Warwickshire County Council

Strategic Flood Risk Assessment for
Local Development Framework
Level 1
Volume 1
February 2008

Halcrow Group Limited

Warwickshire County Council

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

Contents Amendment Record

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1		Draft Report	06/12/07	RD
1	A	Draft Report	28/01/08	RD
2		Final Report	18/02/08	RD
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Executive Summary

In August 2007 a group comprising Coventry City Council, Solihull Metropolitan Borough Council and the County, Districts and Boroughs of Warwickshire commissioned Halcrow to produce a Level 1 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS 25). The purpose of this SFRA is to assess and map all forms of flood risk from groundwater, surface water, sewer and river sources, taking into account future climate change predictions, and use this as an evidence base to locate future development primarily in low flood risk areas. The outputs from the SFRA will give the County Council the necessary information to inform the Minerals and Waste Development Framework (MWDF) to ensure due regard is paid to flood risk in the creation of policies and plans.

In accordance with the recently published document "Development and Flood Risk, a Practice Guide Companion to PPS 25" (February 2007), a Level 1 SFRA has been carried out and is contained herein. The study takes full account of the effect of climate change predictions as set out in PPS 25. The assessment also complies with the content of the accepted proposal dated July 2007. The SFRA should be regarded as a 'living' document and reviewed on a regular basis in light of new information as it becomes available.

In accordance with PPS25, areas of 'low', 'medium' and 'high' risk have been mapped using data collected from the Environment Agency, Warwickshire County Council, Severn Trent Water, the Highways Agency and British Waterways (BW). This has included information on flooding from rivers, surface water (land drainage), groundwater, artificial water bodies and sewers. This provides the basis for the Sequential Test to be applied.

The Council will need to 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 or land use proposed. Where the need to apply the Exception Test is identified, if the Council considers that there are an insufficient number of suitable sites for development, the scope of the SFRA could be widened to a Level 2 assessment. It is recommended that this is undertaken by a suitably qualified technical expert or engineer.

1 Introduction

1.1 Terms of Reference

In August 2007 a group comprising Coventry City Council, Solihull Metropolitan Borough Council and the County, Districts and Boroughs of Warwickshire commissioned Halcrow to produce a Level 1 SFRA in accordance with PPS 25. This document presents the findings of the SFRA for Warwickshire County Council, giving a holistic view of flood risk in the County. The information presented in this document and in Volume 2 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.

1.2 Project Aims

The aims of PPS 25 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. With regard to minerals and waste plans, PPS 25 says that the County Council should apply the Sequential Approach to the allocation of sites for waste management, mineral working and processing. The aim of this 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). Cleary 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

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

Halcrow has carried out this project in accordance with the methodology outlined in the Coventry, Solihull and Warwickshire SFRA Project Proposal, dated July 2007, though the methodology and deliverables have been aligned to the document "Development and Flood Risk: A Practice Guide Companion to PPS 25'". The SFRA has also followed advice from the Environment Agency.

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 PPS 25 as a desk-based study using existing information to allow application of the Sequential Test on the basis of Table D1 of PPS 25, and to identify whether application of the Exception Test is likely to be necessary.

The best available data within the study timescale has been collected for use in this study; however it is 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 Maps and this should be reflected in the SFRA document, to ensure that the best information is used to guide the site selection process for future minerals and waste sites.

1.4 Project Deliverables

The project outputs for Level 1 SFRA have been adopted for this study. The deliverables of this assessment are as follows:

- A summary document
- A technical report
- A series of maps

Following the advice from Section 2.34 of the Practice Guide Companion to PPS 25, the key project outputs are as follows:

1) Plans showing the administrative boundaries of the study area, watercourse centreline, modelled watercourses, canals, defences, Areas Benefiting from Defences (ABDs), Internal Drainage Board (IDB) areas and culverted watercourse sections (Volume 2, Tiles A1-A20)

2) Strategic flood risk maps showing flooding from all sources, including fluvial Flood Zones (including the functional floodplain where possible), and areas at risk of flooding from sources other than rivers (Volume 2, Tiles B1-B20)

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

4) The location of any flood risk management measures, including both infrastructure (Volume 2, Tiles A1-A20) and the coverage of flood warning systems (Volume 2, Tile F1)

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)

1.5 Outcomes of the SFRA Process

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 necessary, where the Exception Test needs to be applied (see Sections 1.5.1 and 1.5.2 respectively).

PPS 25 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). The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for LDFs should meet the requirements of the Strategic Environmental Assessment (SEA) Directive. A 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.

It is important to reiterate that PPS 25 is not applied in isolation, but is a 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.

1.5.1 The Sequential Approach and Sequential Test

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 B shows the Sequential Test process as advocated in PPS 25.

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 3.3.1). PPS 25 says that all opportunities to locate new water-compatible 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. If there is no reasonably available site in Flood Zone 1, the flood vulnerability (see table below, Table D3 of PPS 25) 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 to sites with lower flood risk (towards the adjacent zone of lower probability of flooding) from all sources as indicated by the SFRA.

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. It is acknowledged that sand and gravel sites are typically found in abundance within floodplains, and as such might be the only available areas for mineral working and processing. As sand and gravel workings are classed as a 'water-compatible' use they can be worked in the highest risk areas, Flood Zones 3a and 3b. However, the site should be designed in such as way as to enable any storage and office accommodation to be located outside Flood Zones 3a and 3b.

The table overleaf outlines the compatibility of different minerals and waste sites to each Flood Zone.

Flood Risk Vulnerability and Flood Zone 'Compatibility' (Adapted from Table D3 of PPS 25)

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

1.5.2 The Exception Test

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. 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 the table above.

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.

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 Core Strategy's SA;

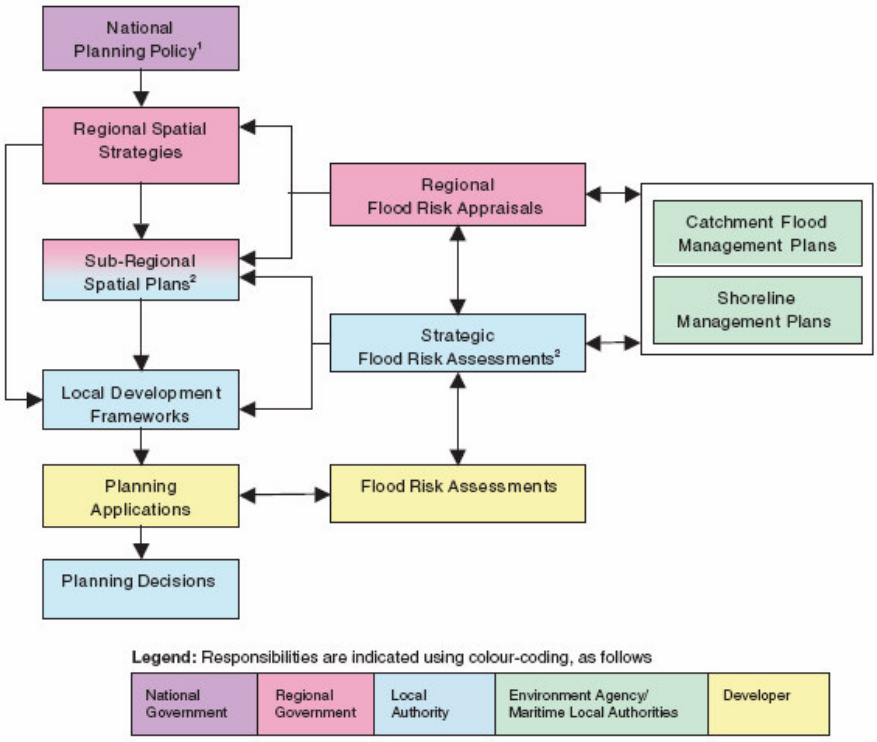
b) The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and,

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

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

1.6 SFRA Context

The figure overleaf, taken from the PPS 25 Practice Guide, 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 between 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.

1.7 The Study Area

Warwickshire is a non-metropolitan County covering an area of some 1,975km^2. The County lies within the West Midlands and is bounded to the north-west by the West Midlands metropolitan county and Staffordshire, by Leicestershire to the north-east, Northamptonshire to the east, Worcestershire to the west, Oxfordshire to the south and Gloucestershire to the south-west. The County comprises the five Districts and Boroughs of North Warwickshire Borough Council, Nuneaton and Bedworth Borough Council, Rugby Borough Council, Warwick District Council and Stratford-on-Avon District Council.

The majority of Warwickshire's population live in the north and centre of the County. The main urban areas include the market towns of Atherstone, Bedworth, Nuneaton and Rugby located in the northern and eastern extent of Warwickshire; with the towns of Royal Leamington Spa, Stratford-upon-Avon, Kenilworth, Alcester and Warwick located in the central and western extents. The south of the County is predominantly rural and more sparsely populated, with the largest town being Shipston-on-Stour. A number of smaller towns are located within Warwickshire including Coleshill, Southam, Bulkington, Polesworth, Kingsbury, Henley-in-Arden, Wellsbourne, along with the villages of Studley, Shipton and Whitnash. The total estimated population in 2006 was 522,200. There are no cities within Warwickshire since both Coventry and Birmingham were incorporated into the West Midlands County in the 1970s and are now metropolitan authorities in themselves.

There are good road and rail links with surrounding major urban areas and a strong local economy, containing a number of employers and attractions. There are many SSSIs, Sites of Importance for Nature Conservation, Regionally Important Geological Sites and Parks and Gardens of Historical Interest. Attractions within the County include Warwick Castle, Kenilworth Castle, the Royal Pump Rooms, Stoneleigh Park (National Agricultural Centre) along with a number of cultural and historical attractions within the town of Stratford-upon-Avon, which is considered one of the most important tourist destinations within the UK. These attributes, coupled with the County's convenient location, make the County a popular location to live, work and visit. This has led to considerable development pressures within the County.

1.7.1 Main Rivers and Hydrology

The County contains a number of designated Main Rivers which flow through the various Districts and Boroughs.

River Anker rises within the Borough of Rugby by Wolvey (SP 4362 8759) and flows in a north-westerly direction through the Borough. The watercourse is initially Non-Main River before becoming designated Main River by Stretton Baskerville (SP 4032 9096). At this point the watercourse forms the boundary between the Boroughs of Rugby and Nuneaton and Bedworth before continuing to flow in a north-westerly direction through the Borough of Nuneaton and Bedworth where the River Anker Flood Relief Channel (FRC) is located. The watercourse then exits the Borough of Nuneaton and Bedworth before flowing through the northern extent of the District of North Warwickshire, briefly forming the boundary between North Warwickshire Borough Council and the District of Hinckley and Bosworth. The watercourse exits the Borough of North Warwickshire beneath Shuttington Bridge at SK 248 050.

Two tributaries of the River Anker flow through the northern extent of the County: the Bramcote Brook and Harrow Brook. The Bramcote Brook rises in the Borough of North Warwickshire at Austrey Meadows (SK 279 060) and flows in a southerly then south-westerly direction through the Borough for approximately 3.8km until it reaches its confluence with the River Anker at SK 264 039. The floodplain of the Bramcote Brook is predominantly rural with a low to moderate relief catchment. The Harrow Brook flows in the northern extent of Warwickshire. It enters the County by Dodwells Bridge Industrial Estate (SP 3972 9310) and forms the boundary between the Borough Councils of Nuneaton and Bedworth and Rugby, before flowing into the River Anker at SP 3888 9114. The Sketchley Brook forms a tributary of the Harrow Brook and enters the County in the north-eastern extent by the Limekilns (SP 4090 9237) and flows into the Borough of Rugby in a south-westerly direction through rural floodplain until it meets the confluence of the Harrow Brook at SP 3913 9158.

