Cheltenham Borough Council

Strategic Flood Risk Assessment for
Local Development Framework
Level 1
Volume 1 - FINAL
September 2008

Halcrow Group Limited

Cheltenham Borough Council

Strategic Flood Risk Assessment for Local Development Framework Level 1 - FINAL Volume 1

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Contents

List of Tables & Figures

Tables

Figures

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Executive Summary

In December 2007 Gloucestershire County Council, in partnership with its Local Authorities, commissioned Halcrow to produce a Level 1 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25). The purpose of the SFRA is to assess and map all forms of flood risk from groundwater, surface water, impounded water bodies, sewer and river sources, taking into account future climate change predictions, to allow the Councils to use this as an evidence base to locate future development primarily in low flood risk areas. The outputs from the SFRA will also help the Councils to prepare sustainable policies for the long-term management of flood risk.

Flooding is a natural process which shapes the natural environment, but also threatens life and can cause substantial distress and damage to property. The effects of weather events can be increased in severity as a consequence of past decisions about the location, design and nature of development and as a consequence of climate change. While flooding cannot be wholly prevented, its impacts can be avoided and reduced through good planning and management. The SFRA aims to ensure that flood risk forms one of the material planning considerations to help deliver sustainable development.

Cheltenham Borough occupies a low-lying urban area of the Lower Severn catchment. The rivers contributing to flood risk originate within, or in the vicinity of, the Borough. Of relevance is the River Chelt which flows through the centre of Cheltenham, regulated by a flood alleviation scheme. Flood risk is influenced by surface water and the overloading of the old drainage system, particularly during intense rainfall events. In the future, climate change means that areas in Flood Zones 2 and 3 are likely to flood more frequently, and the extent of flooding might increase. Surface water flooding might also increase although this can be reduced by the improved management of surface water.

The SFRA is an important tool which will inform the Council of the nature of flood risk in the Borough. It will provide an important part of the evidence base for the preparation of the Local Development Framework (LDF), in particular the Core Strategy. Furthermore the SFRA will provide useful information for the Sustainability Appraisal (SA) and will assist in the development of appropriate flood risk management policies. The suggested policies in the SFRA take direction from PPS25, Making Space for Water, the Water Framework Directive and Catchment Flood Management Plans (CFMPs). The Severn CFMP states that actions will be taken in the Borough to reduce flood risk, both now and in the future. Apart from the continued use of defences, there are opportunities for the Council to assist in the reduction of risk by vigorously applying PPS25 and promoting the use of SUDS.

In accordance with PPS25 and its Practice Guide (2006), areas of 'low', 'medium' and 'high' risk have been mapped using data from the Environment Agency, Gloucestershire County Council and its Local Authorities, water companies, the Highways Agency and British Waterways. This has included information on flooding from all sources and provides the basis for the Sequential Test to be applied. The Councils must apply the Sequential Test to all sites within the 'high' and 'medium' risk Flood Zones. In instances where there is an area of overlap between the site boundary and flood risk area, this should be utilised as an opportunity to reduce flood risk within the site by using the flood risk areas as open space. It is important that policies recognise the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities. Where the need to apply the Exception Test is identified the scope of the SFRA should be widened to a Level 2 SFRA. It is recommended that this is undertaken by a suitably qualified technical expert.

The SFRA has been reviewed and approved by the Environment Agency, and a letter which signs off the SFRA can be found in Appendix A.

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1 Introduction

1.1 Terms of Reference

1.1.1 In December 2007 Gloucestershire County Council, in partnership with its Local Authorities, commissioned Halcrow to produce a Level 1 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25). This report presents the findings of the SFRA for Cheltenham Borough Council.

1.2 Project Aims

1.2.1 The aims of PPS25 planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is necessary in such areas, exceptionally, the policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall. 'Safe' in the context of this study means that dry pedestrian access to and from the development is possible without passing through the 1% AEP (1 in 100 year) plus climate change floodplain; emergency vehicular access is possible during times of flood; and the development includes flood resistance and resilience measures to ensure it is safe.

1.2.2 The aim of the SFRA therefore is to map all forms of flood risk and use this as an evidence base to locate new development primarily in low flood risk areas (Zone 1). Where development cannot be located in Flood Zone 1, the planning authority will need to apply the Sequential Test to land use allocations and, where necessary, the Exception Test (requiring a Level 2 SFRA). In addition, the SFRA allows the planning authority to:

- Prepare appropriate policies for the management of flood risk
- Inform the Sustainability Appraisal (SA) so that flood risk is taken account of, when considering options and in the preparation of strategic land use policies
- Identify the level of detail required for site-specific Flood Risk Assessments (FRAs)
- Determine the acceptability of flood risk in relation to emergency planning capability

1.2.3 The SFRA will inform the site selection process for future development sites and provide recommendations for policies to deal with non-allocated sites. The SFRA will feed into the Local Authority's SA of the Local Development Documents (LDDs) and will enable informed decisions to be made relating to land use and development allocation within the respective Development Plan Documents (DPDs).

1.3 Project Objectives

1.3.1 Halcrow has carried out this project in accordance with the Project Brief, dated October 2007, though the methodology and deliverables have been aligned to the document "Development and Flood Risk: A Practice Guide Companion to PPS25" (2006). The SFRA has also followed advice from the Environment Agency.

1.3.2 For this study, a Level 1 SFRA approach has been agreed with the Council and the Environment Agency. A Level 1 SFRA is defined in the Practice Guide Companion to PPS25 (2006) as principally being a desk-based study using existing information to allow application of the Sequential Test on the

basis of Table D1 of PPS25 and to identify whether application of the Exception Test is likely to be necessary.

1.3.3 The best available data within the study timescale has been collected for use in this study, and the nature of the data used has been agreed with the Environment Agency, specifically Flood Zone information. It is, however, important to recognise that the SFRA is a 'living' document. As new information becomes available (such as improved river models) updates will be made to the Flood Zone maps and this should be reflected in the SFRA document, to ensure that the best information is used to guide the site selection process for future developments.

1.4 Project Deliverables

1.4.1 The project outputs for a Level 1 SFRA have been adopted for this study. The deliverables of this assessment are: a technical report; a summary document and a series of maps (a map index can be found in Appendix B).

1.4.2 Following the advice from Section 2.34 of the Practice Guide Companion to PPS25 (2006), the key project outputs are as follows:

1) Plans showing the administrative boundaries of the study area, watercourse centrelines, modelled watercourses, canals, defences, Areas Benefiting from Defences (ABDs) and culverted watercourse sections (Volume 2, Tiles A1-A5)

2) Strategic flood risk maps showing flooding from all sources, including fluvial Flood Zones, and areas at risk of flooding from other sources (Volume 2, Tiles B1-B5)

3) An assessment of the implications of climate change for flood risk in the study area over an appropriate time period (Volume 2, Tiles C1-C5)

4) The location of any flood risk management measures, including both infrastructure (Volume 2, Tiles A1-A5) and the coverage of flood warning systems (Volume 2, Tile F1)

5) Guidance on the application of the Sequential Test (see Chapter 8)

6) Guidance on the preparation of FRAs for development sites (see Chapter 9)

7) Guidance on the likely applicability of different Sustainable Drainage System (SUDS) techniques for managing surface water run-off at key development sites (see Chapter 10)

1.5 Outcomes of the SFRA Process

1.5.1 The Level 1 SFRA provides sufficient data and information to enable the planning authority to apply the Sequential Test to land use allocations and to therefore identify where the Exception Test needs to be applied (see sections 1.5.4 and 1.5.5 respectively).

1.5.2 PPS25 also indicates that SAs should be informed by the SFRA for their area. Under the Town and Country Planning (Local Development - England) Regulations 2004, an SA is required for all LDFs. The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for LDFs should meet the requirements of the Strategic Environmental Assessment (SEA) Directive. An SFRA is used as a tool by a planning authority for the production of development briefs, setting constraints, identifying locations of emergency planning measures and requirements for FRAs.

1.5.3 It is important to reiterate that PPS25 should not be applied in isolation, but as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy. Clearly a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base upon which informed decisions can be made. Importantly, policies should recognise the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities.

The Sequential Test

1.5.4 The primary objective of PPS25 is to steer development towards areas of lowest flood risk. PPS25 therefore advocates a sequential approach to guide the planning decision making process (i.e. the allocation of sites). In simple terms, this requires planners to seek to allocate sites for future development within areas of lowest flood risk in the first instance. Preference should therefore be given to locating new development in Flood Zone 1, Low Probability (see section 2.3). If there is no reasonably available site in Flood Zone 1, the flood vulnerability (see table D3 of PPS25, below) of the proposed development can be taken into account in locating development in Flood Zone 2 (Medium Probability) and then Flood Zone 3 (High Probability). Within each Flood Zone new development should be directed away from 'other sources' of flood risk and towards the area of lowest probability of flooding, as indicated by the SFRA. Appendix C shows the Sequential Test process as advocated in PPS25.

1.5.5 As an integral part of the sequential approach, PPS25 stipulates permissible development types in Table D3 (flood risk vulnerability and Flood Zone 'compatibility'). This considers both the degree of flood risk posed to the site, and the likely vulnerability of the proposed development to damage (and indeed the risk to the lives of the site tenants) should a flood occur. Provided the Sequential Test is carried out and it can be demonstrated that there are no sites available fully in Flood Zone 1, a site can be developed in accordance with Table D3 of PPS25. It is important to note that where a 'tick' is shown in Table D3 of PPS25, this does not imply that development may immediately proceed; the Sequential Test must still be applied and passed.

Table 1.1: Flood Risk Vulnerability and Flood Zone 'Compatibility' (Table D3 of PPS25)

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

Key:

✔ Development is appropriate

✗ Development should not be permitted

1.5.6 Table D2 of PPS25 (Table 1.2) classifies different types of development under different flood risk vulnerabilities, and should be used with Tables D1 and D3 in allocating new development as part of the Sequential Test.

Table 1.2: Flood Risk Vulnerability Classification (Table D2 of PPS25)

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations and chemical tank facilities
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding • Emergency dispersal points • Basement dwellings • Caravans, mobile homes and park homes intended for permanent residential use • Installations requiring hazardous substances consent[1]
More Vulnerable	• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels • Non-residential uses for health services, nurseries and educational establishments • Landfill and sites used for waste management facilities for hazardous waste[2] • Sites used for holiday or short-let caravans and camping, subject to specific warning and evacuation plan
Less Vulnerable	• Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure • Land and buildings used for agriculture and forestry • Waste treatment (except landfill and hazardous waste facilities) • Minerals working and processing (except for sand and gravel working) • Water treatment plants • Sewage treatment plants (if adequate pollution control measures are in place)
Water-compatible Development	• Flood control infrastructure • Water transmission infrastructure and pumping stations • Sewage transmission infrastructure and pumping stations • Sand and gravel workings • Docks, marinas and wharves • Navigation facilities • MOD defence installations • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location • Water-based recreation (excluding sleeping accommodation) • Lifeguard and coastguard stations • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan

1 DETR Circular 04/00 – Para 18: Planning controls for hazardous substances.
www.communities.gov.uk/index.asp?id=1144377

2 See Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10 for definition.
www.communities.gov.uk/index.asp?id=1500757

Notes:

1) This classification is based partly on Defra/Environment Agency research on Flood risks to people (FD2321/TR2)[21] also on the need to keep some uses to keep functioning during flooding

2) Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

3) The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular classification

The Exception Test

1.5.7 If, following application of the Sequential Test, it is not possible, or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied as indicated by Table D3 of PPS25. This test provides a method of managing flood risk while still allowing necessary development to occur.

1.5.8 The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons (the need to avoid social or economic blight and the need for essential civil infrastructure to remain operational during floods). It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

1.5.9 For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community which outweigh flood risk, informed by an SFRA where one has been prepared. If the DPD has reached the 'submission' stage (see Figure 4 of PPS12: Local Development Frameworks) the benefits of the development should contribute to the DPDs SA process;

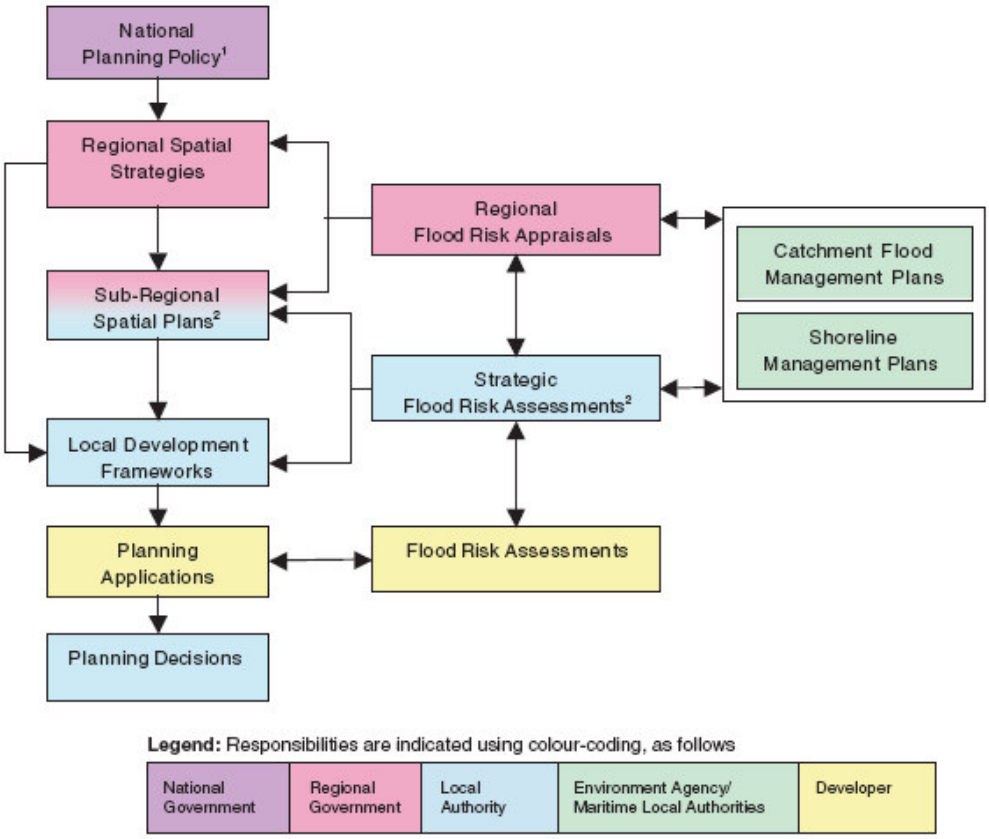
b) The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and,

c) A flood risk assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

1.5.10 It is possible that the Council will need to apply the Exception Test if sites fall within Flood Zone 2 and 3, although it is not possible to fully determine this until the Sequential Test process has been undertaken.

1.6 SFRA Context

1.6.1 Figure 1.1, taken from the PPS25 Practice Guide (2006), illustrates the responsibilities for the production of key documents required to effectively manage flood risk through each stage of the spatial planning process, and, importantly, shows the link with other strategic documents.



Notes

1 Including Planning Policy Statement 25 *'Development and Flood Risk'* and the other flooding-related national planning policy listed in Appendix B of this Practice Guide.

2 SFRAs may cover more than one local planning authority region, and the adoption of a catchment-based approach by a number of LPAs working in partnership could be highly beneficial.

3 This diagram has been developed from the original within the Defra/EA 2005 report FD2320.

Figure 1.1: Development planning process for flood risk

1.7 The Study Area

1.7.1 Cheltenham Borough covers an area of 46.8km^2 of central Gloucestershire. The Borough is bordered by the Cotswold District to the east and Tewkesbury Borough to the north, west and south. The Borough consists of the town of Cheltenham Spa and its rural hinterland and in 2006 had a total estimated population of 111,500. The Borough's rural land is heavily protected, with 22% of the Borough designated as AONB and 17% designated as Green Belt.

1.7.2 Cheltenham is one of Gloucestershire's major urban settlements situated between the Cotswolds and the vale of the River Severn. The town itself is relatively flat, with gentle slopes down to the River Chelt, which flows through the town centre (though it is culverted and regulated by a flood alleviation scheme in places). To the east of Leckhampton, Prestbury and Charlton Kings, the topography of the land rises steeply towards the escarpment of the Cotswold Hills AONB. Historically, the town has existed since Saxon times and expanded further following the discovery of mineral waters in the eighteenth Century, after which the town became established as a fashionable tourist resort. Further development in the early nineteenth Century gave rise to large areas of Regency architecture in the

Pittville, Montpellier and Lansdown areas, with associated elegant parks, private grounds and wide, tree-lined avenues which today form the basis of the Cheltenham (Central) Conservation Area. Recreation and tourism are also important to the Borough, with the town itself well known for being the home of the flagship race of British steeplechase horseracing, the Cheltenham Gold Cup.

1.7.3 In recent years, the Borough has become an important employment centre with the national and regional administrative headquarters of a number of major firms and government departments located within the Borough. Cheltenham has good communication links with surrounding areas, with three main roads passing through the Borough providing links with London, South Wales, Coventry, Bath, Evesham and Cirencester. In addition, the M5 motorway, linking Birmingham and the north to Bristol and the West Country, passes within close vicinity of the town centre. Cheltenham railway station is located on the main Bristol-Birmingham line, with connections to many parts of the UK. This, along with its high quality shopping and other facilities, make the town an attractive place to live, work and visit. Within the emerging Regional Spatial Strategy for the South West region, Cheltenham has been identified as a strategically significant city and town (SSCT) where development has been proposed to be concentrated over the next 20 years.

1.8 Main Rivers, Hydrology, Geology & Topography

1.8.1 Cheltenham Borough occupies a low-lying urban area of the Lower Severn catchment with gentle topography; the only significant hills lie in the east of the Borough near the Cotswold District boundary. There are no fewer than 9 main rivers in Cheltenham Borough, each with its own catchment. The river catchments contributing to flood risk in the Borough of Cheltenham are mainly small catchments originating within, or in the vicinity of, the Borough. The whole Borough falls within the Severn (Lower Mid) catchment and ultimately drains into the River Severn.

1.8.2 The catchment descriptors for the various river catchments in the Borough are shown in Table 1.3 as taken from the Flood Estimation Handbook (FEH) Version 2. It is notable that the catchments show a relatively low BFIHOST (Base Flow Index derived using Hydrology of Soil Types classification) and relatively high SPRHOST (Standard Percentage Runoff derived using Hydrology of Soil Types classification) as would be expected from catchments underlain by largely impermeable rock. The bedrock beneath the Borough is indeed mainly Lower Lias impermeable clay. These parameters would indicate 'flashy' catchments with a relatively quick response to precipitation; a large proportion of any rain falling becomes runoff even when the soil is not saturated. The low values for DPSBAR (average Drainage Path Slope – an index of catchment steepness) for these catchments, however, would indicate the contrary; the gentle topography reduces the speed with which they respond to rainfall and correspondingly reduce the risk of flash flooding. Nevertheless, the high degree of urbanisation coupled with the small size of the catchments and impermeable underlying rock mean that the greatest flood risk in the region is from high-intensity convective storms more common during the summer season.

1.8.3 Inspection of the Environment Agency's Flood Map in the region indicates that Cheltenham Borough is sufficiently distant from the River Severn (around 7km) to be largely unaffected by river levels on the Severn.

1.8.4 The Main Rivers within Cheltenham Borough are listed in Table 1.3, along with brief watercourse descriptions and eight figure grid references for clarification on locations (using standard Ordnance Survey (OS) notation). Main Rivers are watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Food and Rural Affairs (also shown in

Volume 2, Tiles A1-A5). The Environment Agency has permissive powers to carry out works necessary for flood defence purposes on these rivers. The overall responsibility for maintenance, however, lies with the riparian owner. Named minor rivers (or ordinary watercourses) within the Borough are listed in Table 1.4. Minor rivers cover every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority or Internal Drainage Board (IDB) where relevant, has powers for ordinary watercourses.

1.8.5 Solid geology and drift maps are shown in Volume 2, Tiles D1 and D2 respectively.

Table 1.3: Main Rivers in Cheltenham Borough and associated catchment descriptors as per FEH Version 2

			Upstream Catchment Descriptors* (from FEH CD ROM)					
River Name	**Enters Borough**	**Exits Borough**	**Downstream point of catchment**	**Upstream Catchment Area (km2)**	**BFI HOST**	**SPR HOST**	**DPSBAR (m/km)**	**Watercourse Description**
Hyde Brook	SO 9580 2541	SO 9277 2671	SO 9277 2671	14.87 (small)	0.414 (low)	41.04 (high)	65.9 (low)	Although various arms of the Hyde Brook originate within Tewkesbury as minor rivers, it originates as a main river in Cheltenham. The main river enters the Borough to the north and flows along the council boundary for around 3.5 km, leaving the Borough prior to its confluence with the River Swilgate.
Mill Stream / Noverton Brook / Prestbury Brook	SO 9759 2394 and SO 9781 2364	-						The Noverton Brook rises in the Borough at SO 9786 2366, flowing in a north westerly direction before joining the Mill Stream at SO 9697 2406. The Mill Stream rises as a main river in the Tewkesbury Borough to the west and enters the Cheltenham Borough very briefly (for some 100m) before returning to Tewkesbury and re-entering around 250m downstream. The Stream continues westwards for 350m before its confluence with the Prestbury Brook at SO 9696 2406. It then continues north west through Prestbury and the Cheltenham racecourse toward its confluence with the Hyde Brook at SO 9584 2535. Localised flooding problems have been reported along the Mill Stream in the Prestbury area.[3]

* Underneath each of the numerical parameters are written approximate classifications ('low', 'medium' or 'high' for example) derived from a comparison with the 943 gauged catchments which were used to produce these catchment descriptors – see Flood Estimation Handbook, Volume 5, pp.73 ff. Note that catchment descriptors for very small catchments are less reliable as any inaccuracies in the FEH CD ROM data can be exacerbated.

3 Cheltenham Borough Local Plan: Second Review first deposit: **Utilities Infrastructure**.

			Upstream Catchment Descriptors* (from FEH CD ROM)					
River Name	**Enters Borough**	**Exits Borough**	**Downstream point of catchment**	**Upstream Catchment Area (km2)**	**BFI HOST**	**SPR HOST**	**DPSBAR (m/km)**	**Watercourse Description**
Wymans Brook	-	-	SO 9269 2618	9.66 (small)	0.299 (low)	46.86 (high)	53.6 (low)	Wymans Brook originates with two arms to the east of the Borough near SO 9822 2272 and SO 9739 2272 at the base of a small hill (325mAOD) and flows westward, the two arms forming a single river at around SO 9598 2316. The Brook continues westward through areas such as Cleevemount, Marle Hill, Swindon and Kingsditch to the north of the town and finally turns into the River Swilgate near SO 9326 2482. Inadequate culvert and storage capacity at Pittville Park (near SO 9513 2347) has resulted in some flooding along the Brook.[3]
River Swilgate	-	SO 9269 2618						The River Swilgate is a continuation of Wymans Brook from SO 9362 2482 onward. It flows northward along the council boundary for around 1.5km before leaving the Borough near the village of Elmstone Hardwicke.
River Chelt	SO 9867 1976	SO 9145 2463	SO 9145 2463	29.07 (small)	0.444 (average)	35.59 (average)	84.9 (average)	The River Chelt originates at the Dowdeswell Reservoir in the Cotswold hills to the east of the Borough and flows north west through various culverts in Cheltenham town centre and along the council boundary with Tewkesbury for 1.1km before leaving the Borough. The relatively high value for DPSBAR of 85 m/km shows that the portion of the catchment upstream of the town itself (and close to the town) is relatively steep and increases the speed with which the catchment responds to rainfall. During a major rainfall event, therefore, peak surface water runoff in the town may well coincide with high flows on the Chelt thereby further increasing flood risk. A flood alleviation scheme along the River Chelt including temporary storage at Cox's Meadow and Sandford Park was recently constructed and is currently under review in the wake of the flooding in summer 2007.
Lilley Brook	-	-						The Lilley Brook arises as a minor river around SO 9683 1833 and becomes a main river just upstream of the town at Lilley Brook Bridge (SO 9648 1935). It continues northward through Moor End and Charlton Park to its confluence with the Chelt just upstream of Cox's Meadow at SO 9587 2114.

			Upstream Catchment Descriptors* (from FEH CD ROM)					
River Name	**Enters Borough**	**Exits Borough**	**Downstream point of catchment**	**Upstream Catchment Area (km2)**	**BFI HOST**	**SPR HOST**	**DPSBAR (m/km)**	**Watercourse Description**
Southfield Brook	-	-						The Southfield Brook also arises as a minor river and becomes a main river upon entering the town. It flows into the Lilley Brook 700m later at SO 9596 2013.
Hatherley Brook	-	SO 9067 2235	SO 9067 2235	12.18 (small)	0.314 (low)	45.67 (high)	52.3 (low)	One of the three arms of the Hatherley Brook arises as a main river in Cheltenham at SO 9435 1979 and another arm arises as a minor river in Tewkesbury Borough and becomes a main river at SO 9375 2038. These two arms become one river at SO 9368 2076 and the Brook then continues north west through the south of Cheltenham (Hatherley and Benhall) picking up its third arm at SO 9208 2158 and leaving the Borough south of Fiddler's Green.
Ham Brook	SO 9156 2037	SO 9130 2013	SO 9130 2013	0.78 (very small)	0.195 (low)	55.11 (high)	10.2 (low)	Norman's Brook enters Cheltenham Borough for only 300m in the Hatherley area close to the point where it issues (in Tewkesbury Borough).

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Table 1.4: Named minor rivers in Cheltenham Borough

Minor River	Main River into which it flows
Hyde Brook	Hyde Brook
River Swilgate	River Swilgate
Southfield Brook	Southfield Brook
Lilley Brook	Lilley Brook
Hatherley Brook	Hatherley Brook

1.9 Key Recommendations: Chapter One

- The primary objective of PPS25 is to steer development towards areas of lowest flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, the planning authority will need to apply the Sequential Test to land use allocations and, where necessary, the Exception Test (requiring a Level 2 SFRA).
- The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where some continuing development is necessary for wider sustainable development reasons or where restrictive national designations such as AONBs, SSSIs and WHSs prevent the availability of unconstrained sites in lower risk areas.
- To achieve safe development, dry pedestrian access to and from the development must be possible without passing through the 1% AEP (1 in 100 year) plus climate change floodplain; emergency vehicular access must be possible during times of flood; and the development must include flood resistance and resilience measures to ensure it is safe.
- The SFRA is a living document. As new flood risk information becomes available (such as updated Flood Zone information and more extensive information on flooding from other sources) it should be incorporated into the SFRA.
- The Sustainability Appraisal should be informed by the SFRA, to promote sustainable development.
- PPS25 should not be applied in isolation, but as part of the planning process. A careful balance must be struck between PPS25 and the requirements of other planning policy.
- Policies should recognise the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities.

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2 Study Methodology

2.1 Level 1 SFRA Methodology

2.1.1 PPS25 recommends a staged approach to SFRAs, dependant on the development pressures and significance of flooding issues in the study area. The practice guide companion to PPS25 (2006) recommends that a Level 1 SFRA should principally be a desk-based study making use of existing information, to allow application of the Sequential Test and to identify where the Exception Test is likely to be necessary. The main tasks undertaken during the study were as follows:

a) Establishing relationships and understanding the planning context:

An Inception meeting was held to build relationships between the project team, the Councils and the Environment Agency. This allowed the partnering approach to form and allowed the free exchange of available information. Discussions were held on planning pressures and the status of the Councils' LDF, to gain a clear picture of the challenges faced by the planning teams, and the various opportunities and constraints guiding the site allocation process. The study area was also discussed in detail, giving an overview of local features and flooding experienced from all sources.

b) Gathering data and analysing it for suitability:

A quality review of flood risk information was carried out by an experienced core team, who reviewed the collated data, assessed its significance and quality and advised on which data would be needed to drive the SFRA. The main approach adopted for the SFRA was to build on previous studies and existing information, supplied during the data collection phase.

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

A series of GIS maps were produced using the data gathered in the early phases of the study. The main mapping output is the strategic flood risk maps of the entire study area, which shows Flood Zones 1, 2 and 3 and flooding from all other sources, and should be used to carry out the Sequential Test. Other maps include study area maps showing canals and fluvial features, climate change maps showing the impacts of climate change on flood probability, geological maps, historic flood outline maps, and maps showing flood watch and warning areas. Hardcopy maps are provided in Volume 2 of the SFRA report, while GIS layers can be found in the CD at the front of this report.

d) Providing suitable guidance

Sections have been written in the report providing guidance on policy considerations, the application of the Sequential Test, guidance for the preparation of FRAs and guidance for the application of SUDS in the study area. A planning workshop has also provided further guidance on the application of the Sequential Test. This established the principles of Sequential Test, provided mock Sequential Testing scenarios and helped to develop broad policy recommendations.

