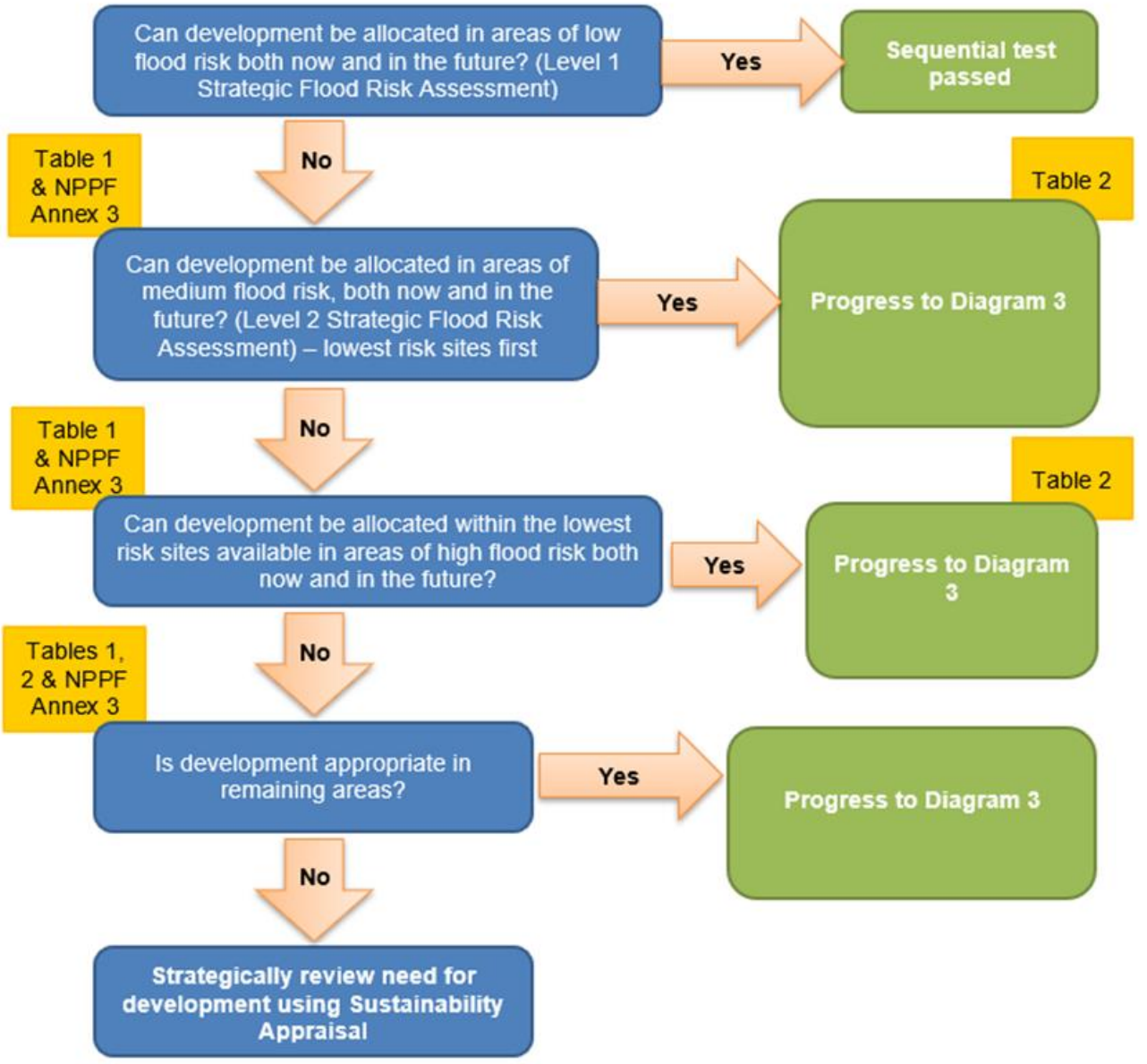


Figure 5-3 Application of the sequential test for plan preparation16

Notes on Diagram 2:

- 'Tables 1 and 2' refer to the flood zone and flood risk tables of the FRCC-PPG Paragraphs 078-079
- 'Areas of low flood risk' include:
  - Areas within Flood Zone 1 (rivers),
  - Areas not at additional risk from climate change.
  - Areas within the low risk surface water flood event extent of the Risk of Flooding from Surface Water map,

16 Flood risk and coastal change: paragraph 25, GOV.UK, 2022

- ‘Areas of medium flood risk’ include:
  - Areas within Flood Zone 2 (rivers),
  - Areas within the medium risk surface water flood event extent of the Risk of Flooding from Surface Water map,
  - Areas at risk from Flood Zone 2 plus climate change,
- ‘Areas of high flood risk’ include:
  - Areas within Flood Zone 3 (rivers),
  - Areas within the high risk surface water flood event extent of the Risk of Flooding from Surface Water map
  - Areas at risk from Flood Zone 3 plus climate change.

Sources of flooding other than fluvial and surface water also need to be considered. For example, if the site is solely within Flood Zone 1 but is at risk from other sources and/or climate change impacts, the sequential test has not been satisfied.

The approach shown in Figure 5-3 provides an open demonstration of the sequential test being applied in line with the NPPF and the FRCC-PPG. The LPA should agree a locally specific approach to application of the sequential test, based on the available evidence and circumstances. The EA would not be required to approve the locally specific approach taken by the LPA; however, the LPA can consult the EA regarding proposed sites and any local information or consultations with the LLFA should also be taken into account.

This Level 1 SFRA provides the main evidence required to carry out this process. The process also enables those sites that have passed the sequential test and may require the exception test, to be identified. *The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3 of the NPPF* (para 163).

5.4 The exception test for local plan preparation

The NPPF, para 164, states:

“*To pass the exception test it should be demonstrated that:*

a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.”

Both elements of the test must be passed to enable allocation in the local plan. A Level 2 SFRA would normally inform on whether the second part of the exception test can be passed, notwithstanding the requirement for a site-specific FRA at the planning application stage. However, as stated in para 166 of the NPPF, the test may need to be reapplied if relevant aspects of the planning proposal had not been considered when the test was first applied to allocate the site in the local plan, or if more recent information about existing or potential flood risk is available and should be accounted for.

Figure 5-4 presents Diagram 2 of the FRCC-PPG (para 033) which illustrates the application of the exception test for allocating sites in the local plan. This process should be informed by a Level 2 SFRA.

