Gloucestershire County Council

Strategic Flood Risk Assessment for
Minerals and Waste Development Framework
Level 1 - FINAL
September 2008

Halcrow Group Limited

Gloucestershire County Council

Strategic Flood Risk Assessment for Minerals and Waste Development Framework Level 1 - FINAL

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1		Draft Report	25/04/08	RD
2		Final Report	22/08/09	RD
2	A	Final Report	23/09/08	RD

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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, river and tidal 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 and to give the County Council the necessary information to inform the Minerals and Waste Development Framework (MWDF). 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.

Gloucestershire County Council requires an SFRA to form part of the MWDF (2006-2026) evidence base. The Level 1 SFRA will assist the Sustainability Appraisal (SA) and Strategic Environmental Assessment (SEA) in the evaluation of the MWDF proposed policies in relation to flood risk. As part of the Gloucestershire SFRA commission, an SFRA document has been produced for each of the six local authorities in Gloucestershire. This document provides the County Council with the necessary information on the application of the SFRA to minerals and waste site allocations. The County Council should use the information in the individual District documents and maps, supplied with this report, to ensure flood risk is fully taken into account in the MWDF planning proposals.

The SFRA is an important tool which will inform the Council of the nature of flood risk in the County. It will provide an important part of the evidence base for the preparation of the MWDF, in particular the Core Strategy. Furthermore the SFRA will provide useful information for the SA. It will assist in the development of appropriate flood risk management policies. The suggested policies contained in this document take strong direction from the recommendations of PPS25, Making Space for Water, the Water Framework Directive and relevant Catchment Flood Management Plans (CFMPs).

In accordance with PPS25 and its Practice Guide (2006), areas of ‘low’, ‘medium’ and ‘high’ risk have been mapped using data collected from the Environment Agency, Gloucestershire County Council and its Local Authorities, water companies, the Highways Agency, Internal Drainage Boards (IDBs) and British Waterways. This included information on flooding from all sources and provides the basis for the Sequential Test to be applied. The Council must apply the Sequential Test to all minerals and waste sites within the ‘high’ and ‘medium’ risk flood zones 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 proposed. It is important that policies should 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).

1.1.2 This document sets the context of the SFRA for Gloucestershire County Council's Minerals and Waste Development (MWDF). As part of this commission an SFRA has been produced for each of the six local authorities in Gloucestershire. The information presented in these documents will give the County Council the necessary information to inform the MWDF to ensure due regard is paid to flood risk in the creation of policies and plans. They should be used in conjunction with this report to appropriately inform the MWDF with regard to flood risk in Gloucestershire.

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 Practice Guide Companion to PPS25 (2006, paragraph 1.39) provides guidance for Minerals and Waste authorities when preparing SFRAs by stating:

"Waste and mineral planning authorities (including county councils) should develop their policies and plans with due regard to Regional Spatial Strategies (RSS), Regional Flood Risk Appraisals (RFRAs) and any available SFRAs. They should apply the sequential approach to allocation of sites for waste management, mineral extraction and processing."

1.2.3 The MWDF should therefore use the information and data presented in the individual District Council SFRAs undertaken as part of this commission to allow a sequential approach to the allocation of Minerals and Waste sites within Gloucestershire. The provision of the SFRA data as GIS layers for Gloucestershire (included in the CD attached to this report) will enable this process.

1.2.4 PPS25 states that the County Council should apply the Sequential Approach to the allocation of sites for waste management, mineral working and processing. The aim of the SFRA therefore is to map all forms of flood risk and use this as an evidence base to locate minerals and waste sites in the appropriate flood risk areas, with preference given to the lowest flood risk area (Zone 1). Clearly minerals can only be worked where they occur, therefore the findings of this study should be used to decide if an alternative mineral site in a lower risk Flood Zone would be more appropriate to take forward as a preferred site. Where minerals and waste sites cannot be located in Flood Zone 1, the planning authority will need to apply the Sequential Test to minerals and waste allocations and, where necessary, the Exception Test (Level 2 SFRA). In addition, the SFRA will allow the Council 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

1.2.5 The SFRA will inform the site selection process for future minerals and waste 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 documents, 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 Level 1 SFRA have been adopted for this study. The deliverables of this assessment are as follows:

- A summary document, technical report and series of maps for each Gloucestershire LPA (map indices can be found in Appendix B and relate to the individual District documents)
- A Minerals and Waste document for the County Council

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

1) Plans showing the administrative boundaries of the study area, watercourse centrelines, modelled watercourses, canals, defences, Areas Benefiting from Defences (ABDs), Internal Drainage Board (IDB) areas and culverted watercourse sections (Volume 2, A Tiles)

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, B Tiles)

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

4) The location of any flood risk management measures, including both infrastructure (Volume 2, A Tiles) and the coverage of flood warning systems (Volume 2, F Tiles)

5) Guidance on the application of the Sequential Test (see Chapter 9)

6) Guidance on the preparation of FRAs for development sites (see Chapter 10)

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 11 of District Documents)

1.5 Outcomes of the SFRA Process

1.5.1 A Level 1 SFRA provides sufficient data and information to enable a planning authority to apply the Sequential Test to land use allocations and can therefore identify where the Exception Test needs to be applied (see Sections 1.5.4 and 1.5.8 respectively).

1.5.2 PPS25 also indicates that SAs should be informed by the SFRA. Under the Town and Country Planning (Local Development - England) Regulations 2004, a SA is required for all Local Development Frameworks (LDFs) and MWDFs. 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 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 Approach and Sequential Test

1.5.4 The Sequential Approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk, and can be applied both between and within Flood Zones. The Sequential Test refers to the application of this approach by Local Planning Authorities (LPAs). 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. Appendix C shows the Sequential Test process as advocated in PPS 25.

1.5.5 In carrying out the Sequential Test, preference should be given to locating sites for waste management, mineral extraction and processing 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 1.1) 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.

1.5.6 While mineral working and processing works are classed as 'less vulnerable' and can therefore be carried out in Flood Zone 3a, the opportunity to locate these workings in Flood Zone 1 should be taken in preference to working and processing minerals in higher flood risk areas. The placement of such workings in Flood Zone 1 better enables any storage and office accommodation to be located in lower risk areas, reduces the risk posed to those working on site and allows the workings to continue operation while higher risk areas might be affected by a flood event.

1.5.7 Sand and gravel sites are typically found in abundance within floodplains, and as such might be the only available areas for sand and gravel working and processing. Sand and gravel workings are therefore classed as 'water-compatible'. The 'water-compatible' classification means they can be worked in the highest risk areas, Flood Zones 3a and 3b. However, a sequential approach is still required to ensure that alternative sites are considered, should they exist, and that the layout minimises the detrimental impact on floodplain storage capacity and flow conveyance throughout the life cycle of the mineral allocation site. Should a sand and gravel workings be located in high flood risk areas, the site should be designed in such a way as to enable any storage and office accommodation to be located outside Flood Zones 3a and 3b. Table 1.1 outlines the compatibility of different minerals and waste sites to each Flood Zone.