2.2 Need for a Level 2 SFRA

2.2.1 Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitably available sites for development within zones of lower flood risk or due to possible increases in flood risk arising from climate change, the scope of the SFRA may need to be widened to a Level 2 assessment.

2.2.2 This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding) taking into account the presence of flood risk management measures such as flood defences. This could include 2D modelling and breach/overtopping analysis for certain locations.

2.2.3 Level 2 SFRA outputs include:

- An appraisal of the condition of flood defence infrastructure and likely future policy
- An appraisal of the probability and consequence of breach or overtopping of flood defence infrastructure
- Maps showing distribution of flood risk across zones
- Guidance on appropriate policies for making sites which satisfy parts a) and b) of the Exception Test safe; and the requirements for satisfying part c) of the Exception Test
- Guidance on the preparation of FRAs for sites with varying flood risk across the Flood Zone

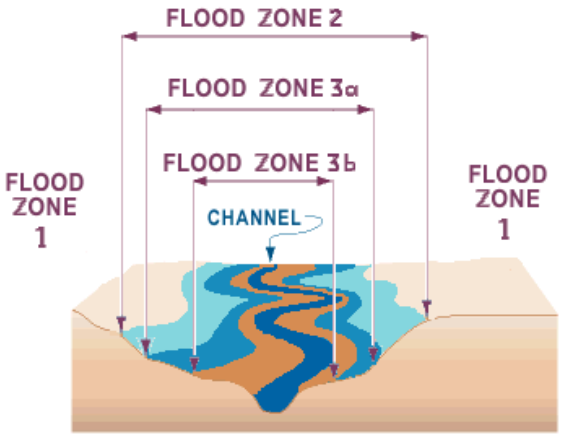
2.2.4 In general, the Level 2 SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zone 3, which are protected by existing defences. This should minimise the extent to which individual developers need to undertake separate studies on the same problem. The scope of a Level 2 SFRA cannot be fully determined until the Sequential Test has been undertaken by the Council on all possible site allocations.

2.3 Technical Background

2.3.1 It is useful to gain a good understanding of Flood Zones and the approaches taken to satisfy the Level 1 SFRA requirements, using existing data.

Flood Zones

2.3.2 Flood Zones show the areas potentially at risk of flooding from rivers, ignoring the presence of defences (although areas benefiting from formal defences are identified).



2.3.3 PPS25 defines the Flood Zones as follows:

Zone 1: Low Probability

2.3.4 This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Zone 2: Medium Probability

2.3.5 This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Zone 3a: High Probability

2.3.6 This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Zone 3b: The Functional Floodplain

2.3.7 This zone comprises land where water has to flow or be stored in times of flood (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, including water conveyance routes). The SFRA maps Flood Zone 3b where it has been produced. Where no modelled outlines have been produced, Flood Zone 3b has been shown to equal Flood Zone 3a.

2.3.8 It should be noted that flooding from surface water, groundwater, sewers and impounded water bodies can occur in any zone, even Flood Zone 1.

2.3.9 Flood Zone maps in the SFRA have been produced from two sources: Environment Agency Flood Map, published and updated quarterly on their website, and detailed local hydraulic modelled outlines (a list of these models can be found in Table 5.1).

2.4 Environment Agency Flood Zone Maps

2.4.1 A national flood map dataset has been produced by the Environment Agency. Most fluvial Flood Zones 2 and 3 are derived from the modelling package JFlow, which is a 'coarse' modelling approach (see Appendix D for further details). In many places the results of flood mapping studies have superseded the JFlow outlines. Generally these studies have included detailed hydrological research, surveyed river cross sections, and more precise digital modelling such as ISIS, TuFlow and HecRas.

2.4.2 It should be noted that not all minor watercourses have had Flood Zone maps produced for them. Only watercourses with a catchment area greater than 3km² have been modelled using JFlow software and, therefore, smaller watercourses as identified on the 10K or 25K OS maps within Flood Zone 1 may not be covered by the Environment Agency Flood Zone maps. As such, for any development site located adjacent to an unmapped watercourse within Flood Zone 1, it is recommended that an 8m development easement from the top of bank is applied, and a site specific FRA is undertaken. It should be noted that the Environment Agency is not the statutory consultee for ordinary watercourses and developers should refer to the Council's Land Drainage departments where they exist.

2.4.3 The Environment Agency Flood Map does not show the potential impact of climate change or the functional floodplain, Flood Zone 3b, which is a recent PPS25 requirement.

2.5 Key Recommendations: Chapter Two

- Not all minor watercourses have had Flood Zone maps produced for them, specifically, those with a catchment area of less than 3km². These watercourses may appear to be fully in Flood Zone 1, when in reality a degree of flood risk will be posed. For any development site located adjacent to an unmapped watercourse within Flood Zone 1, an 8m development easement from the top of bank must be applied and a site specific FRA undertaken.
- The Environment Agency is not the statutory consultee for ordinary watercourses and developers should refer to the Council's Land Drainage departments where they exist.

3 Planning Context

3.1 Introduction

3.1.1 This section provides an overview of the planning policy framework relevant to Cheltenham Borough Council.

3.1.2 This report has been prepared in accordance with PPS25 and its Practice Guide companion (2006) and fulfils the requirements of PPS25: Development and Flood Risk. Information contained in the SFRA provides evidence to facilitate the preparation of robust policies for flood risk management, used to inform the SA of LDDs and enable informed decisions to be made relating to land use and development allocations within the respective DPDs.

3.1.3 The success of the SFRA is heavily dependent upon the Council's ability to implement the recommendations put forward for future sustainable flood risk management. It is ultimately the responsibility of the Council to establish robust policies that will ensure future sustainability with respect to flood risk.

3.2 Planning Policy Framework

3.2.1 The UK planning system has a comprehensive hierarchy of policies and plans, beginning with national guidance. This provides a policy basis for regional plans through to development plans at the local level. Development plans are intended to provide the framework for the future development of an area. They are prepared following public and stakeholder involvement and are intended to reconcile conflicts between the need for development and the need to protect the wider built and natural environment.

3.2.2 The Government is currently implementing reforms to the planning system, with Planning Policy Statements (PPS) replacing Planning Policy Guidance (PPG), Regional Spatial Strategies (RSS) replacing Regional Planning Guidance (RPG) and Local Development Frameworks (LDF) replacing Structure Plans, Local Plans and Unitary Development Plans.

3.2.3 The following paragraphs provide an overview of the relevant policy documents for the SFRA.

3.3 National Planning Policy

PPS1: Creating Sustainable Communities (2005)

3.3.1 PPS1 sets out the Government's objectives for the planning system. It confirms that good planning should deliver the development in the right place, at the right time, and protect the environment. It identifies sustainable development as the core principle underpinning planning and requires that development plans ensure it is pursued in an integrated manner.

Planning and Climate Change (Supplement to PPS1)

3.3.2 Planning and Climate Change was published in December 2007 as a supplement to Planning Policy Statement 1. The Statement requires planning authorities to tackle both the causes of climate change (reduction of green house gas emissions) and the impacts of a changing climate (flooding, habitat migration).

PPS3: Housing (2006)

3.3.3 PPS3 has been developed in response to recommendations in the Barker Review of Housing Supply (March 2004). Its principal aim is to underpin the necessary step change in housing delivery, improving the supply and affordability of housing in all communities including rural areas.

3.3.4 PPS3 states that the Government's key housing policy goal is to ensure that everyone has the opportunity of living in a decent home, which they can afford, in a community where they want to live. The specific outcomes that the planning system should deliver in relation to housing are:

- Well designed, high quality housing that is built to a high standard
- A mix of market and affordable housing for all households in all areas
- A sufficient quantity of housing, taking into account need and demand and seeking to improve choice
- Housing developments in suitable locations offering a good range of community facilities and with good access to jobs, key services and infrastructure
- A flexible, responsive supply of land; which is used efficiently and effectively, including the use of previously developed land

3.3.5 Housing policies should help to deliver sustainable development objectives, in particular seeking to minimise environmental impact taking account of climate change and flood risk, and take into account market information, in particular housing need and demand.

PPS4: Planning for Sustainable Economic Development (Consultation Paper, 2007)

3.3.6 The new PPS on Planning for Sustainable Economic Development sets out how planning bodies should, in the wider context of delivering sustainable development, positively plan for sustainable economic growth and respond to the challenges of the global economy, in their plan policies and planning decisions.

PPS6: Planning for Town Centres (2005)

3.3.7 PPS6 sets out the Government's policy on planning for the future of town centres.

PPS7: Sustainable Development in Rural Areas (2004)

3.3.8 PPS7 sets out the Government's planning policies for rural areas, including country towns and villages and the wider, largely undeveloped countryside up to the fringes of larger urban areas.

PPS9: Biodiversity and Geological Conservation (2005)

3.3.9 PPS9 sets out policies on protection of biodiversity and geological conservation through the planning system. The broad aim is that development should have minimal impacts on biodiversity and geological conservation interests and enhance them where possible. Appropriate weight should be attached to the need to protect international and national designated sites.

PPS10: Planning for Sustainable Waste Management (2005)

3.3.10 PPS 10 gives criteria that must be considered in testing the suitability of sites for waste development, which includes protection of water resources; air emissions including dust; odours; and noise and vibration.

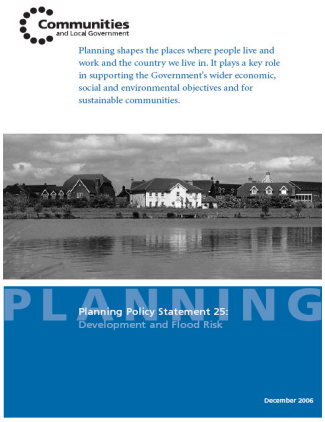
PPG15: Planning and the Historic Environment (1994)

3.3.11 PPG15 sets out policies on the protection of the historic environment and recognises that planning plays an important role in preserving built and natural heritage.

PPG17: Planning for Open Space and Recreation (2002)

3.3.12 PPG17 recognises the importance that public open spaces, green areas and recreational rights of way can play in supporting regeneration and contributing to local quality of life.

PPS25: Development and Flood Risk (2006)



3.3.13 PPS25 sets out a plan led approach to flood risk. It confirms that all forms of flooding and their impact on the natural and built environment are material planning considerations. It clarifies the sequential approach (a process that minimises risk by directing development to areas of lowest risk), matches types of development to degrees of flood risk and strengthens the requirement to include FRAs at all levels of the planning process. Regional planning bodies and local planning authorities (LPAs) should, amongst other things, reduce flood risk by safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water and flood defences.

Town and Country Planning Legislative Changes

3.3.14 Amendments to the Town and Country Planning (General Development Procedure) Order 1995 came into force on 1 October 2006 introducing further requirements for LPAs to consult the Environment Agency before determining applications for development in flood risk areas.

3.3.15 The Town and Country Planning (Flooding) (England) Direction 2007 (which came into force on 1st January 2007) seeks to safeguard against inappropriate development in flood risk areas. The Direction introduces a requirement for LPAs to notify the Secretary of State of any application for major development (e.g. 10 or more dwellings) in a flood risk area which it proposes to approve against Environment Agency advice.

3.4 Regional Planning Policy

3.4.1 Regional planning policies provide the overarching framework for the preparation of the LDFs. The Draft South West Regional Spatial Strategy (RSS) provides a broad development strategy for the South West Region up to 2026. The RSS will supersede RPG 10, which was prepared in the late 1990s. The new strategy for the region is more positive, more explicit and more prescriptive regarding matters that require a strategic approach.

3.4.2 The purpose of the RSS is to provide a long term land-use and transport planning framework for the Region. It influences the future planning of the region in a number of ways:

- As part of the development plan system it provides guidance on the location and scale of development for interpretation in LDFs
- It guides investment in transport and provides a framework for the preparation of Local Transport Plans (LTPs)

- It provides spatial context for the plans, programmes and investments of other agencies and organisations in the South West

3.4.3 When the RSS is published, countywide Structure Plans will be superseded, and their policies replaced by the RSS. Until that time, Structure Plan policies are 'saved' until adoption of the plan. The Gloucestershire Structure Plan Second Review policies (adopted November 1999) are currently saved.

3.4.4 The draft RSS was placed on deposit from 6th June 2006 to 30th August 2006 and following consultation period responses to the report were received from individuals, organisations, interest groups and local authorities. The South West RSS Panel team was appointed by the Secretary of State to conduct an Examination in Public (EiP) of selected issues arising out of the draft RSS. The report of the findings was published in January 2008 and recommendations of changes to the draft RSS were made. The panel stressed that as a result of their recommendations, there may be a further need to modify or delete policies and/or text throughout the Strategy as necessary. It is therefore recommended that reference to the findings of the panel report be made.

3.4.5 The Northern Sub-Region, of which Gloucestershire is part, will continue to be the main focus for growth in the South West. The area has the potential to continue as a major focus of growth and economic expansion here is likely to be above the national average. Development plans will need to identify strategic employment sites, and provision needs to be made to meet future development requirements at sustainable development locations.

3.4.6 Table 3.1 illustrates the housing requirements for Gloucestershire put forward within the draft RSS, along with the recommendations made by the South West RSS Panel team in their report.

Table 3. 2: Housing requirements for the Gloucester and Cheltenham area

	Draft RSS Figures			Panel Modifications		
Gloucester and Cheltenham Housing Market Area	**2006-2026 Overall Annual Net Dwelling Requirement**	**2006-2016 Annual Average Net Dwelling Requirement**	**2016-2026 Annual Average Net Dwelling Requirement**	**2006-2026 Overall Annual Net Dwelling Requirement**	**2006-2016 Annual Average Net Dwelling Requirement**	**2016-2026 Annual Average Net Dwelling Requirement**
Cheltenham	**425**	**425**	**425**	**405**	**405**	**405**
Gloucester	575	575	575	575	575	575
Tewkesbury	525	525	525	730	730	730
Cotswold	300	340	260	345	345	345
Forest of Dean	270	300	240	310	310	310
Stroud	335	435	235	455	455	455
TOTAL	2430	2600	2260	2820	2820	2820

Relevant RSS Policies

3.4.7 Four high level Sustainable Development Policies (SD1 to SD4) are put forward in the RSS which set the broad sustainability context for the RSS, aiming to make future development and lifestyle choices in the region more sustainable. The points relevant to the SFRA are as follows:

- SD1 states that the region's Ecological Footprint will be stabilised and then reduced by ensuring that development respects environmental limits;
- SD2 states that the region will adapt to the anticipated changes of climate change by avoiding the need for development in flood risk areas and incorporating measures in design and construction to reduce the effects of flooding
- SD4 states that growth and development will be planned for and managed positively to create and maintain Sustainable Communities throughout the Region by providing networks of accessible green space for people to enjoy [these can also be utilised as flood storage areas which can provide a positive reduction to flood risk]

3.4.8 These policies, and an assessment of contextual evidence, leads to a Spatial Strategy for the region, which will provide the most sustainable way of dealing with change and pressure for development, while addressing some of the region's major challenges. The Spatial Strategy for the South West is based on recognition of the diverse needs and potential for change of different places and parts of the region. Development will be planned to meet the needs of all communities and to realise their potential within environmental limits.

3.4.9 What follows are sub-regional expressions of SD1 to SD4 in spatial policy and development terms. The varied characteristics of the region mean the Spatial Strategy has three distinct emphases. The RSS presents more locationally specific policies grouped within each of the three distinct Strategy Emphases. Gloucestershire falls in the 'north and centre of the region' grouping. SR1 states that:

"In the north and central part of the region, the strategic emphasis is to realise economic potential by enabling the Strategically Significant Cities and Towns (SSCTs) [Cheltenham and Gloucester in the SFRA study area] to develop, maintain and improve their roles as service and employment centres, with a view to enhancing regional prosperity and addressing regeneration. Sufficient housing will be provided to complement this role and to meet the needs of a growing population".

3.4.10 Chapter 7 of the RSS discusses 'enhancing distinctive environments and cultural life', in which it puts forward Policy F1 - Flood Risk:

"Taking account of climate change and the increasing risk of coastal and river flooding, the priority is to:

- *Defend existing properties and, where possible, locate new development in places with little or no risk of flooding*
- *Protect floodplains and land liable to tidal and coastal flooding from development*
- *Follow a sequential approach to development in flood risk areas*
- *Use development to reduce the risk of flooding through location, layout and design*

- *Relocate existing development from areas of the coast at risk, which cannot be realistically defended*
- *Identify areas of opportunity for managed realignment to reduce the risk of flooding and create new wildlife areas"*

3.4.11 The RSS states that in implementing Policy F1, LDDs will need to:

- Require SFRAs to guide development away from floodplains, areas at risk or likely to be at risk in the future from flooding, or where development would increase the risk of flooding elsewhere
- Ensure that the location of new development is compatible with relevant Shoreline Management Plans (SMPs) and River Basin Management Plans (RBMPs) and other existing relevant strategies, and takes account of the Environment Agency's Flood Map
- Seek to reduce the causes of flooding by requiring that all developments and, where subject to planning control, all land uses (including agricultural activities changes to drainage in existing settlements) should not add to the risk of flooding elsewhere and should reduce flooding pressures using appropriate SUDS techniques
- Require that all developments on the perimeter of towns and villages take account of local flooding risks from agricultural run-off
- Ensure that development proposals do not prejudice future coastal management or the capacity of the coast to form a natural sea defence, or to adjust to changes, without endangering life or property
- Include proposals which allow for the relocation of existing development from areas of the coast at risk, which cannot be realistically defended

3.4.12 Recommended flood risk management policies, to be developed as part of the LDF, are put forward in Chapter 7. These have been developed in accordance with the above core objectives.

3.4.13 Other policies in the Draft RSS of particular relevance to this study are:

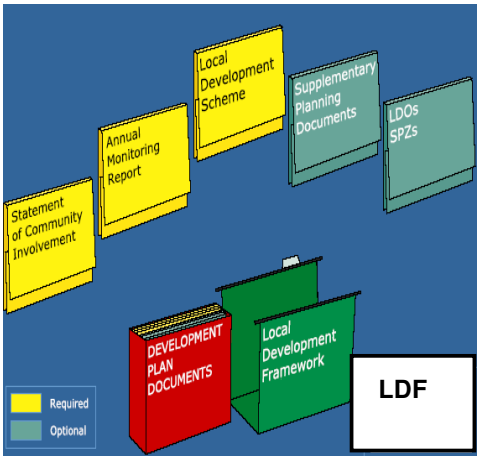
- **RE6: Water Resources.** This states that *"The Region's network of ground, surface and coastal waters and associated ecosystems will be protected and enhanced, taking account of the Environment Agency's 'Regional Water Resources Strategy', catchment abstraction management strategies, groundwater vulnerability maps, groundwater source protection zone maps and river basin management plans. Surface and groundwater pollution risks must be minimised so that environmental quality standards are achieved and where possible exceeded. LPAs, through their LDDs, must ensure that rates of planned development do not exceed the capacity of existing water supply and wastewater treatment systems and do not proceed ahead of essential planned improvements to these systems".* Information on groundwater source protection zones can be found in Chapter 10.
- **Development Policy G: Sustainable Construction.** This states that *"Developers, local authorities, regional agencies and others must ensure that their strategies, plans and programmes achieve best practice in sustainable construction".* This includes the point: *"Requiring the use of sustainable drainage systems to minimise flood risk associated with new*

developments". Information on the use of SUDS can be found in Chapter 10, as well as in the policy recommendations in Chapter 7.

3.5 Local Planning Policy

Local Development Framework

3.5.1 The reforms to the planning system mean that the LPA will gradually depart from the Local Plan and create new planning policies within the new planning system, known as the LDF. The LDF will deliver the vision of the RSS, at the local level. Unlike its predecessors such as the Local Plan or Structure Plan, the LDF is not a single document but rather a 'folder' into which a series of documents are placed. This flexible approach enables some aspects of the Framework to be revised quickly in response to changing circumstances, whilst leaving others to endure for the longer term. The composite documents (the LDDs) have different purposes, some used to guide and others to inform. The main documents involved are:



- The Statement of Community Involvement
- The Annual Monitoring Report
- The Local Development Scheme (LDS)
- Supplementary Planning Documents (SPDs)
- The Core strategy
- Site Specific Allocations
- Adopted Proposals map
- Generic Development Control Policies DPD

3.5.2 SPDs may be prepared to add further detail or guidance to DPDs.

3.5.3 Prior to the LDF, the first Cheltenham Borough Local Plan was adopted in December 1997. The Local Plan was subject to four rounds of consultation between 2002 and 2004 resulting in a number of changes and in February 2004 a revised local plan was issued for public consultation. A public local inquiry into the Local Plan was held in November 2004 with alterations made following a review by an independent inspector. Further modifications were made to the Cheltenham Borough Local Plan Second Review and following a period of further consultation it was formally adopted in June 2006. The Cheltenham Borough Local Plan Second Review covers the period 2001 to 2011. The Local Plan is saved for a minimum of three years (to July 2009) as part of the LDS.

3.5.4 In 2004, following the introduction of the Planning and Compulsory Purchase Act, Cheltenham Borough Council was required to halt any further progress with the Local Plan and to instead begin preparation of the LDF. Policies within the Local Plan are saved until 2009. The LDF will eventually replace the Second Review Cheltenham Local Plan.

3.5.5 In preparing the LDF, the Council is required to prepare a LDS. This is a three-year project plan setting out, in detail, how and when the Council intends to prepare the various components of its LDF. On 17th March 2008 Cheltenham Borough Council agreed in principle to prepare a joint Core Strategy with Gloucester City Council and Tewkesbury Borough Council. The implications of this

decision are that Cheltenham's LDS, approved October 2007 in respect of the Core Strategy, is now deferred. A timetable will be agreed in due course between the three relevant local authorities and Government Office for the South West. However, the timetable in relation to supplementary planning documents within the LDS is still current.

3.5.6 The SCI sets out when and how the Council will undertake public and stakeholder consultation with regard to the LDF process and in determining significant planning applications. Cheltenham's adopted SCI was adopted by the Council on 9th October, 2006.

3.5.7 The Core Strategy is the most important part of the LDF, which will establish the planning objectives for Cheltenham to 2026 and set out the overall context for future development and growth in Cheltenham. The scoping report has been produced and identifies the key plans and policies that will influence the Core Strategy, establishes a baseline of evidence for Cheltenham and identifies the key issues from Cheltenham's community strategy. These have been drawn together to identify a number of key sustainability objectives against which options for the Core Strategy will be assessed. Further Core Strategy work will involve partnering with Gloucester City Council and Tewkesbury Borough Council.

3.5.8 The LDF will contain various policies and proposals that will influence the development of Cheltenham in the period up to 2026. It is essential that these policies and proposals are based on robust, comprehensive and up-to-date evidence. Indeed, the SFRA forms part of this evidence base. An extensive evidence base is currently being prepared by the Cheltenham Borough Council, details of which can be found on the website.

3.6 Key Recommendations: Chapter Three

- The success of the SFRA is heavily dependent upon the Council's ability to implement the recommendations put forward in the SFRA for future sustainable flood risk management.
- While policy recommendations are put forward in Chapter 7, it is ultimately the responsibility of the Council to establish robust policies that will ensure future sustainability with respect to flood risk.

4 Data Collection and Review

4.1 Overview of Flooding Sources

4.1.1 Flooding can come from a variety of sources, including rivers, rainfall on the ground surface (surface water), rising groundwater, overwhelmed sewer and drainage systems and breached or overtopped reservoirs and canals. This chapter gives a strategic assessment of the risk posed to the study area from these sources.

4.2 Approach to Data Gathering

4.2.1 Throughout the data collection and review process it has been critical to make best use of the significant amount of information which already exists with respect to flood risk (held by the Councils, Environment Agency, British Waterways, the Highways Agency, Severn Trent Water, Thames Water, Wessex Water, Welsh Water, Bristol Water and IDBs). The data gathering process has resulted in a review of:

- Strategically important documents including the Regional Flood Risk Appraisal and the Pitt Review
- Historical flooding information from Environment Agency historic flood outlines and various datasets from water companies, the Councils and British Waterways, detailing flooding experienced from 'other sources'
- Environment Agency Flood Zone maps and detailed flood risk mapping outputs, including fluvial climate change outputs
- Information on flood risk management infrastructure, including defences, culverts and structures (supported by information from the Councils and the Environment Agency's National Flood and Coastal Defence Database (NFCDD))
- Existing flood risk management reports including Catchment Flood Management Plans (CFMPs)
- Environment Agency flood warning and flood watch information

4.2.2 The team has been able to review the collected data, assess its significance and quality and advise on which part of the collected data should be used for the SFRA. The main approach to the SFRA has been to build on previous studies and gathered information.

4.2.3 Consultation has formed a key part of the data gathering stage of the SFRA. The aforementioned stakeholders were consulted during the SFRA and as part of the consultation process, an Inception meeting was held to allow key stakeholders to share their experience and knowledge of flooding issues across the study area. The benefits of adopting a partnering approach (as advocated by PPS25) are significant and have helped to ensure that the findings and recommendations of the SFRA are relevant and workable for the Council.

4.3 The Pitt Review

4.3.1 Following the summer 2007 floods an independent review of the flood-related emergencies which occurred was undertaken by Sir Michael Pitt on behalf of the Government. The final report has been published and should be reviewed by the Council with appropriate action taken where the report recommends it.

4.3.2 A summary of the summer 2007 June and July 2007 events, in terms of rainfall and subsequent flooding, is summarised in Section 4.5.4 to 4.5.16. In the main, the Pitt review has been guided by four key principles and conclusions reached, including:

- The needs of those individuals and communities who have suffered flood or are at risk
- That change will only happen with strong and more effective leadership across the board
- That we must be much clearer about who does what
- That we must be willing to work together and share information

4.3.3 These principles were translated into recommendations, which have been included in Appendix E of this report. Attention should be drawn specifically to recommendations 14, 15, 16, 17 and 19 which address the role of the Local Authority with regards to flood risk management and recommends that the Local Authority takes a lead role in the management of flood risk with the support of the relevant organisations.

4.4 Findings of the Regional Flood Risk Appraisal

4.4.1 The South West Regional Flood Risk Appraisal (RFRA) was completed in February 2007, to inform the Regional Sustainability Appraisal (RSA) as part of the RSS. It provides a broad overview of the source and significance of all types of flood risk across the region, and is used to assess and influence housing and employment as well as to identify where flood risk management measures may be functional at a regional level. The main aim of the RFRA is to direct development away from areas at highest risk of flooding.

4.4.2 The RFRA states that around 100,000 properties in the South West Region lie in Flood Zone 3. While flood defences do reduce the risk of flooding, the RFRA re-iterates that these do not eliminate the risk of flooding due to the residual risk of breach or overtopping. By their very nature, residual risks have a low probability of occurrence. However, consequences can vary from low (e.g. marginal overtopping of a flood defence wall) to high (e.g. sudden collapse of high flood defence bank, where property is close by). Residual risk tends to depend upon the extent and height of the flood defences in the locality and the density, and proximity of development relative to the defences (further details on residual risk can be found in Section 6.8). Flood risk also remains from sources including sewers, surface water and groundwater [and impounded water bodies]. Secondary sources of flooding such as these are very significant at the local level, but tend not to be regionally significant as primary sources.

4.4.3 The RFRA discusses the impact of climate change on flood risk in the South West region. This tends to focus on the concern over sea level rise and the effects this will have on the coast of the South West. The RFRA does not consider the impact of climate change on rivers as there is no data that considers these areas for the whole of the South West. The RFRA does, however, refer to Defra guidance on climate change (outlined in Table 5.2) and states that increases in river flows as a result of climate change should be assessed in site specific FRAs and detailed design. Further details of climate change within the Borough can be found in Section 5.5.

4.4.4 An appraisal of regionally significant flood risk was carried out as part of the study, with Gloucester and Cheltenham making up one of the 9 sub-regions covered by the South West RFRA. The South West RFRA states that the most extensive area at risk from flooding is that around the River Chelt. In

general, the RFRA tends to focus on flood risk in Gloucester rather than Cheltenham, therefore the LPA should use the findings of the SFRA to locate future development and formulate appropriate flood risk management and development control policies.

4.5 Historical Flooding

4.5.1 Recent years have seen a number of large scale flood events throughout the UK including Easter and October 1998, autumn 2000, February 2002, New Year 2003, February 2004 and more recently summer 2007. The Environment Agency has produced a number of historic flood outlines for the Midlands region and the following events have been mapped in the Cheltenham Borough:

- July 1968
- Summer 2007

4.5.2 These historic flood outlines can be found in Volume 2, Tiles E1-E4. In **July 1968**, small localised flooding was experienced throughout the Borough from the Wymans Brook, River Chelt, Prestbury Brook and Hatherly Brook. Further flooding from the River Chelt has been documented during the 18th and 19th century4. Historically as industry in the town grew, the Chelt was diverted from its natural course to higher ground in order to feed the great mills. The original river valley was subsequently developed with housing estates, public buildings and industrial development. Consequently, when flood events take place, out of bank flooding occurs and the water runs to the valley bottom following natural topography and inundating development in the town centre. An event in **May 1979** was estimated to have a return period of only 5% AEP (1 in 20 years), but caused considerable damage and disruption, as have subsequent flood events since **December 1979** and 1981, 9th **January 1992** and 13th **January 1993**. Historically the main areas affected by floodwater include; Old Bath Road, Keynsham Road, College Road, Bath Parade, the junction of Great Western Road and Millbrook Street and Arle Avenue.