The River Tame and a number of its tributaries flow through Warwickshire. The River Tame is the largest tributary of the River Trent and enters the County in the north-western extent by Water Orton (SP 1670 9150). The watercourse initially flows in an easterly direction and forms the boundary between the Borough of North Warwickshire and the Metropolitan District of Birmingham, before continuing to flow in an easterly then northerly direction through the Borough of North Warwickshire. The River Tame flows through predominantly rural floodplain as it continues its course through the Borough and is bordered by a number of small urban settlements along with a series of pools, gravel workings and nature reserves. At Lea Marston the watercourse flows through the Lea Marston Lakes (SP 2070 9370), a unique series of settlement lakes designed to remove pollution generated from the upper catchment of the Tame. The watercourse exits the Borough at SP 2050 9920 where it is

bordered by a series of pools and gravel workings. Two tributaries join the River Tame as it flows through the County, the River Bourne and River Blythe.

The River Bourne forms a right bank tributary of the River Tame. The watercourses rises by New Arley (SP 295 893) in the Borough of North Warwickshire and flows in a westerly, then north-westerly direction through predominantly rural floodplain. The first 6.7km at the watercourse are designated non-main river however at Furnace End (SP 247 912) the River Bourne becomes designated Main River, before continuing to flow in a westerly direction and joining the River Tame at SP 215 915.

The River Blythe forms a right bank tributary of the River Tame entering the County in the north-western extent in the south of the Borough of North Warwickshire by Hampton-in-Arden (SP 2204 8209). Here the watercourse forms the boundary between the Boroughs of North Warwickshire and Solihull Metropolitan Council for approximately 1.4km before turning to flow in a northerly direction through the Borough of North Warwickshire joining the River Tame at SP 212 916. Three tributaries join the River Blythe. The Shadow Brook joins on the left bank towards the south of the Borough of North Warwickshire (SP 2162 8253) where the watercourse forms the boundary with Solihull Metropolitan Council. This watercourse does not enter the County. The Hollywell Brook enters the County at SP 2108 8359 before flowing through the Borough of North Warwickshire in a north-easterly direction and joining the left bank of the River Blythe at SP 2138 8390.

The River Cole forms a left bank tributary of the River Blythe entering the County in the north at the south-western extent of the Borough of North Warwickshire to the north east of Fordbridge (SP 183 879) at the border with Solihull Metropolitan Council. The watercourse flows in a predominantly north-easterly direction joining the left bank of the River Blythe at SP 2120 9110. The catchment is of moderate relief with elevations of approximately 79mAOD at the Coleshill Gauging Station. The overlying geology of the catchment (drift-covered clay) and the considerable urbanisation in the upper reaches (outside of the Borough) produces fast runoff and heavy rain can result in sudden floods. However, the absence of significant tributaries means that the floodwaters subside quickly. Within the Borough of North Warwickshire, the Coleshill Brook forms a right bank tributary of the River Cole and is designated Main River as it emerges from the downstream face of the M42 at SP 196 877. The Coleshill Brook flows in a north-westerly direction through the Borough, joining the River Cole at watercourse at (SP 1890 8820).

Towards the north-western extent of the Borough of Rugby, the Withy Brook flows in a south-easterly direction through the Borough for approximately 3.6km before flowing into Coventry City towards its confluence with the River Sowe at SP 3849 8020. The River Leam also flows through the Borough of Rugby. The watercourse is designated Main River from SP 4945 6726 and flows in a westerly direction through the Borough, forming the boundary between Rugby Borough and the District of Warwick briefly before flowing into the District of Warwick at SP 3930 6997, before continuing in a south-westerly direction and joining the left bank of the River Avon at SP 3093 6552. Tributaries of the River Leam include the Millholme Brook and Birdingbury Brook which flow through the Borough of Rugby.

The River Itchen also forms a tributary of the River Leam. The River Itchen rises towards the eastern extent of the Stratford-on-Avon District by Priors Marston (SP 4722 5846) where the watercourse is designated non Main River, and flows in a south-westerly, then northerly direction through the District. At SP 4060 6203 the River Itchen becomes designated Main River and continues to flow in a

northerly, then north-westerly direction, briefly forming the boundary between the Districts of Stratford-on-Avon and Warwick, and then Warwick and the Borough of Rugby, before joining the River Leam before joining the left bank of the River Leam by Marton (SP 4053 6900).

The River Avon, a major tributary of the River Severn, flows through three of the Borough Councils within Warwickshire. The watercourse enters the Borough of Rugby in the eastern extent at SP 5450 7770 and flows through the centre of the Borough in a westerly direction passing through the town centre of Rugby, before briefly forming the boundary with Warwick District Council. The River Avon then continues to flow in a south-westerly direction through the District of Warwick, until it meets the District of Stratford-on-Avon, forming the boundary between two Districts for approximately 6km. The River Avon then continues to flow in a predominantly south-westerly direction through the District of Stratford-upon-Avon. In the south-western extent of the District the River Avon briefly exits and flows in a south-westerly direction into the District of Wychavon, before forming the boundary between the two Districts and finally exiting at SP 0670 4835 by Harvington.

A number of tributaries of the River Avon flow through Warwickshire. The River Swift, forming a right bank tributary of the River Avon, enters the County within the Borough of Rugby in the north-eastern extent by Lutterworth (SP 5211 8206) and flows through the eastern edge of the Borough in a predominantly southerly direction, before joining the River Avon at SP 5036 7669. The Clifton Brook, is designated Main River from the downstream face of Clifton Bridge (SP 5208 7588) and flows in a north-westerly direction through the Borough of Rugby to join the left bank of the River Avon by Mill Gardens (SP 5155 7649).

The River Sowe forms a right bank tributary of the River Avon. The River Sowe flows through Warwickshire, becoming designated Main River in the District of Nuneaton and Bedworth the north of Bedworth Heath (SP 3459 8686) and flowing in an easterly, then southerly direction through the urban settlement of Bedworth before exiting the District of Nuneaton and Bedworth by Rowley's Green (SP 3442 8393) after which the watercourse continues to flow in a south-easterly direction into the City of Coventry. At SP 3450 7560 the Rive Sowe re-enters Warwickshire within the north-eastern extent of the District of Warwick by Baginton. The River Sherbourne also joins the River Sowe at this location. This watercourse flows into the District of Warwick from the City of Coventry area. The River Sowe then continues in a south-westerly direction through the District before joining the River Avon on the right bank by Stoneleigh (SP 3250 7240). The River Leam enters the District of Warwick in the east by Marton (SP 4053 6900) where it forms the boundary between the District and the Borough of Rugby. The watercourse then flows in a south-westerly direction through the District, turning to flow in a westerly direction through Royal Leamington Spa before joining the left bank of the River Avon by Warwick (SP 3016 6564).

A number of tributaries of the River Avon are located within the District of Stratford-on-Avon. These include the River Dene, Shottery Brook, River Stour, Marchfont Brook, Noleham Brook and River Arrow. The River Dene rises in the eastern extent of the District by Edgehill (SP 3720 4744) where the watercourse is initially designated as non-Main River. The River Dene flows in a northerly then westerly direction before turning to flow once again in a northerly direction towards Wellsbourne (SP 2771 5539). To the south east of Wellsbourne at SP 2845 5441 the watercourse becomes designated Main River, before continuing to flow in a north-westerly direction and joining the River Avon on the left bank at SP 2585 5631.

The Shottery Brook rises to the north-west of Bishopton (SP 1846 5691) and flows in a south-westerly direction through Stratford-Upon-Avon and Shottery (SP 1854 5473) before joining the River Avon at SP 1840 5342 to the west of Stratford-on-Avon Racecourse. An unnamed watercourse runs parallel to the Shottery Brook and is designated Main River from SP 1941 5552 and flows in a southerly direction through Stratford-Upon-Avon before joining the right bank of the River Avon at SP 1944 5335 to the east of the Racecourse.

The River Stour, enters the District in the south-east by Traitors Ford (SP 3369 3642) and flows in a predominantly westerly direction through Stourton (SP 2948 3685) before becoming designated Main River by Burmington (SP 2638 3715). At this point the watercourse briefly forms the boundary between the District of Stratford-on-Avon and the Cotswold District. The watercourse then continues to flow in a predominantly north-easterly direction passing through a number of small towns and villages, before joining the River Avon at SP 2101 5077.

The Marchfont Brook, forming a left bank tributary of the River Avon, rises in the south-west of the District to the south-west of Preston-on-Stour (SP 1991 4811), and flows in a north-westerly direction through predominantly rural floodplain. At SP 1688 5130 the watercourse becomes designated Main River, before continuing to flow in a north-westerly direction and joining the River Avon to the east of Weston on Avon at SP 1594 5203.

The Noleham Brook, forming a left bank tributary of the River Avon, entering the District by Pebworth (SP 1439 4688) where the watercourse forms the boundary between the Districts of Stratford-upon-Avon and Wychavon and flows in a north-easterly direction. To the east of Long Marston (SP 1484 4825) the watercourse turns to flow in a north-westerly direction before joining the River Avon at SP 1173 5144.

The River Arrow, forming a right bank tributary of the River Avon, entering the District to the north of Studley at SP 0686 6504 and flowing in a south-easterly direction through Studley (SP 0751 6393), Coughton (SP 0838 6056) and Alcester (SP 0883 5789), before turning to flow in a south-westerly direction and joining the River Avon at SP 0827 5073 to the east of Salford Priors. The River Alne is also located within the District of Stratford-on-Avon and forms a tributary of the River Arrow. The River Alne, rises just outside the District at the edge of the Arden Plateau (SP 0901 6957), and flows initially in an easterly direction, before becoming designated Main River at SP 1443 6837 and turning to flow in a southerly the south-westerly direction through Henley-in-Arden (SP 1528 6633), Wootton Warren (SP 1569 6332) and Aston Cantlow (SP 1377 5994), before joining the left bank of the River Arrow at SP 0933 5734.

A number of additional Main Rivers are also located within the Districts of Warwick and Stratford-on-Avon. Within the District of Warwick, the Canley Brook enters the District in the northern extent by Canley (SP 3007 7538) and flows in a predominantly southern direction before joining the left bank of the Finham Brook at SP 3068 7303. The Finham Brook rises in the northern extent of the District at SP 2629 7519 where it is initially classified as non Main River. The watercourse flows in a south-easterly direction, becoming designated Main River as it flows along the north-western edge of Kenilworth at SP 2765 7317. Here, the watercourse turns to flow in a north-easterly direction through the northern extent of Kenilworth before joining the right bank of the River Sowe at SP 3366 7378 by Stoneleigh. The River Stowe, rises within the District of Stratford-on-Avon at SP 4467 6425 where the watercourse is designated non Main River, and flowing in a southerly, then south-westerly

direction. At the downstream face of the A425, Daventry Road, the watercourse becomes designated Main River and continues to flow in a predominantly westerly direction before joining the right bank of the River Alne by Stoney Thorpe Hall (SP 4061 6204).

Watercourse maps, giving an overview of fluvial features in the study area, can be found in Volume 2, Tiles A1-A20. A number of minor watercourses and non-Main Rivers also flow through the District which have been analysed where data exists.

There are no IDBs operating in the County Council's area.

1.7.2 Geology and Topography

The topography, geology and soil are all important in influencing the way the catchment responds to a rainfall event. The degree to which a material allows water to percolate through it, the permeability, affects the extent of overland flow and therefore the amount of run-off reaching the watercourse. Steep slopes or clay rich (low permeability) soils will promote rapid surface runoff, whereas more permeable rock such as limestone and sandstone may result in a more subdued response.