Table 1.2: Flood Risk Vulnerability and Flood Zone 'Compatibility' (Adapted from Table D3 of PPS25)

Flood Risk Vulnerability and Flood Zone 'Compatibility' Table for mineral and waste land uses					
Flood Risk Vulnerability Classification	**Mineral and Waste Land Uses**	**Flood Zone**			
		1	**2**	**3a**	**3b**
Essential Infrastructure		✓	✓	***ET***	***ET***
Water Compatible	Sand and Gravel Workings	✓	✓	✓	✓
Less Vulnerable	Waste treatment (except landfill and hazardous waste facilities) and Minerals working and processing (except for sand and gravel working)	✓	✓	✓	***X***
More Vulnerable	Landfill and sites used for waste management facilities for hazardous waste	✓	✓	***ET***	***X***
Highly Vulnerable	Installations requiring hazardous substances consent	✓	***ET***	***X***	***X***

ET : Exception Test Required

✓ : Development is appropriate

X : Development should not be permitted

The Exception Test

1.5.8 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. Instances where the Exception Test might need to be applied are indicated in Table 1.1.

1.5.9 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.

1.5.10 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 a 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;

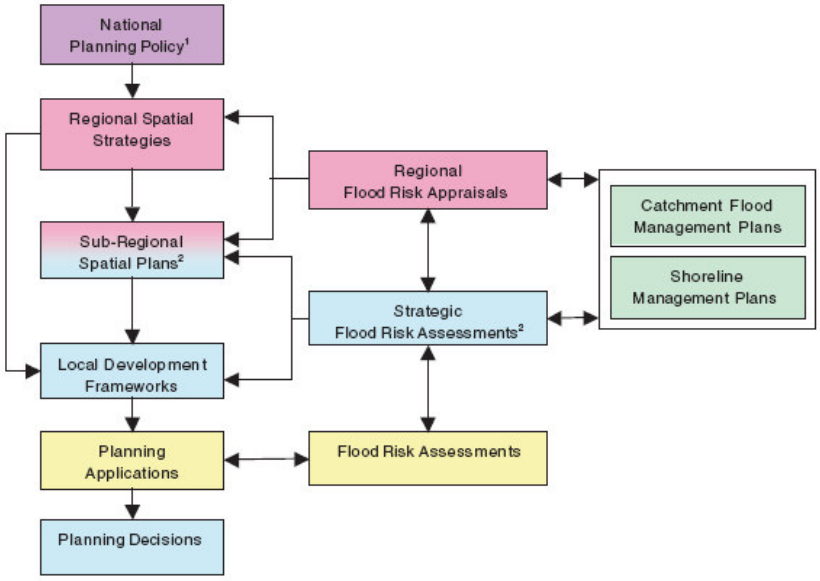
b) The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and,

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

1.5.11 It is possible that the Council will need to apply the Exception Test if relevant waste sites fall within Flood Zones 2 or 3 (as outlined in Table D3 of PPS25), 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 1.2: Development planning process for flood risk

1.7 The Study Area

1.7.1 The SFRA covers the County of Gloucestershire, encompassing six local authorities which include Forest of Dean District Council, Tewkesbury Borough Council, Gloucester City Council, Cheltenham Borough Council, Stroud District Council and Cotswold District Council. The County is covered by the South West Regional Spatial Strategy, as detailed in Section 3.4.

1.7.2 Gloucestershire covers an area of some 2700km² and borders Malvern Hills and Wychavon District Councils of Worcestershire to the north; Stratford on Avon District Council of Warwickshire to the north east; West Oxfordshire District Council to the east; Vale of White Horse District Council and Swindon Borough Council to the south east, North Wiltshire District Council and South Gloucestershire Unitary Authority to the south and Wales to the east.

1.7.3 Gloucestershire commands are predominantly rural setting, with population centred around the main urban areas of Gloucester, Cheltenham, Stroud and Cirencester, though numerous small towns and villages exist. The County is drained predominantly by the lower reaches of the River Severn, which flows through the centre of Gloucestershire from the north east to the south west. The Cotswold Hills to the east of the County and the upland areas of the Forest of Dean to the west form the Severn's catchment boundary; areas which are in sharp contrast to the lowland river valley. To the south east of the Cotswold Hills the prevalent catchment is the River Thames catchment, which drains the majority of the Cotswold District.

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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:

a) Establishing relationships and understanding the planning context:

An Inception meeting was held to build relationships between the project team, the County and District Councils and the Environment Agency. This allowed the partnering approach to form, and allowed the free exchange of available information. Discussions were held on the status of the District Councils' LDFs, the County Council's MWDF and planning pressures 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. GIS layers of the SFRA data for Gloucestershire 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

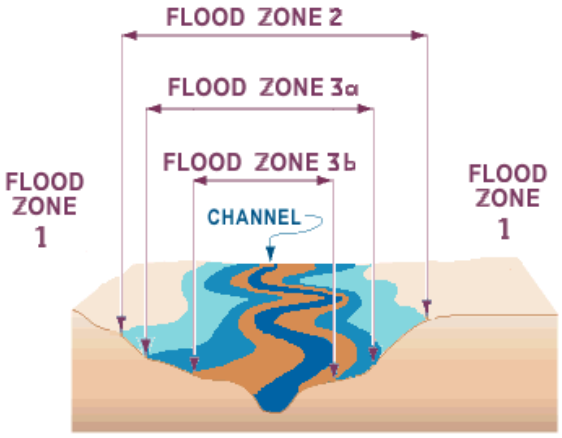
2.2.4 In general, the Level 2 SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zone 3, which are protected by existing defences. This should minimise the extent to which individual developers need to undertake separate studies on the 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 or the sea, ignoring the presence of defences (although areas benefiting from formal defences are identified).



PPS25 defines the Flood Zones as follows:

Zone 1: Low Probability

2.3.3 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

2.3.4 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

2.3.5 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

2.3.6 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, or at another probability agreed between the LPA and the Environment Agency, 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.

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

2.3.8 Flood Zone maps in the SFRA have been produced from two sources: Environment Agency Flood Zone maps, published and updated quarterly on their website, and detailed local hydraulic modelled outlines (a list of these models can be found in the individual District SFRA documents Volume 1, 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 (although with regard to sand and gravel workings this can be negotiated with the Environment Agency), 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.

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3 Planning Context

3.1 Introduction

3.1.1 This chapter provides an overview of the planning policy framework relevant to the Gloucestershire County Council MWDF.

3.1.2 This report conforms to National and Regional Planning Policy. Information contained in the Gloucestershire SFRA will provide evidence to facilitate the preparation of robust policies for flood risk management. The SFRA should be used to inform the SA of LDDs and will enable informed decisions to be made relating to land use and development allocation 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 which provides a broad framework for regional plans through to development plans at the local level. Development plans are intended to provide clear guidance for prospective developers. 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 PPSs replacing Planning Policy Guidance (PPG), Minerals Policy Statements (MPS) replacing Minerals Planning Guidance Notes (MPG), Regional Spatial Strategies (RSS) replacing Regional Planning Guidance (RPG) and LDFs replacing Structure and Local Plans and Unitary Development Plans.

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

3.3 National Planning Policy

PPS 1: Creating Sustainable Communities (2005)

3.3.1 PPS 1 sets out the Government's objectives for the planning system. It confirms that good planning should deliver the right development in the right place and 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 PPS 1)

3.3.2 Planning and Climate Change has been introduced in consultation form as a proposed supplement to Planning Policy Statement 1. The Draft 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). Minerals and waste developments potentially have much to offer in this respect, particularly regarding site restoration where woodland management (providing carbon sink) may be a realistic option.

PPS 7: Sustainable Development in Rural Areas (2004)

3.3.3 PPS 7 urges planning authorities to encourage use of lower grade agricultural land in preference to grades 1, 2 and 3a of the Agricultural Land Classification. For many types of minerals development the use of higher grade land in unavoidable, although high quality restoration of quarries can ensure that impacts to agricultural land are kept to a minimum.