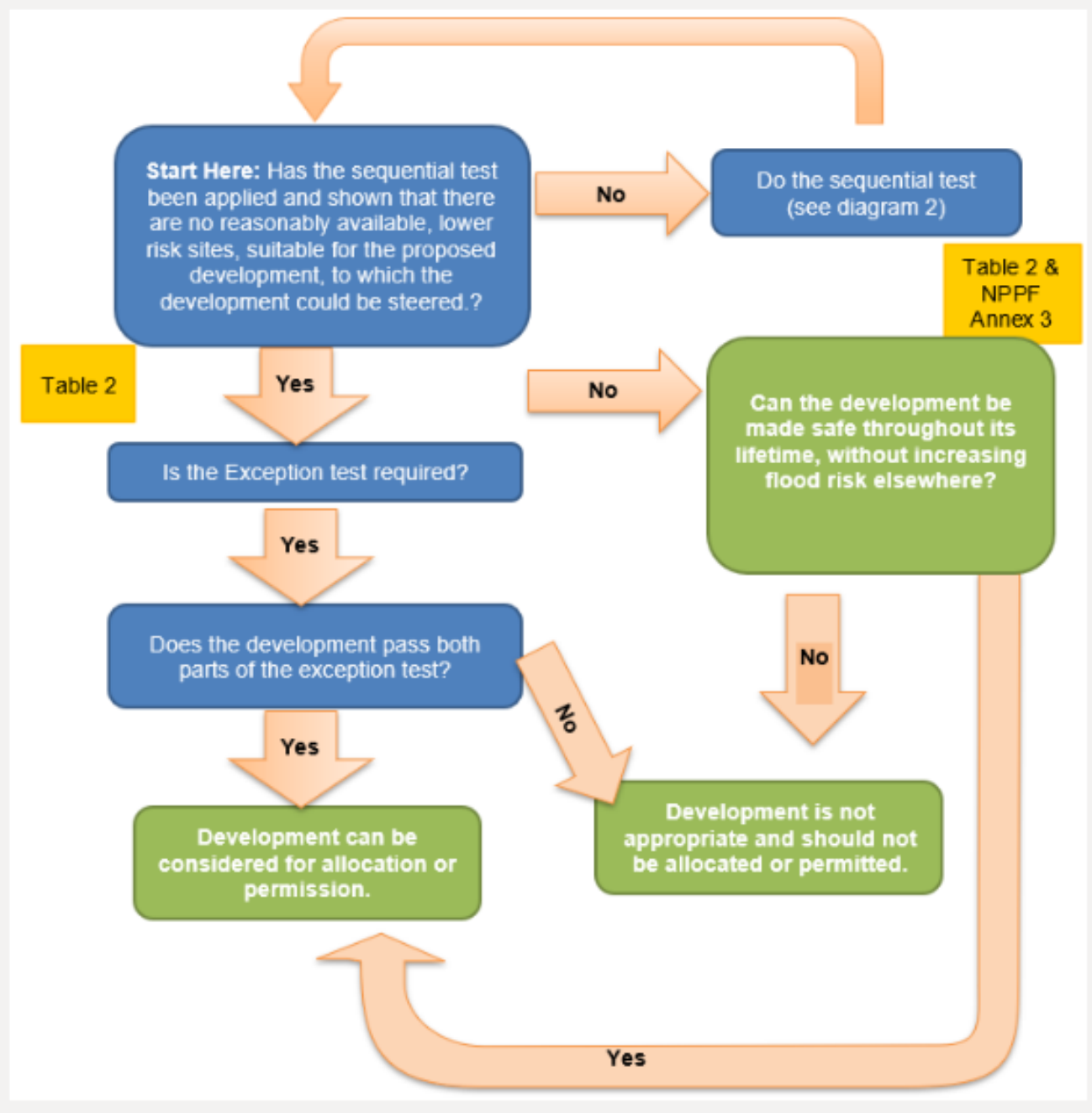


Figure 5-4 Application of the exception test to plan preparation

Where it is found to be unlikely that the exception test can be passed due to few wider sustainability benefits (part a), the risk of flooding being too great (part b), or the viability of the site being compromised by the level of flood risk management work required, then the LPA should consider avoiding the site altogether.

Once this process has been completed, the LPA should then be able to allocate appropriate development sites through the local plan as well as prepare flood risk policy including the requirement to prepare site-specific FRAs for all allocated sites that remain at risk of flooding or that are greater than one hectare in area.

5.5 Development management sequential and exception testing

5.5.1 Sequential testing for developers

CDC, with advice from the EA, is responsible for considering the extent to which sequential testing considerations have been satisfied for local plan site allocations.

Developers are required to apply the sequential test to all available potential development sites, unless a site is:

- A strategic allocation and the test has already been carried out by the LPA through the local plan process, or
- A change of use (except to a higher vulnerability classification), or
- A minor development (householder development, small non-residential extensions with a footprint of less than 250m^2), or
- A development in Flood Zone 1 unless there are other flooding issues in the area of the development (i.e. surface water, groundwater, sewer flooding, residual risk).

This Level 1 SFRA contains information on all sources of flooding, to the extent that information was made available. This should be considered when a developer undertakes the sequential test, including the consideration of reasonably available sites at lower flood risk. The impacts of climate change on all sources of flood risk, where feasible, should be robustly accounted for.

Local circumstances must be used to define the area of application of the sequential test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear e.g. school catchments, in other cases it may be identified by other local plan policies. For some sites e.g. regional distribution sites, it may be suitable to widen the search area beyond LPA administrative boundaries. The LPA should be consulted before deciding on the appropriate search area.

The sources of information on reasonably available sites may include:

- Site allocations in the local plan,
- Sites with planning permission but not yet built,
- Strategic Housing and Economic Land Availability Assessments (SHELAAs) / five-year land supply / annual monitoring reports,
- Locally listed sites for sale.

It may be that a number of smaller sites or part of a larger site at lower flood risk form a suitable alternative to a development site at high flood risk.

Ownership or landowner agreement is not acceptable as a reason not to consider alternatives.

5.5.2 Exception testing for developers

If, following application of the sequential test it has been agreed with the LPA that it is not possible for the development to be located in areas with a lower probability of flooding, the exception test must then be applied if required (as set out in Table 3 of the FRCC-PPG). Developers are required to apply the exception test to all applicable sites.

The applicant will need to provide information that the application can pass both parts of the exception test by:

- Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk (part a).
- Referring to wider sustainability objectives in the Sustainability Appraisal. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.
- Detailing the suitability issues the development will address and how doing it will outweigh the flood risk concerns for the site e.g. by facilitating wider regeneration of an area, contributing to the local economy, providing community facilities, infrastructure that benefits the wider area, etc.
- Demonstrating that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall (part b).
- Demonstrating that the site will be safe, and site users will not be exposed to hazardous flooding from any source. The FRA should consider actual and residual risk and how this will be managed over the lifetime of the development, including:
  - The design of any flood defence infrastructure, including operation and maintenance,
  - Availability of dry access and egress routes during a flood,
  - Design of the development to manage and reduce flood risk wherever possible i.e. through SuDS, including for designated ownership and maintenance procedures,
  - Resident awareness through appropriate emergency plans and signposting / signage,
  - Emergency planning and flood warning and evacuation procedures, including whether the development would increase the pressure on emergency services to rescue people during a flood event; and
  - Any funding arrangements required for implementing mitigation measures, maintenance procedures.

5.6 Site-specific Flood Risk Assessment

The principal aims of an FRA are to determine the level of flood risk to a site and to confirm that suitable flood management measures can be developed to control flooding, and safeguard life and property, without increasing risk to the surrounding area, for the lifetime of the development.

Once the site has been sequentially tested and has been identified as being likely to pass the exception test through a Level 2 SFRA, a site-specific FRA should be undertaken. The LPA, LLFA and EA should be consulted to determine the content and scope of the FRA.