The geology of the Warwickshire is one of the most varied in any English County spanning 600 million years. The rock units range through many geological periods including the Precambrian, Cambrian, Devonian, Carboniferous, Permian, Triassic, and the younger Jurassic. Unconsolidated Quaternary 'drift' deposits are widespread. Geological maps can be found in Volume 2; Tiles D1 (solid) and D2 (drift).

Solid Geology

In the broadest sense, the 'solid' or bedrock' geology of the county can be divided into three terrains:

(1) The Warwickshire coalfield

The Warwickshire coalfield, partly equating to the Warwickshire plateau, comprises a broadly spindle-shaped outcrop of relatively old rocks, running from Warwick in the south to the Staffordshire border near Tamworth in the north. The surface geology is dominated by Upper Carboniferous mudstones and sandstones, roughly 300 million years old, overlain by similar rock-types of slightly younger Permian age in the Warwick-Kenilworth area. A narrow strip of older rocks up to 600 million years old, running up the eastern side of the coalfield from Bedworth to near Mancetter, is known as the Nuneaton inlier. There, the surface geology includes narrowly outcropping, steeply dipping Precambrian volcanic rocks, Cambrian sandstones and shales, Ordovician intrusive igneous rocks and a small patch of Devonian sandstones near Mancetter. Carboniferous Coal Measures also occur at the surface in this area.

(2) Triassic lowlands

Surrounding the coalfield, a broadly u-shaped lowland terrain runs roughly from Polesworth, down through Brinklow, Cubbington, Leamington Spa, through the Avon Valley and northwards through Henley-in-Arden, Solihull and Coleshill. The surface geology of this area is dominated by sedimentary rocks of Triassic age – sandstones overlain by considerable thicknesses of red mudstone. Triassic sandstones also occur patchily on the margins of the coalfield. These are roughly 200 to 250 million years old.

(3) Jurassic fringe

The remainder of the county, running broadly from Rugby, down to Shipston-on-Stour, and then up into the Avon Valley near Stratford, is dominated by sedimentary rocks of Jurassic age, roughly 170 to 200 million years old. This area is dominated by the Feldon clay lowlands, underlain by Lower Jurassic mudstone and limestone beds. Along the eastern and southern fringes of the county, outlying hills and ridges of younger Jurassic rocks occur. Napton Hill, parts of the Burton Dassett Hills and Edge Hill for example, are capped by the Marlstone – a thin, resistant ironstone. Further south and west, as at Brailes, Tysoe and Ilmington, the hills are capped by sandstones and limestones of Middle Jurassic age.

Drift Geology

Drift deposits comprise unconsolidated sediments dating back several hundred thousand years to the middle part of the Pleistocene period. These deposits are widely distributed throughout the county. Older drift deposits are partly glacial in origin and include river gravels, finely bedded clays and tills – pebbly clay deposits deposited by ice sheets. The younger drift deposits include deposits of sand and gravel – river terrace deposits, along the modern valley sides.

Topography

Towards the northern extent of the County within the Borough of North Warwickshire, the topography is comprised of higher elevations and steeper slopes in the east and lower and gradual changes in elevation to the north and west. The higher elevations of 180m AOD, can be found east of Coleshill and also near Bentley and Oldbury. To the north of Atherstone and Grendon where the A5 road runs through the Borough and towards Kingsbury in the west, lower elevations of 65m AOD and less steep topography can be found. The Borough of Nuneaton and Bedworth is comprised of higher elevations and steeper slopes in the west and lower and gradual changes in elevation to the north and east. The higher elevations of 160m AOD can be found west of Nuneaton near Stockingford. The lower elevations and less steep topography are situated in the centre of Nuneaton.

Towards the eastern extent of the County, the topography is rather undulating, with gradual changes in elevation across the Borough of Rugby. Isolated high elevations of 160m AOD can be found in the very south of the Borough of Rugby near Flecknoe, north-west of Daventry.

Within the District of Warwick, the general trend in topography appears to show a gradual increase in elevation in a south-east to north-west direction. The lower elevations of 50-70m AOD are found in and around Kenilworth, Leamington Spa and Warwick, with higher elevations of 120-140m AOD to the western extent of the District in and around Hockley Heath and Lapworth.

The topography of the District of Stratford-on-Avon is rather undulating with pockets of higher elevations and steeper slopes on the periphery of the District mostly in the east past Shipston on Stour and in the south-east near Long Compton. The highest elevation of 260m AOD is located in the south-west near Meon Hill. Central and west lying areas with in the District are dominated by lower elevations.

2 Planning Context

2.1 Introduction

This chapter provides an overview of the planning policy framework relevant to Warwickshire County Council.

This report conforms to National and Regional Planning Policy. Information contained in the 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.

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.

2.2 Planning Policy Framework

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.

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.

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

2.3 National Planning Policy

2.3.1 PPS 1: Creating Sustainable Communities (2005)

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.

2.3.2 Planning and Climate Change (Consultation Draft Supplement to PPS 1)

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.

2.3.3 PPS 7: Sustainable Development in Rural Areas (2004)

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.

2.3.4 PPS 9: Biodiversity and Geological Conservation (2005)

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.

2.3.5 PPS 10: Planning for Sustainable Waste Management (2005)

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.

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

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.

2.3.7 PPS 22: Renewable Energy (2004)

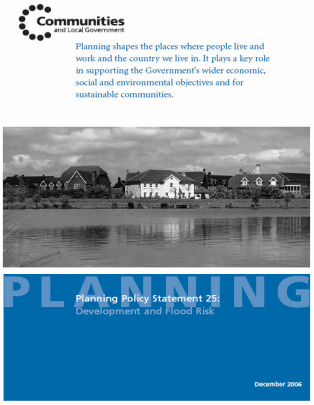
PPS 22 sets out how the planning system can contribute to the implementation of the government's energy policies through enabling the use of renewable energy. Waste development in particular can contribute to this aim. The accompanying good practice guidance to PPS 22 recognises the following types of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

2.3.8 PPS 23: Planning and Pollution Control

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.

2.3.9 PPS 25: Development and Flood Risk (2006)



PPS 25 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 Test, a process that 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 (RPB) and LPAs should, inter alia, 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.

2.3.10 MPS 1: Planning and Minerals

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.

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

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.

2.3.12 MPG 7: The Reclamation of Mineral Workings

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.

2.3.13 Town and Country Planning Amendments

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.

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.

2.4 Regional Planning Policy

Regional planning policies provide the overarching framework for the preparation of the LDF. RPG for the West Midlands (RPG11) was published in June 2004 but under the Planning and Compulsory Purchase Act 2004, RPG11 was automatically replaced by a new Regional Spatial Strategy (RSS) for the West Midlands. The purpose of the West Midlands Regional Spatial Strategy (WMRSS) is to provide a long term land-use and transport planning framework for the West Midlands region. The

WMRSS framework guides the preparation of local authority development plans and local transport plans. It determines (amongst other things) the scale and distribution of housing and economic development for each Local Authority within the region, investment priorities for transport and sets out policies for enhancing the environment. The WMRSS has been prepared by the West Midlands Regional Assembly and has been guided by the national policy framework provided by Planning Policy Guidance, particularly PPG 11, and other key policy documents and plans including the National Sustainable Development Strategy.

The WMRSS was published in June 2004. In approving the document the Secretary of State identified a number of issues where further work was required. The revision is being carried out in three stages.

The WMRSS identifies the Major Urban Areas of Solihull and Coventry as places where more development opportunities will be created to retain and attract people and investment. Both these areas have also been identified as two of the local authorities to receive support under the Government's Growth Point Initiative, meaning that substantial levels of growth are expected between 2006 and 2016. RSS 11 also identifies Rugby as an area where new development will be focused.

The WMRSS states that more rural areas of the West Midlands will be regenerated, through the improvement of choice in housing; diversification of the rural economy; better transport links; improving health, education, skills training, social, shopping and community facilities, the sustainable use of environmental assets, and the prudent use of natural resources.

The "Development and Flood Risk" section of the WMRSS sets out the following in relation to Flood Risk Management:

> *"**8.42** The implications of climate change for the severity of floods is uncertain but the most realistic approach is to accept that flooding is an inevitable process. PPG25 [now PPS25] Development and Flood Risk sets out detailed guidance on how flood risk should be considered at all stages of the planning and development process, including a sequential approach to locating development. Local authorities should also consider local Environment Agency plans, Catchment Flood Management Plans and indicative floodplains (Quality of the Environment – Assets Diagram).*
>
> ***8.43** For the review of this RPG the RPB with the Environment Agency and other partners should identify where flooding issues are likely to be of Regional significance, assess their implications for the distribution of development and where appropriate, set out appropriate policies and measures to address them. This could include defining areas where sustainable drainage systems would best contribute to reducing flood risk, and improving water quality where the need to improve the performance of the floodplain, attenuate flows and provide local treatment of polluted run-off is greatest. However it should be borne in mind that sustainable drainage systems are unlikely to provide the complete answer to problems associated with large-scale river flooding episodes; in the longer term they can help attenuate flows and reduce the risk of flooding in urban areas downstream.*
>
> ***8.44** When considering the possible risks, implications and steps needed to prevent general flooding affecting new development, the potential for sewer flooding should also be considered by developers and planning authorities. Large new developments may require some new or updated infrastructure in the existing sewer network and treatment works in order to cope with the*

additional load. Sustainable drainage systems can, in the correct conditions, help alleviate sewer flooding problems by preventing surface water from entering the sewerage system."

2.5 Local Planning Policy

2.5.1 Warwickshire Minerals and Waste Development Framework

Warwickshire County Council is the Mineral and Waste Planning Authority for the County. The Development Group fulfils the Council's statutory duty to deal with planning applications involving mineral extraction and the depositing, recycling and management of waste.

In line with its statutory duty, Warwickshire County Council has prepared the Minerals Local Plan to identify those areas of the county where significant mineral resources occur, including sand, gravel, hard rock and coal and where there would be least planning objection to possible workings. The Council has also prepared a Waste Local Plan in order to identify the most suitable areas for the processing and/or disposal of waste. Both Local Plans were adopted in 1995 and although they will be replaced with a MWDF in accordance with the requirements of the Planning and Compulsory Purchase Act (2004), they were saved until September 2007. Beyond this date the Secretary of State agreed to the saving of a number of policies contained within the plans and these, together with the allocations, are saved until there are new policies to replace them. Details of the policies that have been saved are included on the web pages for the respective local plans.

In the main, the changes imposed by the Planning and Compulsory Purchase Act (2004) are intended to speed up the overall planning process and to make it more transparent. The MWDF has often been described as a folder of documents. The County Council will only produce plans relating to minerals and waste, while the District and Borough Councils are responsible for planning the location of future housing, employment sites, shops etc.

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.

Warwickshire County Council is required under the Planning and Compulsory Purchase Act (2004) to undertake a SA of the DPDs. It is also a statutory requirement to conduct an environmental assessment in accordance with the SEA Directive and the SEA Regulations 2004. An SFRA is required to support the site selection process and these will feed into the SA process. The Sequential Test of PPS 25 will be undertaken as part of this process.

3 Minerals and Waste

3.1 Introduction

This 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 PPS 25 and the implications this has for minerals and waste sites.

3.2 Context

Warwickshire 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.

3.3 Mineral Extraction

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.

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 1.5.1 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 mineral sites in higher risk areas. In instances where mineral workings are located in Flood Zones 3a and 3b, it is imperative 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.

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 PPS 25 states that decision makers should seek to locate mineral workings 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.

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.

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.

Where a minerals resource occurs across Warwickshire's boundary it is worth working in partnership with neighboring 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.

3.4 Waste Sites

As outlined in Section 3.3, 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 1.5.1 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.

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.