PPS 9: Biodiversity and Geological Conservation (2005)

3.3.4 PPS 9 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.

PPS 10: Planning for Sustainable Waste Management (2005)

3.3.5 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.

PPG 17: Planning for Open Space and Recreation (2002)

3.3.6 PPG 17 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.

PPS 22: Renewable Energy (2004)

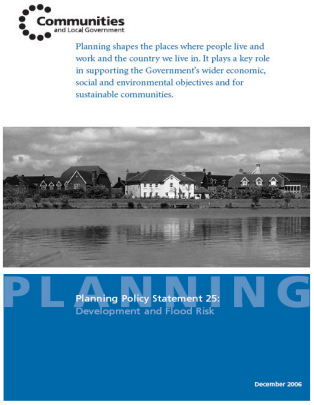
3.3.7 PPS 22 sets out how the planning system can contribute to the implementation of the government's energy policies through enabling the use of renewable energy. Waste development in particular can contribute to this aim. The accompanying good practice guidance to PPS 22 recognises the following types of waste related sources of renewable energy:

- Energy from Waste (Biological processes) including Anaerobic Digestion, landfill & sewage sludge digestion
- Energy from Waste (Thermal processes) including pyrolysis and gasification

PPS 23: Planning and Pollution Control

3.3.8 PPS 23 sets out national policy on the protection of the environment stating that "*any consideration of the quality of land, air or water and potential impacts arising from development, possibly leading to impacts on health, is capable of being a material planning consideration"* and goes on to state that "LD*Ds, which set the policy framework for the development of an area, can prevent harmful development and mitigate the impact of potentially polluting developments over the medium to the long term"*. Minerals and waste development can be associated with various impacts on the environment, therefore development control policies will be required to ensure that the impacts of development are avoided and/or mitigated.

PPS 25: Development and Flood Risk (2006)



3.3.9 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.

MPS 1: Planning and Minerals

3.3.10 MPS 1 sets out the Government's key overarching policies and principles which apply to all types of mineral extraction and development in England. It provides national polices and guidance to planning authorities and the minerals industry to ensure that the need by society and the economy for minerals is managed in an integrated way against its impact on the environment and communities.

MPS 2: Controlling and Mitigating the Environmental Effects of Minerals Extraction in England

3.3.11 MPS 2 considers the impacts of minerals development on the environment stating "the need to keep these impacts to an acceptable minimum in the planning and operation of extraction sites is a high priority". The document provides additional guidance in the form of annexes which to date cover dust and noise.

MPG 7: The Reclamation of Mineral Workings

3.3.12 MPG 7 recognises that the impacts of minerals development can continue beyond the life of the mine or quarry and therefore encourages the restoration of minerals development at the earliest opportunity.

Town and Country Planning Amendments

3.3.13 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.

3.3.14 The Town and Country Planning (Flooding) (England) Direction 2007 was published in December 2006. To safeguard against inappropriate development in flood risk areas, it 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. The Direction came into force on 1 January 2007.

3.4 Regional Planning Policy

3.4.1 This section provides an overview of the South West Regional Spatial Strategy (RSS) relevant to Minerals and Waste. Details of how the RSS impacts upon LDFs can be found in the individual District SFRA documents.

3.4.2 Regional planning policies provide the overarching framework for the preparation of LDFs and MWDFs. The Draft South West 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.

3.4.3 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 and MWDFs
- 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

3.4.4 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 MWDF 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;
- 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

3.4.5 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.

3.4.6 The RSS identifies the regional apportionment for aggregate demand, and states that Gloucestershire will provide the following:

Table 3.3: Aggregate demand for Gloucestershire

Crushed Rock (million tonnes, Mt)	Annualised Production Rate (Mt)	Sand and Gravel (Mt)	Annualised Production Rate (Mt)
39.09* (31.09)	2.44* (1.94)	18.18	1.14

*Potential reduction if proposed re-apportionment of 8Mt is feasible

3.4.7 Policy RE11 states that mineral planning authorities should endeavour to maintain a landbank of at least seven years during the period to 2016. The ability to meet their primary aggregate apportionment, as set out in Table 3.1, will be tested against environmental factors as the Mineral

Development Documents are brought forward. What is also reinforced is the opportunities that extraction of minerals can make for biodiversity, geo-diversity and amenity gains through appropriate restoration and aftercare. Indeed, the restoration of mineral workings to flood storage areas can have a positive impact on flood risk reduction in many cases.

3.4.8 With regard to waste sites, the RSS provides capacity allocations for the main waste streams for Gloucestershire for the years 2010, 2013 and 2020 as follows:

Table 3.4: Capacity allocations for the main waste streams for Gloucestershire

Target Year	Minimum Source Separated (000s t/annum)	Maximum Secondary Treatment (000s t/annum)	Maximum Landfill (000s t/annum)
2010	130	80	160
2013	150	120	130
2020	170	200	60

3.4.9 Policy W1 states that Waste Planning Authorities will make provision in their Waste Development Frameworks for a network of strategic and local waste collection, transfer, treatment (including recycling) and disposal sites to provide the capacity to meet the indicative allocations as shown above for 2010, 2013 and 2020.

Relevant RSS Policies

3.4.10 Section 7 of the RSS sets out the Region's approach on two critical aspects of 'quality of life' in the region: culture and environment. The aim is to enhance the distinctive environments and the quality and diversity of our cultural life, including cultural activity and infrastructure; natural environment landscape, nature conservation, historic environment), the coast, flood risk, energy, water resources, land management, woodlands and forests, air quality, minerals, and waste management. It also contributes to the Draft RSS policies in Section 1 (SD1 to SD4) of living within environmental limits and achieving sustainable communities by setting out ways the region can use natural resources more wisely, protect and enhance distinctive natural environments, and increase access to and participation in cultural activities.

3.4.11 Chapter 7 goes on to put forward policies relevant to the management of flood risk, as follows:

- **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"*

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

- **Policy RE6: Water Resources:** *"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.

3.5 Local Planning Policy

Gloucestershire Minerals and Waste Development Framework

3.5.1 The Gloucestershire Minerals and Waste Local Plans were adopted in May 2003 and autumn 2004 respectively. Under the 2004 Planning and Compulsory Purchase Act the Minerals and Waste Planning Authority will move towards the preparation of the Minerals and Waste Development Framework (MWDF) for the period 2006 to 2026. In the interim the Minerals Local Plan and Waste Local Plan were automatically saved for a period of at least three years from September 2004 or from

date of adoption. Beyond 2007 only some of the policies and proposals have been saved by the Secretary of State. The schedules of saved policies from the Minerals and Waste Local Plans comprise the development plan until replaced as and when new development plan documents are adopted.

3.5.2 The MWDF will consist of several DPDs such as the Core Strategy and Site-specific Allocations. The Minerals Development Framework will contain details of all sites allocated for minerals extraction and processing during the plan period and policies specific to particular sites, while the Waste Development Framework will contain details of all sites allocated for waste management during the plan period and policies specific to particular sites. The timetable for preparing the MWDF and the documents intended to be produced are set out in a Minerals and Waste Development Scheme (MWDS). These Development Plan Documents (DPDs) to be produced include:

- Proposals Map
- Minerals Core Strategy
- Waste Core Strategy
- Waste Site Allocations
- Minerals Site Allocations
- Development control Policies
- Annual Monitoring Report

3.5.3 Gloucestershire County Council requires an SFRA to form part of the MWDF evidence base. This Level 1 SFRA will assist the Sustainability Appraisal and Strategic Environmental Assessment in the evaluation of the MWDF proposed policies in relation to flood risk.