4.5.3 Section 4.5.3 provides a detailed account of the summer 2007 floods and how the events affected the County of Gloucestershire as a whole. This event has been covered in detail because it is the most recent and memorable event to have affected the County. It should be stressed however that other historical events have affected the County which are just as important in obtaining an understanding of the flood risk posed to the Borough. All historical flood events should also therefore be considered as part of any assessment of flood risk within the Borough.

Summer 2007 Floods

4.5.4 This section provides an account of the summer 2007 floods including a timeline of events, the rainfall that was experienced and how this manifested itself as river flows and subsequent flooding. The historic flood outline of this event, which can be found in Volume 2, Tiles E1-E4, depicts the extent of the flooding. This was produced by the Environment Agency and involved the deployment of numerous survey teams to capture wrack marks and levels so that the extent of flooding could be captured. The outlines were then verified by the Environment Agency using aerial photography of the event, information from the public, ground photos and information from Gloucestershire County Council. Consultation with local authorities took place for further verification. The scale of the event was unprecedented and as much data as was realistically possible was gathered. While the majority of flood affected areas were captured, some minor omissions may remain.

4 Chronology of British Hydrological Events, http://www.dundee.ac.uk/geography/cbhe/

4.5.5 It should be noted that at this stage, the Environment Agency does not intend to change the existing Flood Zone information (as presented in Volume 2, Tiles B1-B5) in light of the summer 2007 flood events. Liaison with the Environment Agency has confirmed that this may change in the future, but until such time the latest Flood Zone information should be used to enable the Sequential Test and therefore locate future development. However, historic flood events should be taken into account for all development sites. Where a historic flood event has affected a proposed development site, flood resistance and resilience should be incorporated into the site.

Timeline of Events[5]

4.5.6 The 15th June 2007 marked the beginning of extreme flood events in the UK. During June, North and East Yorkshire suffered severe thunderstorms with resultant flooding, causing the fire brigade to launch 'the biggest rescue effort in peacetime Britain'. In early July, forecasters warned of treacherous weather for the rest of July and in mid July, the Met Office issued severe weather warnings as strong winds and low pressure swept across England. On 20th July over 3 inches of rain fell in just 12 hours over much of south and south west England. Resultant severe flooding was experienced across Gloucestershire. Up to 10,000 people were left stranded on the M5 as drivers were forced to abandon cars, and 500 people were stranded at Gloucester railway station as the railway network failed. Rest centres were set up for some 2,000 people unable to travel home.

4.5.7 On 22nd July Mythe water treatment works flooded, leaving over 350,000 people without clean water for up to 17 days. Despite efforts to distribute bottled water and bowsers, the lack of water for basic daily use caused severe distress to thousands of people. Electricity supplies throughout the County were also threatened, with Walham switching station (which serves over half a million homes across Gloucestershire and South Wales) and Castle Meads electricity sub-station under threat from rising flood water. Walham switching station was protected following the mobilisation of temporary defences and temporary pumping equipment in a joint effort from the Environment Agency, British Waterways, Armed Forces, Fire and Rescue and Police Services. British Waterways lowered the Gloucester and Sharpness Canal which created sufficient capacity to enable the emergency services to pump water from the switching station in order to prevent it from flooding. However, Castle Meads sub-station had to be shut down on the 23rd July before it flooded, leaving approximately 42,000 people without power. The effects of the infrastructure failure were felt outside the flooded areas and resulted in an increase in demand for emergency responses.

4.5.8 The emergency response in the county of Gloucestershire was coordinated by the Gold Command. Rainfall, river levels and sea conditions were monitored by the Environment Agency with data used to issue flood warnings. On 27th July another heavy downpour of rain occurred, causing further localised flooding in Gloucestershire. The emotional and financial toll that the floods caused is undisputable.

5 Pitt, M. (2007) Learning Lessons from the 2007 floods – An independent review by Sir Michael Pitt

How the Summer 2007 Floods Affected Cheltenham Borough Council

4.5.9 The June flood has been assessed as having a 1.33% (or 1 in 75 year) probability of occurring in any year. The July flood has been assessed as having a less than 0.8% (or 1 in 125 year) likelihood of occurring in any year. Property flooding occurred in Cheltenham from surface water, the River Chelt and other rivers, including Hatherley Brook and Wymans Brook. The River Chelt Flood Alleviation as a whole protected over 600 residential properties and the commercial centre of Cheltenham town in this flood, though 50-100 properties flooded. The July flood exceeded the River Chelt Flood Alleviation Scheme's design therefore the defences were overwhelmed with such a severe event. Approximately 230 properties flooded as a result and around 600 properties in total were flooded in July. The Cheltenham to Birmingham railway line was also affected by floodwater. The historic flood outlines produced following the summer 2007 flood events can be found in Volume 2, Tiles E1-E4.

Rainfall Data

4.5.10 The flooding followed unprecedented rainfall; the wettest-ever May to July period since national records began in 1766. The Centre for Ecology and Hydrology[6] states that May to July produced hydrological conditions with no close modern parallel for the summer period in England and Wales. Met Office records show that an average of 414mm of rain fell across England and Wales during a three month period - 228mm greater than the average May to July rainfall recorded. Table 4.1[7] confirms the outstanding character of the May to July rainfall in 2007.

Table 4.1: Highest May-July rainfall totals for England and Wales

Rank	Year	mm	% of 1971 - 2000 average
1	**2007**	**415**	**223**
2	1789	349	187
3	1879	342	184
4	1828	330	177
5	1782	329	177
6	1797	324	174
7	1830	323	173
8	1766	319	171
9	1768	317	170
10	1860	315	169
11	1817	313	168
12	1777	312	167
13	1924	308	165
14	1779	307	165
15	1816	304	163

4.5.11 The heavy rainfall was a result of exceptional weather patterns across the UK and was linked to both the strength and location of the jet stream, and unusually high Atlantic Sea temperatures. The jet stream is a ribbon of strong winds that are concentrated in a narrow band in the atmosphere and are formed by temperature differences. At the boundary between cold polar air and warm tropical air

6 Centre for Ecology & Hydrology http://www.ceh.ac.uk/data/nrfa/index.html

7 Marsh, T.J. and Hannaford, J. (2007) The summer 2007 floods in England and Wales – a hydrological appraisal. Centre for Ecology and Hydrology

weather fronts can develop which can bring heavy rainfall and strong winds. For much of summer 2007, the jet stream was further south and stronger than usual (Figure 4.1), resulting in more rain bearing depressions crossing southern and central parts of the UK, with the higher Atlantic sea temperatures leading to the creation of more rain clouds.

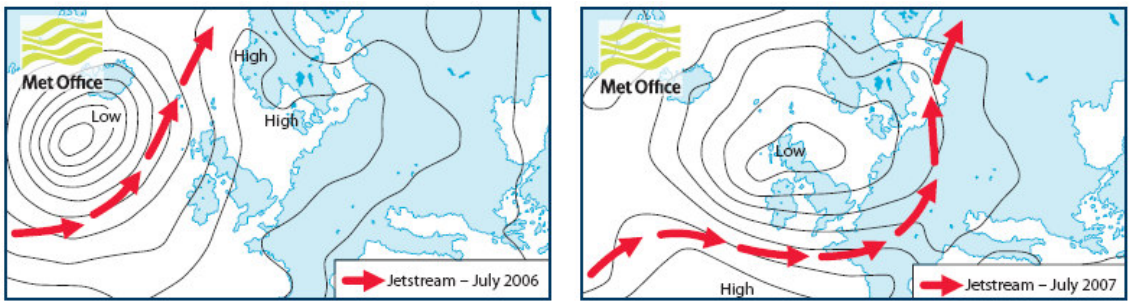


Figure 4.2: Comparison of the position of the Jet Stream in July 2006 and July 2007 (Met Office 2007)

4.5.12 The first rainfall event occurred between 14th and 15th June, affecting areas in the Midlands, North East and South West. This generally did not result in serious flooding within Gloucestershire but a substantial quantity of rainfall was absorbed by the dry ground and produced waterlogged conditions. Further heavy, persistent and frequent rain fell across Gloucestershire between 24th and 25th June, with approximately one month's rainfall falling in two days. Some flooding from smaller watercourses, which responded quickly to local runoff, was experienced within Gloucestershire, however at this stage there was no significant flooding from the River Severn.

4.5.13 The third rainfall event substantially affected Gloucestershire and occurred on the 20th July, resulting in extensive flooding throughout the lower Severn catchment. This was a result of a slow-moving depression centred over south-east England moving slowly northwards. Embedded convective cells contributed to significant spatial variability but a defining characteristic of the storm was the large area (>30,000 km²) registering exceptional rainfall totals[7]. Gloucestershire was one of the worst affected, receiving 197mm of rainfall during July 2007. This is more than four times greater than the average monthly rainfall recorded since records began in 1766.

4.5.14 The rainfall fell onto already saturated ground resulting in quick, widespread flooding from a variety of sources, not just watercourses. It is important to note that surface water, sewer and groundwater flooding played a considerable role in the summer flood event, adding to the complications. Drains and sewers were overwhelmed by the intense and prolonged rainfall, rapidly causing flooding.

River Flow Data

4.5.15 The exceptional rainfall manifested itself as extremely high river flows. Peak river flows eclipsed previous recorded maxima in some (mostly central England) catchments, runoff patterns were more typical of a wet winter and summer flow regimes were redefined over wide areas.

4.5.16 Record flood flows were recorded in Gloucestershire as a result of the exceptional flows in the Rivers Teme and Avon and the heavy rainfall experienced across Gloucestershire and Worcestershire. River levels at the Gloucester Docks gauge reached a peak of 4.92m on 23rd July. This was only 1cm lower than the highest recorded level in 1947. Across Gloucestershire, sustained high levels in the major rivers hampered the drainage of floodwaters away from afflicted communities, particularly Tewkesbury.

4.6 Fluvial Flood Risk in Cheltenham Borough

4.6.1 Flood Zones show the areas potentially at risk of flooding from rivers, ignoring the presence of defences (although areas benefiting from formal defences are identified). This information has been used, in conjunction with other data, to give an account of flood risk in study area. This has focused primarily on the Main Rivers including the River Chelt, Lilley Brook, Normans Brook, Hatherly Brook, River Swilgate, Wymans Brook and Hyde Brook. In some places, small ditches and streams exist without Flood Zones. It is clear that many of these watercourses, though small, do pose local flood risk issues. Site-specific FRAs will be required for all new developments, to appropriately take these drainage systems into account. The assessment of flood risk has also been enhanced using information from previous modelling reports and valuable local knowledge obtained from the Council.

4.6.2 An initial assessment of the Flood Zone maps within the Borough indicate that of the 51,927 properties located within the Borough, 1,598 are located within Flood Zone 3 and, 2,649 are located within Flood Zone 2 (Table 4.2).

Table 4.2: Properties located within Flood Zone maps within Cheltenham Borough

	No. Properties	Percentage of Properties Located within Flood Zone (%)
Whole Borough	51,927	-
Flood Zone 3	1,598	3.1
Flood Zone 2	2,649	5.1

4.6.3 Towards the northern extent of the Borough the Mill Stream and River Swilgate flow in a westerly direction. Flood Zone maps exist initially for a small section of the Mill Stream which extends onto Cheltenham Racecourse at Prestbury (SO 1597 2469). Downstream of the railway line the watercourse becomes known as the River Swilgate (and also the Hyde Brook) and forms the northern boundary of the Borough. Flood Zones 2 and 3 extend across the Borough boundary and are relatively narrow in extent, encroaching onto predominantly rural floodplain. Misalignments are evident within the Flood Zone maps for the Mills Stream and River Swilgate and are detailed in Section 4.7.

4.6.4 Flood Zone maps for the River Chelt are initially narrow at the upstream extent of the watercourse as it enters the Borough downstream of Dowdeswell Reservoir (SO 9860 1976), reflecting the steep nature of the Chelt catchment in its upper reaches at the edge of the Cotswold Escarpment. As the watercourse continues in a westerly direction through the Borough, the Flood Zone maps widen. A significant number of properties and roads are located within Flood Zones 2 and 3 for the River Chelt as it flows through the Borough, in particular through Cheltenham town centre. Historically, the town centre has been affected by flooding on a number of occasions with many locations affected including Old Bath Road, Keynsham Road, College Road, Bath Parade, the junction of Great Western Road and Millbrook Street and Arle Avenue. Due to the small and steep nature of the catchment in its upper reaches the peak surface water and peak river flows overlap during prolonged rainfall events. During both the summer 2007 flood events, flooding was exacerbated by surface water due to the drainage systems becoming overloaded.

4.6.5 A number of misalignments are apparent within Flood Zones 2 and 3 between the point at which the watercourse enters the Borough and Charlton Kings, and further downstream as the watercourse continues to flow through the Borough (Section 4.7). It should be noted that a Strategic Flood Risk Mapping Study (SFRM) is currently being undertaken for the River Chelt with Flood Zone maps being updated between Balcarras Farm (SO 9769 2030) and the A38 at Stain's Bridge (SO 8689 2493) located outside of the Borough. This information should be incorporated into the SFRA once available and existing Flood Zone maps should be interpreted with caution until the revised outlines become available.

4.6.6 Towards the south western extent of the Borough the Hatherley Brook flows in a north-westerly direction. Flood Zones 2 and 3 for the watercourse and adjoining tributaries are generally narrow, with very little difference in the extent between Flood Zones 3b and 2. A number of properties are located within Flood Zones 2 and 3 through Leckhampton, however, there appears to be very little flood risk along the remainder of the watercourse as it continues to flow through the Borough before exiting by the Golden Valley. Consultation with the Council has indicated that properties at Leckhampton were affected by flooding from the Hatherley Brook during the summer 2007 flood events. This corresponds with both the 1968 and 2007 historic flood outlines from the Environment Agency. Any further proposed development in this area would need to ensure that flood risk is not increased along the watercourse through a site specific FRA.

4.6.7 At Cleevemount, the Wymans Brook flows in a north-westerly direction through the Borough. A number of properties and a bus station are located within Flood Zones 2 and 3 at Cleevemount, between Wymans Road and Evesham Road. Historic flood outlines for the summer 2007 flood event correspond with the existing Flood Zone maps at this location. Here, the watercourse is culverted in a number of places, which may be adding to the risk of flooding. Downstream of Evesham Road, the Flood Zones widen slightly, before the watercourse is once again culverted downstream of Pitville Park. Again, this location experienced flooding during the summer 2007 flood event, to a greater extent than the existing Flood Zone maps. The Flood Zone maps appear to be slightly misaligned at this location, following the path of the lower ground through the recreation ground and Prince of Wales Stadium (Section 4.7). Downstream of the Dismantled Railway line, as the watercourse flows through Wymans Brook, a significant number of properties are located within Flood Zones 2 and 3. Again, misalignments are apparent within the Flood Zones, with flood risk being shown through culverted sections. To the south of Swindon, a large industrial estate is located within Flood Zones 2 and 3, before the watercourse turns in a northerly direction, forming the boundary of the Borough and flowing through rural floodplain. This industrial estate also experienced flooding during the summer 2007 flood event.

4.7 Issues with Existing Flood Zone maps

4.7.1 During the review of the existing flood map information, some inaccuracies were identified and these are detailed in Table 4.3. It should be noted that most of the Flood Zone information in the study area has been derived from the modelling package JFLOW, which is national broadscale model and as such has known limitations. The accuracy of the Flood Zones in some areas is poor, likely to be due to the high number of culverts particularly along the River Chelt through the town centre and the Wymans Brook. The Flood Zones can be misaligned from the channel or follow a path which does not have a watercourse. The JFLOW flood extents also do not show the impact of flood defence structures.

4.7.2 When viewing the Flood Zone data with OS Tiles these inaccuracies are clear, and whilst the best available information has been used in the SFRA, appropriate judgement should be exercised when applying the Sequential Test. In the future, updates to the Flood Zone maps may be undertaken as part of the Environment Agency's ongoing Flood Map improvements. Updates to the Flood Zone maps should therefore be incorporated into the SFRA when they become available. It may be prudent for a suitably qualified flood risk management specialist to review and assess preliminary site allocations, to advise on local Flood map issues and areas where further investigation may be required (such as a Level 2 SFRA).

Table 4.3: Inaccuracies with Flood Maps within Cheltenham Borough

Watercourse	Location(s)	Problem
River Chelt	Dowdeswell to Charlton Kings	Misalignments in Flood Zone maps in upper reaches between Dowdeswell and Charlton Kings. Culverted sections through Cheltenham town centre. It should be noted that the Flood Zone maps for the River Chelt are currently be updated and should be incorporated into the SFRA when available (refer to Section 5.1.1)
Lilley Brook	Charlton Park	Misalignments through Charlton Park with Flood Zone maps following lower lying gardens of properties. It should be noted that a small section of the Flood Zone maps for the Lilley Brook are currently be updated as part of the River Chelt SFRM study and should be incorporated into the SFRA when available (refer to Section 5.1.1)
Mill Stream & River Swilgate	Various	Flood Zone misaligned from the channel at various points along its course through the Borough
Wymans Brook	Cleevemount, Wymans Brook & Swindon	Culverted sections at upstream extent of Flood Zone and downstream of Pitville Park. Flood Zone maps are misaligned and appear to follow path of lower ground through recreation centre. Downstream of the dismantled railway there are a number of culverted sections showing flood risk and the Flood Zone maps are misaligned in a number of places through Wymans Brook

4.8 Flooding from Other Sources

4.8.1 Methodologies for recording flooding from sources other than fluvial or tidal were not standardised until 2006. Therefore records held of such flooding can be incomplete, or not to a uniform standard. Records of flooding from other sources also tend to show locations that have flooded in the past, rather than give an indication of flood risk areas based on probabilities, like the Flood Zone maps.

Information has been gathered on flooding experienced from sources other than rivers, and is described in this section.

4.9 Flooding from Artificial Drainage Systems (Sewers)

4.9.1 Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled.

4.9.2 Higher flows are likely to occur during periods of prolonged rainfall, common to the autumn and winter months. This is also when the capacity of the sewer systems is most likely to be reached. During periods of low flow, for example summer months, sewers become susceptible to blockage as the low flows are unable to transport solids. This leads to deposition and gradual build up of solid debris.

4.9.3 One water company covers the Cheltenham Borough study area: Severn Trent Water (STW). STW has been consulted for information on flooding from surface water and artificial drainage sources and this has been provided where data has been made available.

4.9.4 All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes records of flooding incidents from foul sewers, combined sewers and surface water sewers which are deemed to be public and therefore maintained by the Water Company. Flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register.

4.9.5 The DG5 register tends to show, to a greater or lesser extent: the location of the incident, the date of the incident, a description of the incident, whether the incident occurred internally or externally and the register the incident has been recorded on. When an incident is reported, a decision chart is used to assess whether the properties/areas are 'at risk' and then the record is added to the appropriate register.

4.9.6 The recording of flood events by the authorities has often led to improvements intended to prevent reoccurrence, so historical flooding is not necessarily evidence of propensity for future flooding. Further, Cheltenham Borough Council is currently undertaking a review of known flood risk areas and investigating potential alleviation schemes. Findings from this study should be incorporated into this SFRA upon completion. In addition, Cheltenham Borough in conjunction with Tewkesbury District and Gloucester City Council are currently investigating the potential of undertaking a Surface Water Management Plan.

4.9.7 The DG5 data received from STW has been provided at four-digit postcode level, hence no street level information on flooding was available. In summary it is evident that twenty postcode areas within the Cheltenham Borough are identified as having properties at risk of flooding from artificial drainage systems and surface water runoff (Table 4.4). It is not possible to identify the exact location of the properties at risk within the postcode polygons and therefore caution should be taken when interpreting this information, as it is at a coarse resolution. In general the level of flood risk from artificial drainage systems within the Borough is medium to low with the areas at highest risk located towards the south-west of the Borough by Hatherley, Tivoli and Lansdown and towards the northern extent of the Borough by St Paul's, Marle Hill, Wymans Brook, Oakley and Lynworth (Volume 2, Tile B6).

Table 4.4: Flooding From Sewers as Recorded in the Severn Trent Water DG5 Register

Postcode Area	No. Properties Affected	Level of Risk
GL50 2	13	Medium
GL50 3	4	Low
GL50 4	9*	Medium
GL51 0	2*	Low
GL 51 3	9*	Medium
GL51 4	3*	Low
GL51 6	3*	Low
GL51 7	2	Low
GL51 8	4	Low
GL51 9	2*	Low
GL52 2	3	Low
GL52 3	4*	Low
GL52 5	13*	Medium
GL52 6	4	Low
GL52 7	6*	Medium
GL53 0	2*	Low
GL53 7	2	Low
GL53 8	4	Low
GL53 9	5*	Low
GL54 4	1*	Low

∗ These numbers include properties within this postcode area which fall outside the Council Boundary

4.9.8 Within Cheltenham Borough there are three main sewerage areas, each based on an existing watercourse through which flows a main foul trunk sewer: The Northern Outfall Sewer which follows the line of the Wymans Brook between Midwinter allotments and Manor Road, before running along the line of Hayden Road to Pilgrove Pumping Station (completed in 1970); the Hatherley Trunk Sewer which drains the southern area of Cheltenham and follows the line of the Hatherley Brook between Hatherley Park and the Hayden Water Reclamation Works (completed in 1978); and the Chelt Main Sewer and the Wymans Brook Combined Sewer which drain the central area of the Borough and are gradually being replaced.

4.9.9 Much of the Cheltenham Central Area Main Sewerage System is over 120 years old and thought to be in a poor structural state. A programme of sewer replacement is being implemented and is thought to involve work beyond the current 5-year Capital Programme. The Chelt main sewer has a large overflow which joins the River Chelt at Arle. It has been recommended by the Environment Agency that any further development within the catchment area of this sewer system deals with

surface water appropriately at the surface so that betterment is achieved. An increase in site runoff should not occur as this would increase the sewage flow and would lead to the overflow being used more frequently[7].

4.9.10 STW has stressed that Local Planning Authorities should adopt a planning policy requiring the use of SUDS as proposed in PPS25 and that the Sequential Test should be used to allocate land for development within low risk Flood Zones, so that the risk of fluvial flooding is minimised. This reduces the risk of fluvial flood waters entering public foul and surface water sewers and resultant widespread flooding and pollution. Individual developments should be designed so that natural flood pathways are left free of buildings. These recommendations are put forward as policy considerations, in Chapter 7. Guidance on the application of SUDS can be found in Chapter 10.

4.10 Flooding from Surface Water

4.10.1 Surface water flooding occurs when excess water runs off across the surface of the land and is usually the product of short duration but intense storms. This type of flooding usually occurs because the ground is unable to absorb the high volume of water that falls on it in a short period of time, or because the amount of water arriving on a particular area is greater than the capacity of the drainage facilities that take it away. Surface water flooding can also occur from wet antecedent conditions. Where discharge is directly to a watercourse, locally high water levels can cause back-up and prevent drainage taking place. In each instance the water remains on the surface and flows along the easiest flow path towards a low spot in the landscape. The impermeability of concrete and tarmac is often responsible for reduced infiltration and resultant high runoff. Roads often make for easy flow paths, leading to situations where roads become impassable.

4.10.2 Surface water flooding is often short lived and localised. Several instances may result from a single storm throughout the catchment. Often there is limited notice as to the possibility of this type of flooding. This, combined with the high velocities achievable when water is flowing along a contained smooth surface such as a road, can cause surface water flooding to be devastating in nature. Suspended material can be carried into drains by overland flows or floodwaters and this can also lead to them becoming blocked, exacerbating the problem.

4.10.3 There is currently no dataset depicting predicted surface water flood risk areas, and time restraints have precluded surface water flood risk mapping for Gloucestershire as part of the SFRA. Through the duration of the Level 1 study, surface water modelling has come to the fore and methodologies are rapidly being developed. The Pitt Review notes that the Environment Agency is assessing the feasibility of developing a rapid, national topographic screening technique to show areas which are susceptible to surface water flooding from heavy rainfall, which could be used to inform future updates of the SFRA. In the interim, data on surface water flooding hotspots included in the SFRA (Volume 2, B Tiles) will be of use to local emergency responders and for planning purposes. It should be noted, however, that through the duration of the study the Environment Agency has firmed its requirement for surface water modelling as part of SFRAs, and has requested that surface water modelling is carried out as part of a Level 2 SFRA.

4.10.4 The Highways Agency and the County Council provided extensive databases of surface water flooding locations and these have been mapped as GIS points in Volume 2, Tiles B1-B5. The geology and topography of the Borough contribute to the rainfall response within the Borough and therefore the likelihood and nature of surface water flooding (see Section 1.8). Overall, surface water flooding is deemed to be a particular issue in the Borough given the abundance of impermeable surfaces in

the town in particular, especially when local intense rainstorms occur. In the past the River Chelt was diverted from its natural course to higher ground in order to feed the great mills. The original river valley was subsequently developed with housing estates, public buildings and industrial development. Consequently, when intense rainfall events occur, runoff follows natural topography and accumulates at the valley bottom, which can flood areas of the town centre. In addition, the drainage system is known to be quite old and there is potential for the drainage systems to overload and exacerbate surface water flooding. Any site-specific FRA would need to adequately assess the risk from surface water flooding and ensure the site achieves betterment.

4.10.5 A change in the way surface water is managed is required to alleviate the risk of flooding from this source. Management of surface water through the overland system is generally considered more effective than relying solely on the capacity of underground systems. Slowing down the water and storing it before it reaches the piped system can greatly reduce the potential impact of surface water flooding. In less extreme circumstances than summer 2007, this approach should be able to prevent flooding. This approach is set out in the Government's new Water Strategy, Future Water[8]. It states that by 2030 surface water will be managed more sustainably by allowing for the increased capture and reuse of water, slow absorption through the ground, and more above-ground storage and routing of surface water separate from the foul sewer, where appropriate. There will be less reliance on the upgrading of the sewer system to higher design standards and rather that water will be increasingly managed on the surface.

4.10.6 The Pitt Review recommends the production of Local Authority Surface Water Management Plans (SWMPs), a first step in realising the sustainable management of surface water. SWMPs should focus on risk management and optimising the provision of sustainable surface water drainage infrastructure (i.e. SUDS). They should also take account of the risks of surface water and sewer flooding and how these might affect an area in combination with flooding from rivers and (where relevant) canals, reservoirs, the sea or groundwater. SWMP guidance may be developed as a supplementary planning document within the LDF to address flooding and water management issues. Further details on SWMPs can be found in paragraph 4.23 of the PPS25 Practice Guide (2008), which became available during the course of this study.

4.10.7 It is recommended that the Council considers the production of a SWMP for the Borough.

4.11 Flooding from Impounded Water Bodies

4.11.1 As part of the SFRA it is necessary to consider the risk of overtopping or breach of reservoirs and canals. British Waterways (BW) was consulted to gain information on past reservoir breach and overtopping incidents of canals, while the Environment Agency was consulted to gain a comprehensive overview of reservoirs currently held under the Reservoirs Act, and any breach and overtopping information of these reservoirs. Where reservoirs and canals impound water above the natural ground level, there may be a risk of failure of the embankment resulting in rapid inundation of the surrounding area.

Canals

4.11.2 It is important that canals are included in an SFRA as they can form a vital land drainage function. Any FRA should also take account of canals. Occasionally, canals can overtop due to high inflows

8 Defra – Water Strategy, Future Water (2008)

from natural catchments and if overtopping occurs from adjacent water courses. This additional water can be routed/conveyed by the canal which may cause issues elsewhere, not only within the catchment of interest but also in neighbouring catchments where the canal might cross a catchment boundary. However, there are no canals, raised or otherwise, located within the Borough and assessment of the OS maps indicates that there are no canals located adjacent to watercourses that flow through the Borough.

Reservoirs

4.11.3 Many reservoirs in the UK lie immediately upstream of, or adjacent to, heavily populated areas. The rapid, uncontrolled discharge of water from such reservoirs could have catastrophic consequences on life and property (though the risk of this occurrence is very low). Reservoirs with an impounded volume in excess of 25,000 cubic metres (measured above natural ground level) are governed by the Reservoirs Act 1975 and are listed on a register held by the Environment Agency. The reservoir register for Cheltenham Borough Council is detailed in Table 4.5.