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

4 Study Methodology

4.1 Level 1 SFRA Methodology

A Level 1 SFRA is defined in the Practice Guide Companion as a desk-based study using existing information to allow application of the Sequential Test and to identify where the Exception Test is likely to be necessary. The main tasks undertaken during the study were as follows:

a) Establishing relationships and understanding the planning context:

An Inception meeting was held to build relationships between the project team, the Councils and the Environment Agency. This allowed the partnering approach to form, and allow the free exchange of available information. Discussions were held on the status of the Council's LDFs 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 to 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 Geographical Information System (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 for the entire study area, which shows Flood Zones 1, 2 and 3 and flooding from all other sources, and should be used to carry out the Sequential Test. Other maps include study area maps showing canals and fluvial features, climate change maps showing the impacts of climate change on flood probability, geological maps, historic flood outline maps, and maps showing flood watch and warning areas. Hardcopy maps are provided in Volume 2 of the SFRA report, while GIS layers can be found in the CD at the front of this report.

d) Providing suitable guidance

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

4.2 Need for a Level 2 SFRA

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.

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.

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

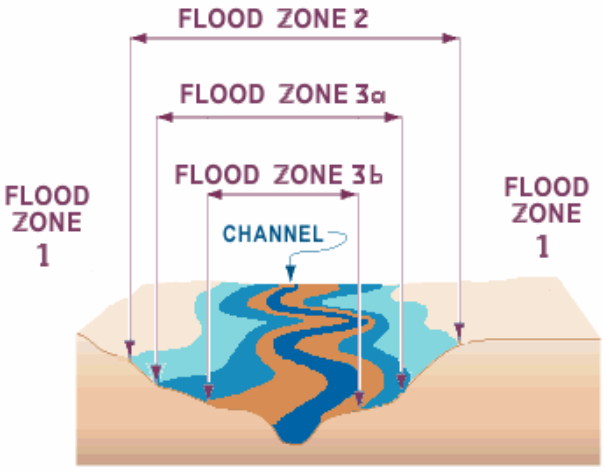
In general, the Level 2 SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zone 3, which are protected by existing defences. This should minimise the extent to which individual developers need to undertake separate studies on the same 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.

4.3 Technical Background

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

4.3.1 Flood Zones

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).



PPS 25 defines the Flood Zones as follows:

Zone 1: Low Probability

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

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

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

This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone where possible (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

Flood Zone maps in this SFRA have been produced from two sources: Environment Agency Flood Zone maps, published and updated quarterly in their website, and detailed local hydraulic modelled outlines.

4.4 Environment Agency Flood Zone maps

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 C). 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.

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 25K OS map within Flood Zone 1 may not be covered by the Environment Agency Flood Maps. As such, for any development site located adjacent to an unmapped watercourse within Flood Zone 1, it is recommended that a site specific FRA is undertaken to asses the extent of the floodplain and flood risk posed to the site.

The Environment Agency flood maps do not show the functional floodplain, Flood Zone 3b, which is a recent PPS 25 requirement.

5 Flood Risk in the Study Area

5.1 Approach to Data Gathering

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 Council, Environment Agency, BW, the Highways Agency, Severn Trent Water and other key consultees). The team has been able to review the collected data, assess its significance and quality, and advise on which part of the collected data needed to be used for the SFRA. The main approach to the SFRA has been to build on previous studies and gathered information.

Consultation has formed a key part of the data gathering stage of the SFRA. The above 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 PPS 25) are significant and have helped to ensure that the findings and recommendations of the SFRA are relevant and workable for the Council.

5.2 Historical Flooding

Recent years have seen a number of large scale flood events throughout the UK including October 1998, autumn 2000, February 2002, New Year 2003, February 2004 and more recently summer 2007. The Environment Agency has produced a number of historic flood outlines covering Warwickshire (Volume 2, Tile E1) which illustrate the extent of flooding.

The earliest historical flood outline for Warwickshire pertains to the March 1947 flood event. This event affected both urban and rural areas of the River Avon within the District of Stratford-on-Avon and is thought to be the largest event to have occurred along this watercourse within the District. Historic flood outlines have also been produced for the June 1977 and March 1978 flood events, which again affected the urban areas of Henley-in-Arden and Ashleworth respectively within District of Stratford-on-Avon.

A number of historic flood outlines are also available for Warwickshire after these dates including:

- July 1968 – affecting a number of watercourses within the District of Stratford-on-Avon including the River Avon, River Itchen, River Dene and River Stour
- February 1979 - affecting small areas of the River Avon within the Districts of Warwick and Stratford-on-Avon
- March 1981 – affecting small areas of Eathorpe (SP 3980 6988) and Marton (SP 4064 6911) along the River Leam located on the boundary between the District of Warwick and the Borough of Rugby
- January 1985 – affecting large areas of the River Avon and its tributaries (including the River Swift, Clifton Brook, Noleham Brook and the River Leam and it's tributary the River Itchen) through the Borough of Rugby and Districts of Warwick and Stratford-on-Avon
- January 1992 – affecting small areas along the River Leam within the District of Warwick; and, small sections of the River Avon within the Districts of Warwick and Stratford-on-Avon

- September 1992 – affecting large areas of the River Swift, River Avon and Clifton Brook within the Borough of Rugby; and, a small area of the River Leam by Eathorpe (SP 3902 6901) in the District of Warwick

- December 1992 – significantly affecting the Rivers Tame, Blythe and Anker along their entire length within the Borough of North Warwickshire; and, sections of the River Anker within the Borough of Nuneaton where some properties in Attleborough were inundated

- April 1998 – affecting large areas of the River Avon through the Borough of Rugby and the Districts of Warwick and North Warwickshire

The January 1985 and April 1998 were the largest scale events recorded by the Environment Agency. The 1985 event in particular affected the lengths of the river Avon and River Leam which flow through the District of Stratford on Avon and the Borough of Rugby, while the 1998 event affected similar areas but did not reach as far upstream of the River Leam. Both events affected the lengths of the Rivers Avon and Leam which run through the Borough of Rugby, though the floodplain was mainly affected and few properties were flooded. The Environment Agency Flood Zone maps have incorporated the extent of the flooding from this event.

The April 1998 event had the most significant effect upon the Stratford-upon-Avon District. This flood event brought severe disruption to many parts of central England, and at the time ranked as the UK's worst flood disaster since 1947 (although in Stratford-upon-Avon the 1947 levels were not reached). Both urban and rural areas were affected by this event and Stratford-on-Avon District Council undertook an extensive flood history survey following the Easter 1998 flood event. This information is included within the existing historic flood outlines provided by the Environment Agency.

Most recently widespread flooding was experienced through the County during the summer of 2007 (June and July). England experienced the wettest three months to the end of July since records began, with at least twice the average rainfall falling across parts of the country. The extreme conditions led to large scale urban and rural flooding across south-west England, north-east England and the Midlands.

In the Borough of North Warwickshire Polesworth Bridge on Bridge Street was badly affected, and the B5000 was closed. The flooding in this area was attributed to fluvial flooding. Consultation with the Environment Agency has indicated that historical flood outlines for the recent summer 2007 events on the River Anker will be produced within the future. At the time of this SFRA this data was unavailable; however, the information should be incorporated into the SFRA when it becomes available.

Within the District of Warwick, the extreme rainfall that occurred on the 14th and 15th June 2007 resulted in significant flooding in the area of Cubbington. Flooding occurred from a number of sources including fluvial flooding, surface water and artificial drainage. The drainage systems in the area (public, private, highway or land drainage) were not designed to cope with the exceptional conditions and as a result widespread flooding occurred, with the worst locations affected being in the bowl of New Street and Knightly Close and the valley bounded by Ladycroft, Price Road, Offchurch Road in the dip and the valley through the Thwaites factory. The bowl is at the foot of a steep 85% paved catchment contributing on three sides which amounts to some 28hectares. On the fourth side green field farmland and the school playing field contribute some 26 hectares to the overland flow into the bowls. Some of the green field land is protected by the Pingle Brook Flood Alleviation Scheme

(FAS) constructed by Warwick District Council in 2002. The cause of the flooding was from a combination of sources including: surface water runoff from adjacent farmland and public highways, insufficient capacity of the drainage infrastructure (surface water and foul drainage systems, public foul and surface sewers owned by Severn Trent Water), the failure of the Severn Trent Terminal Pumping Station at Offchurch Road and, the overtopping of the Pingle Brook. It was also reported that the Pingle Brook FAS was overtopped. Water which fails to enter the artificial or surface water drainage system flows along the natural topography of the land and accumulates at the New Street bowl. Much of the existing drainage infrastructure is though to be of insufficient capacity to cope with such a large volume of water. During the July event a number of locations were also affected by flooding. These included Eathorpe, Huningham, Offchurch, Leamington, Warwick, Cubbington and Rowington.

Widespread flooding was also experienced within the District of Stratford-on-Avon during the summer 2007 events. Following the summer 2007 flood events additional flood survey questionnaires were sent to Parish Council's within the District. At the time of this SFRA the information from these questionnaires was still being collated. Once this information becomes available it should be incorporated into the SFRA.

5.3 Fluvial Flood Risk in Warwickshire as defined by the Flood Zone maps

The Environment Agency Flood Zone maps provide an indication of the locations at risk from fluvial sources within the County. Within Warwickshire there are a number of major towns and villages including Atherstone, Polesworth, Coleshill, Nuneaton, Bedworth, Bulkington, Rugby, Royal Leamington Spa, Warwick, Kenilworth, Stratford-upon-Avon, Alcester, Southam, Shipton-on-Stour, Studley and Wellsbourne that are at least partially contained within Flood Zone 2. An analysis of the Flood Zone maps within each District or Borough has been made and is detailed below.

5.3.1 Fluvial Flood Risk within the Borough of North Warwickshire

The Environment Agency Flood Zone maps for the River Anker extend predominantly into undeveloped agricultural land as the watercourse flows along the eastern edge of the Borough, with a number of residential and commercial properties located within Flood Zone 2 as the watercourse flows around and through the market towns of Mancetter (SP 3230 9698), Atherstone (SP 3140 9855) and Polesworth (SK 2608 0235). Anecdotal evidence received from North Warwickshire Borough Council is generally consistent with the extent of flooding shown on the Flood Zone maps. It should be noted however that flooding reported by the Borough Council along Spon Lane (SP 2811 9994) does not appear to be recognised within the current flood maps for the 100 year event. At the confluence of the River Anker with the Penmire Brook (SK 2881 0064) Flood Zone 2 extends approximately 700m on the left bank incorporating a number of properties around Bradley Green and Grendon (SK 2858 0020). The Flood Zone maps for the Penmire Brook appear to be misaligned in places and therefore caution should be taken when interpreting the information.

Towards the north west of the Borough a number of commercial properties and sewage works at Warter Orton are located within the Flood Zone maps for the River Tame. As the watercourse flows in an easterly direction through the Borough Flood Zone 2 extends for approximately 1.8km on the right bank incorporating a number of properties at Nether Whitacre Heath (SP 2172 9285). As the watercourse continues to flow through the Borough in a northerly direction, Flood Zone 2 extends

onto predominantly rural floodplain incorporating Lea Marston Lakes (SP 207 937) and a series of pools and nature reserves as it continues to flow through the Borough.

The Environment Agency Flood Zone maps for the River Cole extend predominantly into agricultural land as the watercourse enters the Borough in the south west, however a number of residential properties are shown to be located within Flood Zone 2 at Coleshill (SP 1991 8948), along with a number of commercial properties as the watercourse continues to flow through the Borough towards its confluence with the River Tame.