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4 Data Collection and Review

4.1 Introduction

4.1.1 This chapter gives an overview of the data collection and review process carried out as part of the Gloucestershire SFRA. 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, therefore flood risk from each of these sources has been assessed. The resultant findings can be found in the individual SFRA documents and maps for each Gloucestershire District.

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 Data Outputs

4.3.1 The findings of the data analysis can be found in Chapter 4 of the individual District SFRA documents. These give a detailed account of flood risk from all sources in each Gloucestershire local authority, including assumptions and limitations. In addition, historic flooding has been assessed and a detailed account of the summer 2007 floods is given.

5 Strategic Flood Risk Mapping

5.1 Strategic Flood Risk Maps

5.1.1 The data assessed in Chapter 4 has allowed the production of strategic flood risk maps, which should be used by the County Council to carry out the Sequential Test on all proposed minerals and waste sites. These maps, which can be found in Volume 2 (B Tiles), show flood risk from sources including fluvial, tidal, 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 for the entire County, and can be interrogated to gain the associated descriptive information. These can be found in the CD attached to this report. The GIS layers showing the fluvial Flood Zones and flooding from other sources should be used by the County Council to carry out the Sequential Test.

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 4% AEP (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 a number of watercourses and the mapped outputs have been utilised for this study, details of which can be found in the individual SFRA documents. 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 JFLOW information has been used and is also presented in Volume 2, B Tiles. It should be noted that some smaller watercourses do not have Flood Zones produced for them.

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 separate high-level historical flooding maps in Volume 2, (B Tiles) of the individual SFRA documents. 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 Gloucestershire 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[1], 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.

5.5.2 Overall, these effects will tend to increase both the extent 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 may 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 5.1.

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

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%	

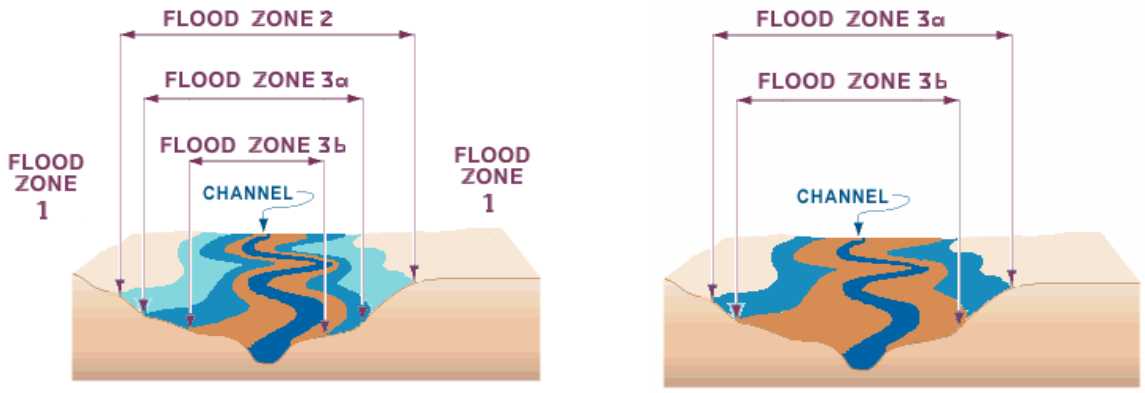
Methods used to derive the Climate Change maps

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 for Gloucestershire. 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 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 any modelled climate change outlines. This approach is explained in the images below.

Current Flood Risk **Future Flood Risk**



5.5.5 Using the information on modelled watercourses in the study area, the model outputs were reviewed. This study has sought to use modelled information for the1% AEP (1 in 100 year) climate change scenario (i.e. 100 +20%) in preference to the technique outlined previously, outlined 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 0.54% AEP (1 in 200 year) outlines often show similar extents to the climate change scenarios of the 100 year event.

5.5.6 Results of this assessment can be found in the individual SFRA documents. The resultant climate change outlines are provided in a series of maps covering the study area in Volume 2 (C Tiles).

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.

Likely Climate Change Impacts

5.5.8 Assessments of likely climate change impacts for each Gloucestershire District can be found in the individual SFRA documents. Overall, upland areas are likely to be subject to deeper, faster flowing water, while in lowland areas the extent of flooding is likely to become greater. Flood waters might also become 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. 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, C Tiles) which show that areas currently in Flood Zone 3a are likely to fall in Flood Zone 3b in the future.

5.5.9 For developments that are likely to have a life span of 100 years or more, such as residential uses, it has been recommended that the LPAs 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. However, given that mineral extraction and landfill sites do not usually have a particularly long life span, this is not considered necessary. The County Council might, however, wish to use this technique when locating waste processing sites which are likely to have a much linger lifespan.

5.5.10 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.

5.5.11 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.

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. Gloucestershire is covered by five CFMPs, which have each been reviewed to support the suggested policies outlined in Chapter 8. Further details about each CFMP and the bearing these have on flood risk management in each Gloucestershire District can be found in the individual SFRA documents.

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 Two strategies have been produced in the Gloucestershire area: the Severn Tidal Strategy (affecting the Forest of Dean, Stroud, Gloucester and Tewkesbury Districts) and the Severn Fluvial Strategy (affecting the Tewkesbury and Gloucester Districts). Each has been reviewed to ascertain impacts that the selected options will have on local authorities, and have fed into the suggested policies outlined in Chapter 8. Further details about each strategy and the bearing these have on flood risk management in Gloucestershire can be found in the individual SFRA documents.

6.4 Flood Defences

6.4.1 Flood defences 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 has also been included in the SFRA. 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.

6.4.2 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.

6.4.3 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).

6.4.4 There are a number of locations at risk of flooding that are currently protected by permanent defences within the County and these can be viewed in Volume 2 (A Tiles). Specific details about defences in each District can be found in the individual SFRA documents.

Informal Defences

6.4.5 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 County has been undertaken as part of this SFRA. Locations identified can be viewed in Volume 2, A Tiles.

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

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.

6.5 Culverts

6.5.1 Sections of culverted watercourse as identified within NFCDD have been demonstrated in Volume 2, (A Tiles). 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 6.7.

6.5.2 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.

6.6 Storage Areas

6.6.1 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.

6.6.2 Details of storage areas can be found in the individual SFRA documents. It should be noted that in many cases, mineral extraction sites can be restored to flood storage areas, offering benefit to the wider community in terms of flood risk management. Options to achieve this should be explored on a site-specific basis in consultation with the Environment Agency.

6.6.3 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.

6.7 Residual Risk

6.7.1 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

6.7.2 ABDs have been mapped in Volume 2 (A Tiles) of the individual SFRA documents. However, an assessment of residual risk should be made at the site-specific level as not all defences have ABDs

produced for them, even though defences may exist. 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 (A Tiles) to assist with this.

6.7.3 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

6.7.4 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 (A Tiles). 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 (A Tiles). In some cases site visits may be required.

6.7.5 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.

6.7.6 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.

6.8 Existing Flood Warning System

6.8.1 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.

6.8.2 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.

6.8.3 A flood warning system is in operation for the main rivers within Gloucestershire and is outlined below in four stages. Flood Watch and Flood Warning Areas can be seen in Volume 2 (E Tiles).

6.8.4 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.