The production of a site-specific FRA can be seen as an iterative process by subdividing the FRA into three stages:

- Stage 1 is a screening study used to identify whether there are any flood risk issues that need to be considered further i.e. reviewing the SFRA outcomes;
- Stage 2 is a scoping study that should be undertaken if the Stage 1 FRA indicates that there are flood risk issues that need further consideration; and
- Stage 3 is a detailed study where further quantitative analysis is required to fully assess flood issues and confirm that effective mitigation measures can be implemented to control flood risk and that the second part of the exception test can be passed.

It is appropriate to review the level of risk present and assess whether development is appropriate and achievable at each stage of the assessment.

The SFRA is an assessment of flood risk at a strategic level. This information can be used to provide evidence for Stages 1 and 2 of the FRA. Where a more detailed FRA is required (Stage 3), then a developer should undertake a detailed assessment of the flood risk at the site which would likely include appropriate flood modelling.

Significant consultation with the LPA and key consultees and stakeholders that are relevant to the site will be required for complex development proposals. Complex developments may need to include flood mitigation measures and compensatory storage.

Together with appropriate consultation, accepted FRA guidance should be followed by developers including:

- Find out when you need to do an FRA as part of a planning application, how to complete one and how it's processed:
  - Flood risk assessments if you're applying for planning permission
  - Flood risk assessment in flood zones 2 and 3
  - Flood risk assessment in flood zone 1 and critical drainage areas
- EA standing advice:
  - Preparing a flood risk assessment: standing advice

In summary, the FRA should address the following:

1. **Development description and location**
   a. What is the type of development and where will it be located?

b. What is the vulnerability classification (Table 2 of FRCC-PPG) of the current and future building use?
c. Has the development site been assessed in the SFRA? If so, has the sequential test been carried out? Has the exception test (if applicable) been applied and passed previously?

2. **Access and egress**
   a. Can safe access and egress routes be achieved during a flood event?
   b. Safe access and escape routes should be explicitly identified as part of an agreed emergency plan.
3. **Definition of flood hazard**
   a. What are the sources of flooding at the site?
   b. For each source how would flooding occur? Referencing any historical records
   c. What existing surface water drainage infrastructure is present on the site? Consultation required with LPA, LLFA, EA and water companies)
4. **Probability**
   a. Confirm the flood zone designation for the site (refer to the Flood Map for Planning: Flood Map for planning)
   b. Determine the actual and residual risks at the site (refer to the SFRA maps and EA modelled depth and hazard information)
   c. What are the discharge rates and volumes generated by the existing site and proposed development?
5. **Climate change**
   a. How is flood risk at the site likely to be affected by climate change?
   b. Check appropriate allowances (see Section 4.8) Flood risk assessments: climate change allowances
6. **Flood risk management measures**
   a. How will the site be protected from flooding, including the potential impacts of climate change, over the lifetime of the development?
7. **Residual risks**
   a. What are the consequences to the site of flood defence failure? Breach / overtopping scenarios should be modelled.
   b. What are the consequences to the site of asset blockage? Culvert, bridge blockage scenarios should be modelled.
   c. Is there residual risk from reservoirs? If so, how can this be mitigated and does the emergency plan address such risk? Reference the EA's Reservoir Flood Map: Reservoir flood risk
   d. Is there residual from canals? If so, how can this be mitigated and does the emergency plan address such risk? Consultation required with the EA, LLFA and Canal & River Trust. Breach / overtopping scenarios should be modelled.

e. What flood-related risks will remain after mitigation measures have been implemented?
f. How, and by whom, will these risks be managed over the lifetime of the development?

8. **Offsite impacts**
   a. How will the proposed development ensure there are no impacts to other development downstream or nearby?
   b. What measures will be implemented to control surface water runoff? SuDS? What arrangements are in place for SuDS ownership, maintenance?
9. **Groundwater**
   a. This mechanism of flooding should be considered particularly when determining the acceptability of SuDS schemes as a way of managing surface water drainage. Developers should consult with the LPA, LLFA and EA at an early stage of the assessment.
10. **Sewer systems**
    a. Where the SFRA has identified a risk of surface water flooding, any water that escapes from the sewer system would tend to follow similar flow paths and pond in similar locations. The SFRA should also contain historical evidence to refer to.
    b. Where required, liaison with the relevant water company should be undertaken at an early stage in the assessment process to confirm localised sewer flooding problems that could affect the site.
    c. Future development should be designed so that it does not exacerbate existing sewer capacity problems. Developers should check with the LPA whether a Water Cycle Study has been developed.

5.7 Surface water management and Sustainable Drainage Systems

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and consequently a potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure. Managing surface water discharges from new development is therefore crucial in managing and reducing flood risk to new and existing development downstream. Carefully planned development can also play a role in reducing the number of properties that are directly at risk from surface water flooding.

The Planning System has a key role to play in setting standards for sustainable drainage from new developments and ensuring that developments are designed to take account of the risk from surface water flooding. Sustainable drainage plays an important part in reducing flows in the sewer network and in meeting environmental targets, alongside investment in maintenance by the water companies on their assets. Water companies plan their investment on a five-year rolling cycle, in consultation with key partners, including the EA and local authorities.

The Department for Levelling Up, Housing and Communities Department for Communities and Local Government (DLUHC) (formally the Department for Communities and Local Government) announced, in December 2014, that the local planning authority, in consultation with the LLFA, should be responsible for delivering SuDS[17] through the planning system. Changes to planning legislation gave provisions for major applications of ten or more residential units or equivalent commercial development to require sustainable drainage within the development proposals in accordance with the 'non-statutory technical standards for sustainable drainage systems'[18], published in March 2015. A Practice Guidance[19] document has also been developed by the Local Authority SuDS Officer Organisation (LASOO) to assist in the application of the non-statutory technical standards.

Developers should be aware of Schedule 3 of the Flood and Management Act (see Appendix A), which is expected to be implemented in 2024, following an independent review commissioned by Government and published in January 2023. The review concluded that the delivery of SuDS should not be made entirely through the planning process and that automatic rights for developers to connect to public sewers should be removed. It is recommended that Schedule 3 be implemented subject to final decisions on scope, threshold, and process. It was also recommended that that the non-statutory technical standards for sustainable drainage systems should be made statutory. Government accepted the recommendations.

The Design and Construction Guidance (DCG) for sewers became the regulated sewerage guidance on 1 April 2020. This allows water and sewerage companies to adopt SuDS components that meet the criteria of the DCG. Details on the sewerage sector guidance can be found online via: Sewerage sector guidance

5.7.1 GCC Sustainable drainage

In order to manage flood risk, all development, regardless of development type, flood zone and development size, must give priority use to SuDS. Particularly for major developments, there is a requirement to assess and include SuDS for managing surface water at the development unless it is demonstrated during the assessment that it is inappropriate for the site i.e. due to high groundwater levels not allowing for infiltration SuDS.

To satisfy the NPPF, applicants must demonstrate that priority has been given to the use of SuDS in their development proposals. SuDS should be provided by default unless demonstrated to be inappropriate. Where priority use of SuDS cannot be achieved, applicants must justify this by submitting robust and acceptable evidence.