Flood Zone maps for the River Blythe extend predominantly into agricultural land with only a few isolated settlements located within Flood Zone 2. Toward its confluence with the Cole Brook, and the River Tame, Flood Zone 2 widens incorporating a number of commercial properties and gravel workings.

A number of properties are located within Flood Zone 2 along the River Bourne as it flows through the Borough at Fillongley (SP 2844 8681), Daw Mill Colliery (SP 2582 8910) and Furnace End (SP 2480 9120). The Flood Zone maps between the point at which the watercourse rises by New Arley (SP 295 893) and Furnace Mill are however misaligned in a number of places and therefore caution should be taken when interpreting the information. Downstream of Furnace Mill the watercourse becomes designate Main River and Flood Zone 2 extends predominantly into rural floodplain incorporating a sewage works at Furnace Mill and Shustoke Reservoir.

A number of the Flood Zone maps within the Borough appear to be misaligned. These include the Langley Brook by Middleton (SP 1707 9789), an unnamed tributary of the River Bourne flowing through Over Whitacre (SP 2560 9175) and the Bourne Brook (SP 2760 8932).

5.3.2 Fluvial Flood Risk within the Borough of Nuneaton & Bedworth

The Environment Agency Flood Zone maps for the River Anker demonstrate that as the watercourse enters the Borough the flood outlines extend onto predominantly rural floodplain incorporating a golf course (SP 4012 9019). As the watercourse flows towards the urban settlement of Nuneaton, the main channel splits at SP 3786 9165, with part of the flow taking the route of the Flood Relief Channel during flood events. The River Trent Catchment Flood Management Plan (CFMP) states that Nuneaton is located near to the headwaters of the River Anker catchment and therefore as a result response rates to rainfall events are relatively fast. People, property and infrastructure within Nuneaton are affected by flooding; however, the town now benefits from the FRC which reduces the probability of flooding and protects in excess of 1000 properties from flooding up to a standard greater than a 1 in 100 year event. Smaller more frequent floods are not considered likely to cause flooding to any properties and in general, flood risk within Nuneaton is assessed as low. A number of residential and commercial properties are however shown to be located within Flood Zone 2 along the route of the main channel particularly through the town centre where Flood Zone 2 extends to up to 300m on the left bank and 200m on the right bank. As the River Anker flows towards the north-western edge of Nuneaton, a small number of properties are located within Flood Zone 2 by Weddington (SP 3597 9350), after which Flood Zone 2 extends predominantly into rural floodplain as the watercourse flows towards the boundary of the Borough.

Two tributaries join the River Anker through Nuneaton town centre, the Wem Brook and Bar Pool Brook. A number of properties are located within Flood Zone 2 along the watercourses as they flow

through Nuneaton towards their confluence with the River Anker. It should be noted that the Flood Maps for the Bar Pool Brook are misaligned in a number of locations and therefore caution should be taken when interpreting this information. Reports from Nuneaton and Bedworth Borough Council have indicated that part of Queen Elizabeth Road adjacent to the balancing lake at (SP 3430 9230) are vulnerable to flooding from the Barpool and Whittleford Brooks and as a result of flooding from surcharged sewers and overland flow from the Camp Hill Estate. Barpool Balancing Pond is designed to accommodate flows from the Barpool Brook; however the scheme is not yet complete. Flood events that occurred on the 21st July 2007 suggest that the sewer infrastructure that discharges into the lake is inadequate.

A number of properties for the Flood Zone maps of an unnamed tributary of the Bar Pool Brook that joins on the right bank at SP 3342 9231 are also located within Flood Zone 2. However the Flood Zone maps for this watercourse are also significantly misaligned and therefore caution should be taken when interpreting the information. A number of properties are also located within the Flood Zone maps for the Change Brook in the downstream extent as it joins the River Anker.

Environment Agency Flood Zone maps for the Harrow Brook indicated that some properties along The Long Shoot (SP 3910 9281) are located within Flood Zone 2. Anecdotal evidence received from Nuneaton and Bedworth Borough Council corresponds with the Flood Zones at this location, with the last major incident reported in 1999. Subsequent to the last incident the Council carried out some minor work to a ditch course joining the Harrow Brook, and the Environment Agency also installed flood protection works in the form of a bund and pumping station to help alleviate the risk of flooding.

A number of properties are located within Flood Zone 2 of the River Sowe as the watercourse flows through the western edge of Bedworth (SP 3503 8680). Here Flood Zone 2 extends for approximately 100m on both the left and right banks. Flood Zone maps for the Breach Brook the meets the right bank of the River Sowe by Exhall (SP 3421 8494) also incorporates a small number of properties within Flood Zone 2 at the downstream extent of the watercourse by its confluence with the Sowe Brook.

5.3.3 Fluvial Flood Risk within the Borough of Rugby

The Environment Agency Flood Zone maps for the River Avon extend predominantly into undeveloped agricultural land as the watercourse enters the Borough in the eastern extent. As the watercourse continues to flow through the Borough in a westerly direction, it flows round the southern edge of Brownsover (SP 5209 7684) extending predominantly onto rural floodplain. After flowing beneath the Oxford Canal, the River Avon flows through the centre of Rugby where a number of residential and commercial properties and recreational land are located within Flood Zone 2. At this point Flood Zone 2 extends up to 250m on the left bank and 200m on the right bank. A number of properties are also located within Flood Zone 2 by Newbold on Avon (SP 4899 7709). As the watercourse then continues to flow in a westerly direction through predominantly rural floodplain, a number of isolated properties and farms are located within Flood Zone 2. At Wolston (SP 4108 7586) a number of residential properties and the Wolston Business Park (now a residential estate) are located within Flood Zone 2. Downstream of Wolston, the River Avon continues to flow in a westerly direction extending onto predominantly undeveloped rural floodplain, extending up to 600m on the right bank by Ryton-on-Dunsmore where Brandon Nature Reserve is located within Flood Zone 2. At the western extent of the Borough, the watercourse forms the boundary with Warwick District Council

and flows in a southerly direction with Flood Zone 2 extending up to 400m into the Borough onto undeveloped rural floodplain.

The River Swift forms a tributary of the River Avon, entering the Borough in the eastern extent by Bransford Bridge (SP 5200 8224). The Environment Agency Flood Zone maps for this watercourse indicate that as the watercourse flows in a southerly direction through the Borough, Flood Zone 2 extends onto predominantly rural floodplain, incorporating Swift Valley Industrial Estate at SP 5010 7819 on the right bank. Flood water is shown to cross the Brownsover Road (SP 5047 7749), resulting in flooding to the industrial units located downstream. Downstream of the Oxford Canal (SP 5020 7730) property is at risk from flooding at Elliot's Field Retail Park and Swift Valley Industrial Estate as the watercourse flows towards it's confluence with the River Avon (SP 5052 7680). The Hydraulic Modelling report of the River Swift (July 1999) provided by the Environment Agency indicated that at Churchover (SP 5070 8070), a canal feeder takes water directly from the River Swift to the Oxford Canal in Rugby. In times of normal flow, the majority of the water in the river is diverted to the canal, with only a small compensatory flow going down the River Swift. However, during flood conditions an automatic sluice gate is raised and the majority of the flow is diverted back into the River Swift. It was reported in the Modelling Report that the Environment Agency have confirmed that very little flow goes down the canal feeder during flood events.

Clifton Brook forms a left bank tributary of the River Avon rising in the south-eastern extent of the Borough and forming part of the Borough's boundary. The Environment Agency Flood Zone maps indicated that Flood Zone 2 extends into predominantly rural floodplain at this location with only a few isolated properties located within the floodplain. As the Clifton Brook flows towards it's confluence with the River Avon, Flood Zone 2 widens and a number of industrial properties are located within the Flood Zone along with some playing fields by Mill Gardens (SP 5152 7641).

The Sow Brook forms a left bank tributary of the River Avon. The Environment Agency Flood Zone maps for this watercourse indicate that a number of industrial properties are located within Flood Zone 2 towards the downstream extent by the confluence with the River Avon. It should be noted however that some misalignments are evident within the flood maps along this watercourse and therefore there is the possibility that the current Flood Zones are incorrect in some places along this watercourse. This is due to the limitations of the method of generating Flood Zones in this area (see Appendix C for more details).

An unnamed tributary joins the left bank of the River Avon by Wolston (SP 4108 7586). Flood Zone maps indicate that the majority of Flood Zone 2 extents onto rural floodplain, apart from a few properties in the downstream extent by Wolston.

Flood Zone maps have been provided by the Environment Agency for the Smite Brook. As the watercourse flows in a westerly direction through the Borough only a small number of properties are located within Flood Zone 2 at Monks Kirby (SP 4663 8292) and Stretton Under Fosse (SP 4299 8057), with the majority of the Flood Zone extending onto rural, undeveloped floodplain.

Towards the northern extent of the Borough, Environment Agency Flood Zone maps have been provided for a number of watercourses including Harrow Brook, Sketchley Brook, the River Anker and Withy Brook. The Harrow Brook runs along the boundary of the Borough with Nuneaton and

Bedworth and the Flood Zone maps indicate that there are no properties located within Flood Zone 2 within the Borough.

The Sketchley Brook enters the Borough on the northern extent at SP 4090 9244 and flows in a south-westerly direction. Although there are no properties located within Flood Zone 2, there are a number of misalignments along the watercourse in particular by Hydes Pastures (SP 4032 9232) and therefore caution should be taken when interpreting the information. A number of misalignments were also apparent in the Flood Zone maps for the Withy Brook. The Flood Zone maps indicate that there are a number of isolated properties located within Flood Zone 2 along this watercourse and therefore caution should be taken when interpreting the data.

The River Anker rises within the Borough and Flood Zone maps have been provided by the Environment Agency. A number of isolated properties are located within Flood Zone 2; however, the majority of the Flood Zone extends into undeveloped rural floodplain. It should be noted that there are a number of misalignments in the Flood Zone maps along the watercourse in particular by Wolvey (SP 4331 8795) and therefore caution should be taken when interpreting the information.

The River Leam flows in the southern extent of the Borough in a westerly direction. The Flood Zone maps provided by the Environment Agency indicate that Flood Zone 2 extends predominantly into rural floodplain, however, a number of properties are located within Flood Zone 2 in the upper reaches of the River Leam by Willoughby (SP 5193 6733), Grandborough (SP 4919 6695), Kites Hardwick (SP 4684 6830), Birdingbury (SP 4337 6838) and Marton (SP 4146 6905). In the upper reaches of the watercourse a number of misalignments are apparent within the Flood Zone maps. Therefore, caution should be taken when interpreting the information. The River Itchen forms the south-western boundary of the Borough with Warwick District Council. Flood Zone 2 extends predominantly into undeveloped rural floodplain, with only a few properties located within the Flood Zone 2 by the confluence with the River Leam at Marton (SP 4146 6905).

The Environment Agency Flood Zone maps for the Millholme Brook indicate that as the watercourse flows in a northerly direction through the Borough, Flood Zone 2 extends predominantly into undeveloped rural floodplain.

5.3.4 Fluvial Flood Risk within the District of Warwick

Flood Zone maps for the River Avon extend predominantly into undeveloped agricultural land from the point at which the watercourse enters the District in the north-eastern extent (SP 3657 7511). As the watercourse flows in a south-westerly direction through the centre of the District, substantial areas of the eastern and southern edge of Warwick are located within Flood Zone 2. Flood Zone outlines for St Johns Brook (a tributary of the River Avon) also show both residential and commercial properties adjacent to the watercourse at risk from flooding.

During the consultation period of the SFRA, concern was raised as to how the Flood Zone maps were produced for the River Avon, specifically Flood Zone 3. Consultation with the Environment Agency has indicated that although detailed modelling work has been undertaken, at certain locations along the watercourse the Easter 1998 historic flood outline was the best available information and therefore this was used to improve the Flood Zones where necessary. Flood Zone maps for Flood Zone 2 can only be amended using historic data where no detailed modelling work is available.