Table 4.5: Reservoir Register for Cheltenham Borough Council

Reservoir	Physical Status	Situation	NGR	Category	Year Built	Dam Type	Maximum Height	Capacity	Surface Area
The Reservoir - Cheltenham Racecourse	In Operation	Near Cheltenham	SO9597 425033	Non-impounding	Unknown	Unknown	Unknown	Unknown	Unknown
Cox's Meadow	In Operation	Cheltenham	SO 95660 21270	Non-impounding	Unknown	Unknown	Unknown	Unknown	Unknown

4.11.4 A number of flood storage areas are also located within or close to the Borough boundary, namely Dowdeswell Reservoir and Cox's Meadow. Dowdeswell is located outside the eastern extent of the Borough (SO 9884 1973) upstream of Cheltenham, within the Cotswold District. Dowdeswell Reservoir is contained within the Environment Agency's Reservoir Register. The reservoir has been modified for use from a water supply reservoir to a flood storage reservoir. Further details of storage areas can be found in Section 6.7.

4.11.5 Due to high standards of inspection and maintenance required by legislation, normally flood risk from registered reservoirs is moderately low. Whilst the reservoir register, and indeed the SFRA, has identified impounded water bodies with a storage volume greater the 25,000m^3, it should be stressed that a number of smaller impounded water bodies are located within the Borough, all of which pose flood risk. Therefore development immediately downstream of any reservoir or impounded water body (not just those contained within the reservoirs database) should be discouraged and will be subject to a Level 2 SFRA if the development is deemed necessary.

4.11.6 Consultation with the Environment Agency has indicated that there are no records of breaching/overtopping of reservoirs within the Cheltenham Borough area. Reporting of dam incidents to the Environment Agency is a voluntary process and the system has only been in place since 2007. Prior to that reports of incidents were collected on an ad hoc basis by the Building Research Establishment, from published papers and questionnaires. Due to the voluntary nature of incident reporting the records held by the Environment Agency are not complete and the incidents provided

only represent those overtopping incidents or breaches that the Environment Agency have been informed of. It should be noted that when referring to 'overtopping' the records held by the Environment Agency are referring to the overtopping of an embankment and are not referring to water flowing down a reservoir spillway. A spillway operating in the way that it was designed is not a reportable reservoir incident under the post-incident reporting system.

4.11.7 Defra's 'Making Space for Water' project 'Flooding from Other Sources HA4a' refers to the need for flood risk mapping for all sources of flooding. The study concluded that flood risk mapping is feasible for many sources of flooding that are not currently covered by the Environment Agency Flood Map, using existing flow modelling and GIS tools. However, there are significant constraints in terms of the need to undertake extensive data collection to ensure the production of flood maps that will be useful and are not dominated by modelling uncertainties. The outcome of the HA4a project is to produce a report on the feasibility of mapping possible flooding from other sources; it will not produce the actual maps that show these risks. The intention is that these requirements can be built into the Environment Agency's next Flood Mapping Strategy 2008-13. The project is also considering means of making this information available to interested parties, both internal and external.

4.11.8 Recommendations put forward by the Pitt Review further highlight the need for inundation maps of reservoir breaches which provide a spatial indication of flood risk from impounded water bodies. Guidance put forward by Defra in their Research and Development Technical Report FD2320/TR2 FRA Guidance for New Development refers to the CIRIA Report C542 Risk Management for UK Reservoirs. The report was prepared following extensive consultation with the UK reservoir community and is aimed chiefly at reservoir owners, engineers, regulators, insurers and safety personnel concerned with reservoirs in the UK. The document provides an examination of past reservoir failure and provides an assessment procedure to determine potential floodwater levels and their impact following a failure. As noted by the Pitt Review, once inundation maps of reservoir breaches have been produced by reservoir undertakers, the Council should incorporate this information into the Community Risk Register and emergency planning procedures, and indeed the SFRA. The Defra document FD2321/TR2[9] also provides further guidance on the mapping of reservoir flood plans.

4.12 Flooding from Groundwater

4.12.1 Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive regional aquifers (e.g. Chalk or Sandstone) or localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding occurs as a result of water rising from the underlying rocks or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas the water table is usually at shallower depths anyway, so during very wet periods, all the additional groundwater flowing towards these areas can cause the water table to rise to the surface causing groundwater flooding.

4.12.2 Different geological aquifers can react in different ways to high rainfall intensity events. For example, limestone aquifers can readily transmit groundwater as they are fractured in nature and thus may

9 Defra/Environment Agency Flood and Coastal Defence R&D Programme; R&D Outputs: Flood Risk To People, Phase 2, FD2321/TR2 Guidance Document, March 2006

exacerbate flooding issues in watercourses when combined with other hydrological factors. In comparison, the effects and impacts of groundwater flooding in sandstone aquifers can take long periods of time to dissipate due to the high storage potential of the aquifer. Groundwater flooding differs from fluvial flooding and surface water flooding in that it may take weeks or months to dissipate, because groundwater flow is very slow and water levels take much longer to fall, therefore groundwater flooding effects can still be evident a long time river levels have subsided.

4.12.3 In recent times the decline in industry has led to an increase in groundwater levels due to a reduction of abstraction, though there is no record of this problem in the study area.

4.12.4 In comparison to fluvial and tidal flooding, the understanding of the risks posed by groundwater flooding is limited and mapping of areas susceptible to groundwater flooding is in its infancy. There is currently no one organisation with responsibility to respond to groundwater flooding, therefore the risks and mechanisms of groundwater flooding are poorly reported. Groundwater level monitoring records are available for areas on Major Aquifers, however, at lower lying valley areas, which can be susceptible to groundwater flooding such as mudstones, clays and superficial alluvial deposits, very few records are available. This gap is currently being addressed as part of Defra's Making Space for Water (MSfW) consultation on Groundwater flooding records collation, monitoring and risk assessment (Reference HA5). The need for a national co-ordination of groundwater flooding risk management within the overall flood and coastal erosion risk management framework has been recognised, and Reference Document HA5 has put forward recommendations for the effective monitoring and collation of groundwater flooding information along with further recommendations for organisational and funding changes to implement this and direction for the strategic overview role of the Environment Agency.

Historical Groundwater Flooding

4.12.5 The most widespread and recent incident of groundwater flooding throughout the UK occurred during the winter of 2000/2001 (with some further locations affected during 2002/2003) and followed a period of exceptionally heavy rainfall. During an eight month period from September 2000, rainfall in England and Wales was 166% of the long term average with the highest rainfall coinciding with areas of Chalk outcrop. Summer groundwater flooding is relatively rare as dry soil conditions normally preclude widespread aquifer recharge during the summer months (exceptions include 1879, 1912 and 2007).

4.12.6 Following the widespread floods of winter 2000/2001 Defra commissioned a study investigating the occurrence of groundwater flooding throughout England. Provisional maps of areas vulnerable to groundwater emergence from consolidated aquifers (Groundwater Emergence Maps, GEMs) were produced to asses the geographical extent and severity of the groundwater flooding in 2000/01[10]. Analysis of the GEMs indicated that the problem of groundwater flooding within England is largely confined to Chalk aquifers, particularly in the southeast of England[11].

10 Morris, S.E, Cobby, D and Parkes A (2007) Towards Groundwater Flood Risk Mapping, Quarterly Journal of Geology and Hydrogeology

11 Jacobs (2004), Strategy for Flood and Erosion Risk Management: Groundwater Flooding Scoping Study (LDS 23). Jacobs, Reading

Groundwater Flooding within Cheltenham Borough

4.12.7 As discussed, records of groundwater flooding are generally limited and methods of mapping areas susceptible to groundwater flooding are in their infancy. Consultation with the Environment Agency has indicated the GEMs do not cover the Cheltenham Borough and that there are no recorded incidents of groundwater flooding within the Borough.

4.12.8 In conclusion, areas at risk from groundwater flooding are largely unknown. Although data collected for the SFRA has not uncovered areas potentially susceptible, the assessment undertaken as part of this SFRA is not exhaustive and the risk of flooding from groundwater flooding must be considered as part of any further FRA.

4.13 Key Recommendations: Chapter Four

- In the Pitt Review, attention should be drawn to recommendations 14, 15, 16, 17 and 19, which address the role of the Local Authority with regards to flood risk management. It recommends that the Local Authority takes a lead role in the management of flood risk with the support of the relevant organisations.
- All historical events, including summer 2007, are important in obtaining an understanding of the flood risk posed to the Borough, and should all be considered in the location of new development and as part of any assessment of flood risk.
- The accuracy of the Flood Zones in some areas of the Borough is poor; they can be misaligned from the channel or follow a path which does not have a watercourse. When viewing the Flood Zone data with OS Tiles these inaccuracies are clear, therefore appropriate judgement should be exercised when applying the Sequential Test. It may be prudent for a suitably qualified flood risk management specialist to review and assess preliminary site allocations, to advise on local Flood Map issues and areas where further investigation may be required (such as a Level 2 SFRA).
- An SFRM study is currently being undertaken for the River Chelt, which will produce updated Flood Maps. This information should be incorporated into the SFRA once available and existing Flood Zone maps should be interpreted with caution until the revised outlines become available.
- The Chelt main sewer has a large overflow which joins the River Chelt at Arle. The Environment Agency recommends that any further development within the catchment area of this sewer system deals with surface water appropriately at the surface so that betterment is achieved. An increase in site runoff should not occur as this would increase the sewage flow and would lead to the overflow being used more frequently.
- There should be less reliance on the upgrading of the sewer system to higher design standards to accommodate new developments; rather, water should be managed on the surface through the appropriate application of SUDS.
- The Environment Agency will require further surface water investigation and mapping to be carried out as part of a Level 2 SFRA.
- The Council should produce a Surface Water Management Plan, in line with Pitt Review recommendations, which should provide the basis for managing all local flood risk.
- Whilst the SFRA has identified reservoirs with a storage volume greater the 25,000m^3, there are smaller reservoirs are located within the Borough which also pose flood risk. Development immediately downstream of any reservoir or impounded water body should be discouraged and will be subject to a Level 2 SFRA if the development is deemed necessary.
- Areas susceptible to groundwater flooding within the Borough are largely unknown and the SFRA has not uncovered areas potentially at risk. However, the assessment undertaken as part of this SFRA is not exhaustive and the susceptibility to flooding from groundwater must be considered as part of any further FRA.

5 Strategic Flood Risk Mapping

5.1 Strategic Flood Risk Maps

5.1.1 This chapter provides a clear description of the data that has been used for the purpose of strategic flood risk mapping. These maps, which can be found in Volume 2, Tiles B1-B6, show flood risk from sources including fluvial, surface water, foul and combined sewers, groundwater and impounded water bodies including reservoirs and canals. This information is based on the findings in Chapter 4, which has included an assessment of suitability. The Sequential Test process primarily uses the Flood Zone maps to locate developments in low fluvial flood risk areas. The point of mapping flooding from other sources is to ensure new developments are also located away from areas which have experienced flooding from 'other sources'.

5.1.2 The strategic flood risk information is also presented as GIS layers, and can be interrogated to gain the associated descriptive information. These can be found in the CD attached to this report.

5.1.3 In accordance with the PPS25 Practice Guide (2006), the Level 1 SFRA has used Flood Zone outlines which have been produced using detailed modelling techniques in preference to the Environment Agency's Flood Zone maps, wherever possible. Flood Zone outlines used within the SFRA are undefended and should be used to carry out the Sequential Test. When representing the Flood Zones, Level 1 SFRAs should also show the functional floodplain, Flood Zone 3b, where such outlines exist. If Flood Zone 3b has not been produced as part of a detailed modelling project, similar outlines, such as the 1 in 25 year outline can be used, upon agreement with the Environment Agency. In the absence of such detailed information, the PPS25 Practice Guide (2006) recommends that all areas within Flood Zone 3a should be considered as Flood Zone 3b unless, or until, an appropriate FRA shows to the satisfaction of the Environment Agency that it can be considered as falling within Flood Zone 3a. Therefore, as part of this SFRA, modelled outlines have been used to represent Flood Zone 3b where they exist. Where no modelled outlines exist, Flood Zone 3a has been used to represent Flood Zone 3b.

5.2 Hydraulic (River) Models

5.2.1 River models have been collected and used for the production of the SFRA flood maps. Within the study area, Environment Agency hydraulic models exist for the River Chelt and Hatherley Brook. The table overleaf gives details of the modelled Flood Zone outlines, and the outlines are presented in Volume 2, Tiles B1-B5. In all cases the approach has been discussed and agreed with the Environment Agency.

5.2.2 For the remainder of watercourses in the study area, the Environment Agency's Flood Zone information has been used and is also presented in Volume 2, Tiles B1-B5. It should be noted that some smaller watercourses do not have Flood Zones produced for them.

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Table 5.1: Environment Agency Hydraulic Models and Modelled Flood Zones within Cheltenham Borough

Model	Watercourse	Derived From	Modelled Extents within Borough		Modelled Flood Zones			Notes
			Upstream	Downstream	3b	3a	2	
Hatherley Brook	Hatherley Brook	Environment Agency	SO 9435 1980	SO 9068 2235	✓	✓	✓	4% AEP(1 in 25 year) outline has been used as Flood Zone 3b; 1% AEP (1 in 100 year) outline has been used as Flood Zone 3a and 0.1% AEP (1 in 1000 year) outline has been used as Flood Zone 2.
River Chelt	River Chelt	Environment Agency	SO 9769 2031	SO 8688 2492				Flood mapping study is currently being undertaken. Consultation with the Environment Agency has indicated that modelled flood outlines are expected to be available in Summer 2008. The SFRA should be amended to incorporate this information when it becomes available.
	Lilley Brook	Environment Agency	SO 9583 2102	SO 9587 2114				As above

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5.3 Sewer Flooding

5.3.1 Due to the Data Protection Act, it is not possible to specify the exact locations of past incidents. Instead, data has been received at four-digit postcode level. These postcode polygons outline a series of large geographical areas. Within each postcode area it has been indicated how many incidents have occurred. This information is presented in a separate high-level historical flooding map in Volume 2, Tile B6. This information has also been digitised as a GIS layer.

5.3.2 Sewer flood risk has been classified according to the number of properties flooded from overloaded sewers within each postcode area. The categorisation is as follows:

- Low sewer flood risk: 1 to 5 properties Denoted by a yellow polygon
- Medium sewer flood risk: 6 to 15 properties Denoted by an orange polygon
- High sewer flood risk: >15 properties Denoted by a red polygon

5.3.3 The colour system is designed to indicate that even though a whole postcode area might be shown as at risk, only a few incidents might have been recorded in that area.

5.3.4 Future updates to the DG5 flood register should be fed into future updates of the SFRA. At present, the relatively course resolution of data limits its use for the purpose of spatial planning. In future updates to the SFRA, water companies may provide full location information. In the meantime there is an onus on developers to assess sewer flood risk as fully as possible as part of site-specific FRAs.

5.4 Flooding from Surface Water, Impounded Water Bodies and Groundwater

5.4.1 Flooding from surface water, canals, reservoirs and groundwater has been mapped using the historical data collected in Chapter 4. GIS 'points' have been used to indicate where flooding from these sources has occurred. This is not considered to be exhaustive since the data are based on historical events rather than predictive modelling (and therefore may not represent very rare events) so the full extent of these flooding mechanisms may not have been captured. It is therefore recommended that during future updates to the SFRA, reviews and consultations are undertaken to ensure that any new surface water, canal, reservoir and groundwater flooding locations and issues are fully taken into account.

5.5 Climate Change

5.5.1 In its October 2006 publication of the predicted effects of climate change on the UK[12], Defra described how short duration rainfall could increase by 30% and flows by 20% by the year 2085, and suggested that winters will become generally wetter whilst summers, although drier, will be characterised by more intense rainfall events. Changes in rainfall patterns could result in changes in the intensity, frequency and timescales of rainfall events. Such changes will affect catchment wetness, groundwater flows into rivers and peak flows in watercourses, as well as urban drainage. Changes in sea level could result in tide locking of watercourses draining to the sea and resultant coastal and tidal flooding.

12 Defra, Flood and Coastal Defence Appraisal Guidance, FCDPAG3 Economic Appraisal; Supplementary Note to operating Authorities – Climate Change Impacts; October 2006

5.5.2 Overall, these effects will tend to increase both the size of Flood Zones and the depth of floodwater associated with rivers, and the amount of flooding experienced from 'other sources'. Sites that are currently within Flood Zones 2 and 3 will be subject to more frequent and potentially deeper flooding. PPS25 sets out current guidance for changes to flood risk as a result of climate change, shown in Table 5.2.

Table 5.2: PPS25 Guidance for Changes to Flood Risk as a Result of Climate Change

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

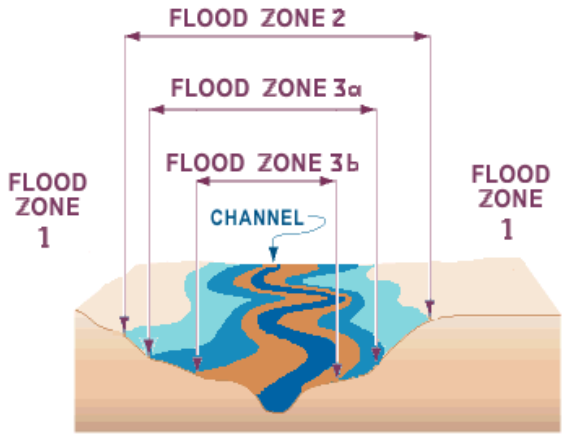
Methods used to derive the Climate Change maps

5.5.3 Sensitivity testing of the national Flood Zone maps has been carried out by the Environment Agency, using the 20% increase in peak river flows expected between 2025 and 2115. In very flat areas, the extent of inundation becomes bigger, while in well-defined floodplains, the depth of the floodwaters increases. This means that areas currently located in a lower-risk zone (e.g. Flood Zone 2) could, in future, be re-classed as lying within a higher risk zone (e.g. Flood Zone 3). In line with these findings, and to represent fluvial climate change scenarios where no other information exists, the Environment Agency Flood Zone maps have been used to infer climate change scenarios. The current Flood Zones have been 'reassigned' to show the following:

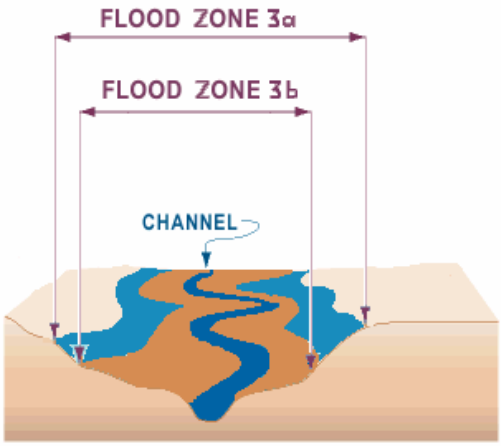
- Over a period of 50 to 100 years areas currently indicated as being within Flood Zone 2 will become Flood Zone 3a
- Over a period of 50 to 100 years areas currently indicated as being within Flood Zone 3a will become Flood Zone 3b

5.5.4 This approach (see below) gives an indication of how Flood Zones and flood probabilities are likely to change over time. The technique adopted is precautionary but one which is suitable to infer possible climate change impacts on fluvial flood risk in the absence of modelled climate change outlines.

Current Flood Risk



Future Flood Risk



5.5.5 A number of watercourses in the study area have been modelled, detailed in the table below. Wherever possible, this study has sought to use modelled information for the 1% AEP (1 in 100 year) climate change scenario (i.e. 100 +20%) in preference to the technique outlined previously, by either:

- Using modelled climate change scenarios for the 1% AEP(1 in 100 year) event (Flood Zone 3a), or
- Where modelled climate change outlines do not exist, using the 0.5% AEP (1 in 200 year) or 1% AEP (1 in 100 year) modelled outlines as a climate change proxy for the 1% AEP (1 in 100 year) event (Flood Zone 3a). This method is supported by the fact that the 0.1% AEP (1 in 1000) or 0.5% AEP (1 in 200 year) outlines often show similar extents to the climate change scenarios of the 100 year event.

Table 5.3: Modelled Flood Outlines used for the 1% AEP (1 in 100 year) Climate Change Scenario

Model	Watercourse	Modelled Flood Outlines				Notes
		1% AEP(1 in 100 year) + 20%	1 in 150 year	0.5% AEP(1 in 200 year)	0.1% AEP(1 in 1000 year)	
Hatherley Brook	Hatherley Brook	✓			✓	1% AEP (1 in 100 year) +20% used for climate change outline

5.5.6 The climate change outlines are provided in a series of maps covering the study area (Volume 2, Tiles C1-C5).

5.5.7 The strategic flood risk maps (Volume 2, B Tiles) show the present-day fluvial flood risk scenario. Where no modelled outlines exist for Flood Zone 3b, Flood Zone 3a has been used to represent Flood Zone 3b. This incorporates potential climate change into the Flood Zone maps and provides an effective method of incorporating climate change into the Sequential Test process.

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Likely Climate Change Impacts

5.5.8 As discussed in Section 5.5.3, upland areas will be subject to deeper, faster flowing water as climate change affects flood risk, while in lowland areas the extent of flooding is likely to become greater. Given the lowland setting of Cheltenham Borough, an increase in flood extent is expected, but flood waters might also be deeper. This means that the flood hazard is likely to increase over time, creating increased risk to humans, more damage to property and higher economic damages. A Level 2 SFRA, which assesses flood hazard, will therefore be required for site allocations which need to satisfy the Exception Test. Velocities are not likely to increase significantly, though the upstream section of the River Chelt is steep which may affect velocities. Certainly, sites that are currently within Flood Zones 2 and 3 will be subject to more frequent and potentially deeper flooding. This is reflected in the climate change maps (Volume 2, Tiles C1-C5) which show that areas currently in Flood Zone 3a are likely to fall in Flood Zone 3b in the future.

5.5.9 The LPA should consider using the climate change maps to carry out the Sequential Test, in order to give a particularly long-term risk-based approach to planning. It should be noted that the climate change maps do not show a climate change scenario for Flood Zone 2. For the purpose of spatial planning it is recommended that a buffer of 10m (measured from the edge of the existing Flood Zone 2) is added to represent future climate change.

5.6.1 It is expected that flood risk from surface water, sewers, groundwater and impounded water bodies will generally increase due to the expected wetter winters (causing more frequent groundwater flooding) and incidence of short-duration high-intensity rainfall events associated with summer convective storms (causing more frequent surface water and sewer flooding). However, if surface water can be better managed at the surface rather than the immediate discharge to sewers (i.e. by the implementation of SUDS) this risk can be reduced.

5.6.2 Should the need to apply the Exception Test be identified, a Level 2 SFRA will be required which should include a detailed investigation into the impacts of climate change on flood risk.

5.6 Key Recommendations: Chapter Five

- Flood Zone outlines used within the SFRA are undefended and should be used to carry out the Sequential Test.
- Modelled outlines have been used to represent Flood Zone 3b where they exist. Where no modelled outlines exist, Flood Zone 3a has been used to represent Flood Zone 3b. This incorporates potential climate change into the Flood Zone maps and provides an effective method of incorporating climate change into the Sequential Test process. 3a should be taken to equal 3b unless, or until, further work is carried out to prove otherwise (e.g. Level 2 SFRA, FRA).
- Future updates to the DG5 flood register (depicting sewer flood incidents) should be fed into future updates of the SFRA. At present, the relatively course resolution of data limits its use for the purpose of spatial planning. In the meantime there is an onus on developers to assess sewer flood risk as fully as possible as part of site-specific FRAs.

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6 Flood Warning Systems and Flood Risk Management Measures

6.1 Flood Risk Management

6.1.1 Flood risk management can reduce the probability of flooding occurrence though the management of land, river systems and flood defences, and reduce the impact though influencing development in flood risk areas, flood warning and emergency response.

6.2 Catchment Flood Management Plans

6.2.1 A Catchment Flood Management Plan (CFMP) is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management (in contrast to flood risk management strategies overleaf, which provide strategic options for flood risk management). It is produced in discussion with other key decision makers within a river catchment. CFMPs are being developed for the whole of England and Wales and are intended to define appropriate policies for the management of flood risk over the next 50 to 100 years. They will not set specific flood risk reduction measures at defined areas within the catchment, but will promote a range of activities for managing flood risk across the whole catchment. Cheltenham Borough Council is covered entirely by the Severn CFMP. Figure 6.1 shows how Cheltenham Borough Council fits within the wider Severn CFMP catchment.

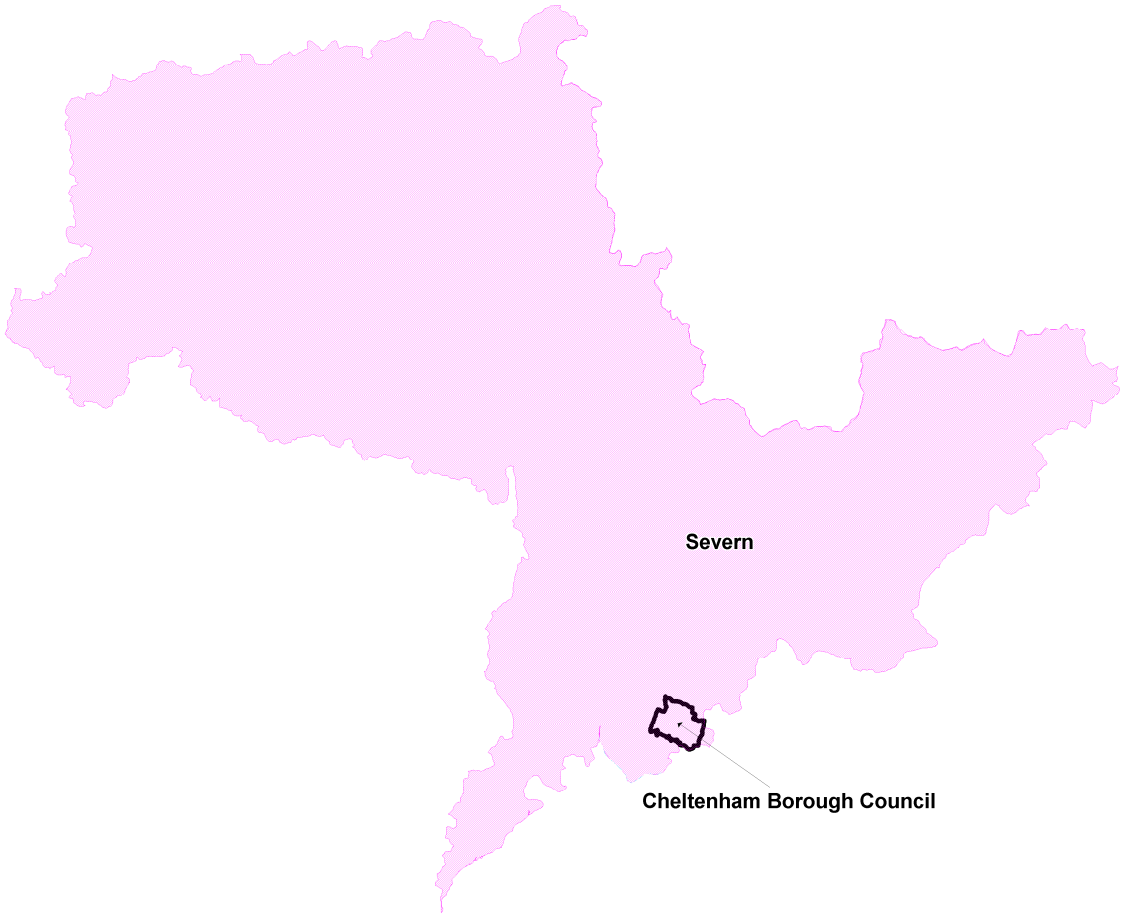

Figure 6.2: How Cheltenham Borough fits in the wider Severn CFMP catchment

Severn CFMP

6.2.2 The first Severn CFMP was undertaken as a pilot study in 2004/2005 and during the course of the production of the SFRA the updated draft Severn CFMP became available. The majority of Cheltenham Borough lies within Policy Unit 17: Cheltenham and North East Gloucester. This unit contains the urban area of Cheltenham. The preferred policy for this unit is Policy 5: 'take further actions to reduce risk (now and/or in the future)'. This is the preferred policy choice because it is proportional to the scale of existing flood risks and the anticipated growth of development and flood risk associated with climate change. Identified actions are:

- Through SFRAs and a Spatial Delivery Plan PPS25 must be applied to ensure that new properties are located in a place that is not of a high risk
- Surface Water Management Plan for Cheltenham to create a strategy for reducing surface water
- Undertake integrated urban drainage project for Cheltenham
- Finish the improvement to defences in Cheltenham
- Undertake Flood Warning study for Cheltenham and for the tributaries to the River Severn
- Establish the importance of the Chelt Basin defences and therefore model how this is likely to affect local flood risk

6.2.3 The policy unit identifies opportunities to implement SUDS within urban areas and the level of flood preparedness (flood warning, flood proofing and flood resilience) should be increased and promoted. An increase in targeted channel maintenance has also been identified as an opportunity to decrease debris build up in channels and help reduce incidents of blockage and resultant flooding.