GCC, has developed the Gloucestershire SuDS Design & Maintenance Guide (November 2015) detailing the requirements as LLFA. It provides direction to the relevant design

17 Sustainable drainage systems, UK Parliament, 2014
18 Sustainable drainage systems, Defra, 2015
19 Non-Statutory Technical Standards for sustainable drainage, LASOO, 2016

guidance for the successful implementation of SuDS and is the basis on which planning consultations from LPAs will be assessed.

5.7.2 SuDS and the NPPF

The NPPF, para 169, states:

"Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

a. Take account of advice from the lead local flood authority;

b. Have appropriate proposed minimum operational standards;

c. Have maintenance arrangements, in place to ensure an acceptable standard of operation for the lifetime of the development; and

d. Where possible, provide multifunctional benefits".

All developments, both major and minor, are to include SuDS, providing multiple benefits that contribute to many other NPPF policies, including climate change, biodiversity net gain, amenity and water quality improvements. Where site conditions may be more challenging, the SuDS components used will need to accommodate the site's opportunities and constraints. At a strategic level, this should mean identifying opportunities for a variety of SuDS components according to geology, soil type, topography, groundwater/mine water conditions, their potential impact on site allocation, and setting out local SuDS guidance and opportunities for in perpetuity adoption and maintenance.

Sustainable drainage should form part of an integrated design methodology secured by detailed planning conditions to ensure that the SuDS to be constructed is maintained to a minimum level of effectiveness.

Sustainable drainage should form part of an integrated design methodology secured by detailed planning conditions to ensure that the SuDS to be constructed is maintained to a minimum level of effectiveness. SuDS maintenance options must:

- Clearly identify who will be responsible for maintaining the SuDS,
- Set out a minimum standard to which the SuDS must be maintained, and
- Ensure funding for SuDS maintenance is fair for householders and premises occupiers.

5.7.3 SuDS hierarchy

The runoff destination should always be the first consideration when considering design criteria for SuDS including the following possible destinations in order of preference:

1. To ground;
2. To surface waterbody;
3. To surface water sewer; or
4. To combined sewer.

Effects on water quality should be investigated when considering runoff destination in terms of the potential hazards arising from development and the sensitivity of the runoff destination.

The EA may also look at the potential impact of an outfall structure through the planning consultation and Environmental Permitting Regulation[20] process. It should be noted that detailing modelling will not be available for all outfalls therefore developers should carry out their own investigations whilst referring to the non-statutory technical standards for sustainable drainage systems (March 2015)[21].

The non-statutory technical standards for sustainable drainage systems sets out appropriate design criteria based on the following:

1. Flood risk outside the development,
2. Peak flow control,
3. Volume control,
4. Flood risk within the development,
5. Structural integrity,
6. Designing for maintenance considerations, and
7. Construction.

Many different SuDS techniques can be implemented. As a result, there is no one standard correct drainage solution for a site. In most cases, using the Management Train principle (see Figure 5-5), will be required, where source control is the primary aim. Source control includes interception of the first 5mm of rainfall and water quality treatment should be as near to source as possible.

In February 2021, Defra published its research project to review and provide recommendations to update the current non-statutory technical standards for sustainable drainage systems[22]. Defra will use this research to inform its drainage policy development. Based on the research findings, recommendations have been made to replace the current standards 1 to 7 with a new suite of six standards to cover the following:

1. Runoff destinations
2. Everyday rainfall
3. Extreme rainfall
4. Water quality
5. Amenity
6. Biodiversity

20 Environmental permits: detailed information | Environment Agency

21 Sustainable drainage systems: non-statutory technical standards, GOV.UK, 2015

22 Defra (2021) Recommendations to Update Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS) - WT15122

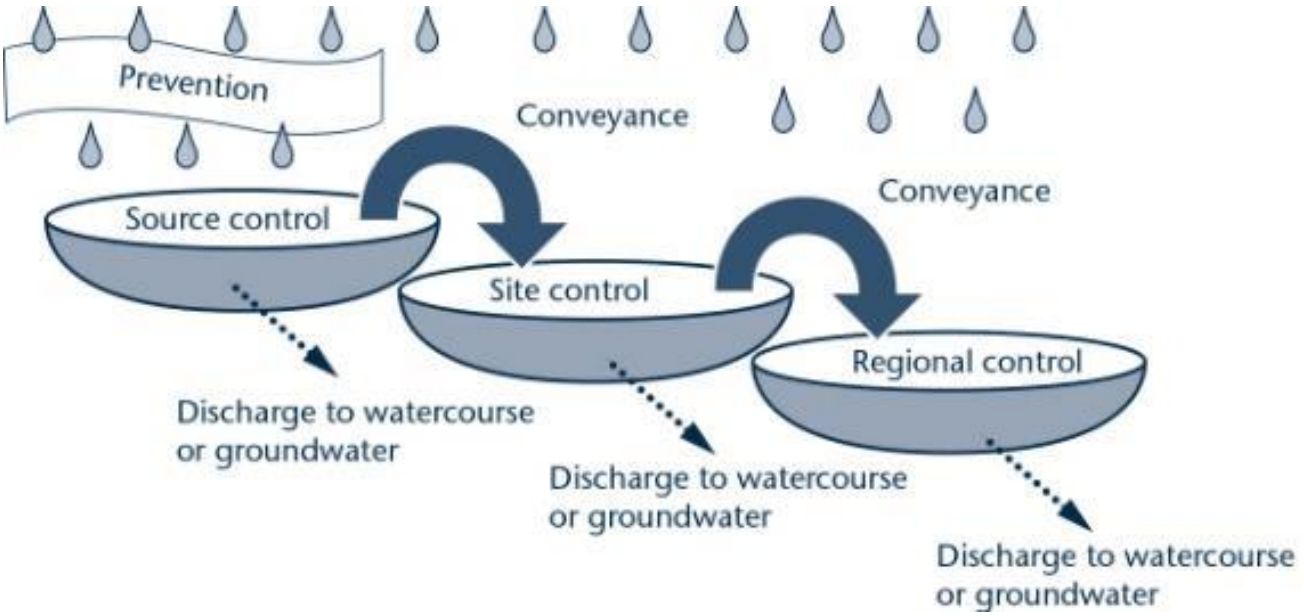


Figure 5-5 SuDS management train principle[23]

The effectiveness of a flow management scheme within a single site is heavily limited by land use and site characteristics including (but not limited to) topography, geology and soil (permeability) and available area. Potential ground contamination associated with urban and former industrial sites should be investigated with concern being placed on the depth of the local water table and potential contamination risks that will affect water quality. The design, construction and ongoing maintenance regime of any SuDS scheme must be carefully defined as part of a site-specific FRA. A clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential for successful SuDS implementation.

In addition to the national standards, the LPA may set local requirements for planning permission that include more rigorous obligations than the non-statutory technical standards. More stringent requirements should be considered where current Greenfield sites lie upstream of high-risk areas. This could include improvements on Greenfield runoff rates. The LPA should always be contacted with regards to its local requirements at the earliest opportunity in development planning.

The CIRIA SuDS Manual[24] 2015 should also be consulted by the LPA and developers. The SuDS manual (C753) is highly regarded and incorporates the latest research, industry practice, technical advice and adaptable processes to assist in the planning, design, construction, management and maintenance of good SuDS. The SuDS Manual complements the non-statutory technical standards and goes further to support the cost-effective delivery of multiple benefits.