- **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

- **Flood Warning:** Flooding of homes and businesses is expected. A Flood Warning could be issued at any time; a Flood Watch may not necessarily be issued first. Act now! The following actions, in addition to those associated with Flood Watch, are recommended:
  - Move pets, vehicles, food, valuables and other items to safety
  - Put sandbags or floodboards in place
  - Prepare to turn off gas and electricity
  - Be prepared to evacuate your home
  - Protect yourself, your family and others that need your help

Severe Flood Warning: Severe flooding is expected. A Severe Flood Warning could be issued at any time; a Flood Warning may not necessarily be issued first. There is extreme danger to life and property. Act now! The following actions, in addition to those associated with Flood Warning, are recommended:

- Be prepared to lose power supplies - gas, electricity, water, telephone
- Try to keep calm, and to reassure others, especially children
- Co-operate with emergency services and local authorities
- You may be evacuated

- **All Clear:** Flood Watches or Warnings are no longer in force. An All Clear can be issued at any stage e.g. a Flood Warning could be downgraded to All Clear without going to Flood Watch First. The following is recommended:
  - Flood water levels receding

- Check all is safe to return
- Seek advice

6.9 County Council Flood Response Plan[2]

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

6.9.2 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 6.1):

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

Table 6.3: 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

6.9.3 The plan goes on to give details of flood warning and mitigation, and 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.

6.9.4 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.

6.9.5 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 Table 6.2. 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 6.4: 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	✓		

6.9.6 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.

6.9.7 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.

6.10 Emergency Response Plan Recommendations

6.10.1 It is recommended that the County 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 to maximise the number of people signed up to the FWD service where this can be provided (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.

6.10.2 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.

6.10.3 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. This is particularly important for people who may be working on a mineral extraction site which is located in a river valley. 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

6.10.4 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.

7 Minerals and Waste

The SFRA provides the evidence base which should be used to ensure that flood risk is fully taken into account when allocating minerals and waste sites under the MWDF. This chapter sets out the context of this assessment within PPS25 and the implications this has for minerals and waste sites.

7.1 Context

7.1.1 Gloucestershire County Council has a duty to develop its policies and plans with due regard to flood risk, ensuring that the decision making process firstly seeks to achieve avoidance of flood risk (by applying the Sequential Test), and beyond that, managing risk (by the formulation of appropriate flood risk management and development control policies). This study will support the evidence base of the MWDF, as well as the SA.

7.2 Mineral Extraction

7.2.1 Mineral extraction sites are unique in the sense that they can only be worked where the mineral occurs. Therefore there is a much lesser degree of choice in locating mineral extraction sites as there is with other types of development. It is also sometimes difficult to avoid flood risk areas, particularly in the case of sand and gravel deposits, which are often found in abundance along river corridors.

7.2.2 Under the MWDF, mineral sites will be assessed against a number of sustainability criteria. One of these criteria relates to flood risk, which aims to ensure that mineral sites are subject to the Sequential Approach and located in areas at lowest risk from flooding, as outlined in Section 1.5.4 and again in Chapter 9. The maps showing flood risk from all sources (B Tiles) in Volume 2 of the individual SFRA documents should be used to carry out the Sequential Test. Consideration should be given to alternative sites in a lower risk flood zone in preference to mineral sites in higher risk areas. In instances where mineral workings can be located in Flood Zones 3a and 3b such as sand and gravel extraction, it is important that the site is designed in such as way as to enable any processing, storage and office accommodation to be located outside the high risk Flood Zones where practicable.

7.2.3 Mineral workings are classed as 'less vulnerable' and sand and gravel workings classed as 'water compatible', and can be located in Flood Zones 3a and 3b respectively. However, both are still subject to the Sequential Test and PPS25 states that decision makers should seek to select mineral sites in Flood Zone 1 wherever possible. However, sand and gravel workings, if followed by restoration as a water-body or on-line storage area, can in some cases, increase the capacity of the floodplain, therefore increasing flood storage and reducing flood risk to areas downstream of the site. Work with the Environment Agency will be essential in order to identify locations which could benefit from this, in order to realise these opportunities. Where such workings are located in high risk areas, Flood Zones 3a and 3b, detailed work should be carried out at the Preferred Options stage to assess how these mineral workings can assist in reducing the risk of flooding.

7.2.4 It should also be noted that there may be the opportunity to restore mineral workings in all Flood Risk Zones in such a way that the restoration can provide the potential for surface water attenuation areas, which could help in reducing the overall flood risk of a particular water course.

7.2.5 All mineral extraction sites will require a site-specific FRA to be submitted by the developer, which will address issues including the location of any plant, storage and office accommodation.

7.2.6 Where a minerals resource occurs across Gloucestershire's boundary it is worth working in partnership with neighbouring Councils to ensure flood risk is dealt with consistently in these areas, and that policies are formulated in partnership to ensure there is no conflict in the approach to permitting development in these areas.

7.3 Waste Sites

7.3.1 Under the MWDF waste sites will also be assessed against a number of sustainability criteria. One of these criteria relates to flood risk, which aims to ensure that waste sites are subject to the Sequential Approach and located in areas at lowest risk from flooding, as outlined in Section 1.5.4 and again in Chapter 9. The maps showing flood risk from all sources (B Tiles) in Volume 2 should be used to carry out the Sequential Test. Consideration should be given to alternative sites in a lower risk flood zone in preference to waste sites in higher risk areas.

7.3.2 Waste is not specified as water-compatible development and the Sequential Approach to any waste development should, therefore, be applied. Waste treatment works can be located in all Flood Zones except Flood Zone 3b; landfill and sites used for waste management facilities for hazardous waste can be located in Flood Zones 1 and 2; and installations requiring hazardous substances consent can only be located in Flood Zone 1. However, in all cases, the Sequential Test should be undertaken and opportunities to locate these developments in Flood Zone 1 should be taken in preference to sites in higher risk areas.

7.3.3 All waste management sites will require a site-specific FRA to be submitted by the developer.

8 Flood Risk Management Policy Considerations

8.1 Overview

8.1.1 This chapter provides recommendations for what should be included in the County Council's policy for flood risk management. This section relates specifically to the policy that should be considered for the MWDF. Council policy is considered essential to ensure that the recommended development control conditions can be imposed consistently at the planning application stage.

8.1.2 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.
- **Relevant CFMPs -** strategic planning documents 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.

8.2 Policy Considerations

8.2.1 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.

8.2.2 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 8.3.

8.2.3 **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, and ensure that the vulnerability classification of the proposed Minerals and Waste development is appropriate to the flood zone classification
- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, where an allocation is situated within more than one Flood Zone (e.g. Flood Zones 1, 2 and 3) opportunities should be sought to locate all stockpiles, waste mounds, soil storage areas, screening bunds and associated buildings in the lowest available flood zone (e.g. Flood Zone 1). Where this is not possible, an application should seek opportunities to mitigate any flood risk to its facilities or to offsite receptors which may be at increased flood risk as a consequence of the development

- An FRA should be undertaken for all Minerals and Waste development sites within Flood Zone 2 and 3, and sites with identified flooding from other sources, to assess the risk of flooding to the development and identify options to mitigate the flood risk to the development, site users and surrounding area

- An FRA is required for all Minerals and Waste development sites in Flood Zone 1 with an area greater than 1ha or have a floor area greater than 1000 m^2

- If floodplain storage is removed or reduced (e.g. by the introduction of mineral stockpiles, waste tips, soil storage areas, screening bunds and associated buildings) the development should provide appropriate compensatory storage to ensure that there is no loss in flood storage capacity

- Ensure buildings within a development are 'safe'. To be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. The Environment Agency states that dry pedestrian access/egress should be possible for the 1% AEP (1 in 100 year) +20% for climate change return period event, and residual risk, i.e. the risks remaining after taking the sequential approach and taking mitigating actions, during the 0.1% AEP (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

8.2.4 **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 of the individual SFRA documents outline appropriate SUDS techniques and Chapter 11 provides further guidance for developers on the application of SUDS.