6.3 Flood Risk Management Strategies

6.3.1 The Environment Agency also produces flood risk management strategies, which aim to deliver strategic options for flood risk management. Aims of strategies generally include the following:

- To identify a 100 year framework for sustainable management of flood risk
- To provide a five year plan for capital investment on a project level for flood risk management
- To identify measures to maximise the environmental /social enhancement opportunities

6.3.2 While a Strategy has been produced for the River Severn, options for flood risk management have been assessed for only the river corridor; therefore its recommendations have no bearing on the Borough. No other strategies exist in the Borough.

6.4 Summary of Environment Agency Policies

6.4.1 To summarise, the general direction of the Environment Agency is that within the Borough, actions will be taken to reduce flood risk, both now and in the future. Apart from the continued use of defences, there are opportunities for the Council to assist in the reduction of risk by vigorously applying PPS25 and promoting the use of SUDS. In terms of existing developments, the Council should promote understanding of flood risk and its management so that communities are aware of the steps they can take to reduce the risk. The implementation of Surface Water Management Plans

would be a first step in realising the sustainable management of surface water in both new development and existing developed areas. It is therefore recommended that the Council considers the production of a SWMP for the Borough. In addition, the level of flood preparedness (flood warning, flood proofing and flood resilience) should be increased and promoted in this area. An increase in targeted channel maintenance has also been identified as an opportunity to decrease debris build up in channels and help reduce incidents of blockage and resultant flooding.

6.5 Flood Defences

6.5.1 Flood defences are structures which affect flow in times of flooding and therefore prevent water from entering property. They generally fall into one of two categories: 'formal' or 'informal'. A 'formal' defence is a structure which has been specifically built to control floodwater. It is maintained by its owner (this is not necessarily the Environment Agency) so that it remains in the necessary condition to function. An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas, in addition to their primary function. A study of informal defences is also included in this section. Should any changes be planned in the vicinity of road or railway crossings over rivers in the study, it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal defences should be identified as part of site-specific detailed FRAs and the residual risk of their failure assessed.

6.5.2 The reduction in flood risk that a defence provides depends on the standard of protection (SoP) (the return period against which a defence offers protection) and the performance and reliability of the defence. Flooding may still occur in defended areas if the defence is overtopped or breached, or if flooding occurs as a result of non-fluvial sources such as groundwater flooding, surface water flooding or poor drainage. Development behind defences should, therefore, be planned with due regard to the flood risk in the defended area. This will need to be facilitated by a Level 2 SFRA.

6.5.3 In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the National Flood and Coastal Defence Database (NFCDD) and information from the Council. NFCDD is a good starting point for identifying significant flood defences and potential areas benefiting from defence, but the quantity and quality of information provided differs considerably between structures. The NFCDD is intended to give a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA where the need arises).

6.5.4 There are a number of locations at risk of flooding that are currently protected by permanent defences within the Borough and these can be viewed in Volume 2, Tiles A1-A5. The table overleaf provides details of the existing defences within the Borough that are contained within the Environment Agency's NFCDD database.

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Table 6.1: Environment Agency NFCDD Defences within Cheltenham Borough Council

Watercourse	Location	NGR		Type of Defence	Owner	SOP	Approx. Length (m)	Comments
		Upstream	Downstream					
River Chelt	Kingsditch. Back of properties off Carter road, on and adjacent to Frank Brookes road.	SO 9320 2383	SO 9284 2406	Raised defence	Environment Agency	1:100 Year	466.1	Wall and piled flood defence with ornamental coping. On left bank.
River Chelt	St. Peter's. Adjacent to Brada House, beneath railway to Millbrook street.	SO 9386 2303	SO 9377 2309	Flood defence structure	Environment Agency	1:100 Year	105.2	Concrete floodwall (0.3m high, 0.2m wide). Sheet piling (top = 48.02, toe = 43.5). On right bank.
River Chelt	Alstone. Beneath railway to Millbrook street. Arle avenue.	SO 9384 2299	SO 9381 2300	Flood defence structure.	Environment Agency	1:100 Year	41.7	Floodwall, Sheet piling (Top = 48.2, Toe = 43.5.). Extends into footbridge structure. On left bank.
River Chelt	Rosehurst adjacent to Bath road car park.	SO 9510 2204	SO 9515 2201	Flood defence structure	Environment Agency	1:100 Year	57.6	Concrete wall with brick cladding.
River Chelt	From outlet structure at Rosehursts to pedestrian footpath.	SO 9515 2199	SO 9515 2201	Raised defence	Environment Agency	1:100 Year	27.4	Low flood defence bank (earth).
River Chelt	Sandford Park. Between College road and Keynsham road.	SO 9525 2182	SO 9525 2188	Raised defence	Environment Agency	1:100 Year	63	Earth bund between flood relief culvert and Lido dwarf wall. On left bank.

		NGR						
River Chelt	Sandford Park around kids play area to beyond Lido swimming pool.	SO 9535 2169	SO 9525 2182	Flood defence structure	Environment Agency	1:100 Year	168.3	Dwarf brick flood wall, ties into high ground and earth bank. On left bank.
River Chelt	From Keysham road bridge to end of fire station buildings.	SO 9545 2152	SO 9543 2163	Flood defence structure	Environment Agency	1:100 Year	121.9	Flood defence brick clad wall. Top of wall has brick piers with vertical railing infill. On left bank.
River Chelt	Charlton Drive confluence to U/S face Brookway road bridge.	SO 9621 2095	SO 9612 2099	Flood defence structure	Environment Agency	1:25 Year	106.4	Stone retaining wall, on right bank.

6.5.5 It is useful to summarise the different facets of the River Chelt flood alleviation scheme. The works start downstream of Lilley Brook. In a high flow situation, the River Chelt is designed to spill into Cox's Meadow to limit the flow through the town. The release from Cox's Meadow joins the limited flow in the channel downstream of Old Bath Road before passing to Upper Sandford Park. The excess flow from the channel is again diverted here through Upper Sandford Park. The flow in the channel follows a route which is diverted away from the river's natural path. The existing river channel is thought to be the remains of mill leats and is elevated from the valley bottom. The original valley bottom lies where Cox's Meadow and Sandford Park currently exist. The water in the Park converges around a drop shaft and is taken through culverts to rejoin the channel just upstream of Bath Road. From here the watercourse runs through long culverted sections under the main centre of the town. It emerges at Royal Well Lane, where an old bypass channel has been utilised. The main channel and the bypass channel converge at Honeybourne Way. The River Chelt continues on from here as one channel. Although there are no more long culverted sections, there are still many road and rail bridges. Approximately 7km of the river runs through this highly urbanised and constricted area. In 1996 the responsibility of the River Chelt and flood alleviation was passed from Cheltenham Borough Council to the Environment Agency.

6.5.6 In addition, Cheltenham Borough Council is currently undertaking a review of known flood risk locations and investigating potential alleviation schemes. This information should be incorporated into the SFRA when it becomes available.

Informal Defences

6.5.7 Road and railway embankments and other linear infrastructure may act as informal defence and divert flood water elsewhere, hold back water or create enclosures to form flood storage areas. Raised embankments may also offer a degree of flood protection. An overview assessment of informal defences (primarily railways and major roads) within the Borough has been undertaken as part of this SFRA. Locations identified can be viewed in Volume 2, Tiles A1-A5.

6.5.8 Informal defences should only be relied upon to protect new development following an FRA as outlined within the PPS25 Practice Guide (Paragraph 6.17) (2006). This should investigate:

- The suitability of the embankment materials to prevent seepage of water, and whether it is physically strong enough to withstand the pressure of water on one side
- An assessment as to whether there are any culverts through the embankment or other gaps within the structure that may let water through
- The performance of the structure during recent historical flood events
- The long-term Asset Management Plan (AMP) provided by the owner of the embankment
- Whether by holding water back, the structure may fall under the regulation requirements of the Reservoirs Act (1975).

6.5.9 Only major structures such as motorways and railways acting as informal defences have been identified within this Level 1 SFRA. An assessment of all informal defences should be made as part of an FRA.

6.6 Culverts

6.6.1 Sections of culverted watercourse as identified within NFCDD are illustrated in Volume 2, Tiles A1-A5 and detailed in Table 6.2. It is still possible, however, that culverts exist which are not identified on NFCDD. Therefore when locating new development, OS tiles should be analysed to identify any culverts in the vicinity of development sites. In some cases site visits may be required. Further details of the implications of culverts on new development can be found in Section 6.8.

6.6.2 On any new development site and indeed on existing sites, further culverting and building over of culverts should be avoided. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit.

Table 6.2: Culverted Watercourses as identified within NFCDD

Watercourse	Location	NGR	Owner	Approx. Length (m)	Comments
Hatherley brook	Meadow close, Cheltenham	SO 9113 2213	Local authority	17.1	Road bridge, 2 sections of approx specified length on left and right banks.
Hatherley brook	Edendale road, Cheltenham	SO 9123 2202	Local authority	23.7	Road bridge, 2 sections of approx specified length on left and right banks.
Hatherley brook	Cheltenham. Culvert under the A40.	SO 9136 2187	Local authority	101	Box culvert. 2 sections of approx specified length on left and right banks
Hatherley brook	Benhall Park, Cheltenham.	SO 9210 2168	Unknown	18.8	On right bank.
Hatherley brook	Benhall Park, Cheltenham.	SO 9209 2161	Unknown	24.1	Box culvert. On left bank.
Hatherley brook, Warden Hill Tributary	Benhall Park, Cheltenham.	SO 9211 2157	Unknown	25.7	2 sections of approx specified length on left and right banks
Hatherley brook, Warden Hill Tributary	Benhall Park, Cheltenham. Under railway line.	SO 9220 2151	Unknown	206	2 sections of approx specified length on left and right banks
Hatherley brook, Warden Hill Tributary	Cheltenham. Between Kentmere Close and Alma Road.	SO 9241 2134	Unknown	463.9	Circular concrete culverted channel. 2 sections of approx specified length on left and right banks.
Hatherley brook	Cheltenham. Under railway line.	SO 9252 2153	Unknown	32.2	2 sections of approx specified length on left and right banks.
Hatherley brook	Cheltenham. Parallel to Hatherley Road	SO 9265 2152	Unknown	213	Piped culvert. Screen present at upstream end. 2 sections of approx specified length on left and right banks

Watercourse	Location	NGR	Owner	Approx. Length (m)	Comments
Hatherley brook	Cheltenham. Under Shelburne Road crossing.	SO 9293 2147	Unknown	28.9	Pipe culverted channel. 2 sections of approx specified length on left and right banks
Hatherley brook	Cheltenham. Under Hatherley road.	SO 9328 2137	Unknown	51.5	2 sections of approx specified length on left and right banks
Hatherley brook	Cheltenham. Under Merestones Road crossing.	SO 9364 2084	Unknown	16.8	Box culvert. 2 sections of approx specified length on left and right banks
Hatherley brook, The Burrows Tributary	Cheltenham. Under Merestones Drive.	SO 9369 2075	Unknown	16.6	Pre-cast concrete box culvert with low-flow channel. 2 sections of approx specified length on left and right banks
Hatherley brook	Cheltenham. Under Billings Way	SO 9368 2070	Unknown	16.9	Culverted road crossing. 2 sections of approx specified length on left and right banks
Hatherley brook, The Burrows Tributary	Cheltenham. Under Shurdington Road.	SO 9397 2054	Unknown	17.8	Box culverted channel. 2 sections of approx specified length on left and right banks
River Chelt	Millbrook street to Royal Well Lane	SO 9415 2264	Local authority	27.1	Box culvert channel. 2 sections of approx specified length on left and right banks.
River Chelt	Millbrook street to Royal Well Lane. Beneath Waitrose car park	SO 9422 2258	Unknown	48.9	2 sections of approx specified length on left and right banks
River Chelt	Millbrook street to Royal Well lane. Beneath pedestrian access to back gardens off St Georges road.	SO 9425 2251	Environment Agency & unknown	30.9	2 sections of approx specified length on left and right banks. Left bank culvert owned by EA right bank owned by unknown.
River Chelt	Millbrook street to Royal Well lane	SO 9444 2233	Local authority	41.8	2 sections of approx specified length on left and right banks. Reconstructed by Chelt BC in 2004 Highways maintained.
River Chelt	Royal Well Lane culvert to U/S face Rodney road culvert.	SO 9454 2235	Environment Agency	436.5	Brick Culvert with concrete lining U shaped with flat top. 2 sections of approx specified length on left and right banks

Watercourse	Location	NGR	Owner	Approx. Length (m)	Comments
River Chelt	U/S face Rodney road culvert to D/S face Keynsham road bridge.	SO 9504 2206	Local authority	52.7	Bath road concrete box culvert segmented. 2 sections of approx specified length on left and right banks
River Chelt	Rosehurst	SO 9516 2201	Environment Agency	5	Requires confined space inspection. 2 sections of approx specified length on left and right banks (total length 178 metres from 'Weathered man' culvert)
River Chelt	Between Bath Road and Keynsham road	SO 9520 2195	Environment Agency	138.6	Sandford park culvert, concrete segmented, on left Bank
River Chelt	Between Bath Road and Keynsham road	SO 9522 2198	Environment Agency	144	Flood flow culvert. Requires confined space inspection.
River Chelt	Between Bath Road and Keynsham road	SO 9529 2194	Environment Agency	78.3	Pipe culvert. Requires confined space inspection.
River Chelt	U/S face Rodney road culvert to D/S face Keynsham road bridge.	SO 9529 2196	Environment Agency	16.9	Culverted channel, 2 sections of approx specified length on left and right banks
River Chelt	U/S face Rodney road culvert to D/S face Keynsham road bridge.	SO 9518 2208	Unknown	12.9	Culverted channel, 2 sections of approx specified length on left and right banks
River Chelt	D/S face Rodney Road bridge to Charlton Drive confluence.	SO 9542 2165	Local authority	18.2	Concrete box culvert, 2 sections of approx specified length on left and right banks.
River Chelt	Downstream face Keynsham road bridge to Charlton Drive confluence.	SO 9553 2145	Environment Agency	60.9	1000 x 3000 Concrete segmented. 2 sections of specified length on left bank.
River Chelt	D/S face Rodney Road bridge to Charlton Drive confluence.	SO 9559 2145	Local authority	30.8	Brick arch culverted channel.
Lilley Brook	Cheltenham. Under Moorend Road.	SO 9584 2053	Unknown	18.3	Brick arch road bridge abutment.

Watercourse	Location	NGR	Owner	Approx. Length (m)	Comments
Lilley Brook	Cheltenham. Under road crossing near Pinetrees Road.	SO 9584 2050	Unknown	17.6	Brick arch road crossing abutment. 2 sections of approx specified length on left and right banks.
Lilley Brook	Culvert at Withyholt Court to Southfield Brook confluence.	SO 9584 2039	Unknown	5	Culverted channel through maintained gardens. 2 sections of approx specified length on left and right banks.
Southfield Brook	Cheltenham. Upstream end appears next to Sandy Lane at downstream end of drain next to golf course.	SO 9577 1971	Unknown	74.7	Concrete piped culvert. 2 sections of approx specified length on left and right banks.
Lilley Brook	Cheltenham. Culverted under industrial estate nr Branch Hill Rise.	SO 9629 1974	Unknown	64.3	Box culvert channel. 2 sections of approx specified length on left and right banks.
River Chelt	Charlton Drive confluence to U/S face Brookway road bridge.	SO 9608 2102	Unknown	9.3	Culverted channel, 2 sections of approx specified length on left and right banks.
River Chelt	D/S face Brookway Road bridge to Spring Bridge, London Road.	SO 9623 2094	Local authority	6.8	Culverted channel, 2 sections of approx specified length on left and right banks.
River Chelt	D/S face Brookway Road bridge to D/S face Spring Bridge, London Road.	SO 9644 2082	Local authority	17.6	Brick Arch Culvert, 2 sections of approx specified length on left and right banks.
River Chelt	D/S face Spring Bridge, London Road to Detmore House, Charlton Kings.	SO 9671 2082	Local authority	18.1	Culverted channel, 2 sections of approx specified length on left and right banks.
River Chelt	D/S face Spring Bridge, London Road to Detmore House, Charlton Kings.	SO 9696 2079	Environment Agency & Local Authority	5.4	Culverted channel under footbridge, 2 sections of approx specified length on left and right banks. Left bank culvert owned by E.A. right one by local authority.

Watercourse	Location	NGR	Owner	Approx. Length (m)	Comments
River Chelt	D/S face Spring Bridge, London Road to Detmore House, Charlton Kings.	SO 9743 2061	Local authority	8.3	Culverted channel.
River Chelt	Detmore House, Charlton Kings to Dowdeswell Reservoir.	SO 9756 2043	Environment Agency & unknown	7.2	Culverted channel, 2 sections of approx specified length on left and right banks. Left bank culvert owned by E.A. right one by unknown.
River Chelt	Detmore House, Charlton Kings to Dowdeswell Reservoir.	SO 9766 2032	Environment Agency	6	Culverted channel, 2 sections of approx specified length on left and right banks.
River Chelt	Detmore House, Charlton Kings to Dowdeswell Reservoir.	SO 9811 1999	Environment Agency	7.7	Culverted channel, 2 sections of approx specified length on left and right banks.
Ham Brook	Cheltenham. Under Glenfall Way.	SO 9684 2082	Unknown	16.4	2 concrete pipes in parallel. 2 sections of approx specified length on left and right banks.
Ham Brook	Cheltenham. Under Ryeworth Road.	SO 9705 2109	Unknown	63.2	2 sections of approx specified length on left and right banks.
Ham Brook	Confluence with River Chelt to Glenfall House access bridge.	SO 9725 2130	Unknown	5.4	Culverted channel, 2 sections of approx specified length on left and right banks.
Ham Brook	Confluence with River Chelt to Glenfall House access bridge.	SO 9754 2156	Unknown	31	Culverted channel, 2 sections of approx specified length on left and right banks.
Wymans brook	Under dismantled railway and Tommy Taylor's Lane	SO 9447 2389	Unknown	418.8	Concrete pipe culverted channel. Parks and ponds upstream of culvert. 2 sections of approx specified length on left and right banks.
Wymans brook	D/S face Evesham Road culvert to D/S face Albert Road bridge.	SO 9535 2350	Unknown	38	Culverted channel, 2 sections of approx specified length on left and right banks.
Wymans brook	D/S face Evesham Road culvert to D/S face Albert Road bridge.	SO 9554 2344	Unknown	9.2	Culverted channel, 2 sections of approx specified length on left and right banks.

Watercourse	Location	NGR	Owner	Approx. Length (m)	Comments
Wymans brook	D/S face Albert Road bridge to Football ground, Wymans road.	SO 9557 2344	Unknown	18	Culverted channel, 2 sections of approx specified length on left and right banks.
Wymans brook	D/S face Albert Road bridge to Football ground, Wymans road.	SO 9569 2334	Unknown	232.2	Culverted channel, 2 sections of approx specified length on left and right banks.
Hyde brook	Brockhampton. Under railway line.	SO 9387 2598	Unknown	24.1	2 sections of approx specified length on left and right banks.
Hyde brook	Brockhampton	SO 9395 2595	Unknown	17.2	Masonry box culverted road bridge. On right bank.
Hyde brook	Brockhampton	SO 9516 2583	Unknown	22	Box culverted road bridge. 2 sections of approx specified length on left and right banks.
Hyde brook	Brockhampton. Hyde Road.	SO 9525 2578	Unknown	20.4	2 sections of approx specified length on left and right banks.
Hyde brook	Brockhampton. Under A435.	SO 9546 2568	Unknown	16.4	Masonry arched road bridge. 2 sections of approx specified length on left and right banks.
Hyde brook	Prestbury Park. Under railway line.	SO 9579 2541	Unknown	82.2	Masonry arched culvert. 2 sections of approx specified length on left and right banks.
Hyde brook	Mill Stream, Cheltenham Racecourse	SO 9589 2439	Unknown	116.1	2 sections of approx specified length on left and right banks.
Hyde brook	Mill Stream, Prestbury. Under Bow Bridge.	SO 9672 2422	Unknown	15	Culverted road crossing: masonry arch. 2 sections of approx specified length on left and right banks.
Noverton Brook	Prestbury. Adjacent to church, Parallel to Mill Street.	SO 9696 2404	Unknown	86.5	2 sections of approx specified length on left and right banks.
Noverton Brook	Prestbury. Adjacent to church.	SO 9696 2395	Unknown	7.6	Stone box culvert, 2 sections of approx specified length on left and right banks.
Noverton Brook	Prestbury. In church yard.	SO 9699 2394	Unknown	25.7	Stone box culvert, 2 sections of approx specified length on left and right banks.
Noverton Brook	Prestbury. Parallel and along to High Street.	SO 9712 2393	Unknown	587.3	2 sections of approx specified length on left and right banks.

6.7 Storage Areas

6.7.1 Storage in a catchment is often considered as an important flood management option. Storage can have the effect of delaying the time at which the peak of a hydrograph occurs. Delaying the peak of one hydrograph can alter the phasing of the other hydrographs in a system. Altering the phasing of peaks may mean that it is possible to stop the peak flow from one tributary combining with that of another. This can have the effect of reducing peak flow, and therefore flooding, in the main channel.

6.7.2 Dowdeswell Reservoir, located outside the eastern extent of the Borough (SO 9884 1973) upstream of Cheltenham has been modified for use from a water supply reservoir to a flood storage reservoir. As part of the River Chelt flood alleviation scheme, Dowdeswell reservoir is drawn down to provide storage of runoff from the upper catchment (to enable storage of a 100 year flood event from the upper catchment). The outlet is controlled at the tower where a flow is conveyed via a spillway to a culvert. The flow from the reservoir is controlled so that a small constant flow is released. The reservoir is currently operated by the Environment Agency.

6.7.3 Cox's Meadow (SO 9565 2132) forms an important flood storage area as part of the River Chelt flood alleviation scheme. In a high flow situation, the River Chelt is designed to spill into Cox's Meadow to limit the flow through the town. The meadow has been designed to a 1% AEP (1 in 100 year) design standard. The release from Cox's Meadow joins the limited flow in the channel downstream of Old Bath Road before passing to Upper Sandford Park.

6.7.4 It is imperative that any storage areas used as a means of attenuation of flood waters are safeguarded from development and maintained to ensure their efficient operation during a flood event. If the storage areas are not maintained this may lead to an increased risk of flooding at locations downstream.

6.8 Residual Risk

6.8.1 In producing Flood Zone maps the Environment Agency takes the presence of defences into account by showing the area that benefits from the defence (ABD). This area can also be deemed an area which is at risk of defence overtopping or failure. It can therefore also be described as a residual risk zone. Residual flood risks from defences can arise due to:

- The failure of flood management infrastructure such as a breach of a raised flood defence
- A severe flood event that exceeds a flood management design standard and results in, for example, overtopping
- Issues with deployment of flood defences and pump failure

6.8.2 No ABDs have been produced for the River Chelt but are likely to become available upon the completion of the River Chelt flood mapping project. No other ABDs exist within the Borough.

6.8.3 However, an assessment of residual risk should be made at the site-specific level. Actual levels of residual risk will vary spatially depending on flow routes, velocities, flood depths and proximity to the breach or overtopping location. In the event that development is located in or near a residual risk areas (e.g. behind a defence) the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood hazard in these locations. Known defence locations are mapped in Volume 2, Tiles A1-A5 to assist with this.

6.8.4 Residual risks can also arise from the following sources:

- Blockage or collapse of a culvert
- Blockage of a surface water conveyance system
- Overtopping of an upstream storage area
- Failure of a pumped drainage system
- Surcharging of surface water conveyance systems and SUDS systems, drainage networks

6.8.5 There is currently no dataset which identifies precise residual risk areas from these sources, therefore again any development in the vicinity of culverts, surface water conveyance systems, storage areas and pumped drainage systems should assess residual risk through a Level 2 SFRA. Known culvert locations are mapped in Volume 2, Tiles A1-A5. These should be referenced by those proposing development to identify the possibility of localised residual risks as well as opportunities for de-culverting and restoring the natural channel. OS tiles should be analysed to identify any culverts in the vicinity of development sites which are not recognised in Volume 2, Tiles A1-A5. In some cases site visits may be required.

6.8.6 Poorly maintained trash screens and rubbish inappropriately dumped in watercourses can reduce culvert and structure capacity, therefore presenting residual risk. This can be mitigated by regular inspection and clearance of culverts and trash screens.

6.8.7 It is recommended that any development in the vicinity of culverts should assess the potential of de-culverting. If this is not possible, an assessment of the state of the culvert should be made, and any remedial works carried out prior to the development of the site.

6.9 Existing Flood Warning System

6.9.1 One aspect of the Environment Agency's work is reducing risks to people and to the developed and natural environment from flooding through flood forecasting, flood warning and response. The Environment Agency is the lead organisation on flood warning and they work closely with Local Authorities and Emergency Services to plan for flooding emergencies and reduce the risk of flooding to people and properties. Cheltenham Borough falls within the Midlands Region of the Environment Agency.

6.9.2 When conditions suggest that floods are likely, it is the responsibility of the Environment Agency to issue flood warnings to the Police, Fire and Rescue Service, to the relevant local authorities, and to the public. It is the responsibility of individuals in the community to receive flood warnings via Floodline Warnings Direct (FWD) which passes messages over the telephone network, email, fax and text message.

6.9.3 A flood watch system is in operation for rivers in the North Gloucestershire area which covers watercourses in Cheltenham and is outlined below:

- **Flood Watch:** Flooding of low lying land and roads is expected. Be aware, be prepared, watch out! The following actions are recommended:

- Watch water levels
- Stay tuned to local radio or TV
- Ring Floodline on 0845 988 1188
- Make sure you have what you need to put your flood plan into action
- Alert your neighbours, particularly the elderly
- Check pets and livestock
- Reconsider travel plans

- When the flood event has subsided, this is followed by **All Clear:** Flood Watches or Warnings are no longer in force. The following is recommended:
  - Flood water levels receding
  - Check all is safe to return
  - Seek advice

6.9.4 Flood Watch Areas can be seen in Volume 2, Tile F1. Flood Watches are issued for expected flooding, which could occur anywhere within the Flood Watch Area but with low or minor impact. The trigger for Flood Watch is a forecast that flooding of low impact land is expected.

6.9.5 While there is currently no flood warning service, the feasibility of this is being investigated for the River Chelt. The Table 6.3 details the flood watch coverage within the Cheltenham Borough.

Table 6.3: Flood Watch coverage within the Cheltenham Borough

Type of Warning	Coverage	EA Region
Flood Watch	Rivers in North Gloucestershire - Rivers in Tewkesbury, Cheltenham and Gloucester	Midlands

County Council Flood Response Plan[13]

6.9.6 Gloucestershire County Council owns and operates a number of contingency plans, each detailing how local services will work together to respond to any type of emergency. Every plan is regularly updated and also thoroughly revised at regular intervals. The 'Major Flooding Emergency Plan' aims to detail the roles, responsibilities and actions to be taken by Category One responders in both the mitigation of and response to a major flooding emergency in Gloucestershire. It reflects the known risks of flooding within the County of Gloucestershire, details the response actions of Local Authorities to incidents of flooding and summarises the response of the emergency services and other agencies. Gloucestershire County Council has prepared the plan in close consultation with the Gloucestershire

13 Gloucestershire County Council Emergency Management Service (2007), Major Flooding Emergency Plan (http://www.gloucestershire.gov.uk/index.cfm?articleid=3327)

Local Resilience Forum (LRF), to comply with the statutory duties of the Civil Contingencies Act 2004 and the National Capabilities Programme guidance.