23 CIRIA (2008) Sustainable Drainage Systems: promoting good practice – a CIRIA initiative
24 CIRIA (2008), CIRIA SuDS Manual

5.7.4 Overland flow paths

Underground drainage systems have a finite capacity and regard should always be given to larger events when the capacity of the network will be exceeded. Hence there is a need to design new developments with exceedance in mind. This should be considered alongside any surface water flows likely to enter a development site from the surrounding area.

Masterplanning should ensure that existing overland flow paths are retained within the development. As a minimum, the developer should investigate, as part of a site-specific FRA, the likely extents, depths and associated hazards of surface water flooding on a development site, as shown by the RoFSW dataset. This is considered to be an appropriate approach to reduce the risk of flooding to new developments. Green/blue infrastructure should be used wherever possible to accommodate such flow paths. EA standing advice states that floor levels should always be set a minimum of 300 mm above ground level (or 300 mm freeboard above the design flood level) to reduce the consequences of any localised flooding, unless local guidance states otherwise.

The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography; geology and soil (permeability); development density; existing drainage networks both on-site and in the surrounding area; adoption issues; and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined at an early stage and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential.

5.8 Mitigation measures

Whilst the sequential approach to development and flood risk should always be followed, there are certain instances where development must occur in areas of flood risk. This section details the generic mitigation measures that are available for new development and also for existing developments at flood risk.

5.8.1 Site layout and design

Flood risk should be considered at the first stage in planning the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from areas of flood risk for example to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas which may be on lower ground. Whether parking in floodplains is appropriate will be based on the likely flood depths and hazard, evacuation procedures and availability of flood warning.

Waterside areas, or areas along known flow routes, can act as green infrastructure, being 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.

5.8.2 Sustainable Drainage Systems

SuDS provide a means of dealing with the quantity and quality of surface water and can also provide amenity and biodiversity benefits. Given the flexible nature of SuDS they can be used in most situations within new developments as well as being retrofitted into existing developments. SuDS can also be designed to fit into most spaces. For example, permeable paving could be used in parking spaces or rainwater gardens as part of traffic calming measures.

The developer is responsible for ensuring the design, construction and future/ongoing maintenance of any SuDS scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and current drainage arrangements is essential.

5.8.3 Modification of ground levels

Any proposal for modification of ground levels will need to be assessed as part of a detailed FRA.

Modifying ground levels to raise land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for floodwaters. However, care must be taken as raising land above the floodplain could reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land. Raising ground levels can also deflect flood flows, so analyses through modelling should be performed to demonstrate that there are no adverse effects on third party land or property.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary (unless the site is strategically allocated). Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[25].

Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested through appropriate modelling to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

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

5.8.4 Raised floor levels

If raised floor levels are proposed, these should be agreed with CDC and the EA. The minimum Finished Floor Level (FFL) may change dependent upon the vulnerability and flood risk to the development.

EA standing advice[26] states:

Finished floor levels should be a minimum of whichever is higher of 300mm above the:

- *average ground level of the site,*
- *adjacent road level to the building,*
- *estimated river or sea flood level.*

Where floor levels cannot be raised to meet the minimum requirement, the developer must do the following:

- *raise them as much as possible,*
- *consider moving vulnerable uses to upper floors,*
- *include extra flood resistance and resilience measures.*

Where a development is designed to provide protection against 600mm of more of floodwater, advice should be sought from a structural engineer to check and confirm the safety of the design. Additional allowance may be required where there are residual risks relating to blockages to the river channel, culvert or bridge structures and should be considered as part of the FRA.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels. Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route from the development to safe areas.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 and areas at risk of surface water flooding in the high or medium surface water flood zones of the RoFSW should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the exception test as the use becomes highly vulnerable. Access should be situated 300 mm above the design flood level and waterproof construction techniques used.

5.8.5 Property Flood Resilience

Para 167 of the NPPF explains that development must only be allowed in areas at flood risk where, following the sequential and exception tests and supported by an FRA, the development is appropriately flood resistant and resilient.

26 Guidance | Preparing a flood risk assessment: standing advice | Environment Agency | February 2022

Flood resilience and resistance measures are mainly designed to mitigate flood risk and reduce damage and adverse consequences to existing property. Such measures may aim to help residents and businesses recover more quickly following a flood event.

The 'Code of practice for property flood resilience', published by CIRIA in 2021[27], defines active PFR measures as *'…measures which are not permanently installed into the property and will require deployment before a flood event (e.g. a door guard)*'. Passive PFR measures are defined as '…*measures which are installed into the property and do not require further deployment or activation before a flood event (e.g. a flood door or automatic airbrick cover)*'.

Research[28] carried out by the then DCLG (now DLUHC) and the EA recommended that the use of PFR measures should generally be limited to a nominal protection height of 600 mm above ground level, the lowest point of ground abutting the external property walls. This is because the structural integrity of the property may be compromised above this level. The EA recommends that advice from a structural engineer should be sought for any measures to resist a depth of 600 mm or more.

It should be noted that it is not possible to completely prevent flooding to all communities and businesses. Also, PFR measures would not be expected to cause an increase in flood risk to other properties or other parts of the local community. They will help mitigate against flood risk but, as with any flood alleviation scheme, flood risk cannot be removed completely. Emergency plans should, therefore, be in place that describe the installation of measures and residual risks.

As the flood risk posed to a property cannot be removed completely, it is recommended that PFR products are deployed in conjunction with pumps of a sufficient capacity. Pumps help manage residual flood risks not addressed by PFR measures alone such as rising groundwater.

5.8.5.1 Definitions

Flood resilience measures aim to reduce the damage caused by floodwater entering a property. Flood resilience measures are based on an understanding that internal flooding may occur again and when considering this eventuality, homes and businesses are encouraged to plan for flooding with an aim of rapid recovery and the return of the property to a habitable state.

For example, tiled floors are easier to clean than carpets, raised electricity sockets and high-level wall fixings for TVs/computers may mean that that power supply remains unaffected. Raising kitchen or storage units may also prevent damage that may not require replacement after a flood. There is a lot of information available about what items get

27 CIRIA (2021) Code of practice for property flood resilience (C790F)

28 DCLG & EA (2007) Improving the Flood Performance of New Buildings - Flood Resilient Construction

damaged by floodwater and features that are considered to provide effective resilience measures that can be installed at a property.

Flood resistance measures aim to reduce the amount of floodwater entering the property. Obvious inflow routes, such as through doors and airbricks may be managed, for example, by installing bespoke flood doors, door flood barriers and automatic closing airbricks. However, the property's condition and construction are also key to understanding how floodwater may enter and move between buildings. For example, floodwater can also flow between properties through connecting cavity walls, cellars, beneath suspended floors and through internal walls. Flood resistance measure alone may not keep floodwater out. Building condition is a critical component of any flood mitigation study.