In the east of the District the River Leam flows in a northerly direction along the District boundary before turning in a westerly direction towards Royal Leamington Spa. The Environment Agency's Flood Zone maps demonstrate that as the watercourse flows through the district, Flood Zone 2 extends into predominantly agricultural land and also incorporates a number of properties within smaller settlements such as Eathorpe (SP 3913 6912), Hunningham (SP 3731 6853) and Offchurch (SP 3585 6602). Anecdotal evidence received from the District Council corresponds well with the existing Flood Zone maps at these locations. The Environment Agency maps also demonstrate that as the River Leam flows through the settlement of Royal Leamington Spa, substantial areas of the town centre lie within Flood Zone 2 until the watercourse reaches it confluence with the River Avon.

Flood Zone maps for an unnamed tributary joining the River Leam immediately downstream of Radford Road Bridge (SP 3383 6511) demonstrate that a small number of properties are located within Flood Zone 2 by Danesbury Crescent (SP 3362 6477) and Marlborough Drive (SP 3358 6451). It should be noted however that some misalignments are evident within the flood map and therefore there is the possibility that the current Flood Zones are incorrect in some places along this watercourse. This is due to the limitations of the method of generating Flood Zones in this area (see Appendix C for more details).

Flood Maps in the north-eastern extent of the District indicate that a small number of properties are located within Flood Zone 2 along the River Sowe downstream of Baginton Bridge (SP 3395 7528) along with a large works at the confluence of the Finham Brook (SP 3339 7386). A number of residential and commercial properties are also shown at risk of flooding from the Finham Brook as the watercourse flows around the western edge and centre of Kenilworth, and a few isolated properties are located within Flood Zone 2 along the Canley Brook including The Shrubberies at SP 3115 7596.

Other smaller watercourses within the District indicate a degree of flood risk to properties including the Gog Brook (SP 2740 6388), Fisher's Brook (SP 2761 6340) and Sherbourne Brook (SP 2608 6152) and Longbridge Brook (SP 2673 6179) in the south-western extent of the District. It should be noted that the flood outlines appear to be misaligned in places and therefore caution should be taken when interpreting the information.

5.3.5 Fluvial Flood Risk within the District of Stratford-on-Avon

Flood Zone maps for the River Avon extend predominantly into undeveloped agricultural land from the point at which the watercourse enters the District in the north-east by Sherbourne (SP 2596 6075), with only a number of isolated properties and caravan parks contained within Flood Zone 2 in Hampton Lucy (SP 2596 6075), Alveston (SP 2362 5658) and Tiddington (SP 2189 5603). As the River Avon flows through Stratford-upon-Avon a number of residential and commercial properties and recreational areas including Stratford-on-Avon Racecourse are located within Flood Zone 2. Through the town centre, Flood Zone 2 extends up to 600m on the right bank and 700m on the left bank. The tributary of the Shottery Brook join the River Avon in the centre of Stratford-upon-Avon where a number of both residential and commercial properties are located within Flood Zone 2. As the River Avon continues to flow in a south-westerly direction through the District, Flood Zone 2 extends onto predominantly rural floodplain, with a number of properties located within Flood Zone 2 at Luddington (SP 1729 5224), Weston-on-Avon (SP 1598 5195), Welford-on-Avon (SP 1447 5293), Barton (SP 1075 5121), Bidford-on-Avon (SP 0978 5174), Marcliffe (SP 0957 5066), and Salford Priors (SP 0785 5098). The River Avon then exits the District with Flood Zone 2 extending across the District boundary onto the Worcester Flood Meadows, before re-entering the District where Flood Zone 2

extends onto predominantly rural floodplain before exiting the District in the south-western extent at SP 0668 4841).

A number of tributaries of the River Avon flow through the District including the Thelsford Brook, River Dene, River Stour, Shottery Brook, Marchfont Brook, Noleham Brook, River Arrow and a number of unnamed tributaries. Where available, Flood Zone maps for these watercourses appear to flow predominantly through rural floodplain, with a number of smaller towns located within Flood Zone 2. The Flood Zone maps for the River Dene extend into rural floodplain particularly in the upper reaches with only a few properties located within Flood Zone 2 by Walton (SP 2860 5324) and Wellesbourne (SP 2774 5529). However, there are a number of misalignments in the Flood Zone maps for this watercourse particularly in the upper reaches by Kineton (SP 3412 5075). Similarly, there a number of misalignments in the Flood Zone maps for the unnamed tributary that joins the left bank of the River Dene by Butlers Marston (SP 3194 5021). Caution should therefore be taken when interpreting the Flood Maps for these watercourses.

Flood Zone maps provided by the Environment Agency for the River Stour (a left bank tributary of the River Avon) indicate that a number of properties are located within Flood Zone 2 at Tidmington (SP 2602 3816), Willington (SP 2678 3863), Shipton-on-Stour (SP 2619 4063), Tredington (SP 2629 4361), Alderminster (SP 2301 4854), Preston-on-Stour (SP 2145 4999), Atherstone-on-Stour (SP 2058 5096) and Clifton Chambers (SP 1982 5215).

A number of properties are located within Flood Zone 2 along the River Arrow as it flows in a southerly direction through the District. As with other watercourses within the District, much of Flood Zone 2 extends on rural, undeveloped floodplain, however commercial and residential properties are located within Flood Zone 2 by Studley (SP 0762 6401), Coughton (SP 0831 6274), Alcester (upstream of the tributary with the River Alne, SP 0896 5765) and Broom (SP 0876 5344).

Flood Zone maps for the River Alne have been provided by the Environment Agency. In the upper reaches by Tanworth-in-Arden (SP 1193 7081) there are a number of misalignments win the outlines and therefore this information should be used with caution. As the watercourse flows through the District, Flood Zone 2 incorporates a number of properties in the settlements of: Beadesert (SP 1543 6792), Henley-in-Arden (SP 1526 6630), Aston Cantlow (SP 1385 6018), Great Alne Mills (SP 1221 5892) and Alcester (SP 0976 5767).

Flood Zone maps were also provided for an unnamed tributary that joins the River Avon at SP 2583 5662. As this watercourse flows through the District a number of properties are located within Flood Zone 2 to the north-east of Wellsbourne (SP 2815 5593) and Charlecote (SP 2724 5685). It should be noted however that this Flood Zone maps for this watercourse are misaligned in places and therefore caution should be taken when interpreting this information.

The Flood Zone maps for the River Stowe contain a number of properties as it flows through Southam (SP 4181 6155). Upstream of Southam the Flood Maps extend into predominantly rural floodplain, apart from a number of isolated properties and farms which are located within Flood Zone 2. The River Stowe flows into the River Itchen at SP 4101 6513. Flood Zone maps for the River Itchen extend into predominantly rural floodplain as the watercourse flows through its upper reaches, with only a few isolated properties, farms and a sewage treatment works (SP 4074 6278) are located within Flood Zone 2. The Flood Zone maps appear to be misaligned in a number of places along the

watercourse as it flows through the District. Downstream of the Grand Union Canal, the Flood Zone maps widen with a number of properties located within Flood Zone 2 at Long Itchington (SP 4101 6513).

A number of minor watercourses also flow through the District of Stratford-on-Avon and the Flood Zone maps for these watercourses extend onto predominantly rural floodplain with the exception of isolated properties and farms. The Environment Agency Flood Zone maps should be consulted along minor watercourses where development is proposed.

5.4 Flooding from Other Sources

Methodologies for recording flooding from sources other than fluvial or tidal were not standardised until 2006. Therefore records held of such flooding can be incomplete, or not to a uniform standard. Information has been gathered on flooding experienced from sources other than rivers, and is described in this section.

5.4.1 Flooding from Artificial Drainage Systems and Surface Water Runoff

All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes records of flooding incidents from foul sewers, combined sewers and surface water sewers which are deemed to be public and therefore maintained by the Water Company. It should be noted that flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register. The DG5 register tends to show, to a greater or lesser extent: the date of the most recent incident, the post town, locality, street, post code, a type and problem description, if internal flooding occurred, details of curtilage flooding, and the eastings and northings of the flood incident. The recording of flood events by the authorities has often led to improvements intended to prevent reoccurrence, so historical flooding is not necessarily evidence of propensity for future flooding.

Information on flooding from surface water and artificial drainage sources has been provided by Severn Trent Water (STW) and Thames Water (TW). Due to the Data Protection Act, it is not possible to specify the exact locations of past incidents. Therefore STW and TW have provided the first four digits of postcodes in the study area, and have indicated how many incidents have occurred within each postcode area. This information has been digitised as a GIS layer. Where a flooding incident has been recorded within a four-digit postcode area, the whole area is shown as at risk when in fact only a few incidents might have been recorded in that area. Therefore, when the information is displayed on the paper maps the majority of the County would appear to be affected by sewer flooding, when in fact a much smaller area has been affected in the past. The affected postcode areas have therefore not been displayed on the paper maps, so that other information can still be viewed. Instead, a digital GIS layer has been provided which allows the user to view the data within a GIS package and by clicking on a post code area establish the numbers of properties affected within each area. This can be found on the data CD attached to the front cover of this report.

Within the Warwickshire 106 postcode areas have been identified as having properties at risk of flooding from artificial drainage systems and surface water runoff. As discussed, the implications of the Data Protection Act means this report cannot pin-point the exact locations of properties at risk; however, the numbers of properties affected within each post code area has been identified and detailed in Appendix D. The Environment Agency has asked that, should development take place in

these areas, further work should be carried out to investigate the nature and scale of the risk posed, so that mitigation can be put in place and the areas can be targeted through appropriate policies for reducing flood risk.

It is evident from the table that flooding from artificial sources occurs throughout Warwickshire with the most reported incidents in the central parts of the County in particular within the District of Warwick where the most reported incidents were in the north of the District by Kenilworth within post code areas CV8 2 and CV8 1. A significant number of incidents were also reported within the District of Warwick towards the south-western and south-eastern extents (post code areas CV31, CV31 2, CV32 4, CV32 7 and CV35 8).

Within the Borough of North Warwickshire flooding from artificial sources occurs throughout the majority of the Borough apart from the central area which is predominantly rural. The post code areas with the most reported incidents were: CV7 7 (15 reported incidents), CV10 0 (13 reported incidents) and CV9 2 (12 reported incidents).

Within the Borough of Nuneaton and Bedworth flooding from artificial sources occurs at a number of locations within the northern and southern post code areas including post code area CV10 0 where there were thirteen reported incidents, CV12 9 eleven reported incidents and, CV12 0 eight reported incidents.

Flooding from artificial sources has been reported within Rugby town itself within the eastern post code areas within the Borough of Rugby. Post code area CV21 3 had sixteen reported incidents, CV22 5 eleven reported incidents and CV22 6 eight reported incidents. Post code area CV12 9 had eleven reported incidents, however, it should be noted that only a small percentage of this postcode area actually lies within the Borough of Rugby, and since it is not possible to pin-point the exact locations of properties at risk due to data protection requirements, caution should be taken when interpreting this data.

Within the District of Stratford-on-Avon flooding from artificial sources has occurred at a number of locations within the northern and central post code areas with post code area CV31 1 demonstrating the most reported incidents (24). However it should be noted that part of this post code area extends into the District of Warwick and due to data protection requirements it has not been possible to locate the exact locations of the recorded incidents. A number of incidents of flooding were also reported within post code areas CV37 9 by the Stratford area and B80 7 by Studley.