6.9.7 The first section gives the background information to the plan. The Gloucestershire LRF Risk Assessment Subgroup has assessed the potential Impact and Likelihood of a Major Flooding Emergency affecting Gloucestershire as follows:

Table 6.4: Potential impact and Likelihood of a Major Flooding Emergency affecting Gloucestershire

Severe Weather	**(SW7) Localised coastal / tidal flooding**		
Outcome description	**Impact**	**Likelihood**	**Overall Risk**
Sea surge, high tides, gale force winds affecting the coastline, some defences overtopped. Localised impact with infrastructure affected and up to 1,000 properties flooded. Multi-agency response invoked with some local evacuation. Impact on infrastructure includes disruption to traffic for one-three days, impact on access to agricultural land and impact to infrastructure.	**Significant (4)**	**Unlikely (3)**	**VERY HIGH**
Severe Weather	**(SW8) Major local fluvial flooding**		
Outcome description	**Impact**	**Likelihood**	**Overall Risk**
A sustained period of heavy rainfall extending over two weeks, perhaps combined with snow melt, resulting in steadily rising river levels. Localised flooding of more than 100 but less than 1,000 properties. Some impact on minor roads and some A and trunk roads impassable. Some rail lines would be closed. Most waterways would be closed to traffic due to strong currents and water levels.	**Moderate (3)**	**Possible (4)**	**HIGH**
Severe Weather	**(SW8) Major local fluvial flooding**		
Outcome description	**Impact**	**Likelihood**	**Overall Risk**
A sustained period of heavy rainfall extending over two weeks, perhaps combined with snow melt, resulting in steadily rising river levels. Localised flooding of more than 1,000 and less than 10,000 properties. Major impact on minor roads and some A and trunk roads impassable. Some rail lines would be closed. Most waterways would be closed to traffic due to strong currents and water levels.	**Moderate (3)**	**Unlikely (3)**	**HIGH**
Severe Weather	**(SW9)Localised fluvial flooding (flash flooding)**		
Outcome description	**Impact**	**Likelihood**	**Overall Risk**
Heavy localised rainfall in steep valley catchment leading to flash flooding. Likely that no flood defences in place. Possibility no flood warning service available / suddenness of events means timely flood warnings not possible. Flooding of up to 200 properties.	**Moderate (3)**	**Possible (4)**	**HIGH**

Source: Gloucestershire LRF Community Risk Register

6.9.8 The plan goes on to give details of flood warning and mitigation (as presented in Section 6.9), then gives information on immediate response. This details the roles and responsibilities of the County Council, LPAs, Gloucestershire Constabulary, Gloucestershire Fire and Rescue Service, Great Western Ambulance Service, the Environment Agency, British Waterways, utility companies, Gloucestershire Primary Care Trust, the media and the general public are put forwards.

6.9.9 Of particular relevance is the LPA roles and responsibilities. The primary role of local authorities in responding to any emergency is to provide care and support for those affected. They deliver this through close working partnerships with the emergency services and other agencies involved in the combined response. In Gloucestershire both the District Councils and the County Council's involvement may be required in responding to a flooding emergency. The District Councils, as land

drainage authorities, are primarily responsible for assisting with flooding to property, whereas the County Council is primarily responsible with flooding on the highway.

6.9.10 The Area Highways Managers within Gloucestershire Highways will deal with flooding of highways. Each of the Area Depots has a stockpile of sandbags and a supply of sand, which can be used to assist in preventing highway runoff entering houses, etc. District Councils provide different levels of out-of-hours service within the County in respect of the provision of sandbags to the public. The public are expected to take reasonable measures to protect their own property and to assist this public information has been disseminated. Response may be provided at a County and/or District level as summarised in the table below. In principle, Districts will provide the service and the County will support unless the incident severely affects more than one District such that County resources are required.

Table 6.5: County and District Flood Response Responsibilities

Required Response	County Responsibility		District Responsibility
Co-ordination of the local authority response and liaison with other organisations, including provision if required of a representative to support Police arrangements for coordination	✓	Or	✓
Emergency care including feeding, accommodation and welfare for those who have been evacuated from their homes or those affected by flooding but remaining in their homes	✓	And	✓
Emergency transport for personnel, equipment, materials such as sandbags and, if necessary, evacuation	✓	And	✓
Information services for liaison with the media on the local authority response and for information to the public, relatives of evacuees etc.	✓	Or	✓
Flood alleviation – for flood prevention, such as issuing of sandbags, clearance of blocked culverts, for dealing with flooded roads and diversions and for other assistance to the public, such as drying-out facilities, and issuing of sandbags	✓	And	✓
Emergency environmental health advice for action relating to environmental problems caused by flooding			✓
Joint agency co-ordination of non-life threatening floods and of the recovery phase following a flooding incident	✓	Or	✓
Co-ordination of the voluntary response	✓		

6.9.11 As the emphasis moves from the immediate response to the recovery phase, the local authority will take the lead role to facilitate the rehabilitation of the community and the restoration of the environment. Involvement may include the provision of welfare needs and access to appropriate personal, social, psychological and financial support.

6.9.12 Where there is a need to evacuate people the District Council for the area concerned has the responsibility for providing Rest Centres and the provision of transport. It is recognised that during a sudden onset emergency the public may be evacuated to any site deemed necessary by the emergency services. As such the County and District Councils will work together to provide what support is deemed necessary at that site and arrange transport to transfer to a designated Rest Centre.

Cheltenham Borough Council Flood Response Plan

6.9.13 The council has an emergency response plan to enable an effective response. The plan is updated following lessons learnt from real life incidents, training exercises and any changes in council service provision. The council also has specific plans for flooding and the establishment of emergency rest centres, details of which are given on the Council's website. Following the summer 2007 flood events, the Council is currently updating the Emergency Plan.

Emergency Response Plan Recommendations

6.9.14 It is recommended that the Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that the Council works with the Environment Agency to promote the awareness of flood risk. Currently there is no flood warning system for Cheltenham and this is a significant issue when considering safe development. It is therefore recommended that the Council works with the Environment Agency to implement a flood warning service for the area. This could have implications for developer contributions. Should a flood warning service be implemented within the Borough by the Environment Agency, the Council and Environment Agency should work together to maximise the number of people signed up to the FWD service (previously this has involved targeted mail shots to those identified as living within Flood Zone 3a). Within the study area particular attention should be given to vulnerable people including those with impaired hearing or sight and those with restricted mobility.

6.9.15 Following the summer 2007 flood events, it is recommended that a review of designated rest centres and other major facilities should be carried out to ensure that they have the necessary levels of resilience to enable them to be used in the response to flooding and other major emergencies, or that alternative arrangements are put in place. A review of current local arrangements for water rescue should also be carried out to consider whether they are adequate in light of the summer's events and the community risk register. Further, Local Resilience Forums should consider the vulnerability of motorways and trunk roads to flooding and consider the potential for warnings and strategic road clearance and closures to avoid people becoming stranded. Finally, the community risk register should reflect risks to critical infrastructure from flooding and other hazards.

6.9.16 With respect to new developments, those proposing the development should take advice from the Council's emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. As a minimum these plans should include information on:

- How flood warning is to be provided:
    - Availability of existing warning systems

- Rate of onset of flooding and available warning time and
- Method of dissemination of flood warning

- What will be done to protect the infrastructure and contents:
  - How more easily damaged items could be relocated
  - The potential time taken to respond to a flood warning
  - Ensuring safe occupancy and access to and from the development
  - Occupant awareness of the potential frequency and duration of flood events
  - Provision of safe (i.e. dry) access to and from the development
  - Ability to maintain key services during an event
  - Vulnerability of occupants and whether rescue by emergency services may be necessary and feasible
  - Expected time taken to re-establish normal practices following a flood event

6.9.17 In some areas, particularly for existing properties and proposed developments behind defences, it may be necessary to extend the scope of the SFRA to Level 2. The outputs from detailed overtopping and breach analysis of the key defences will provide refined hazard information on flood depths, velocities and flow paths, which could be used by the LPA emergency planning teams to define new or refine existing emergency plans for these areas.

6.10 Key Recommendations: Chapter Six

- The relevant CFMP policies, outlined in the SFRA, should be taken into account in the Council's own flood risk management policies.
- Development behind defences should be avoided. Where development behind defences is required, breach and overtopping scenarios will need to be assessed through a Level 2 SFRA.
- Informal defences (e.g. road and railway embankments) should only be relied upon to protect new development following an FRA, undertaken in accordance with paragraph 6.17 of the PPS25 Practice Guide (2006).
- Further culverting and building over of culverts should be avoided. All new developments with culverts running through their site should seek to de-culvert rivers.
- If de-culverting is not possible, an assessment of the state of the culvert should be made, and any remedial works carried out prior to the development of the site. In addition, the residual risk arising from a potential blockage of the culvert should be assessed through a Level 2 SFRA.
- Regular inspection and clearance of culverts and trash screens should be carried out to reduce the risk of blockage during a flood event, which can exacerbate flooding.
- Areas of extended floodplain, acting as natural storage areas, should be safeguarded from development and maintained to ensure their efficient operation during a flood event.
- Flood Zone 3b should be protected from development, the use of green corridors in flood risk areas should be promoted and the natural course of rivers should be restored. These will all act as a means of risk reduction and should be explored through the planning process.
- Any development in the vicinity of culverts, surface water conveyance systems, storage areas and pumped drainage systems should assess residual risk through a Level 2 SFRA.
- The Council's Emergency Response Plan should be reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing sites and those being promoted through the LDF.
- The Council should work with the Environment Agency to implement a flood warning service for the area. This could have implications for developer contributions. Should a flood warning service be implemented within the Borough by the Environment Agency, the Council and Environment Agency should work together to maximise the number of people signed up to the FWD service (previously this has involved targeted mail shots to those identified as living within Flood Zone 3a). Particular attention should be given to vulnerable people including those with impaired hearing or sight and those with restricted mobility.

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7 Flood Risk Management Policy Considerations

7.1 Overview

7.1.1 This chapter provides recommendations for what should be included in the Council's policy for flood risk management. Council policy is considered essential to ensure that the recommended development control conditions can be imposed consistently at the planning application stage. The suggested policies put forward in this section take a strong lead from PPS25, Making Space for Water, the Water Framework Directive and the draft Severn CFMP.

7.1.2 The policy recommendations provided in this chapter are not exhaustive and it is therefore recommended that the Council refers to the following key flood risk management documents in order to fully inform their own flood risk management policies:

- **Planning Policy Statement 25: Development and Flood Risk** – sets out national policy for development and flood risk and supports the Government's objectives for sustainable communities.
- **Severn CFMP** - strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years.
- **Making Space for Water** - outlines the Government's proposals for forward planning of flood management over the next 20 years advocating a holistic approach to achieve sustainable development. The protection of the functional floodplain is central to the strategy.
- **Water Framework Directive** - European Community (EC) water legislation which requires all inland and coastal waters to reach good ecological status by 2015.

7.2 Policy Considerations

7.2.1 A key aim of an SFRA is to define flood risk management objectives and identify key policy considerations. It should be noted that it is ultimately the responsibility of the Council to formally formulate these policies and implement them.

7.2.2 It is recommended that the following flood risk objectives are taken into account during the policy making process and, where appropriate, used to strengthen or enhance the development control policies provided in Section 7.3.

7.2.3 **Flood Risk Objective 1: To Seek Flood Risk Reduction through Spatial Planning and Site Design:**

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1
- Use the Sequential Test and approach within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits

- Ensure that a positive gain in floodplain storage capacity is provided on-site and ensure that there is no negative impact on flood conveyance routes
- Build resilience into a site's design (e.g. flood resistant of resilient design, raised floor levels)
- Identify long-term opportunities to remove development from the floodplain through land swapping
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian access to and from the development should be possible without passing through the 1 in 100 year plus climate change floodplain; emergency vehicular access should be possible during times of flood; and the development should include flood resistance and resilience measures to ensure it is safe. Residual risk, i.e. the risks remaining after taking the sequential approach and taking mitigating actions, during the 1 in 1000 year event, should also be 'safe'.
- Avoid development immediately downstream/adjacent to reservoirs/impounded water bodies which will be at high hazard areas in the event of failure.

7.2.4 Flood Risk Objective 2: To Reduce Surface Water Runoff from New Developments and Agricultural Land:

- SUDS are required on all new development. Section 10.4 outlines appropriate SUDS techniques for the Borough and Chapter 9 provides further guidance for developers on the application of SUDS.
- As part of any ongoing or future development within the Borough, the treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques as outlined in section 10.4.
- All sites should meet the following criteria:
  - As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified
  - Attenuation should be provided to a 1 in 100 year standard taking account of climate change
  - Space should be specifically set aside for SUDS and used to inform the overall site layout
  - Promote environmental stewardship schemes to reduce water and soil runoff from agricultural land

  However, a greater level of betterment may be required within specific locations or areas of the county where necessary due to local issues as identified by any local authority or other appropriate drainage authority.
- All sites require the following approach to be taken:
  - Application of a SUDS management train
  - A hierarchical approach should be applied to the SUDS used:

1. Preventative measures to ensure that there are not unnecessary impermeable areas on-site

2. Source control measures such as rainwater harvesting and infiltration systems provided site conditions are appropriate

3. Site control measures where prevention and source control measures alone cannot deal with all on-site drainage. Above ground attenuation systems, such as balancing ponds and swales, should be considered in preference to below ground attenuation, due to the water quality, biodiversity and amenity benefits they offer

4. Regional control measures should only be considered where none of the above preferred options can be achieved

- A hierarchical approach should also be applied to the disposal of surface water from the site taking the following order: rainwater harvesting systems, an adequate soakaway or other adequate infiltration system, a watercourse, a surface water sewer and, only as a last resort, a combined sewer

- Exceedance design measures should be applied to ensure that extreme events above the design standards of the system do not pose adverse impacts

- SUDS should be designed for the lifetime of the development, with suitable provisions for likely future permitted and minor development e.g. paving of front gardens or minor extensions (it may be possible to achieve this either through suitable planning or engineered solutions)

7.2.5 Flood Risk Objective 3: To Enhance and Restore the River Corridor:

- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. de-culverting, the use of bioengineered river walls, raising bridge soffits to take into account climate change)

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment or/and renewal should be made to ensure the lifetime is commensurate with lifetime of the development. Developer contributions should be sought for this purpose. When the structure is beyond its life, and/or no longer required, the first consideration should be to remove the structure. If it is identified that the structure is still required but still requires replacement, opportunities for further enhancement work should be sought.

- Existing structures should only be removed once it can be demonstrated that it will not cause an unacceptable increase in flood risk, on-site and elsewhere

- Avoid further culverting and building over of culverts. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit

- Set development back from rivers, seeking a minimum 8 metre wide undeveloped buffer strip from the top of bank

7.2.6 **Flood Risk Objective 4: To Protect and Promote Areas for Future Flood Alleviation Schemes**

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

7.2.7 **Flood Risk Objective 5: To Improve Flood Awareness and Emergency Planning**

- Seek to improve the emergency planning process using the outputs from the SFRA
- Encourage all those within Flood Zone 3a and 3b (residential and commercial occupiers) to sign-up to Floodline Warnings Direct service operated by the Environment Agency, where this service can be provided
- Ensure robust emergency (evacuation) plans are implemented for new developments in areas at risk of flooding

7.3 Development Control Policies

7.3.1 For the purposes of development control, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated 'windfall' sites. In all Flood Zones, developers and local authorities should realise opportunities to reduce the overall level of flood risk in the area and beyond through the location, layout and design (in that order) of development.

7.3.2 The following reflects the minimum requirements under PPS25 (reference should be made to Tables D1-D3 in PPS25).

Future Development within Flood Zone 1

7.3.3 There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1 (unless the issues outlined in Section 8.4 are identified), although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

7.3.4 Typically, a Drainage Impact Assessment will be required to demonstrate that the treatment and control of surface water runoff can provide a level of betterment, incorporating the use of various SUDS techniques, which should take into account the local geological and groundwater conditions. As a minimum, there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.

7.3.5 Consideration must be given to the effect of the new development in terms of off-site consequences from all sources of flooding.

7.3.6 For sites where the access and egress routes are within Flood Zone 3 or 2, the site should be considered as if being within that higher Flood Zone itself.

Future Development within Flood Zone 2

7.3.7 Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category, though it will be necessary to undertake the Sequential Test. Should the Exception Test be required a Level 2 SFRA should be carried out.

7.3.8 Where other planning pressures dictate that 'highly vulnerable' land uses should proceed, it will be necessary to ensure that the requirements of the Exception Test are satisfied.

7.3.9 The following is required:

- A detailed site-specific FRA should be prepared in accordance with PPS25 and Council Development Control policies
- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm
- Safe dry pedestrian access to and from the development should be possible above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for climate change and emergency vehicular access should be possible during times of flood
- Flood resistance and resilience should be incorporated into the design
- People (including those with restricted mobility) should be able to remain safe inside the new development up to a 0.1% AEP (1 in 1000 year) event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety is practicable up to a 0.1% AEP (1 in 1000 year) event
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone from top of bank, to allow appropriate access for routine maintenance and emergency clearance.

Future development within High Probability Flood Zone 3a

7.3.10 Land use with High Probability Flood Zone 3a should be restricted to the 'less vulnerable' uses to satisfy the requirements of the Sequential Test. For 'more vulnerable' uses it is necessary to ensure that the requirements of the Exception Test are satisfied, which will require a Level 2 SFRA.

7.3.11 The following should be considered:

- A detailed site-specific FRA should be prepared in accordance with PPS25 and Council Development Control policies. Properties situated within close proximity to formal defences or

water retaining structures (reservoirs/canals) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Council, the Environment Agency and/or the operating authority, as appropriate.

- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and de-culverting). This should be optimised by developing land sequentially, with areas at risk of flooding favoured for green space. There should be a positive gain in the floodwater storage capacity provided and there should not be any detrimental impact on floodwater flow conveyance.

- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 300mm. Within defended the areas the maximum water level should be assessed from a breach analysis. Where there is sufficient depth between the underside of the floor slab and the existing ground level, under-floor voids should be included with adequate void openings.

- The development should allow safe dry pedestrian access to and from the development above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for climate change emergency vehicular access should be possible during times of flood.

- An evacuation plan should be prepared. With respect to new developments, those proposing the development should take advice from the LPAs emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. All access requirements should be discussed and agreed with the Council and the Environment Agency.

- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 600 mm above the 1 in 100 year flood level plus climate change.

- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified. Space should be set aside for SUDS.

- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone from top of bank, to allow appropriate access for routine maintenance and emergency clearance.

- For sites where the access and egress routes are within Flood Zone 3 or 2, the site should be considered as if being within that higher Flood Zone itself.

Future development within Functional Floodplain Zone 3b

7.3.12 This zone comprises land where water has to flow or be stored in times of flood (land which would flood with an annual probability of 5% (1 in 20 year) or greater in any year or is designed to flood in an extreme (0.1%) flood, including water conveyance routes. Where a modelled outline for Flood Zone

3b has not been produced, its extent is equal to Flood Zone 3a. Therefore for any development site falling in Flood Zone 3a with no 3b available, this section should be used to understand the requirements of development.

- Development in High Probability Flood Zone 3b should be restricted to 'water-compatible uses' only.
- PPS25 dictates that 'essential infrastructure' can be located in Flood Zone 3b if the Exception test is passed (this would require a Level 2 SFRA). However, appropriate judgement should be exercised when attempting the Exception Test for essential infrastructure in Flood Zone 3b. Essential infrastructure includes: essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; and strategic utility infrastructure, including electricity generating power stations and grid and primary substations. Essential transport infrastructure may be appropriate if designed in such a way that flood flow routes and flood storage areas are not affected (e.g. designing a bridge to cross the flood risk area). However, utility infrastructure may be less appropriate due to the potential consequences that may occur should the utility site become flooded (as demonstrated by the flooding of Mythe Treatment Works, Castlemeads electricity sub-station and the near-flooding of the Walham electricity sub-station during the summer 2007 flood events).
- 'Essential infrastructure' in this zone must be designed and constructed to remain operational in times of flood and not impede water flow.
- Associated buildings, such as boathouses, should be situated outside 3b and should follow the guidance for development in the relevant Flood Zone (as outlined above)
- Building extensions proposed in 3b should be discouraged. Where permitted, they should follow the guidelines of 3a (as outlined above). The local authority should request and review an FRA for the extension. The FRA should demonstrate that the extension will minimise the impact on flow conveyance and lost storage.

7.4 Council Specific Policy Issues

7.4.1 The general direction of the Environment Agency is that within the Borough, actions will be taken to reduce flood risk, both now and in the future. Apart from the continued use of defences, there are opportunities for the Council to assist in the reduction of risk by vigorously applying PPS25 and promoting the use of SUDS. In terms of existing developments, the Council should promote understanding of flood risk and its management so that communities are aware of the steps they can take to reduce the risk. The implementation of Surface Water Management Plans would be a first step in realising the sustainable management of surface water in both new development and existing developed areas. It is therefore recommended that the Council considers the production of a SWMP for the Borough. In addition, the level of flood preparedness (flood warning, flood proofing and flood resilience) should be increased and promoted in this area.

7.5 Sensitive Development Locations

7.5.1 Properties at Leckhampton were affected by flooding from the Hatherley Brook during the summer 2007 flood events. This corresponds with both the 1968 and 2007 historic flood outlines from the Environment Agency. Consultation with the Council has indicated that this area is particularly

sensitive to flood risk and any proposed development in this area would need to ensure that flood risk is not increased along the watercourse through a site specific FRA.

7.5.2 Much of the Cheltenham Central Area Main Sewerage System is over 120 years old and thought to be in a poor structural state. The Chelt main sewer has a large overflow which joins the River Chelt at Arle. It has been recommended by the Environment Agency that any further development within the catchment area of this sewer system deals with surface water appropriately at the surface so that betterment is achieved. An increase in site runoff should not occur as this would increase the sewage flow and would lead to the overflow being used more frequently, increasing flood risk elsewhere.

7.5.3 Assuming that future site allocations and windfall sites are guided by PPS25 and the recommendations provided in this report, there are few other locations in which development would significantly increase flood risk.

7.5.4 In general, any development (including developments in Low Probability Flood Zone 1) which does not incorporate appropriate SUDS methods may increase the risk of surface and/or fluvial flooding both on-site and off-site (downstream). As such effective development control policies to incorporate SUDS on all new development should be implemented. Site-specific assessments will be required to ensure the appropriate SUDS method is implemented in accordance with geological conditions.

7.5.5 Areas within the Borough are protected by defences, with resultant residual risk areas (these will be available for the River Chelt once the SFRM study is complete). Any development situated behind defences will need careful consideration. The following paragraph comes from the PPS25 Practice Guide Companion (2006):

"When proposing new development behind flood defences, the impact on residual flood risk to other properties should be considered. New development behind flood defences can increase the residual flood risk, should these defences breach or overtop, by disrupting conveyance routes (flow paths) and/or by displacing flood water. If conveyance routes that allow flood water to pass back into a river following failure of a flood defence are blocked this will potentially increase flood risk to existing properties. If there is a finite volume of water able to pass into a defended area following a failure of the defences, then a new development, by displacing some of the flood water, will increase the risk to existing properties".

7.5.6 Therefore any development behind defences should be appropriately assessed through a Level 2 SFRA, to ensure no increased risk elsewhere in the event of a defence breach or overtopping.

7.5.7 The natural floodplain of watercourses is an important feature for flood risk management. Future development sites should be guided away from these areas using the Sequential Test, and in line with recommended policies, should be safeguarded for the future. Any development in these areas would have detrimental effect on flood risk in the immediate vicinity and downstream, by the displacement of flood water.

7.5.8 Finally, it is clear that numerous culverts exist in the study area. Culverts pose a residual risk if river flows are greater than their capacity, if they become blocked, or if they collapse. Any development upstream of culverts should appropriately assess the structural integrity, clearance and maintenance regime and capacity, to ensure all residual risks to the development are minimised. All options for de-culverting should be explored.

7.6 Key Recommendations: Chapter Seven

- The suggested flood risk management policies outlined in Section 7.2 should be taken into account during the policy making process and, where appropriate, used to strengthen or enhance the development control policies provided in Section 7.3.
- For the purposes of development control, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated 'windfall' sites. Recommendations are outlined in Section 7.3.
- Sections 7.4 and 7.5 should be referred to when considering council-specific policies and sensitive development locations respectively.

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8 Guidance on Application of the Sequential Approach & Sequential Test

This section provides guidance on how to apply the Sequential Approach and Sequential Test. Guidance on how windfall sites should be dealt with is given in Section 7.3

8.1 The Sequential Approach

8.1.1 The Sequential Approach is a simple decision-making tool designed to ensure that areas at little or no risk of flooding are developed in preference to areas at higher risk. PPS25 (paragraphs 14-15) sets out the requirement to apply the Sequential Approach. The aim of the Sequential Approach should be to keep all new development out of medium and high risk areas (Flood Zones 2 and 3) and away from locations affected by other sources of flooding. Opportunities to locate new developments in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

8.2 The Sequential Test

8.2.1 The Sequential Test refers to the application of the Sequential Approach, by the Council. The Sequential Test is a key component of the hierarchical approach to avoiding and managing flood risk. The Sequential Test is outlined in PPS25, paragraphs 16-17, as well as Annex D, paragraphs D1-D8 and tables D1-D3.

8.2.2 When allocating land for development, the LPA must demonstrate that it has applied the Sequential Test and has attempted to place all new development in Flood Zone 1 (and away from other sources of flooding). Guidance as to how to apply the Sequential Test is outlined herein.

8.3 Step One: Strategic Overview of flood risk across all potential development areas

8.3.1 The recommended initial step is to determine the extents of potential land allocations on a GIS system. GIS layers of the most up-to-date Flood Zones, main and minor watercourses, canals, flooding from other sources data, defences, culverts and ABDs (located in the CD attached to the front of this report) should then be superimposed on the site layers. Summary tables of flood risk issues should then be prepared for each location, indicating if the potential sites overlap Flood Zones 2, 3, localised flooding areas or if there are records of historic fluvial flood incidents shown in the maps (a template to assist with this process is provided in Appendix F). This can be carried out by a consultant to ensure all issues are fully captured. For the site allocations process, as part of the LDF, it is then recommended that the summary tables and proposed locations are sent to the Environment Agency for verification. Particular care should be taken by identifying allocations that could increase flood risk elsewhere (flood incident points, localised flooding areas, Flood Zones) and lack of dry access.

8.4 Step Two: Flood Risk Issues in Zone 1

8.4.1 The next step should be to analyse all potential sites within Zone 1 by identifying those that:

- Have watercourses without Flood Zone information
- Are affected by flooding from sources other than rivers or have been affected by historic flood events

- Do not have safe dry access routes during flood events (i.e. a site with its access and egress route being within Flood Zone 3 would be sequentially considered as being within Flood Zone 3 itself)

Each of these points is addressed below.

8.4.2 For any development site containing or located adjacent to a watercourse without Flood Zone information, it is recommended that a minimum 8m development easement from the top of bank is applied, and a site specific FRA is undertaken.

8.4.3 For sites with evidence of flooding from other sources, or have been affected by historic flood events (where the source may be unknown), the Sequential Approach should be used to steer new development away from these areas. An assessment of likely significance of flood risk should be carried out in terms of likely probability of flooding and potential consequences/flood damages (advice from a drainage specialist may be required, such as the SFRA consultant, the Environment Agency, a highways drainage engineer and/or the planning authority drainage specialist). The purpose is to identify sites with significant flood risk, which may need to be facilitated by a Level 2 SFRA. If a site with significant flood risk is identified within Zone 1, this should be considered as if it was in the High Probability Zone 3a, for further application of the Sequential Test in Zone 3a (see Section 8.5), bearing in mind that if a more vulnerable land use is required for the site, it will have to pass the Exception Test. Where these tests are passed, the development must include flood resilience and resistance measures. The potential site owners/residents must also be made aware that they live/work in a localised flood risk area.

8.4.4 Sites without safe dry access routes during flood events are not likely to be able to proceed unless road raising works could be identified that would not impede flood flows or cause a loss in the floodplain storage capacity of the floodplain. This may not always be possible.

8.4.5 It is important to note that most potential sites that pass the Sequential Test in Zone 1 will still require site-specific FRAs. The vulnerability to flooding from other sources (as well as from river flooding) and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, with appropriate mitigating action, should be incorporated in an FRA. This need only be brief unless the factors above or other local considerations require particular attention. It is recommended that FRAs are produced for Zone 1 sites of less than one hectare, at locations where there are records of previous flood incidents.

8.5 Step Three: Sequential Test in Zones 2 and 3

8.5.1 The third step is to sequentially allocate sites as part of a SA. It is recommended that prior to incorporating the Sequential Test within the SA, the following actions take place:

a) Apply the measure of avoidance/prevention by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, ensuring flood risk areas remain as open space and river enhancements are undertaken (such as the removal of culverts) as part of the regeneration process.

b) Provisionally adopt land uses that are fully compatible with the vulnerability classification of PPS25, to try to avoid the need to apply the Exception Test where possible.

8.5.2 Once this has all been carried out, the need to apply the Exception Test might be identified. It is important to note that the Exception Test should only be carried out when it is not possible, or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding. The Exception Test is also only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons (the need to avoid social or economic blight and the need for essential civil infrastructure to remain operational during floods). It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

8.5.3 The need to apply the Exception Test should always prompt the production of a Level 2 SFRA.

8.6 Application of the Sequential Approach to Other Sources of Flooding

8.6.1 Development proposals in any location (Flood Zones 1, 2, 3a and 3b) must take into account the likelihood of flooding from sources other than rivers and the sea (where applicable). The principle of locating development in lower risk areas should therefore be applied to other sources of flooding.

8.6.2 The information collated within the SFRA has identified areas in which risk from other sources of flooding is likely to be an important consideration. The Council should therefore use the Sequential Approach to steer new development away from areas at risk from other sources of flooding, as well as fluvial.