5.8.5.2 Property mitigation surveys

To define the scale and type of resistance or resilience measures required, a survey will need to be undertaken to pick up property threshold levels, air brick levels, doorways, historic flood levels and a number of ground spot levels required to better understand the flood mechanisms for floodwater arriving at the property (e.g. along roads and pavements). The depth of flooding recorded at a property will help guide the selection of the most appropriate PFR measures. Surveys will need to include:

- Detailed property information i.e. structure, presence of air bricks, cellars, outlet pipes, floor levels, door and window levels, manhole and grid locations,
- An assessment of flood risk, including property (cross) threshold levels,
- Routes of water ingress (fluvial, ground and surface water flooding),
- An assessment of the impact of floodwaters,
- A schedule of recommended measures to help to reduce risk,
- Details of recommendations (including indicative costs),
- Advice on future maintenance of measures, and
- Advice on flood preparedness and emergency planning.

All sources of flooding will need to be considered, including a comprehensive survey of openings (doors, windows and air bricks), as well as potential seepage routes through walls and floors, ingress through service cables, pipes, drains and identification of possible weaknesses in any deteriorating brickwork or mortar.

5.9 Emergency planning

The provisions for emergency planning for local authorities as Category 1 responders are set out by the Civil Contingencies Act, 2004[29] and the National Flood Emergency Framework for England, December 2014[30]. This framework is a resource for all involved in emergency planning and response to flooding from rivers, surface water, groundwater and reservoirs.

29 Civil Contingencies Act, GOV.UK, 2004
30 The national flood emergency framework for England, GOV.UK, 2014

The framework sets out Government's strategic approach to:

- Ensuring all delivery bodies understand their respective roles and responsibilities when planning for and responding to flood related emergencies,
- Giving all those involved in an emergency flooding situation a common point of reference which includes key information, guidance and key policies,
- Establishing clear thresholds for emergency response arrangements,
- Placing proper emphasis on the multi-agency approach to managing flooding events,
- Providing clarity on the means of improving resilience and minimising the impact of flood events,
- Providing a basis for individual responders to develop and review their own plans, and
- Being a long-term asset that will provide the basis for continuous improvement in flood emergency management.

Along with the EA flood warning systems, there are a range of flood plans at a local level, outlining the major risks from flooding and the strategic and tactical response framework for key responders. The EA and the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) have produced guidance on flood risk emergency plans for new development (September 2019)[31]. It would however be for the LPA to review and approve flood risk emergency plans with their emergency planners or through the Local Resilience Forum (see Section 5.9.1.1).

This SFRA contains useful data to allow emergency planning processes to be tailored to the needs of the area and be specific to the flood risks faced. The SFRA Maps in Appendix B and accompanying GIS layers should be made available to emergency planners to help prepare for any flood event and throughout the planning process.

5.9.1 Civil Contingencies Act

Under the Civil Contingencies Act (CCA, 2004)[32], the LLFA and LPA are classified as Category 1 responders and thus have duties to assess the risk of emergencies occurring, and use this to:

- Inform contingency planning,
- Put in place emergency plans,
- Put in place business continuity management arrangements,
- Put in place arrangements to make information available to the public about civil protection matters,
- Maintain arrangements to warn, inform and advise the public in the event of an emergency,
- Share information with other local responders to enhance coordination, and

31 Flood Risk Emergency Plans for New Development, ADEPT/EA, September 2019
32 The Civil Contingencies Act, GOV.UK, 2013

- Cooperate with other local responders to enhance coordination and efficiency and to provide advice and assistance to businesses and voluntary organisations about business continuity management.

During an emergency, such as a flood event, the local authority must co-operate with other Category 1 responders (such as the emergency services and the EA) to provide the core response.

5.9.1.1 Gloucestershire Local Resilience Forum (GLRF)

CDC is a partner of the Gloucestershire Local Resilience Forum (GLRF). The role of the Resilience Forum is to ensure an appropriate level of preparedness to enable an effective multiagency response to emergency incidents that may have a significant impact on the communities of Cotswold District Council and other areas within Gloucestershire. GLRF consists of representatives from the Emergency Services, all six of Gloucestershire's local authorities (CDC, Gloucester City Council, Cheltenham Borough Council, Tewkesbury Borough Council, Stroud district Council and Forest of Dean Council), Gloucestershire Police, NHS England, the EA and Public Health England.

5.9.1.2 Community Risk Register

As a strategic decision-making organisation, the GLRF prepared a Community Risk Register (CRR)[33], last updated in 2015 at the time of writing, which considers the likelihood and consequences of the most significant risks and hazards the area faces, including fluvial and urban flooding. This SFRA can help to inform this. The CRR is considered as the first step in the emergency planning process and is designed to reassure the local community that measures and plans are in place to respond to the potential hazards listed within the CRR.

5.9.1.3 Community Emergency Plan

Communities may need to rely on their own resources to minimise the impact of an emergency, including a flood, before the emergency services arrive. Many communities already help each other in times of need, but experience shows that those who are prepared cope better during an emergency. Communities with local knowledge, enthusiasm and information are a great asset and a Community Emergency Plan can help. Details on how to produce a community emergency plan, including a toolkit and template, are available from the Government's website[34].

A number of parishes within CDC have completed community emergency plans. The Community Resilience sub group of the GLRF have recently updated the template and guidance and are actively promoting Community Emergency plans to parishes and town councils: How to prepare for an emergency

33 Community Risk Register, GLRF, 2015
34 Resilience in society: infrastructure, communities and business, GOV.UK, 2013

5.9.1.4 Local flood plans

This SFRA provides a number of flood risk data sources that should be used when producing or updating flood plans. The LPA will be unable to write their own specific flood plans for new developments at flood risk. Developers should write their own. Generally, owners with individual properties at risk should write their own individual flood plans, however larger developments or regeneration areas, such as retail parks, hotels and leisure complexes, should consider writing one collective plan for the assets within an area.

This SFRA can help to:

- Update these flood plans if appropriate;
- Inform emergency planners in understanding the possibility, likelihood and spatial distribution of all sources of flooding;
- Identify safe evacuation routes and access routes for emergency services;
- Identify key strategic locations to be protected in flooding emergencies, and the locations of refuge areas which are capable of remaining operational during flood events;
- Provide information on risks in relation to key infrastructure, and any risk management activities, plans or business continuity arrangements;
- Raise awareness and engage local communities;
- Support emergency responders in planning for and delivering a proportionate, scalable and flexible response to the level of risk; and
- Provide flood risk evidence for further studies.

The following guidance written by the EA and ADEPT is aimed at LPAs to help assist in setting up their own guidelines on what should be included in flood risk emergency plans: Flood risk emergency plans

As LLFA, GCC has produced a Local Flood Risk Management Strategy which explains how local flood risk is managed in the Cotswold district. This strategy is available online via:

Gloucestershire Local Flood Risk Management Strategy

5.10 Flood warning and evacuation plans

Developments that include areas that are designed to flood (e.g. amenity greenspace areas) or have a residual risk associated with them (e.g. located behind a flood defence), will need to provide appropriate flood warning and instructions so users and residents are safe in a flood. This will include both physical warning signs and written flood warning and evacuation plans. Those using the new development should be made aware of any evacuation plans.

In relation to a new development, it is up to the LPA to determine whether the flood warning and evacuation plans, or equivalent procedures, are sufficient or not. If the LPA is not satisfied, taking into account all relevant considerations, that a development can be considered safe without the provision of safe access and egress, then planning permission should be refused.