- As part of any ongoing or future development within the County, 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 of the individual SFRA documents.

- 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. For the Cotswold District, where prevention, source control/infiltration cannot deal with all on-site site drainage, for both Greenfield and Brownfield sites, the development runoff volumes and peak flow rates leaving the site should be attenuated to the Greenfield discharge conditions. Note: For some currently highly constrained Brownfield sites it may not be feasible to meet this requirement. In these exceptional circumstances (subject to agreement with the Council and/or the Environment Agency) those proposing the development will be required to use the Greenfield conditions as the starting position for identifying what the next best option feasible on-site is. When involved, the Environment Agency will wish to see full justification as to why Greenfield conditions cannot be met.

  - 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)

8.2.5 **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)
- 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

- 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

- Opportunities to reduce flood risk as a result of the restoration process of mineral sites located within Flood Zone 2 and 3 should be considered at the earliest planning stage

- The conservation of strategic flood storage areas is imperative. Where necessary site specific FRAs should consider floodplain obstructions such as stockpiles, waste tips, soil storage areas, screening bunds and associated buildings. Opportunities should be taken where appropriate to ensure new flood storage capacity is achieved as part of the restoration process.

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

8.2.6 **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

8.2.7 **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

8.3 Development Control Policies

8.3.1 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.

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

Future Development within Flood Zone 1

8.3.3 There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1 (unless the issues outlined in Section 9.4 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.

8.3.4 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. For Cotswold District, where prevention, source control/infiltration cannot deal with all on-site site drainage, for both Greenfield and Brownfield sites, the development runoff volumes and peak flow rates leaving the site should be attenuated to the Greenfield discharge conditions. Note: For some currently highly constrained Brownfield sites it may not be feasible to meet this requirement. In these exceptional circumstances (subject to agreement with Council and/or the Environment Agency) those proposing the development will be required to use the Greenfield conditions as the starting position for identifying what the next best option feasible on-site is. When involved, the Environment Agency will wish to see full justification as to why Greenfield conditions cannot be met. Consideration must be given to the effect of the new development in terms of off-site consequences from all sources of flooding.

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

8.3.6 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

8.3.7 Following application of the Sequential Test, 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.

8.3.8 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.

8.3.9 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 (300mm for sites located within the Cotswold District)
- 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. Within the Cotswold District, for some currently highly constrained Brownfield sites it may not be feasible to meet this requirement. In these exceptional circumstances (subject to agreement with the Council and/or the Environment Agency) those proposing the development will be required to use the Greenfield conditions as the starting position for identifying what is feasible on-site. When involved, the Environment Agency will wish to see full justification as to why Greenfield conditions cannot be met and a minimum reduction of 20% will be required.
- 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

8.3.10 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.

8.3.11 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.
- A sequential approach should be followed within the site layout locating the higher vulnerability uses to the parts of the site with the lowest probability of flooding and to allow for SUDS.
- 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 600mm (300mm for Cotswold District). 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 (300mm for Cotswold District).

- 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. For Cotswold District, where prevention, source control/infiltration cannot deal with all on-site site drainage, for both Greenfield and Brownfield sites, the development runoff volumes and peak flow rates leaving the site should be attenuated to the Greenfield discharge conditions. Note: For some currently highly constrained Brownfield sites it may not be feasible to meet this requirement. In these exceptional circumstances (subject to agreement with Council and/or the Environment Agency) those proposing the development will be required to use the Greenfield conditions as the starting position for identifying what the next best option feasible on-site is. When involved, the Environment Agency will wish to see full justification as to why Greenfield conditions cannot be met.

- 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

8.3.12 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.

- Following application of the Sequential Test, 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). A sequential approach should be followed within the site layout locating the higher vulnerability uses to the parts of the site with the lowest probability of flooding and to allow for SUDS.
- 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.
- Any underground development e.g. swimming pools should consider both the impact they may have upon the movement of groundwater and the potential to increase risk elsewhere, as well as the risk to the development.

8.3.13 If sand and gravel workings are located in Flood Zone 3b, every effort should be made to locate all stockpiles, waste mounds, soil storage areas, screening bunds and associated buildings in the lowest available flood zone (e.g. Flood Zone 1). Emergency planning procedures should be in place to ensure those working on site can easily exit the site during a flood event.

9 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 8.3

9.1 The Sequential Approach

9.1.1 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.

9.2 The Sequential Test

9.2.1 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.

9.2.2 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.

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

9.3.1 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 E). 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.

9.4 Step Two: Flood Risk Issues in Zone 1

9.4.1 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.

9.4.2 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.

9.4.3 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 9.5), 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.

9.4.4 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.

9.4.5 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.

9.5 Step Three: Sequential Test in Zones 2 and 3

9.5.1 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.

9.5.2 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.

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

9.6 Application of the Sequential Approach to Other Sources of Flooding

9.6.1 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.

9.6.2 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.

9.6.3 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.

9.7 Dealing with Windfall Sites

9.7.1 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 8.3 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.

9.7.2 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.

9.7.3 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.

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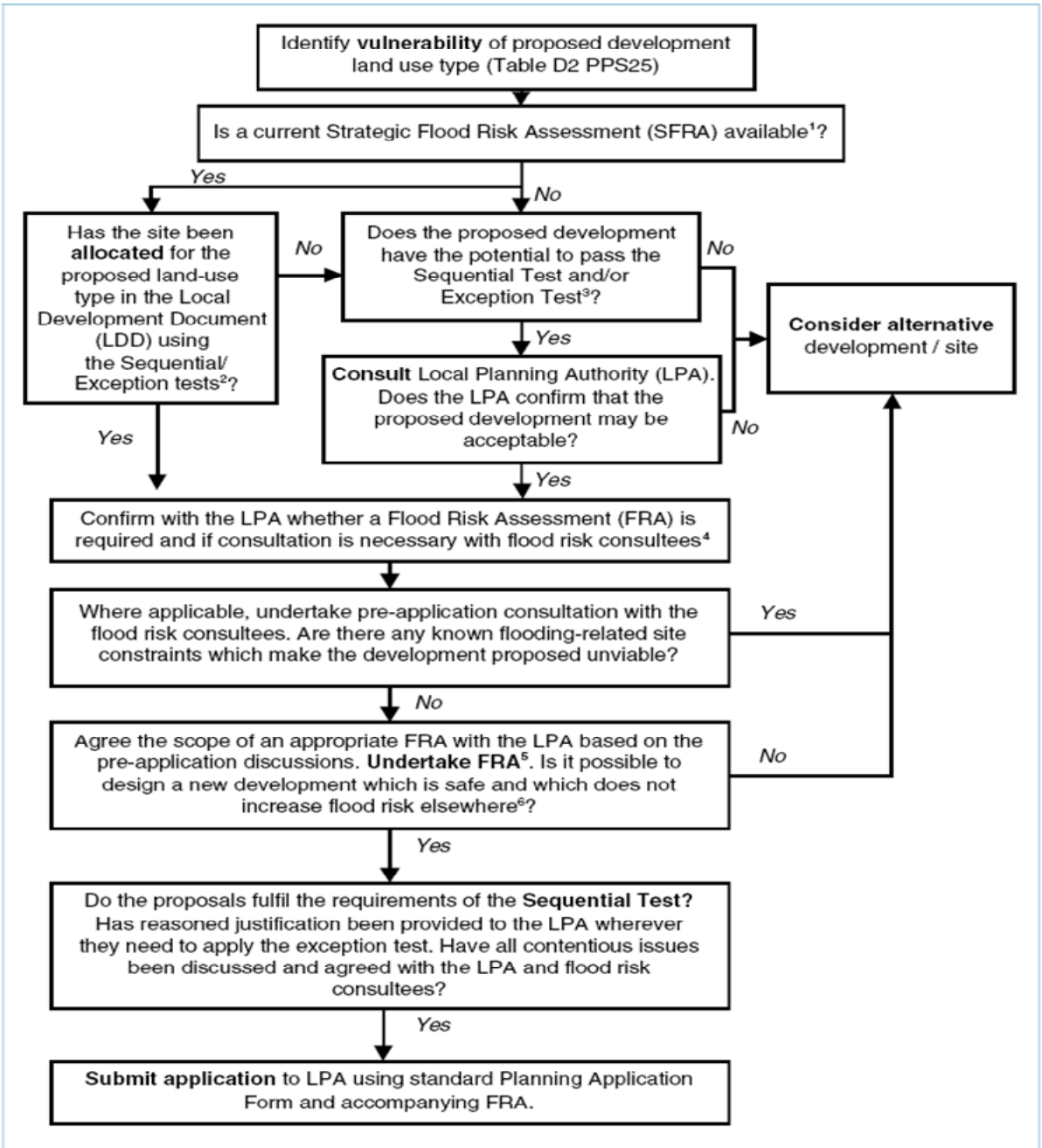
10 Guidance for Developers