8.6.3 The SFRA has highlighted areas where information of flooding from other sources is currently poorly understood or will require further refinement in the future. Of particular relevance is the fact that the Environment Agency now requires further investigation/mapping of surface water flooding to be carried out as part of a Level 2 SFRA, to ensure that potential allocations can be Sequentially Tested against this source of flooding.

8.7 Dealing with Windfall Sites

8.7.1 Any proposal for development on a 'windfall' site will by definition differ to a site allocated in a development plan that has been sequentially tested. Following the completion of the SFRA, the LPA should develop policies in the LDDs on how windfall sites should be treated in flood risk terms (refer to Section 7.3 for suggested policies). LPAs should, through application of the Sequential Test, identify areas where windfall development would be considered as appropriate i.e. defining the type of windfall development which would be acceptable in certain flood risk areas and what the broad criteria should be for submitting a planning application under these circumstances. PPS3 outlines that LPAs should not make allowances for windfall sites for the first ten years of land supply, unless they can demonstrate genuine local circumstances that prevent specific sites being identified. Windfall sites should be subject to the same consideration of flood risk as other housing development.

8.7.2 The Sequential Test should be applied to windfall sites, unless the area and the flood risk vulnerability proposed in which they occur has been sequentially tested on the basis of a SFRA. Where the Sequential Test has not been applied to the area, proposals will need to provide evidence to the LPA that they have adequately considered other reasonably available sites. This will involve considering windfall sites against other sites allocated as suitable for housing in plans.

8.7.3 It should also be noted that paragraphs 4.33-4.39 of the PPS25 Practice Guide (2008) give guidance on applying the Sequential Test to areas requiring redevelopment or regeneration; redevelopment of an existing property and change of use.

8.8 Key Recommendations: Chapter Eight

- The Sequential Test must be carried out on all potential development sites. The aim is to keep all new development out of medium and high risk areas (Flood Zones 2 and 3) and away from locations affected by other sources of flooding.
- GIS layers of all the data depicted on the maps in Volume 2 have been provided with the SFRA. Using a GIS system to superimpose this information on to potential development sites provides an effective means of assessing sites in regard to the Sequential Approach. Using the GIS information, summary tables of flood risk issues should be prepared for each site, indicating if the potential sites overlap Flood Zones 2, 3, localised flooding areas or if there are records of historic fluvial flood incidents shown in the maps (a template to assist with this process in provided in Appendix F). Particular attention should be paid to identifying flood risk issues in Flood Zone 1 (Section 8.4).
- Prior to incorporating the Sequential Test and Exception Test within the Sustainability Appraisal, the following actions must take place:

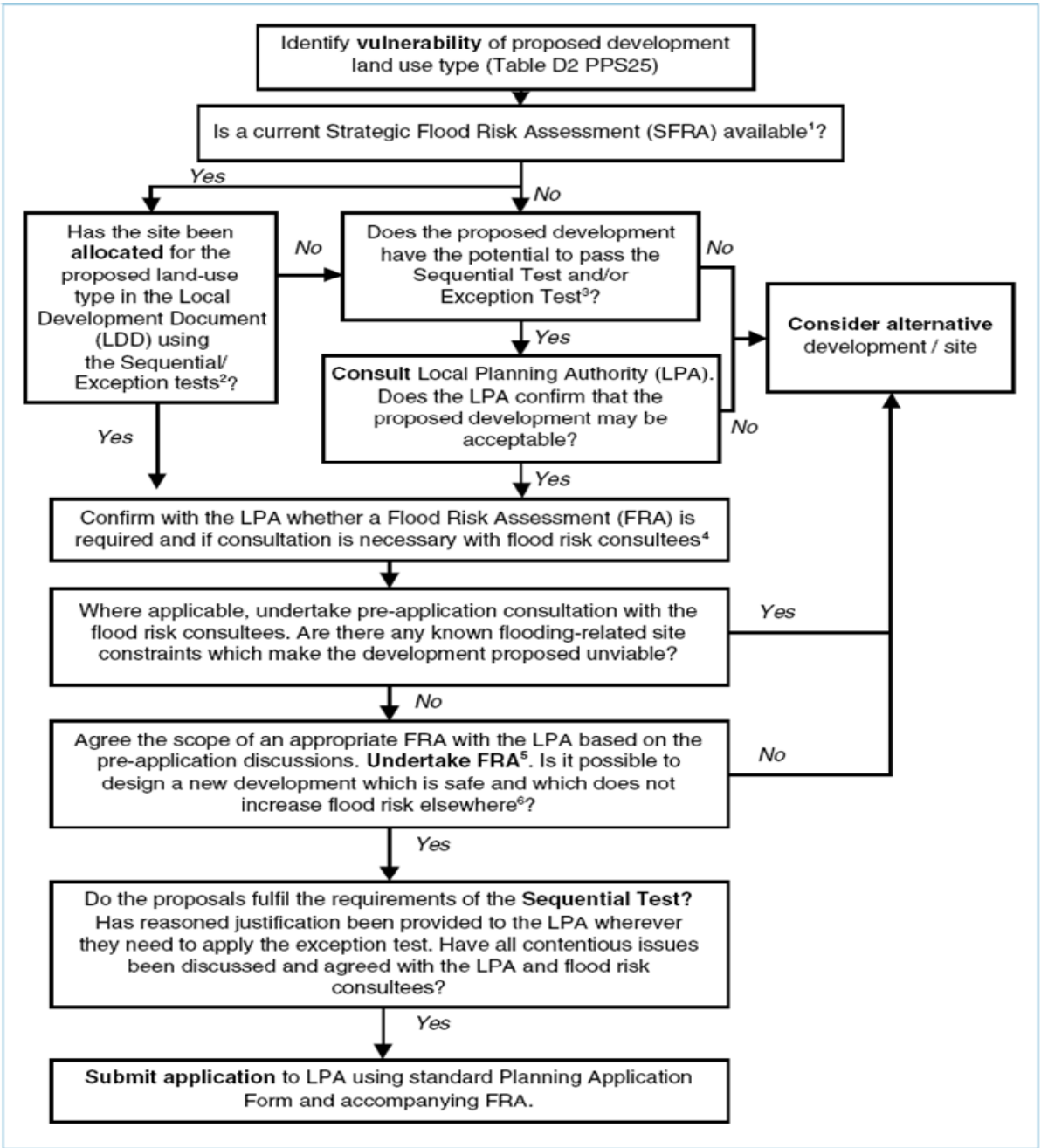
  a) Apply the measure of avoidance/prevention by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, ensuring flood risk areas remain as open space and river enhancements are undertaken (such as the removal of culverts) as part of the regeneration process.

  b) Provisionally adopt land uses that are fully compatible with the vulnerability classification of PPS25, to try to avoid the need to apply the Exception Test where possible.
- Following application of the Sequential Test, if any sites are identified for application of the Exception Test a Level 2 SFRA should be progressed.
- Most potential sites that pass the Sequential Test in Zone 1 will require site-specific FRAs.
- It is recommended that FRAs are produced for Zone 1 sites of less than one hectare, at locations where there are records of previous flood incidents.
- The Sequential Test should be applied to windfall sites, unless the area and the flood risk vulnerability proposed in which they occur has been sequentially tested on the basis of a SFRA.
- Paragraphs 4.33-4.39 of the PPS25 Practice Guide (2008) give guidance on applying the Sequential Test to areas requiring redevelopment or regeneration; redevelopment of an existing property and change of use.

9 Guidance for Developers

9.1.1 Site-specific FRAs will be required for most proposed developments and the level of detail will depend on the level of flood risk at the site (see general details about FRA requirements in Appendix E in PPS25). A FRA should assess flooding from other sources at the site-specific level and offer mitigating options for the management of the risk, without increasing flood risk elsewhere. The onus is on the developer to provide this information in support of a planning application. Prior to undertaking a FRA, developers should ensure that the Sequential Test has been passed at the site to ensure that a site-specific FRA is required and unnecessary time and expenditure is avoided.

9.1.2 Since the release of PPS25 in December 2006, the Environment Agency has power of direction over the determination of planning applications, which can be refused on the grounds of flood risk. Should the Council wish to disregard the advice of the Environment Agency then the planning application could be put before the Secretary of State (as indicated by PPS25 paragraphs 25-29). It is therefore imperative that developers hold discussions over the need for FRAs early on within the planning process. Consultation should be undertaken with the Environment Agency and the relevant Council to ensure that the Council's policies on flood risk management are respected and taken account of, and that the scope of the FRA is commensurate with the level of flood risk. The following reflects best practice on what should be addressed within a detailed FRA. Those proposing development should also be directed towards Annex F of PPS25 (the figure overleaf shows the recommended process of undertaking an FRA as part of an individual planning application).



Notes

1 A SFRA can be defined as current if it has been prepared in accordance with PPS25.
2 If the site has been allocated in this way then subsequent steps in the process are likely to be significantly more straightforward.
3 If a site has not been allocated in the LDD because it was considered that the flood risk is unacceptable, it is unlikely that a proposed development at the site will be accepted by the LPA.
4 See pages 30-31 for key consultees to the planning process with regard to flood risk.
5 Guidance on undertaking a FRA can be found in Chapter 2.
6 Including surface water management.

Figure 9.1: Guidance for developers for individual planning applications

Note: the footnotes refer to pages in the PPS25 Practice Guide (2006).

9.2 Proposed Development within Flood Zone 1

9.2.1 The risk of other sources of flooding (surface water drainage, sewers, impounded water bodies, groundwater) must be considered, and SUDS techniques must be employed to ensure no worsening of existing flooding problems elsewhere within the area.

9.2.2 The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular 'zones' of the area. These recommendations should form the basis for the site-based FRA.

9.3 Proposed Development within Medium Probability Zone 2

9.3.1 For all sites within Medium Probability Zone 2, a scoping level FRA should be prepared based upon readily available existing flooding information, sourced from the Environment Agency. If there is a significant flood risk from other sources (surface water drainage, sewers, impounded water bodies, groundwater) identified then a more detailed FRA should be prepared. It will be necessary to demonstrate that the residual risk of flooding to the property is effectively managed throughout, for example, the provision of raised floor levels and the provision of planned evacuation routes or safe havens.

9.4 Proposed Developments within High Probability Flood Zone 3a

9.4.1 All FRAs supporting proposed development within High Probability Zone 3a should assess the proposed development against all elements of the Council's flood policy, and include an assessment of the following:

- The risk of flooding to and from the development from other sources (e.g. surface water, sewers, impounded water bodies, groundwater) as well as from river flooding. This will involve discussion with the Council, Environment Agency and/or operating authority to confirm whether a localised risk of flooding exists at the proposed site. Localised flooding may also occur, typically associated with local catchment runoff following intense rainfall passing directly over the area. This localised risk of flooding must also be considered as an integral part of the detailed FRA.

- The risk of flooding to and from the development over its lifetime (including the potential impacts of climate change as well as changes that may occur, such as permitted development), i.e. maximum water levels and depths, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.

- The potential of the development to increase flood risk elsewhere through the addition of impermeable surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment to be carried out by a suitably qualified engineer.

- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood

defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.

- Details of existing site levels, proposed site levels and proposed ground floor levels should be provided on maps. A topographic survey and flood extents must be shown on maps to show the full extent of the 1% AEP (1 in 100 year) flood with and without an appropriate allowance for climate change and, where relevant, the extent of the functional floodplain. In addition, where safe access and egress is required, it must be demonstrated on the maps that it can be provided from the property to an area wholly outside of the floodplain.

- Demonstration that a positive gain in floodplain storage capacity is provided. This should be provided through 'level for level' floodplain compensation. Further guidance can be found in the CIRIA document C624 Development and Flood Risk (the use of under-floor voids will not normally, by itself be considered as mitigation).

- Demonstration that the layout and design of the development will not have a detrimental impact upon floodwater flow conveyance.

- Demonstration that opportunities to reduce flood risk and enhance river corridors have been maximised, for example, through the removal of unnecessary obstructions such as culverts or low bridges (subject to these works not causing in themselves an unacceptable increase in flood risk).

- Demonstration that the development is consistent with the relevant CFMP and its policy units

9.4.2 It is essential that developers thoroughly review the existing and future structural integrity of informal defences, if present, upon which the development will rely (i.e. over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the unlikely event of a defence failure. This would be particularly important for development that could potentially be affected as a result of a breach of any canals in the study area.

9.5 Proposed Developments within Functional Floodplain Flood Zone 3b

9.5.1 In line with PPS25, after having applied the Sequential Test, development will not normally be allowed in the Functional Floodplain unless it is classified as a 'water compatible' or 'essential infrastructure' use. Table D2 from PPS 25 details the type of developments classified as 'water compatible' or 'essential Infrastructure.' Refer to Section 7.3 for further guidance on compatible uses.

9.6 SUDS Requirements

9.6.1 Annex F of PPS25 outlines a range of SUDS options which could be applied to new development sites. Although not all will be appropriate for individual development sites, a suitable drainage approach should be possible on almost every site. All new development sites will require the following:

- To obtain the most benefit, SUDS must be considered as early as possible in the planning process

- The drainage system to be designed to accommodate all storm events up to and including the 1% AEP (1 in 100 year) event, with an appropriate allowance for climate change

- Application of a SUDS management train

- As outlined in section 10.4, which outlines appropriate SUDS techniques for the Borough, a hierarchical approach should be applied to the SUDS used, in order of priority:

    1. Preventative measures should be the preferred option i.e. ensuring there are not unnecessary impermeable areas on-site,

    2. Source control measures such as rainwater harvesting and infiltration systems should be the next preferred option, provided the site conditions are appropriate,

    3. Site control measures should be the next preferred option, where prevention and source control measures alone cannot deal with all on-site drainage. Above ground site control attenuation systems, such as balancing ponds and swales, should be considered in preference to below ground attenuation, due to the water quality, biodiversity and amenity benefits they offer.

    4. Regional control measures should only be considered where none of the above preferred options can be achieved.

- A hierarchical approach should be applied to the disposal of surface water from the site referencing in order of priority:

    1. Rainwater harvesting systems

    2. An adequate soakaway or other adequate infiltration system

    3. A watercourse

    4. A surface water sewer

    5. A combined sewer, only as a last resort

- Where prevention, source control/infiltration cannot deal with all on-site site drainage, as a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified

- Exceedance design measures to be applied to ensure that extreme events above the design standards of the system do not pose adverse impacts

- A sequential approach should be applied to the site layout to specifically set aside space for SUDS

- They should be designed for the lifetime of the development, with suitable provisions for likely future permitted and minor development e.g. paving of front gardens or minor extensions (it may be possible to achieve this either through suitable planning or engineered solutions).

9.7 Raised Floor Levels and Basements (Freeboard)

9.7.1 The raising of floor levels above the 1% AEP (1 in 100 year) peak flood level will ensure that the damage to property is minimised. Given the anticipated increase in flood levels due to climate change, the adopted floor level should be raised above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for the potential impacts of climate change (refer to Section 5.5).

9.7.2 It is highlighted that many of those areas currently situated within Medium Probability Zone 2 could become part of the High Probability Zone 3. This is important as it means that properties that are today at relatively low risk will, in 20 to 100 years, be within High Probability Zone 3a. It is imperative therefore that planning and development control decisions take due consideration of the potential risk of flooding in future years.

9.7.3 Wherever possible, floor levels should be situated a minimum of 600 mm above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for the potential impacts of climate change, determined as an outcome of the site-based FRA. Additional freeboard may be required because of the risk of blockages to the channel, culverts or bridges. The height that the floor level is raised above the flood level is referred to as the 'freeboard', and is determined as a measure of residual risks. Where the depth between the underside of the floor slab and the existing ground level will allow, under-floor voids should be included with openings. In these instances the voids and openings should reach between the existing ground level and the 1% AEP (1 in 100 year) flood level with an appropriate allowance for the potential impacts of climate change.

9.7.4 The use of basements within flood risk areas should be discouraged. Where basements are permitted however, it is necessary to ensure that the basement access points are situated a minimum of 600 mm above the 1% AEP (1 in 100 year) plus climate change flood level plus climate change. The basement must have unimpeded access and waterproof construction to avoid seepage during flooding conditions. Habitable uses of basements within Flood Zone 3 should not be permitted, while basement dwellings can be allowed in Flood Zone 2 provided they pass the Sequential and Exception Tests.

9.8 Development Behind Defences

9.8.1 Prior to the development of areas behind defences, the Sequential and Exception Tests must be undertaken in the first instance. Where the need to apply the Exception Test is identified, this should be supported by a Level 2 SFRA.

9.8.2 Areas behind defences are at particular risk due to breach or overtopping, resulting in the rapid on-set of fast-flowing, deep water flooding with little or no warning. Risks will therefore be highest closest to these defences and as such it is recommended that the LPAs should set back developments and ensure that those proposing developments develop robust evacuation plans as part of their FRA in consultation with the Environment Agency.

9.8.3 Consideration of flood risk behind defences should be made as part of detailed FRAs. Developers should review Volume 2, Tiles A1-A21 to determine the location of structures and defences in proximity to the site and therefore identify the possibility of localised residual flood risk. The FRA should take into account:

- The potential mechanisms of failure of flood defence infrastructure
- The standard of protection and design freeboard
- The asset condition of the flood defence
- The height of the flood defence infrastructure and retained water levels compared to ground levels

- The potential location, width and invert level of breach(es) in the flood defences
- The duration of water levels during a flood event or tidal cycle
- The period it would take the operating authority to close the breach
- The period it would take for water to drain from the flooded area following a breach or overtopping event
- The residual risk from failure through demountable defences or pumps not being in position / operation when they are used

9.8.4 In addition to this it is recommended that should any development be proposed in a defended flood area, the potential cumulative impact of loss of storage on flood risk elsewhere should be considered.

9.9 Car Parks

9.9.1 Car parking may be appropriate in areas subject to shallow, low velocity flooding where there is not a risk of the vehicles being washed away or the surrounding transport network becoming unsafe to drive through (e.g. in High Probability Zone 3a), provided sufficient flood warning is available, and appropriately located and worded signs are in place. However, this would still need to consider the sequential approach and be discussed and agreed with the LPA and/or the Environment Agency. As part of an FRA, the developer should consider the likelihood of people being able to move their cars within the flood warning time.

9.10 Developer Contributions

9.10.1 If new developments are placed on Flood Zones 2 or 3, it might be necessary for local infrastructure to be increased. With regards to flood risk, it might also be necessary to extend flood warning system coverage where appropriate, or increase the maintenance of flood defences. The LPA and other authorities might wish to request developer contributions to cover the cost of this, and if so this should be achieved through a Section 106 Legal Agreement. The LPA and the Environment Agency may wish to work in conjunction with each other to formulate a consistent process for obtaining developer contribution.

9.11 Key Recommendations: Chapter Nine

- FRAs will be required for most proposed developments (general details about FRA requirements are in Appendix E of PPS25).
- The onus is on the developer to provide an FRA in support of a planning application.
- Prior to undertaking a FRA, developers should ensure that the Sequential Test has been passed at the site.
- Developers should consult with the Environment Agency and the Council to ensure that the Council's policies on flood risk management are respected and taken account of, and that the scope of the FRA is commensurate with the level of flood risk.
- Section 9.2-9.5 of the SFRA reflects best practice on what should be addressed within a detailed FRA.
- A suitable drainage approach should be possible on almost every site. All new development sites must follow the guidance outlined in Section 9.6. The FRA must demonstrate that these requirements have been achieved.
- Floor levels for developments in flood risk areas must be situated a minimum of 600mm above the 1% AEP (1 in 100 year) plus climate change flood level, determined as an outcome of the site-based FRA.
- The use of basements within flood risk areas should be discouraged. Where basements are permitted however, it is necessary to ensure that the basement access points are situated a minimum of 600 mm above the 100 year plus climate change flood level.

10 Guidance for the Application of Sustainable Drainage Systems

10.1 Introduction

10.1.1 PPS1: Delivering sustainable development; PPS23: Planning and Pollution Control; and PPS25 require that LPAs should promote SUDS. LPAs should therefore ensure policies encourage sustainable drainage practices in their LDDs. SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of rainfall (surface water) is considered an essential element of reducing future flood risk to both the site and its surroundings. Indeed, reducing the rate of discharge from urban sites to Greenfield runoff rates is one of the most effective ways of reducing and managing flood risk within the area.

10.1.2 SUDS systems need to be considered at and early stage, prior to defining the layout of a proposed site, in accordance with the Sequential Approach. This is likely to lead to a reduction in the overall cost of draining the site as it is much more difficult and expensive to retrofit SUDS to a site that has a development layout already designed. For major development schemes proposed where there are likely to be many competing issues, SUDS should ideally be discussed pre-application to maximise the on-site opportunities. This in return should result in a reduced cost to the developer for the system.

10.2 Effective application of SUDS techniques

10.2.1 A hierarchical approach is recommended for selection of SUDS techniques to dispose of surface runoff. The SUDS Manual (CIRIA 697) states that 'wherever possible, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas'. This is illustrated by the SUDS Management Train (see Figure 10.1).

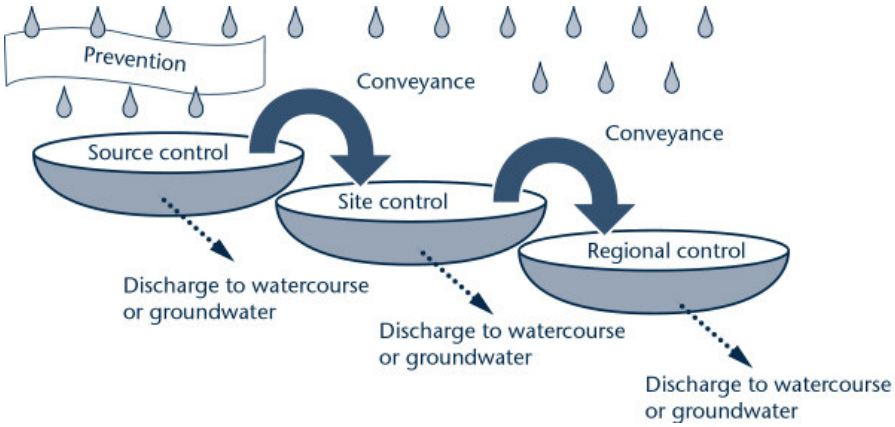


Figure 10.1: SUDS Management Train (from the Environment Agency website)

10.2.2 The first stage, 'prevention' stresses the benefit of avoiding runoff in the first place, and also refers to the need to prevent pollution. Prevention of runoff can be achieved by maintaining a permeable area. This can be achieved by avoiding paving a surface, instead using permeable materials which allow rainfall to soak directly into the ground. It may also be possible to allow roof water to discharge straight onto a lawn in order to soak into the ground, but infiltration must avoid pollution of the soil and

groundwater. This includes ensuring minimal use of herbicides on lawns, secure storage of oils and chemicals to avoid leakage and dog litter policies.

10.2.3 If prevention methods are not sufficient to avoid runoff, the next preferred option is to store and dispose of it on site. This includes measures such as permeable paving or rainwater harvesting, which has the added benefit of reducing demand on public water supply, and reduces costs for the user of the rainwater (if they purchase water using a water meter). Where water cannot be directly infiltrated into the ground, it may be conveyed some distance before infiltration or, alternatively, discharged into a watercourse. As the runoff is conveyed further, it moves from source control to site control and then regional control.

10.2.4 Infiltration is preferred over disposal to a watercourse or the public sewer system as this more commonly deals with runoff nearer to source and serves to replenish groundwater. This recommendation is reinforced by the requirements of the Building Regulations Part H3. If infiltration is not viable (due to a high water table, local impermeable soils, contamination issues including source protection zones etc.), then the next option of preference is for the runoff to be discharged into a nearby watercourse. Only if neither of these options is possible should the water be discharged into the public sewer system.

10.3 Types of SUDS Systems

10.3.1 SUDS may improve the sustainable management of water for a site by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream
- Reducing volumes of water flowing directly to watercourses or sewers from developed sites
- Improving water quality compared with conventional surface water sewers by removing pollutants from diffuse pollutant sources
- Reducing potable water demand through rainwater harvesting
- Improving amenity through the provision of public open space and wildlife habitat
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained

10.3.2 Any reduction in the amount of water that originates from any given site is likely to be small however if applied across the catchment, the cumulative effect from a number sites could be significant.

10.3.3 There are numerous different ways that SUDS can be incorporated into a development. The appropriate application of a SUDS scheme to a specific development is heavily dependent upon the topography and geology of the site and the surrounding areas. Careful consideration of the site characteristics is necessary to ensure the future sustainability of the adopted drainage system. When designing surface water drainage systems, PPS25 states that climate change should be taken into account appropriate to the predicted lifetime of the development, and designed to account for the predicted increases in rainfall intensity, as outlined in Table 5.2.

10.3.4 The most commonly found components of a SUDS system are described below:

- Pervious surfaces: Surfaces that allow inflow of rainwater into the underlying construction or soil.
- Green roofs: Vegetated roofs that reduce the volume and rate of runoff and remove pollution. They comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/ landscaping/ permeable car parking, over a drainage layer. They are designed to intercept and retain precipitation, reduce the volume of runoff and attenuate peak flow.
- Filter drains: Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
- Filter strips: Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
- Swales: Shallow vegetated channels that conduct and retain water, and may also permit infiltration; the vegetation filters particulate matter.
- Basins: Ponds and wetlands areas that may be utilised for surface runoff storage.
- Infiltration Devices: Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.
- Bioretention areas: Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground.
- Pipes and accessories: A series of conduits and their accessories normally laid underground, that convey surface water to a suitable location for treatment and/or disposal (although sustainable, these techniques should be considered where other SUDS techniques are not practicable).

10.3.5 The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.

10.3.6 For more guidance on SUDS, the following documents and websites are recommended as a starting point:

- Planning Policy Statement 25 (PPS25) Development and flood risk (Department for Communities and Local Government, 2006 – Free download from CLG web site http://www.communities.com)
- Development and flood risk: A practice Guide Companion to PPS25 (Department for Communities and Local Government, 2006 – Free download from CLG web site http://www.communities.com)
- The SUDS Manual – CIRIA C697 (2007) (Woods Ballard B; Kellagher R et al, 2007). Free download from CIRIA bookshop (www.ciria.org). Provides the best practice guidance on the planning, design, construction, operation and maintenance of SUDS and facilitates their effective implementation within developments.

- CIRIA c644 – Green Roofs (2007) provides guidance on the design, construction and operation of Green Roofs. The guidance also describes how 'quick wins' for biodiversity can be achieved in the built environment by incorporating nesting and roosting boxes for birds, bats and other animals.

- Interim Code of Practice for Sustainable Drainage Systems (National SUDS Working Group, 2004). Free download from CIRIA web site www.ciria.org or Environment Agency web site www.environment-agency.gov.uk

- Preliminary rainfall runoff management for developments (DEFRA/Environment Agency R&D Technical Report W5-074/A/TR/1 Revision D) – Free download from Environment Agency web site www.environment-agency.gov.uk

- C625 Model agreements for sustainable drainage systems (Shaffer et al, 2004 – available from CIRIA bookshop www.ciria.org)

- C539 Rainwater and grey water use in buildings – best practice guide – available from CIRIA bookshop www.ciria.org

- C582 Source control using constructed pervious surface: hydraulic, structural and water quality performance issues (Pratt et al, 2002 – available from CIRIA bookshop www.ciria.org)

- C635 Designing for exceedance in urban drainage – good practice – free download from CIRIA bookshop www.ciria.org

- Report 156 Infiltration drainage – manual of good practice (Bettess R, 1996 – available from CIRIA bookshop www.ciria.org)

- Harvesting rainwater for domestic uses: an information guide (Environment Agency, 2003 – Free download from Environment Agency web site www.environment-agency.gov.uk)

- www.ciria.org.uk/suds/

10.4 Application of SUDS for Cheltenham Borough Council

10.4.1 The Borough has a mixture of freely draining, slowly permeable and impeded drainage lime-rich and slightly acidic loamy and clayey soils. The more permeable sites should have priority given to infiltration drainage techniques, as opposed to discharging surface water to watercourses. Where less permeability is found and infiltration techniques that rely on discharge into the existing soils are not viable (also due to a high water table, source protection zones, contamination etc), discharging site runoff to watercourses is preferable to the use of sewers. Integrated urban drainage should also be used throughout the design process.

10.4.2 The entire Borough has been highlighted by DEFRA as a Nitrate Vulnerable Zone (NVZ) and an area in the east has been classified as a Ground Water Source Protection Zone (GSPZ) by the EA. Any boreholes, water wells or other extraction points should also be identified and taken into account in the design process.

10.4.3 NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff

from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

10.4.4 The GSPZ is situated over the Jurassic Limestone Aquifer and is designated as inner, outer and total catchment areas. The Inner Zone of the GSPZ is the most sensitive areas and varies in diameter from 0.1 to 0.6km. The Outer Zone is also sensitive to contamination and varies in diameter from 0.5 to 1.6km. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination.