Anecdotal evidence received as part of this study indicates that surface water flooding has occurred at various locations throughout the County. The following locations have been identified as areas where surface water flooding has been a particularly problematic:

Borough of North Warwickshire

Warwickshire County Council has consulted UK Coal at Daw Mill Colliery concerning their underground and surface water discharges. The mine discharges approximately 12litres/second into the River Tame via a pipeline running from the Colliery, along the railway and past Shustoke Reservoir. There is also a sewage treatment works on site and emergency discharge points into the brook. The discharge volume and quality are monitored by the Environment Agency. Anecdotal

evidence received as part of this study has indicated that the flooding from field runoff is a problem throughout the whole Borough, particularly in rural areas.

Borough of Nuneaton & Bedworth

It is clear that surface water drainage is an issue in some parts of the study area, and back-up of water during heavy rainfall events can cause roads to become flooded. Anecdotal evidence has indicated that part of Queen Elizabeth Road adjacent to the balancing lake at (SP 3430 9230) is vulnerable to flooding from fluvial sources (the Barpool and Whittleford Brooks) and also as a result of flooding from surcharged sewers and overland flow from the Camp Hill Estate. Barpool Balancing Pond is designed to accommodate flows from the Barpool Brook; however the scheme is not yet complete. Flood events that occurred on the 21st July 2007 suggest that the sewer infrastructure that discharges into the lake is inadequate. In addition, during the summer 2007 events, surface water flooding was also reported by the leisure centre in Attleborough.

District of Warwick

Surface water is known to be transferred into the Tanyard Stream for approximately two miles of railway track drainage between the St Johns roundabout (SP 2930 7090) and Mill End (SP 2960 7270). In addition, surface water runoff from agricultural land is known to be a problem within the District on slopes over 10% during heavy, flashy rainfall events. This was particularly problematic during the summer 2007 flood events as the surrounding land was already saturated and the runoff from large areas of contributing agricultural land resulted in flooding for properties at the foot of the hills. Land management issues relating to farming methods can lead to drainage problems, increasing the speed at which surface water runs from the slopes and into the watercourses. Additional problems with surface water were also experienced from school playing fields and areas of open space during the summer 2007 flood events.

STW has stressed that LPAs should adopt a planning policy requiring the use of SUDS as proposed in PPS 25 and that PPS 25 should be used when allocating land for development within Flood Zones so that the risk of fluvial flooding is minimised. This reduces the risk of fluvial flood waters entering public foul and surface water sewers and resultant widespread flooding and pollution. Individual developments should be designed so that natural flood pathways are left free of buildings. Further guidance on the application of SUDS can be found in Chapter 11, and in the CIRIA Report C635, Designing for Exceedance in Urban Drainage (2006).

5.4.2 Flooding from Impounded Water Bodies

Records of flooding from reservoirs and canals are erratic as there is no requirement for the Environment Agency to show historic flooding from canals and raised reservoirs on plans. In particular, PPS 25 does not require flood risk from canals and raised reservoirs to be shown on the flood map. This is surprising, as overflows from canals are common due to flows from land drainage and their frequent lack of overflows. Occasionally major bank breaches also occur, leading to rapid and deep flooding of adjacent land.

A number of canals are located within Warwickshire. The Coventry Canal runs through the northern extent of the County, through the Boroughs of North Warwickshire and Nuneaton and Bedworth through the towns of Bedworth, Nuneaton, Atherstone, Polesworth and then onwards to Tamworth.

Consultation with BW has indicated that there are no records of canal breaches from these canals within Warwickshire.

The Birmingham and Fazeley Canal runs through the Borough of North Warwickshire. Consultation with BW has indicated that there are no records of canal breaches from this canal within the North Warwickshire Borough.

The Ashby-de-la-Zouch Canal passes briefly through Warwickshire within the Boroughs of Rugby and Nuneaton and Bedworth, from a junction with the Coventry Canal at Bedworth. Consultation with BW has indicated that there are no records of canal breaches within the Nuneaton and Bedworth Borough.

The Oxford Canal, runs from near Coventry into the Borough of Rugby and then eastwards around Rugby, and then through the rural south of the County through the District of Stratford-on-Avon towards Oxford. The Oxford Canal Brinklow Arm also runs through the Borough of Rugby. Consultation with BW has indicated that there is one record of a canal breach within the Borough of Rugby on the Oxford Canal by Hopsford Aqueduct (SP 4153 8306). The breach occurred in 1963 and was of 7m. It was subsequently repaired with sheet piles. It should be noted that the River Swift acts as a source of water for the Oxford Canal, with a feeder channel at Churchover, controlled by BW via a sluice gate on the River Swift. A small section of canal named Old Canal (disused) also runs through the Borough of Rugby.

The Grand Union Canal runs through the Districts of Stratford-on-Avon and Warwick through the towns of Royal Leamington Spa and Warwick before running onwards to Birmingham. The restored Saltisford Canal Arm, is close to the centre of Warwick, and is now a short branch of the Grand Union Canal. Consultation with BW and the District Councils has indicated that a number of canal breaches have occurred along the Grand Union Canal. Within the District of Warwick a canal breach was recorded in 1868 adjacent to Bridge Street by Emscote (SP 2998 6552). A breach by Hatton Locks (SP 2485 6661) occurred in 1985 caused by third party works, where a pipe was driven through the bed which led to the bed collapsing. During the summer 2007 flood events, a series of canal breaches occurred along the Grand Union Canal through Warwick itself including locations at Lower Cape Road (SP 2769 6605), the Yuassa Commercial Unit on Lower Lock Lane (SP 2791 6606), and Exham Close (SP 2808 6617) and Lyton Close causing flooding to property. BW also provided records of breaches within the District of Stratford-on-Avon along the Grand Union Canal by Long Itchington close to Bickley's Bridge (SP 4136 6462) in 1801, 1957-1988 and 1977. The breaches occurred as a result of embankment failure following construction, slip failure due to geotechnical instability, and, as a result of scour to the canal embankment toe from the river Itchen when it was in flood resulting in an increase in water levels within the canal. The river was subsequently re-aligned and the canal embankment rebuilt.

The Stratford-upon-Avon Canal runs from the Grand Union west of Warwick through the District of Warwick and onwards to Stratford within the District of Stratford-on-Avon. Consultation with BW has indicated that a canal breach has occurred within the District of Stratford-on-Avon. Records indicate that in 1987 a small breach occurred near Preston Baggot (SP 1729 6505) where water was seen slowly escaping via a field into a stream.

It is however important that canals are included in any SFRA as they form a vital land drainage function. Any FRA should therefore take account of canals. Not only do canals occasionally overtop in places due to high inflows from natural catchments (i.e. where inflows are higher than the capacity of the flood control structures), but they are also vulnerable where overtopping occurs from adjacent water courses. Additional water from adjacent watercourses must be routed/conveyed by the canal which may cause issues elsewhere, not only within the catchment of interest but also in neighbouring catchments, as the canal crosses catchment boundaries. Additionally, the canal itself can reduce flood risk where BW control flood flows within the canal, or accept flood waters either for temporary storage or transfer.

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

Reservoirs with an impounded volume in excess of 25,000 cubic metres (measured above natural ground level) are governed by the Reservoirs Act and are listed on a register held by the Environment Agency. Due to high standards of inspection and maintenance required by legislation, normally flood risk from registered reservoirs is moderately low.

Consultation with the Environment Agency indicated that a number of reservoirs are held on the Environment Agency's register that are located within Warwickshire. Within the Borough of North Warwickshire, twelve reservoirs are held on the Environment Agency's register. These included: Belfry (SP1760 9660), Broadwater (SP2270 8540), Geary's (SP2200 8250), Great Pool (SP2300 8380), Hall Pool (SP2200 8380), Merevale Park Estate near Atherstone (SP2953 9735), Middleton Hall Lake (SP1900 9820), Molands (SP2230 8220), Park Meadow (SP2260 8460), Shustoke Lower (SP2280 9120) and, Whitacre (SP2130 9110). Investigation into the history of these reservoirs did not uncover any records of breach or overtopping. Anecdotal evidence received as part of the study indicated that Shustoke Reservoir is owned by Severn Trent Water and water from the reservoir is pumped to Whitacre Water Works where it is treated and then piped to Nuneaton and Coventry area. In addition, problems with flooding from Mancetter Quarry have been reported (SP 3090 9507).

One reservoir is held on the Environment Agency's register that is located within the Borough of Nuneaton & Bedworth: Seeswood Pool (SP3280 9050). Investigation into the history of this reservoir did not uncover any records of breach or overtopping.

Within the Borough of Rugby one reservoir is held on the Environment Agency's register: Makin Fisheries Lake 1 (SP4180 8830). The information provided by the Environment Agency reservoir register only covered the Upper Trent area. Analysis of the OS Maps indicated that additional water bodies are located within the Borough. This includes Draycote Water (SP 4586 6964) which is owned by Severn Trent Water and is used as a storage reservoir which is filled by pumping water from the River Leam during winter months to help reduce flooding. Investigation into the history of these reservoirs did not uncover any records of breach or overtopping.

The information received from the Environment Agency's register of reservoirs only covered the Upper Trent area and therefore no reservoirs were identified within the Districts of Warwick and

Stratford-on-Avon as these are located within the West area. Analysis of OS maps indicates that there are no large reservoirs within the Warwick District. However, four reservoirs have been identified within the Stratford-on-Avon District, these being Wormleighton Reservoir (SP 4488 5170), Napton Reservoirs (SP 4667 6301), Stockton Reservoir (SP 4253 6448) and Birshops Bowl Lakes (SP 3891 5841). Investigation into the history of the reservoirs within the District did not uncover any records of breach or overtopping.

5.4.3 Flooding from Groundwater

The Environment Agency can monitor groundwater levels using boreholes and the records of these are held on the WISKI database (a software system). Both the Environment Agency and planning authorities can keep records of instances where a high water table has led to individual groundwater flooding events.

Consultation with the Environment Agency has suggested that there are no known major problems with flooding from groundwater within Warwickshire. However, in 2005, the Environment Agency produced the Warwickshire Avon Catchment Abstraction Management Strategy technical document. The Avon catchment has significant groundwater resources stored in the major aquifers around the Coventry, Warwick, Kenilworth and Bromsgrove areas. This document noted that with regard to Abstraction Point AP2 (the River Sowe at Stoneleigh) the nature of this particular aquifer, has resulted in some areas of the catchment being dominated by rising groundwater levels, which in some cases have broken out resulting in, for example, cellar flooding.

6 Strategic Flood Risk Mapping

6.1 Strategic Flood Risk Maps

A key output of the SFRA is a series of maps covering the LPA area, showing flood risk from sources including fluvial, surface water, foul and combined sewers, groundwater and impounded water bodies such as rivers and canals. The maps use the information detailed in Chapter 4. The strategic flood risk maps are presented as GIS layers, and can be interrogated to gain the associated descriptive information. These can be found in the CD attached to this report.

Level 1 SFRAs should seek to use Flood Zone outlines which have been produced using detailed modelling techniques in preference to the Environment Agency's Flood Zone maps. When representing the Flood Zones, Level 1 SFRAs should also show the functional floodplain, Flood Zone 3b, where such outlines exist. If Flood Zone 3b has not been produced as part of a detailed modelling project, similar outlines, such as the 1 in 25 year outline can be used, upon agreement with the Environment Agency. In the absence of such detailed information, a precautionary assumption has been adopted where Flood Zone 3b has not been modelled. When carrying out the Sequential Test the LPA should assume that where Flood Zone 3b has not been modelled, its extent would be equal to Flood Zone 3a (High Probability).