10.1.1 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). An 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.

10.1.2 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 (Figure 10.1 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 10.2: Guidance for developers for individual planning applications

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

10.2 Proposed Development within Flood Zone 1

10.2.1 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.

10.2.2 The SFRA provides specific recommendations (Chapter 8) 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.

10.2.3 Further guidance on the requirements of site specific FRAs for sites identified as potentially at risk of non-fluvial sources can be found in the CIRIA document C624 *'Development and flood risk – guidance for the construction industry'* (Lancaster et al) available from the CIRIA bookshop (www.ciria.org).

10.3 Proposed Development within Medium Probability Zone 2

10.3.1 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.

10.3.2 Further guidance on the requirements of site specific FRAs for sites identified as potentially at risk of non-fluvial sources can be found in the CIRIA document C624 *'Development and flood risk – guidance for the construction industry'* (Lancaster et al) available from the CIRIA bookshop (www.ciria.org).

10.4 Proposed Developments within High Probability Flood Zone 3a

10.4.1 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

- Further guidance on the requirements of site specific FRAs for sites identified as potentially at risk of non-fluvial sources can be found in the CIRIA document C624 'Development and flood risk – guidance for the construction industry' (Lancaster et al) available from the CIRIA bookshop (www.ciria.org).

10.4.2 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.

10.5 Proposed Developments within Functional Floodplain Flood Zone 3b

10.5.1 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 8.3 for further guidance on compatible uses.

10.6 SUDS Requirements

10.6.1 Annex F of PPS25 outlines a range of SUDS options which could be applied to new development sites. The documents 'Rainfall runoff management for developments – interim national procedure' and

'Preliminary rainfall runoff management for developments (R&D Technical Report W5-074/A Revision D) Environment Agency and Kellagher R, 2005 also provide detailed guidance on what is required to meet, as well as how to meet, the requirements of PPS25 for surface water drainage.

10.6.2 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 of the individual SFRA documents, 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. In Cotswold District, where prevention, source control/infiltration cannot deal with all on-site site drainage, for both Greenfield and Brownfield sites, the development runoff volumes and peak flow rates leaving the site should be attenuated to the Greenfield discharge conditions. Note: For some currently highly constrained Brownfield sites it may not be feasible to meet this requirement. In these exceptional circumstances

(subject to agreement with Council and/or the Environment Agency) those proposing the development will be required to use the Greenfield conditions as the starting position for identifying what the next best option feasible on-site is. When involved, the Environment Agency will wish to see full justification as to why Greenfield conditions cannot be met.

- 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).

10.7 Development Behind Defences

10.7.1 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.

10.7.2 Consideration of flood risk behind defences should be made as part of detailed FRAs. Developers should review Volume 2, A Tiles 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

10.7.3 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.

10.8 Car Parks

10.8.1 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.

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11 Guidance for the Application of Sustainable Drainage Systems

11.1 Introduction

11.1.1 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.

11.1.2 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.

11.2 Effective application of SUDS techniques

11.2.1 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 11.1).

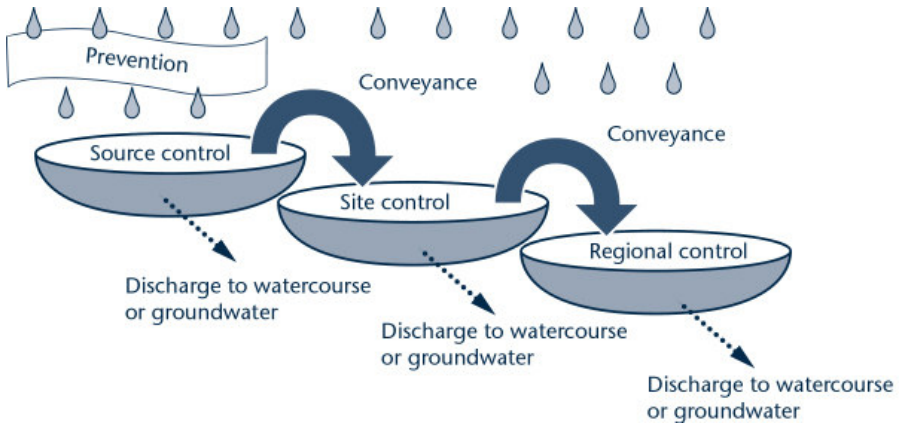

Figure 11.2: SUDS Management Train (from the Environment Agency website)

11.2.2 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.

11.2.3 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.

11.2.4 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.

11.3 Types of SUDS Systems

11.3.1 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

11.3.2 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.

11.3.3 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 5.1.

11.3.4 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).

11.3.5 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. For Cotswold District, for all sites (both Greenfield and Brownfield), the post development runoff volumes and peak flow rates leaving the site should be attenuated to the Greenfield discharge conditions. Where prevention, source control/infiltration cannot deal with all on-site site drainage, for both Greenfield and Brownfield sites, the development runoff volumes and peak flow rates leaving the site should be attenuated to the Greenfield discharge conditions. Note: For some currently highly constrained Brownfield sites it may not be feasible to meet this requirement. In these exceptional circumstances (subject to agreement with the Council and/or the Environment Agency) those proposing the development will be required to use the Greenfield conditions as the starting position for identifying what the next best option feasible on-site is. When involved, the Environment Agency will wish to see full justification as to why Greenfield conditions cannot be met.

11.3.6 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/

11.4 Application of SUDS for Gloucestershire

11.4.1 Details of the application of SUDS for each Gloucestershire District can be found in the individual SFRA documents. These also include details on Nitrate Vulnerable Zones (NVZs) and Groundwater Source Protection Zones (GSPZs) in each District.

11.5 Adoption and Maintenance of SUDS

11.5.1 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.

11.5.2 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.

11.5.3 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.

11.5.4 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.

11.5.5 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.

11.5.6 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.

11.5.7 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.

11.5.8 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.