10.4.5 One GSPZ Inner Zone has been identified by the EA in the east of the borough at Charlton Kings, depicted in the image below14.

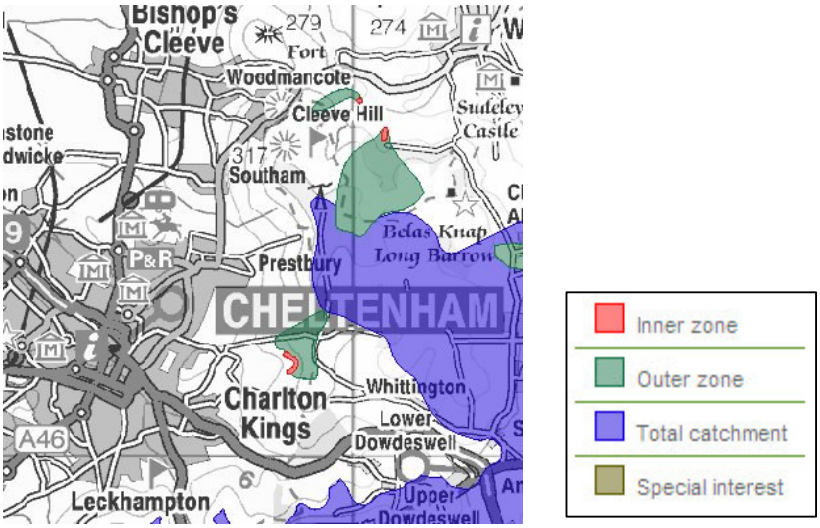


Figure 10.2: GSPZ Inner Zones identified by the Environment Agency

10.4.6 Runoff which is likely to be heavily contaminated must be treated by a proprietary device, which should be carefully considered to ensure the correct system is selected to remove pollutants. PPS 3 (2006) states that source control SUDS must be considered and incorporated where suitable. For example; surface water drained from a car park should implement a filter bed wherever possible before considering an interceptor device to remove contaminants.

10.4.7 If the local soil is contaminated then a lined system is generally required. This may include a drainage design which allows infiltration in the upper layer, but should incorporate an impermeable layer at its base to prevent contamination. In such cases lined underground attenuation storage is used to store a 1% AEP (1 in 100 year) +20% (for climate change) storm event and discharges into a nearby watercourse.

10.4.8 Regardless of the underlying geology identified in the SFRA, where there are no reasons why infiltration is not possible (e.g. contaminated land), soakage tests must be undertaken on site in accordance with either CIRIA Report 156 or BRE365. The SFRA will only provide an early indicator to enable decisions as to the best way forward to be formulated for the design site.

14 http://www.environment-agency.gov.uk/maps/info/groundwater/

10.5 Adoption and Maintenance of SUDS

10.5.1 PPS25 states that when planning SUDS, it is important that developers carefully consider maintenance to ensure that SUDS continue to function over time. Poorly maintained SUDS could lead to an increase in flood risk rather than a reduction.

10.5.2 The future ownership and management of all elements of the SUDS system will need to be addressed at an early stage as the maintenance responsibility must be given to durable and accountable bodies which have the resources to meet the long term needs of the system.

10.5.3 Ensuring developers make a full contribution to the costs of both building and maintaining such systems is vital to their long term effectiveness. The costs of maintaining SUDS devices will be dependant on the types of system used and this should be considered by the developer at an early stage.

10.5.4 Traditional drainage systems are criticised that problems are often hidden underground and take time to eventually be discovered. The majority of SUDS devices are at the surface and pollution or silt build up can be observed as it happens. This means that any issues can be dealt with as they occur, but requires a regular monitoring regime and suitable body to provide the maintenance support.

10.5.5 As the majority of SUDS are at the surface elements, they are best incorporated into local landscape maintenance regimes where possible. An advantage of this is that the site managers and landscape contractors will have a good knowledge of the site through regular maintenance operations such as grass cutting and litter removal. This should also ensure regular monitoring and a quick response to any maintenance needs.

10.5.6 Water companies such as Severn Trent Water Ltd are currently only willing to adopt hard structures and not softer SUDS systems, such as swales or ponds, which provide a break between pipe networks. Until this process changes there will be issues with adoption and developers will have to consult with local authorities to establish the best long term maintenance plan.

10.5.7 SUDS in new developments are usually constructed by the developer and offered for adoption to the responsible organisation. There are currently four main options for determining who might take responsibility for adoption and maintenance of SUDS for a site: Local Planning Authorities, Sewerage Undertakers, Highway Authority or Specialist SUDS undertakers or companies.

10.5.8 Existing legislation (e.g. Section 38 of the Highways Act, 1980 and Section 106 of the Town and Country Planning Act, 1990) can provide a mechanism for SUDS adoption. PPS25 recommends that early consultation with the relevant stakeholders is made to establish and agree responsibilities for long-term maintenance. In addition, the National SUDS Working Group (NSWG) has developed an Interim Code of Practice for SUDS (NSWG, 2004) which provides a set of planning model agreements for use between those public organisations with statutory or regulatory responsibilities relating to SUDS. The model agreements are based on current legislation and the current planning system. This code of practice is complemented by CIRIA publication C625 Model agreements for SUDS.

10.6 Key Recommendations: Chapter Ten

- The Council should endeavour to ensure that SUDS are applied for all new developments, and retro-fitted wherever possible.
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.
- SUDS systems need to be considered at and early stage, prior to defining the layout of a proposed site, in accordance with the Sequential Approach. For major development proposals where there are likely to be many competing issues, SUDS should be discussed pre-application to maximise the on-site opportunities.
- The SUDS management train should be followed (Section 10.2).
- The future ownership and management of all elements of the SUDS system will need to be addressed at an early stage as the maintenance responsibility must be given to durable and accountable bodies which have the resources to meet the long term needs of the system. Ensuring developers make a full contribution to the costs of both building and maintaining such systems is vital to their long term effectiveness.

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11 Summary and Recommendations

11.1.1 This section summarises the findings of the SFRA, recommendations and further work. Key recommendations are summarised at the end of each chapter and should also be reviewed by the reader.

11.2 Summary: Flood Risk Issues

11.2.1 Based on the findings of the SFRA, the following summary of flood risk issues within the Borough can be made:

- Cheltenham Borough occupies a low-lying urban area of the Lower Severn catchment. The rivers contributing to flood risk are small catchments originating within, or in the vicinity of, the Borough. Of particular relevance is the River Chelt which flows through the centre of Cheltenham, regulated by a flood alleviation scheme.

- The high degree of urbanisation coupled with the small size of the catchments and impermeable underlying rock mean that the greatest flood risk in the region is from high-intensity convective storms more common during the summer season.

- Flood risk in the Borough is influenced by surface water and the overloading of the old drainage system, particularly during intense rainfall events. In the future, the effects of climate change mean that areas in Flood Zones 2 and 3 are likely to flood more frequently, and the extent of flooding might increase. Surface water flooding might also increase although this can be averted by the improved management of surface water.

- In general the level of flood risk from artificial drainage systems within the Borough is medium to low with the areas at highest risk located towards the south-west of the Borough by Hatherley, Tivoli and Lansdown; and towards the northern extent of the Borough by St Paul's, Marle Hill, Wymans Brook, Oakley and Lynworth.

- Much of the Cheltenham Central Area Main Sewerage System is over 120 years old and thought to be in a poor structural state. A programme of sewer replacement is being implemented and is thought to involve work beyond the current 5-year Capital Programme. The Chelt main sewer has a large overflow which joins the River Chelt at Arle. It has been recommended by the Environment Agency that any further development within the catchment area of this sewer system deals with surface water appropriately at the surface so that betterment is achieved. An increase in site runoff should not occur as this would increase the sewage flow and would lead to the overflow being used more frequently.

- Flooding from surface water is a problem within the Borough, particularly in the town due to abundance of impermeable surfaces. In the past the River Chelt was diverted from its natural course to higher ground in order to feed the great mills. The original river valley was subsequently developed with housing estates, public buildings and industrial development. Consequently, when intense rainfall events occur, runoff follows natural topography and accumulates at the valley bottom, which can flood areas of the town centre.

- An assessment of flooding from impounded water bodies indicated that there are no canals in the Borough.

- A number of flood storage areas are located within or close to the Borough boundary, namely Dowdeswell Reservoir and Cox's Meadow. Dowdeswell is located outside the eastern extent of the Borough (SO 9884 1973) upstream of Cheltenham and has been modified for use from a water supply reservoir to a flood storage reservoir. Consultation with the Environment Agency has indicated that there are no records of breaching/overtopping of reservoirs within the Cheltenham Borough area.

- There are a number of locations at risk of flooding that are currently protected by permanent defences within the Chelt Borough as identified on the Environment Agency's NFCDD database. Of particular relevance is the River Chelt Alleviation Scheme which attenuates flow through the town through a series of off-line balancing areas, namely Cox's Meadow and Sandford Park. A number of culverted sections are also evident throughout the scheme.

- Cox's Meadow (SO 9565 2132) forms an important flood storage area as part of the River Chelt flood alleviation scheme. In a high flow situation, the River Chelt is designed to spill into Cox's Meadow to limit the flow through the town. The meadow has a design standard of 1% AEP (1 in 100 years). The release from Cox's Meadow joins the limited flow in the channel downstream of Old Bath Road before passing to Upper Sandford Park.

- As part of the Flood Alleviation Scheme Dowdeswell Reservoir is drawn down to provide storage of runoff from the upper catchment (to enable storage of a 100 year flood event from the upper catchment). The outlet is controlled at the tower where a flow is conveyed via a spillway to a culvert. The flow from the reservoir is controlled so that a small constant flow is released. The reservoir is currently operated by the Environment Agency.

11.3 Summary: Flood Zone Data Issues

11.3.1 During the review of the Flood Zone information some inaccuracies were identified. The accuracy of the Flood Zones in some areas is poor, likely to be due to the high number of culverts particularly along the River Chelt through the town centre and the Wymans Brook. The Flood Zones can be misaligned from the channel, show flood risk when a culvert is present, or follow a path which does not have a watercourse. Appropriate judgement should be exercised when applying the Sequential Test. It may be prudent for a suitably qualified flood risk management specialist to review and assess preliminary site allocations, to advise on local Flood Zone issues and areas where modelling, or alternative solutions, might have to be carried out to adequately assist the Sequential Test process.

11.4 Summary: Climate Change Issues

11.4.1 Upland areas will be subject to deeper, faster flowing water as climate change affects flood risk, while in lowland areas the extent of flooding is likely to become greater. Given the lowland setting of Cheltenham Borough, an increase in flood extent is expected, but flood waters might also be deeper. This means that the flood hazard is likely to increase over time, creating increased risk to humans, more damage to property and higher economic damages. A Level 2 SFRA, which assesses flood hazard, will therefore be required for site allocations which need to satisfy the Exception Test. Velocities are not likely to increase significantly, though the upstream section of the River Chelt is steep which may affect velocities. Certainly, sites that are currently within Flood Zones 2 and 3 will be subject to more frequent and potentially deeper flooding. A Level 2 SFRA should assess climate change impacts in detail.

11.4.2 The LPA should consider using the climate change maps to carry out the Sequential Test, in order to give a particularly long-term risk-based approach to planning. It should be noted that the climate change maps do not show a climate change scenario for Flood Zone 2. For the purpose of spatial planning it is recommended that a buffer of 10m (measured from the edge of the existing Flood Zone 2) is added to represent future climate change.

11.5 Recommendations: Site Allocation Process

11.5.1 It is recommended that the outputs from this study are used as an evidence base from which to direct new development to areas of low flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, the Council should use the flood maps to apply the Sequential Test to their remaining land use allocations. The following should be considered:

- Flood Zone 3b has been mapped where it exists. Where it does not exist, Flood Zone 3a has been used to represent Flood Zone 3b.
- The Council should take note of Section 4.7 which outlines areas where the existing Flood Zones outlines are deemed to be of poor resolution. Where emerging site allocations are located in these areas, the Sequential Test process should be verified by a technical expert.
- Following application of the Sequential Test, a detailed interrogation of emerging allocations should be carried out, using the template in Appendix F. This will ensure that that all potential flood risk issues to the site are identified, such as incorrect Flood Zones, residual risk areas and so on. The review should identify resultant required works if necessary (Level 2 SFRA, FRA etc.)

11.5.2 The Sequential Approach should also be applied within development sites to inform site layout, by locating the most vulnerable elements of a development in the lowest risk areas (in accordance with Table D3 of PPS25). The use of Flood Zones 2 and 3 for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.

11.5.3 The Environment Agency will require a Level 2 SFRA to be carried out in order to provide a detailed assessment of the risk of flooding from non-fluvial sources, in areas where new development is proposed.

11.5.4 With regard to fluvial sources of flood risk, a Level 2 SFRA will be required where the need to apply the Exception Test is identified (as outlined in Table D3 of PPS25). This cannot be determined until the Sequential Test has been carried out on all proposed development sites. It is recommended that as soon the need for the Exception Test is established, the Level 2 SFRA is undertaken by a suitably qualified expert so as to provide timely input to the overall LDF process. The following should be noted:

- Breach and overtopping assessments will be required for development situated behind defences and immediately adjacent to raised canals
- The effects of structures in the vicinity of development sites (culverts etc.) might need to be assessed to determine the capacity and identify residual risk areas that might result from blockage. This will inform the appropriate placement of development and ensure appropriate mitigation is put in place. This could also address any mitigation works that might be deemed appropriate.

11.6 Recommendations: Council Policy

11.6.1 It is recommended that for the purpose of clarity, a Supplementary Planning Document should be developed in light of the suggested policies and guidance notes, outlining the minimum requirement of the Environment Agency in response to PPS25. The Council should also work with the Environment Agency to achieve the policy objectives of the Severn CFMP for the area.

11.6.2 It is recommended that the following core considerations should be included within the Council's flood risk management policy documents:

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1
- Seek to ensure Flood Zones 2 and 3 remain undeveloped and protect the functional floodplain from development, promote the use of green corridors in flood risk areas and restore the natural course of rivers. These will all act as a means of risk reduction
- Seek to reinstate functional floodplain wherever possible (e.g. reduce building footprints or relocate to lower flood risk zones)
- The Council should aim to manage flood risk by taking opportunities to maximise the potential of the floodplain to store water
- Use the Sequential Approach within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas, in accordance with Table D3 of PPS25
- Ensure all new development is 'safe', meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain, emergency vehicular access is possible, and flood resistance and resilience is incorporated
- No new building should be allowed in a flood risk area that is not flood resilient
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified
- Further culverting and building over of culverts should be avoided. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit.
- Seek developer contributions (to be determined in consultation with the Environment Agency) via S106 planning obligations to fund (or part fund) strategic flood risk management facilities (such as storage areas) and bring benefit to the wider community.

11.7 Environment Agency Policies Relevant to the Council

11.7.1 The general direction of the Environment Agency is that within the Borough, actions will be taken to reduce flood risk, both now and in the future. Apart from the continued use of defences, there are opportunities for the Council to assist in the reduction of risk by vigorously applying PPS25 and

promoting the use of SUDS. In terms of existing developments, the Council should promote understanding of flood risk and its management so that communities are aware of the steps they can take to reduce the risk. The implementation of Surface Water Management Plans would be a first step in realising the sustainable management of surface water in both new development and existing developed areas. It is therefore recommended that the Council considers the production of a SWMP for the Borough. In addition, the level of flood preparedness (flood warning, flood proofing and flood resilience) should be increased and promoted in this area. An increase in targeted channel maintenance has also been identified as an opportunity to decrease debris build up in channels and help reduce incidents of blockage and resultant flooding.

11.8 Recommendations: Emergency Planning

11.8.1 It is recommended that the Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that the Council works with the Environment Agency to promote the awareness of flood risk, especially to those living in flood risk areas, and encourage communities at risk to sign-up to the Environment Agency Flood Warning Direct service. In line with the Pitt Review, this should be achieved through 'door knocking' by local authorities.

11.8.2 In line with the Pitt Review it is recommended that a review of designated rest centres and other major facilities should be carried out to ensure that they have the necessary levels of resilience to enable them to be used in the response to flooding and other major emergencies, or that alternative arrangements are put in place. A review of current local arrangements for water rescue should also be carried out to consider whether they are adequate in light of the summer's events and the community risk register. Further, Local Resilience Forums should consider the vulnerability of motorways and trunk roads to flooding and consider the potential for warnings and strategic road clearance and closures to avoid people becoming stranded. Finally, the community risk register should reflect risks to critical infrastructure from flooding and other hazards.

11.9 Recommendations: General

11.9.1 A number of general issues and resultant recommendations have come forward through the SFRA process, and should be taken into account by the Council. These are:

- Not all minor watercourses have had Flood Zone maps produced for them, specifically, those with a catchment area of less than 3km^2. Any development site located adjacent to an unmapped watercourse within Flood Zone 1 should apply an 8m development easement from the top of bank, and a site specific FRA undertaken.
- In the future it is likely that the Environment Agency will take strategic direction over managing inland flood risks. The Local Authority should adopt a leadership and scrutiny role, overseeing flood risk management within the local area.
- Although the flood proofing of utilities should be carried out by the service provider, the Council should review the vulnerability of critical infrastructure in the local area and take steps to work with service providers to initiate retrospective FRAs and subsequent flood proofing works if required.

- Incorporate requirements for flood resistant and resilient refurbishment of flooded properties in high flood risk areas.

- In line with the recommendations of the Pitt Review, it is recommended that the Council produces a Surface Water Management Plan as a tool to improve co-ordination of activities between stakeholders involved in surface water drainage.

11.10 Recommendations: Future Updates to the SFRA

11.10.1 The SFRA should be retained as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance. It is recommended that outputs from the following studies are used to update future versions of the SFRA report and associated maps:

- Future Flood Risk Mapping Studies (such as the River Chelt SFRM study)

- Future Flood Risk Management Strategies

- Future groundwater flood risk maps, surface water flood risk maps and reservoir inundations maps. These should also feed into emergency planning documents

11.11 Recommendations: Next Stage of Work

11.11.1 It is recommended that a detailed interrogation of emerging allocations is carried out using the SFRA data and the table supplied in Appendix F. The flood risk posed to each site should be assessed, as well as the presence of defences and culverts. Any issues with the Flood Zones in each development site (mis-alignments etc.) should be identified. The Sequential Test should then be carried out for sites in Flood Zones 2 and 3, or where sites in Flood Zone 1 are affected by other sources of flooding. Where the resolution of flood risk data is poor, appropriate development easements, or further modelling work, should be put identified in consultation with the Environment Agency, to assist the Sequential Test process.

11.11.2 The Environment Agency will require a Level 2 SFRA to be carried out in order to provide a detailed assessment of the risk of flooding from non-fluvial sources, in areas where new development is proposed.

11.11.3 With regard to fluvial sources of flood risk, a Level 2 SFRA will be required where the need to apply the Exception Test is identified (as outlined in Table D3 of PPS25). This cannot be determined until the Sequential Test has been carried out on all proposed development sites. It is recommended that the Level 2 SFRA approach is agreed with the Environment Agency.

11.12 Recommendations: Level 2 SFRA

11.12.1 A Level 2 SFRA should be viewed as rather more site specific than a Level 1 SFRA, addressing flood risk to potential development sites which have gone through the Sequential Test and have been located in Flood Zones 2 or 3, or behind existing defences. The data required for a Level 2 SFRA will therefore depend upon which, if any, of the Council's final list of preferred sites remain in Flood Zones 2 and 3 following application of the Sequential Test and hence where the Exception Test needs to be applied.

11.12.2 In addition, The Environment Agency will require a Level 2 SFRA to be carried out in order to provide a detailed assessment of the risk of flooding from non-fluvial sources, in areas where new development is proposed.

11.12.3 It is important that a Level 2 SFRA considers the variation of flood risk in a Flood Zone. This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding). If development is to be located behind defences, it would be necessary to model constructional failure of the defence (breach) and water levels rising to exceed the level of the defence (overtopping). In some instances improvements to existing flood defences may be required to manage residual flood risks. Here, the SFRA should include an appraisal of the extent of works to provide or raise the flood defence to appropriate standard.

11.12.4 Level 2 SFRA outputs would include:

- Maps showing distribution of flood risk across zones (depth, velocity, rate and onset of flooding)
- An appraisal of the probability and consequence of breach or overtopping of flood defence infrastructure
- An appraisal of the condition of flood defence infrastructure and likely future policy
- Guidance on appropriate policies for making sites which satisfy parts a) and b) of the Exception Test, and the requirements for satisfying part c) of the Exception Test
- Guidance on the preparation of FRAs for sites with varying flood risk across the Flood Zone

11.12.5 As soon as the need to apply the Exception Test is identified, a Level 2 SFRA should be initiated.

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12 Glossary

1) **ABD -** Area Benefiting from Defences. Such areas are defined as areas benefiting from formal flood defences specifically in the event of flooding from rivers with a 1% (1 in100 year) chance in a given year, or flooding from the sea with a 0.5% (1 in200 year) chance in any given year. If the defences were not there these areas would be flooded. An area of land may benefit from the presence of a flood defence even if the defence has overtopped, if the presence of the defence means that the flood water does not extend as far as it would if the defence were not there (Source: Environment Agency Policy Number 132_06)

2) **AONB** - Area of Outstanding Natural Beauty. These are areas of countryside with significant landscape value.

3) **Breach Hazard** – Hazard attributed to flooding caused by the constructional failure of a flood defences or other structure that is acting as a flood defence.

4) **BFIHOST** – Base Flow Index derived from the Hydrology Of Soil Types classification as described in the Flood Estimation Handbook

5) **CFMP** – Catchment Flood Management Plan. A CFMP is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

6) **Core Strategy -** The Development Plan Document which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.

7) **Culvert** - A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal, or other impediment

8) **Defra -** Department of Environment, Food and Rural Affairs Development

9) **DG5 Register -** A register of properties at risk from sewer flooding maintained by UK water companies.

10) **DPD -** Development Plan Document. A DPD is a spatial planning document within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination.

11) **DPSBAR** – Mean drainage path slope

12) **Dry pedestrian egress -** Routes to and from buildings that will remain dry and allow pedestrian/wheelchair evacuation to dry land in times of flood.

13) **Environment Agency -** The leading public body for protecting and improving the environment in England and Wales.

14) **Environmental Stewardship** - Environmental Stewardship is a new agri-environment scheme which provides funding to farmers and other land managers in England who deliver effective environmental management on their land. The scheme is intended to build on the

recognised success of the Environmental Sensitive Areas scheme and the countryside Stewardship Scheme. Flood risk management is among its secondary objectives.

15) **Exception Test -** If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS25 sets out strict requirements for the application of the Test.

16) **Flood Estimation Handbook (FEH) -** The latest hydrological approach for the estimate of flood flows in UK.

17) **Flood Defence** – Natural or man-made infrastructure used to reduce the risk of flooding

18) **Flood Risk –** Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred

19) **FRA –** Flood Risk Assessment. Assessment of **flood risk** posed to a defined area (usually a new development site) as defined above.

20) **Flood Risk Management –** Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences and reduce the impact through influencing development on flood risk areas, flood warning and emergency response.

21) **FWD –** Floodline Warnings Direct. FWD is a system maintained by the Environment Agency which sends out warning messages to homeowners and businesses over the telephone network when floods are likely.

22) **Flood Risk Vulnerability -** PPS25 provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone.

23) **Formal Flood Defence -** A structure built and maintained specifically for flood defence purposes.

24) **Flood Zones -** Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

25) **Functional Floodplain Zone 3b -** Defined as areas at risk of flooding in the 5% AEP (1 in 20 year) design event. In any one year the chance of a 5% AEP (1 in 20 year) event occurring is 5%.

26) **GIS –** Geographic Information System. GIS is any system which stores geographical data, such as elevations, location of buildings and extent of flood outlines.

27) **High probability Zone 3a -** Defined as areas at risk of flooding in the 1% AEP (1 in 100 year) design event. In any one year the chance of a 1% AEP (1 in 100 year) event occurring is 1%.

28) **Informal Flood Defence -** A structure that provides a flood defence function however has not been built and/or maintained for this purpose (e.g. boundary wall).

29) **Integrated urban drainage** – An integrated approach to surface water management

30) **JFLOW -** A computer river model based on routeing a flood calculated by Flood Estimation Handbook methodology along a river corridor the levels of which are derived from a Side Aperture Radar (SAR) remote sensed Digital Terrain Model.

31) **Land Swapping** - looking for long term opportunities to remove development from areas that flood at present and relocate in lower risk locations which is essentially restoration of the floodplain.

32) **LDD** – Local Development Documents

33) **LiDAR -** Light Detection and Ranging. LiDAR is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground.

34) **LDF -** Local Development Framework. The LDF consists of a number of documents which together form the spatial strategy for development and the use of land.

35) **LDS –** Local Development Scheme. A schedule and timetable for production of LDF documents.

36) **Low Probability Zone 1 –** The area outside Zone 2. Defined as an area with less that 0.1% AEP (1 in 1000 year) chance of flooding. In any one year the chance of a 1% AEP (1 in 100 year) event occurring is less than 0.1%.

37) **LPA –** Local Planning Authority

38) **Main River –** All watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Food and Rural Affairs. This can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel. The Environment Agency has permissive power to carry out works of maintenance and improvement on these rivers.

39) **'Making Space for Water' (Defra 2004) -** The Government's new evolving strategy to manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches, so as: a) to reduce the threat to people and their property; b) to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles, c) to secure efficient and reliable funding mechanisms that deliver the levels of investment required.

40) **Medium probability Zone 2 -** Defined as an area at risk of flooding from flood events that are greater than the 1% AEP(1 in 100 year), and less than the 0.1% AEP (1 in 1000 year) design event. The probability of flooding occurring in this area in any one year is between 1% and 0.1%.

41) **Minor River -** Every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority or Internal Drainage Board (IDB) where relevant, has powers for ordinary watercourses.

42) **mAOD –** Metres Above Ordnance Datum

43) **NGR –** National Grid Reference

44) **NFCDD –** National Flood and Coastal Defence Database. Owned by the Environment Agency, NFCDD containing details of the location, standard and condition of all Environment Agency maintained defences.

45) **OS** - Ordnance Survey

46) **Ordinary Watercourse (non-main river, minor watercourse)** – Any section of watercourse not designated as a Main River.

47) **PPG** – Policy Planning Guidance. PPG notes are statements of the Government's national policy and principles towards certain aspects of the town planning framework, and have been superseded by Planning Policy Statements in many cases (below).

48) **PPS -** Planning Policy Statements. The Government has updated its planning advice contained within Planning Policy Guidance Notes with the publication of new style Planning Policy Statements.

49) **PPS 25 -** Planning Policy Statement 25: Development and Flood Risk. PPS 25 reflects the general direction set out in 'Making Space for Water'.

50) **Previously Developed (Brownfield) Land -** Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land.

51) **Residual Risk -** The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

52) **Return Period –** The probability of a flood of a given magnitude occurring within any one year e.g. a 1% AEP (1 in 100 year) event has a probability of occurring once in 100 years, or a 1% chance in any one year. However, a 1% AEP (1 in 100 year) event could occur twice or more within 100 years, or not at all.

53) **RFRA –** Regional Flood Risk Assessment

54) **RSS** - Regional Spatial Strategy. The RSS for Gloucestershire is the South West RRS, a regional planning policy providing the overarching framework for the preparation of LDFs. It provides a broad development strategy for the South West region up to 2026.

55) **Sequential Test -** Informed by a SFRA, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

56) **SEA -** Strategic Environmental Assessment.

57) **SFRA -** Strategic Flood Risk Assessment. An SFRA is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints,

informing sustainability appraisals and identifying locations of emergency planning measures and requirements for flood risk assessments.

58) SFRM – Strategic Flood Risk Management. An Environment Agency Framework which facilitates the implementation of **Flood Risk Management**.

59) **SPD** - Supplementary Planning Document. An SPD provides supplementary guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan, nor are they subject to independent examination.

60) **SPR** – Standard percentage runoff from the Hydrology of Soil Types classification.

61) **SA -** Sustainability Appraisal. An SA is an appraisal of plans, strategies and proposals to test them against broad sustainability objectives.

62) **SoP –** Standard of Protection. The return period against which a defence offers protection.

63) **SSSI** – Site of Special Scientific Interest. SSSIs are designated protected areas in the UK. NNRs and SACs are both SSSIs.

64) **SUDS –** Sustainable Urban Drainage Systems. SUDS are drainage systems which are designed to reduce the impact of urbanisation on the hydrology of a river system.

65) **Sustainable Development –** "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987)

66) **Wrack Mark** – a recorded level following a flood event

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13 References

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APPENDIX A

Environment Agency Sign-off Letter

APPENDIX B

Map Index

APPENDIX C

Sequential Test Process

APPENDIX D

Flood Zone Information

APPENDIX E

Pitt Review Recommendations

APPENDIX F

Template to Assist with Sequential Test