Whilst there is no statutory requirement on the EA or the emergency services to approve evacuation plans, LPAs are accountable under their Civil Contingencies duties, via planning condition or agreement, to ensure that plans are suitable. This should be done in consultation with development management officers. Given the cross-cutting nature of flooding, it is recommended that further discussions are held internally to the LPA between emergency planners and policy planners/development management officers, the LLFA, drainage engineers and also to external stakeholders such as the emergency services, the EA, WW, ST, TW, and Canal & River Trust (if applicable).

It may be useful for both the LLFA and spatial planners to consider whether, as a condition of planning approval, flood evacuation plans should be provided by the developer which aim to safely evacuate people out of flood risk areas, using as few emergency service resources as possible. It may also be useful to consider how key parts of agreed flood evacuation plans could be incorporated within local development documents, including in terms of protecting evacuation routes and assembly areas from inappropriate development.

Once the development goes ahead, it will be the requirement of the plan owner (developer) to make sure the plan is put in place, and to liaise with the LPA and LLFA regarding maintenance and updating of the plan.

At the time of writing there are 17 Flood Warning Areas within the district located primarily along the River Thames and its tributaries. CDC's emergency plans are created by the GLRF.

5.10.1 What should a flood warning and evacuation plan include?

Flood warning and evacuation plans should include the information stated in Table 5-1. Advice and guidance on plans are accessible from the EA website and plan templates are available for businesses and local communities.

Table 5-1 Flood warning and evacuation plans

Consideration	Purpose
Availability of existing flood warning system	The EA offers a flood warning service that currently covers designated Flood Warning Areas in England. In these areas, they are able to provide a full flood warning service.
Rate of onset of flooding	The rate of onset is how quickly the water arrives and the speed at which it rises which, in turn, will govern the opportunity for people to effectively prepare for and respond to a flood. This is an important factor within Emergency Planning in assessing the response time available to the emergency services.
How flood warning is given and occupant's awareness of the likely frequency and duration of flood	Everyone eligible to receive flood warning should be signed up to the EA flood warning service. Where applicable, the

Consideration	Purpose
events	display of flood warning signs should be considered. Particularly sites that will be visited by members of the public on a daily basis such as sports complexes, car parks, retail stores. It is envisaged that the responsibility should fall upon the developers and should be a condition of the planning permission. Information should be provided to new occupants of houses concerning the level of risk and subsequent procedures if a flood occurs.
The availability of site staff, occupants or users to respond to a flood warning and the time taken to respond to a flood warning	The plan should identify roles and responsibilities of all responders. The use of community flood wardens should also be considered.
Designing and locating safe access routes, preparing evacuation routes and the identification of safe locations for evacuees	Dry routes will be critical for people to evacuate as well as emergency services entering the site. The source, extent, depth and flood hazard rating, including allowance for climate change, should be considered when identifying these routes.
Vulnerability of occupants	Vulnerability classifications associated with development as outlined in the FRCC-PPG. This is closely linked to its occupiers i.e. elderly, less able, children are more vulnerable.
How easily damaged items will be relocated, and the expected time taken to re-establish normal use following an event	The impact of flooding can be long lasting well after the event has taken place affecting both the property which has been flooded and the lives that have been disrupted. The resilience of the community to get back to normal will be important including time taken to repair/replace damages.
Mental health	Exposure to a flood event i.e. having your home flooded can have sever effects on the mental health of those affected. There should be guidance on how to get help with mental issues.

5.10.2 EA Flood Warning Areas (FWA) and flood awareness

The EA monitors river levels within the main rivers affecting the authority area and based upon weather predictions provided by The Met Office, makes an assessment of the anticipated maximum water level that is likely to be reached within the proceeding hours (and/or days). Where these predicted water levels are expected to result in inundation of a

populated area, the EA will issue a series of flood warnings within defined FWAs, encouraging residents to take action to avoid damage to property in the first instance.

More information on flood warnings is provided by the EA via:

Flood warnings

Live information on flood warning and flood alerts is available via:

Check for flooding in England

Emergency planners may also use the outputs from this SFRA to raise awareness within local communities. This should include raising awareness of flood risk, roles, responsibilities and measures that people can take to make their homes more resilient to flooding from all sources whilst also encouraging all those at fluvial flood risk to sign up to the EA's Flood Warning Service.

Sign up for flood warnings

It is also recommended that Category 1 responders are provided with appropriate flood response training to help prepare them for the possibility of a major flood with an increased number of people living within flood risk areas, to ensure that adequate pre-planning response and recovery arrangements are in place.

6 Conclusions and recommendations

6.1 Conclusions

This Level 1 SFRA provides a single repository planning tool relating to flood risk and development in the Cotswold district. Key flood risk stakeholders namely the EA, LPA, LLFA, WW, ST and TW were consulted to collate all available and relevant flood risk information on all sources into one comprehensive high-level assessment. Together with this report, this SFRA also provides a suite of interactive GeoPDF flood risk maps (Appendix B) and a development site assessment spreadsheet (Appendix C) illustrating the level of risk to potential development sites. Appendix E provides a commentary on the site screening assessment.

The flood risk information, assessment, guidance and recommendations of the SFRA will provide the LPA with the evidence base required to apply the Sequential Test, as required under the NPPF and demonstrate that a risk-based, sequential approach has been applied in the preparation of its new Local Plan.

Whilst the aim of the sequential approach is the avoidance of high flood risk areas, in some locations where the council is looking for continued growth and/or regeneration, this will not always be possible. This SFRA therefore provides the necessary links between spatial development, wider flood risk management policies, local strategies and plans and on the ground works by combining all available flood risk information together into one single repository. As this is a strategic study, detailed local information on flood risk is not fully accounted for. For a more detailed assessment of specific areas or sites, a Level 2 SFRA may be carried out following on from the completion of a Level 1 assessment, if required.

The data and information used throughout the SFRA process is the most up-to-date data available at the time of writing. Once new, updated or further information becomes available, the LPA should look to update this SFRA. The Level 1 SFRA should be considered to be and maintained as, a ‘live’ entity which is updated as and when required (when new modelling or flood risk information becomes available). The LPA and LLFA can decide to update the SFRA and the EA as a statutory consultee on local plans can also advise on when an update is required to inform the local plan evidence base.

6.2 Data gaps

Gaps in data and information have become apparent throughout the preparation of this SFRA. It may be the case that this information does not exist or has not been made available for the SFRA for unknown reasons. Such gaps in information includes:

- Thames (MRL to St Johns) 2014 hydraulic model - large model with multiple different storm durations. Model simulations that became unstable and were unable to be run are listed below:
  - 1000-year defended
  - 1000-year defended plus 30% climate change uplift

- 1000-year defended plus 43% climate change uplift

- Churn (Baunton to Siddington) 2011. Model simulations that became unstable and were unable to be run are listed below:
  - 100-year defended plus 43% climate change uplift
  - 1000-year defended plus 30% climate change uplift
  - 1000-year defended plus 43% climate change uplift

6.3 Recommendations for further work

The SFRA process has developed into more than just a planning tool. Sitting alongside the SA, LFRMS and FRMP, it can be used to provide a much broader and inclusive vehicle for integrated, strategic and local flood risk management and delivery.