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12 Summary and Recommendations

12.1.1 A number of recommendations have been made throughout this report on the basis of the findings of the SFRA. This considers information from Making Space for Water, the Water Framework Directive, PPS25, CFMPs, the RSS and the Pitt Review. These are summarised below.

12.2 Recommendations: Site Allocation Process

12.2.1 It is recommended that the outputs from this study are used as an evidence base from which to direct minerals and waste sites to areas of low flood risk (Flood Zone 1). In carrying out the Sequential Test, preference should be given to locating sites for waste management, mineral extraction and processing Flood Zone 1, Low Probability. All opportunities to locate new water-compatible developments (i.e. sand and gravel extraction sites) 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. The placement of such workings in Flood Zone 1 better enables any storage and office accommodation to be located in lower risk areas, reduces the risk posed to those working on site and allows the workings to continue operation while higher risk areas might be affected by a flood event. If there is no reasonably available site in Flood Zone 1, the flood vulnerability (as outlined in Table D3 of PPS25) of the proposed development should 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 to sites with lower flood risk (towards the adjacent zone of lower probability of flooding) from all sources as indicated by the SFRA. 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 Sections 4.7/4.8 of the individual District SFRA documents, which outline 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, as outlined below.
- Following application of the Sequential Test, a detailed interrogation of emerging allocations should be carried out using the template in Appendix E. 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, work to determine the restoration of mineral sites to storage areas, etc.)

12.2.2 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). For example, where an allocation is situated within more than one Flood Zone (e.g. Flood Zones 1, 2 and 3) opportunities should be sought to locate all stockpiles, waste mounds, soil storage areas, screening bunds and associated buildings in the lowest available flood zone (e.g. Flood Zone 1).

12.2.3 The Exception Test will need to be applied when 'More Vulnerable' uses (i.e. Landfill and sites used for waste management facilities for hazardous waste) are sequentially located in Flood Zone 3a and/or when 'Highly Vulnerable' uses (i.e. installations requiring hazardous substances consent) are sequentially located in Flood Zone 2. These options should only be considered when there is an insufficient number of suitable sites for development within zones of lower flood risk. In such

circumstances the scope of the SFRA will need to be widened to a Level 2 assessment. The need for a Level 2 SFRA cannot be fully determined until the Council has applied the Sequential Test. 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 developments situated behind raised defences and immediately adjacent to raised canals
- The effects of structures in the vicinity of development sites (culvert 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.

12.3 Recommendations: Council Policy

12.3.1 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.

12.3.2 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, and ensure that the vulnerability classification of the proposed Minerals and Waste development is appropriate to the flood zone classification
- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, where an allocation is situated within more than one Flood Zone (e.g. Flood Zones 1, 2 and 3) opportunities should be sought to locate all stockpiles, waste mounds, soil storage areas, screening bunds and associated buildings in the lowest available flood zone (e.g. Flood Zone 1). Where this is not possible, an application should seek opportunities to mitigate any flood risk to its facilities or to offsite receptors which may be at increased flood risk as a consequence of the development;
- An FRA is required for all Minerals and Waste development sites in Flood Zone 1 with an area greater than 1ha or have a floor area greater than 1000 m^2
- An FRA should be undertaken for all Minerals and Waste development sites within Flood Zone 2 and 3, and sites with identified flooding sources, to assess the risk of flooding to the development and identify options to mitigate the flood risk to the development, site users and surrounding area
- If floodplain storage is removed or reduced (e.g. by the introduction of mineral stockpiles, waste tips, soil storage areas, screening bunds and associated buildings) the development should provide appropriate compensatory storage to ensure that there is no loss in flood storage capacity.
- Should ensure that development does not reduce conveyance through urban areas in the Upper Thames Policy unit
- Ensure buildings within a development are 'safe'. To be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. The Environment Agency

states that dry pedestrian access/egress should be possible for the 1% AEP (1 in 100 year) +20% for climate change return period event, and residual risk, i.e. the risks remaining after taking the sequential approach and taking mitigating actions, during the 0.1% AEP (1 in 1000 year) event, should also be 'safe'.

- Opportunities to reduce flood risk as a result of the restoration process of mineral sites located within Flood Zone 2 and 3 should be considered at the earliest planning stage. Identify sites where developer contributions could be used to fund such opportunities
- The conservation of strategic flood storage areas is imperative. Where necessary site specific FRAs should consider floodplain obstructions such as stockpiles, waste tips, soil storage areas, screening bunds and associated buildings. Opportunities should be taken where appropriate to ensure new flood storage capacity is achieved as part of the restoration process.
- Set development back from rivers, seeking an 8 metre wide undeveloped buffer strip
- Require the use of SUDS in all Flood Zones for both Brownfield and Greenfield sites, to achieve Greenfield discharge rates with a minimum reduction of 20%. Space should be set-aside for SUDS.
- 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.

12.4 Recommendations: Emergency Planning

12.4.1 It is recommended that the County 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 MWDF 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.

12.4.2 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.

12.5 Recommendations: General

12.5.1 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:

- For developments that are likely to have a life span of 100 years or more, it has been recommended that the LPAs 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. However, given that mineral

extraction and landfill sites do not usually have a particularly long life span, this is not considered necessary. The County Council might, however, wish to use this technique when locating waste processing sites which are likely to have a much linger lifespan.

- 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. The County Council should provide assistance and support to the Local Authorities in order to achieve this

- Although the flood proofing of utilities should be carried out by the service provider, the County Council should work with the local authorities to 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.

12.6 Future Updates to the SFRA

12.6.1 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 reports and associated maps:

- Wye and Usk CFMP

- Gloucester Strategy

- Future Flood Risk Mapping Studies

- 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

12.7 Recommendations: Level 2 SFRA

12.7.1 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.

12.7.2 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 or where information in the Level 1 suggests there may be a need to investigate the source and pathway of flooding to existing developed areas.

12.7.3 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.

12.7.4 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

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

12.8 Recommendations: Next Stage of Work

12.8.1 It is recommended that a detailed interrogation of emerging allocations is carried out using the SFRA data and the table supplied in Appendix E. 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.

12.8.2 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, or where information in the Level 1 suggests there may be a high risk to existing developed areas that warrants further investigation into the source and pathway of flooding. This will particularly assist in Development Control and emergency planning decisions and may also help to identify where Surface Water Management Plans may be necessary.

12.8.3 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.

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13 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) **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.

5) **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.

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

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

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

9) **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.

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

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

12) **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.

13) **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.

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

15) **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

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

17) **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.

18) **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.

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

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

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

22) **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%.

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

24) **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%.

25) **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).

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

27) **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.

28) **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.

29) **LDD** – Local Development Documents

30) **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.

31) **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.

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

33) **Low Probability Zone 1 –** The area outside Zone 2. Defined as an area with less that0.1% 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%.

34) **LPA –** Local Planning Authority

35) **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.

36) **'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.

37) **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%.

38) **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

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

40) **MWDF –** Minerals and Waste Development Framework

41) **NGR –** National Grid Reference

42) **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.

43) **OS** - Ordnance Survey

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

45) **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).

46) **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.

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

48) **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.

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

50) **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.

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

52) **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.

53) **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.

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

55) **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.

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

57) **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.

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

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

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

61) **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.

62) **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)

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

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14 References

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

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

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APPENDIX A

Environment Agency Sign-off Letter

APPENDIX B

Map Indices

APPENDIX C

Sequential Test Process

APPENDIX D

Flood Zone Information

APPENDIX E

Template to Assist with Sequential Test