There are a number of plans and assessments listed in

Table 6-1 that may be of benefit to the LPA, in developing their flood risk evidence base to support the delivery of the Local Plan, or to the LLFA to help fill critical gaps in flood risk information that have become apparent through the preparation of this Level 1 SFRA.

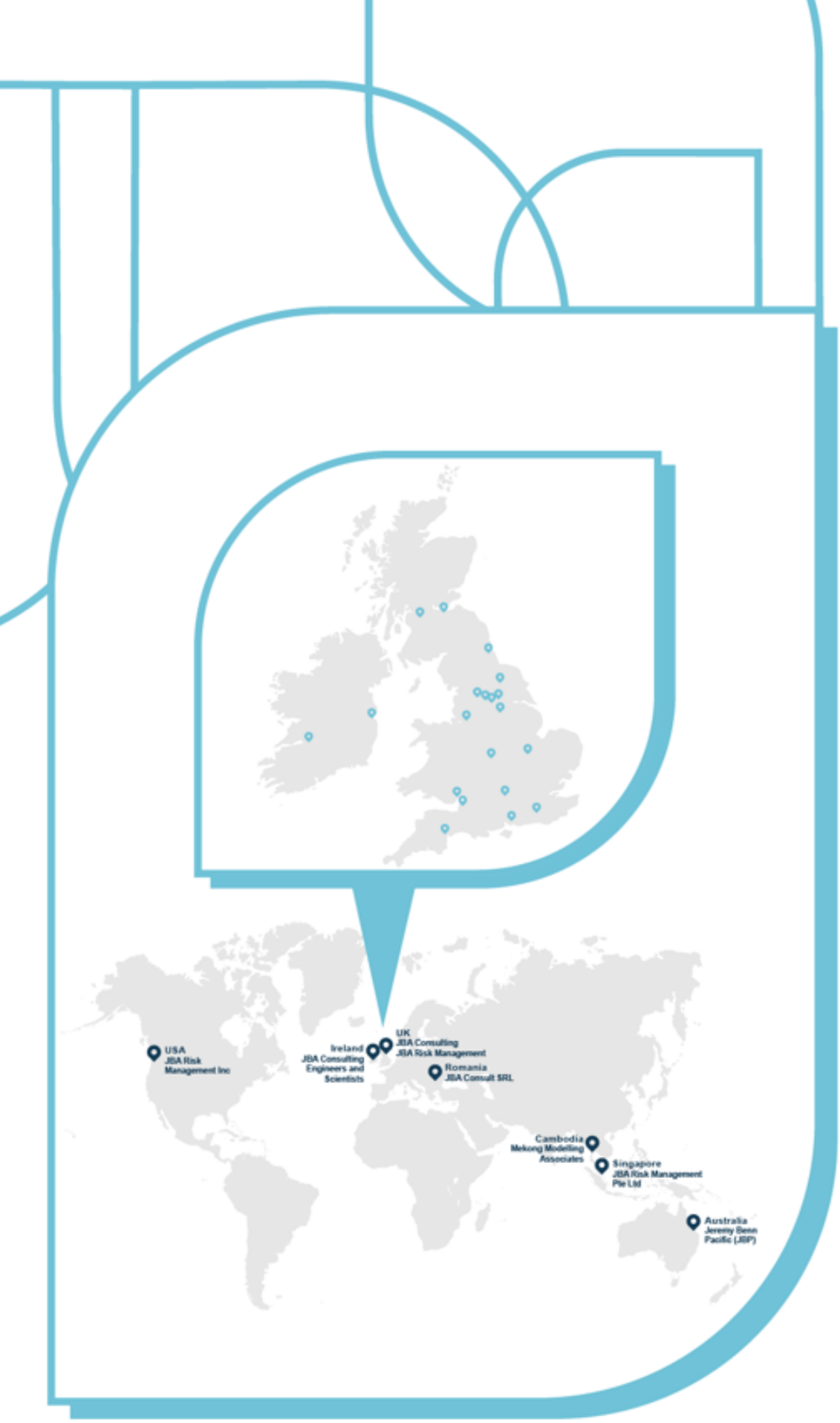
Table 6-1 Plans and assessments beneficial to developing the flood risk evidence base

Type	Study	Reason	Timeframe
Understanding of local flood risk	Level 1 SFRA update	When there are changes to: the predicted impacts of climate change on flood risk; detailed flood modelling - such as from the EA or LLFA; the local plan, spatial development strategy or relevant local development documents; local flood management schemes; flood risk management plans; shoreline management plans; local flood risk management strategies; and national planning policy or guidance. Or after a significant flood event.	As required

Type	Study	Reason	Timeframe
	Level 1 SFRA update; Level 2 SFRA; site-specific FRA	Reviewing of EA flood zones in those areas not covered by existing detailed hydraulic models i.e. the Flood Map for Planning does not cover every watercourse such as those <3km^2 in catchment area or Ordinary Watercourses. If a watercourse or drain is present on OS mapping but is not covered by the Flood Map for Planning, this does not mean there is no potential flood risk. A model may therefore be required to ascertain the flood risk, if any, to any nearby sites.	Short term
	Level 2 SFRA	Further, more detailed assessment of flood risk to at risk sites, as notified by this Level 1 SFRA.	Short term
	SWMP / detailed surface water modelling	GCC has not developed a SWMP for any areas of the Cotswold district. It is recommended that the LLFA uses information from this SFRA to ascertain whether certain locations at high surface water flood risk may benefit from a SWMP or a detailed surface water modelling study.	Short to medium term
Flood storage and attenuation	Working with Natural Processes	Further assess WwNP options in upper catchments to gauge possible areas for Natural Flood Management. Promote creation of floodplain and riparian woodland, floodplain reconnection and runoff attenuation features where the research indicates that it would be beneficial within the district.	Short term

Type	Study	Reason	Timeframe
Data collection	Flood Incident data	GCC, as LLFA, has a duty to investigate and record details of significant flood events within their area. General data collected for each incident, should include date, location, weather, flood source (if apparent without an investigation), impacts (properties flooded or number of people affected) and response by any Risk Management Authority.	Short term
	FRM Asset Register	CDC has a responsibility to update and maintain a register of structures and features, which are considered to have an effect on flood risk.	Ongoing
Risk Assessment	Asset Register Risk Assessment	GCC, as LLFA, should carry out a strategic flood risk assessment of structures and features on the Asset Register to inform capital programme and prioritise maintenance programme.	Short term/ ongoing
Capacity	SuDS review / guidance	The LLFA should clearly identify its requirements of developers for SuDS in new developments. Internal capacity, within CDC should be in place to deal with SuDS applications, set local specification and set policy for adoption and future maintenance of SuDS.	Short term

Type	Study	Reason	Timeframe
Partnership	Wessex Water, Severn Trent and Thames Water	The LLFA should continue to collaborate with WW, ST and TW on sewer and surface water projects. The LPA should work with the relevant water companies to ensure their assets can remain operational and resilient at all times across the catchment and that capacity for new development is appropriate.	Ongoing
	EA	CDC should continue to work with the EA on fluvial flood risk management projects. Potential opportunities for joint schemes to tackle flooding from all sources should be identified.	Ongoing
	Community	Continued involvement with the community through CDC's existing flood risk partnerships.	Ongoing



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