This approach is suitable at the Level 1 SFRA stage when carrying out the Sequential Test, a process whereby development should be placed in the lowest risk zone, Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, decision-makers should take into account the flood risk vulnerability of the development and consider reasonably available sites in Flood Zone 2. Only where there are no reasonably available sites in Flood Zones 1 or 2 should decision-makers consider the suitability of sites in Flood Zone 3.

In the absence of a Flood Zone 3b outline, the implications of assuming Flood Zone 3b is equal to Flood Zone 3a can be summarised in the following example. PPS 25 says that 'more vulnerable' developments, such as a housing development, can be placed in Flood Zone 3a provided it passes the Exception Test, but cannot be placed in Flood Zone 3b. If such a development was placed in Flood Zone 3a following the Sequential Test, further modelling work would have to be carried out as part of a Level 2 SFRA to define the extent of Flood Zone 3b, thereby defining the area where the development could not be placed. In the event that detailed modelling work is not possible, the LPA should assume that Flood Zone 3b extends to the 3a extent, and should therefore remove the development from this area. Should a developer wish to prove otherwise, it is at this stage that developer contributions can be given in order to carry out further modelling work. Such a scenario would be expected in an area where the development pressures are significant and there is little other developable land in lower risk areas.

Should sites be placed in Flood Zones 2 or 3, they should always be assessed through a more detailed Level 2 SFRA, which will refine Flood Zone information, allow the development to be located on parts of the site at lowest probability of flooding, and ensure that other areas do not become subject to increased risk as a result of the development.

6.1.1 Hydraulic (River) Models

River models have been collected and used for the production of the SFRA flood maps. Within Warwickshire, a number of Environment Agency hydraulic models are known to exist. These include:

- River Anker – Covering the whole of the River Anker and FRC in the northern extent of the County, from the point at which it enters the Borough of Nuneaton and Bedworth by Stretton Baskerville (SP 4033 9094), as it continues to flow into the Borough of North Warwickshire by Weddington (SP 3498 9380), to the point at which it exits the Borough of North Warwickshire by Shuttington (SK 248 050)

- River Tame - covering the whole of the main River Tame channel within the Borough of North Warwickshire, extending from the point at which the watercourse enters the Borough at Water Orton (SP 167 915) to the point at which the watercourse exits the northern extent of the Borough (SP 205 992)

- River Cole - covering the whole of the main River Cole channel from the point at which it enters the North Warwickshire Borough at the south western extent to the north east of Fordbridge (SP 183 879) to the point at which the watercourse joins the River Blythe

- River Sowe - covering the whole of the Main River Sowe channel within the Nuneaton and Bedworth Borough from the point at which the watercourse enters the Borough to the west of Bedworth (SP 3440 8700) to the point at which it exits the Borough by Rowley's Green (SP 3442 8393)

- River Avon Upper & Middle Models - covering the whole of the Main River Avon channel within Warwickshire from the point at which it enters the Borough of Rugby in the north-east by Coventry Airport (SP 3657 7511), and covering the whole of the main channel through the Districts of Warwick and Stratford-on-Avon to the point at which the watercourse exits the District of Stratford-on-Avon at the western extent by Harvington (SP 0670 4835)

- River Swift - covering the whole of the Main River Swift channel within the Borough of Rugby from the point at which the watercourse enters the Borough by Bransford Bridge (SP 5200 8224) to the point at which it joins the confluence with the River Avon (SP 5054 7679)

- River Leam - covering the whole of the Main River Leam channel from the point at which the watercourse is designated Main River within the Borough of Rugby (SP 4945 6726) to the point at which it joins the left bank of the River Avon by Warwick (SP 3016 6564)

- River Itchen – covering the main river Itchen channel from the downstream face of the A425 Southam Bridge (SP 4029 6156) within the District of Stratford-on-Avon, and as the watercourse forms the boundary between the District of Stratford-on-Avon, the District of Warwick and the Borough of Rugby, to the point at which it joins the River Leam by Marton (SP 4053 6900)

- Canley Brook - covering the whole of the main Canley Brook channel within the District extending from the point at which the watercourse enters the District of Warwick in the north by Canley (SP 3007 7538) and joins the left bank of the Finham Brook at SP 3068 7303

- River Sowe - covering the whole of the Main River Sowe channel, extending from the point at which the watercourse enters the District of Warwick in the north-eastern extent by Baginton (SP

3450 7560) to the point at which it joins the right bank of the River Avon by Stoneleigh (SP 3250 7240)

- Finham Brook - covering the whole of the length of the Brook from the point that it is designated Main River by the north-western edge of Kenilworth (SP 2765 7317) within the District of Warwick, to the point at which it joins the right bank of the River Sowe by Stoneleigh (SP 3366 7378)
- River Arrow - covering the Main River Arrow channel from the point at which it enters the District of Stratford-on-Avon by Washford (SP 0686 6504) to the confluence with the River Avon (SP 0825 5072)
- River Alne - covering the whole of the Main River Alne from Beaudesert (SP 1538 6794) to the confluence with the River Arrow (SP 09335734)
- River Blythe – covering the Main River Blythe channel from where it enters North Warwickshire at SP 21400 83200, flowing north to the confluence of the River Cole at SP 21220 91190 where the modelled extent ends. Immediately downstream of this the watercourse flows into the River Tame

Hydraulic modelling of the Sow Brook has also been undertaken for Rugby Borough Council and a hydraulic model of a small unnamed watercourse by Princethorpe has also been produced as part of a FRA. However, these models are not owned by the Environment Agency and therefore no changes have been made to the exiting Flood Zone maps for these watercourses.

Modelled flood outlines for Flood Zones 2, 3a and 3b have been provided by the Environment Agency for the hydraulic models covering the County where available. These have been used in preference to the current Environment Agency Flood Zones for Flood Zones 2, 3a and 3b. This is in line with the current guidelines outlined in PPS 25. The Table below provides details of the available modelled flood outlines.

	Flood Zone		
Watercourse	**3b**	**3a**	**2**
River Anker	✓	✓	✓
River Tame	x	x	x
River Cole	✓	✓	✓
River Sowe	x	✓	x
River Avon Upper & Middle	x	x	x
River Swift	✓	✓	x
River Leam	✓	✓	x
River Itchen	✓	✓	x

Canley Brook	**x**	**✓**	**x**
Finham Brook	**x**	**x**	**x**
River Arrow	**x**	**✓**	**x**
River Alne	**x**	**✓**	**x**
River Blythe	**x**	**x**	**x**

Analysis of the modelled flood outlines for the River Anker and River Sowe indicated that the existing Environment Agency Flood Zones already incorporated the modelled outlines therefore no further changes were required to the Flood Zone maps for the River Anker.

It is known that a Flood Mapping study is due to be undertaken for the River Tame with completion expected at the end of March 2008. Modelled outlines will be prepared as part of this study and the current Environment Agency Flood Zone maps should be updated when this information becomes available, however it was not possible to update the current Environment Agency Flood Zone maps at the time this SFRA was undertaken.

6.2 Climate Change Maps

PPS 25 sets out guidance for changes to flood risk as a result of climate change and this is shown below. These climate change scenarios are now included in most Environment Agency river models and flood outlines are produced; for older river studies this is less likely.

The main Climate Change table (adapted to demonstrate effects on rivers) from PPS 25 is shown below:

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%**		

In its November 2006 publication of the predicted effects of climate change on the United Kingdom, Department for the Environment and Rural Affairs (defra) described how short duration rainfall could increase by 30% and flows by 20%, and suggests winters will become generally wetter. These effects will tend to increase both the size of Flood Zones associated with the sea and rivers, and the amount of flooding experienced from “other sources”.

Where climate change outlines have been produced from existing models these outlines have been used on the SFRA climate change maps. If these do not exist, analysis of other modelled scenarios have been undertaken to assess their suitability for use as a climate change proxy. In general our past experience has shown that the 1 in 1000 or 1 in 200 year outlines often show similar extents to the climate change scenarios of the 100 year event.

The table overleaf details models where climate change outlines have been produced or instances where other modelled scenarios have been used to represent a climate change scenario.

Watercourse	Climate Change Outline or Alternative Modelled Outline Available?	Modelled Scenario used
River Anker	✓	100 Year + 20%
River Tame	x	-
River Cole	✓	100 Year + 20%
River Sowe	x	-
River Avon Upper & Middle	x	-
River Swift	✓	150 Year
River Leam	✓	150 Year
River Itchen	✓	150 Year
Canley Brook	x	-
Finham Brook	x	-
River Arrow	✓	200 Year
River Alne	✓	200 Year
River Blythe	x	-

For watercourses where models do not exist, the most up-to-date Environment Agency Flood Zone maps have been used. A 1 in 100 year climate change scenario has been produced by assuming that Flood Zone 2 (1 in 1000 year return period) will become Flood Zone 3 (1 in 100 year return period). It has been assumed that the functional flood plain (Flood Zone 3b - 1 in 20 year return period) will become Flood Zone 3a (1 in 100 year return period). This is a precautionary approach but one which is consistent with modelling experience, which shows that the 1 in 1000 year flood outline is often similar to the climate change scenario for the 100 year event. PPS 25 requires that present day Flood Zone maps are used to carry out the Sequential Test. However, the LPA might wish to use climate change maps to carry out the Sequential Test, in order to give a particularly long-term risk-based approach to planning.

This is the level of detail which PPS 25 requires for a Level 1 SFRA, and gives an indication of how Flood Zones and flood probabilities are likely to change over time. The climate change scenarios are provided in Volume 2, Tile C1.

7 Flood Warning Systems and Flood Risk Management Measures

7.1 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 in flood risk areas, flood warning and emergency response.

7.1.1 Catchment Flood Management Plans

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. Three CFMPs cover Warwickshire: the River Trent, River Severn and River Thames.

River Trent CFMP

The River Trent CFMP is currently being undertaken for the River Trent catchment and at the time of production of this SFRA, the document had been released for consultation (closing 28th January 2008). The study considers flooding over an area covering the River Trent catchment and all of its tributaries, which is a total area of over 10,000 square kilometres. The document gives an overview of flood risk in the River Trent catchment and sets out a preferred plan for sustainable flood risk management over the next 50 - 100 years. The document is currently in draft form and therefore it is possible that changes will be made to the text referred to overleaf. The current draft and final document will be available on the Environment Agency's website.

The Environment Agency and their partners have developed policies to manage flood risk in the future. These policies set our the direction flood risk management will take in the future, and will help achieve their vision for a more sustainable, cost effective and natural approach to managing flood risk. The policy options are detailed overleaf:

Trent CFMP Policy Options

Policy option	Policy
1	No active intervention (including flood warning and maintenance), Continue to monitor and advise
2	Reduce existing flood risk management actions (accepting that flood risk will increase over time).
3	Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline).
4	Take further action to sustain current scale of flood risk in the future (responding to the potential increases in flood risk from urban development, land use change, and climate change
5	Take further action to reduce flood risk (now and in the future)
6	Take action to increase the frequency of flooding to deliver benefits locally or elsewhere, (which may constitute an overall flood risk reduction, for example for habitat inundation).

The Trent catchment and that of its tributaries has been divided into 10 policy units. Each policy unit has been assessed to decide which policy will provide the most appropriate level and direction of flood risk management for both now and the future. Out of the six standard flood risk management policies listed above, one has been applied to each policy unit. These policies have been agreed nationally and are being applied to CFMPs in a standard way across England and Wales.

The allocation of the policies to each unit involved the review of large amounts of information, alongside feedback and extensive consultation and consideration was given to how the policy units would interact with each other. Policy units 6 and 10 from the River Trent CFMP cover Warwickshire and are relevant for the Boroughs of North Warwickshire and Nuneaton and Bedworth. These policy units are detailed in the tables overleaf.

Relevant Trent CFMP Policy Unit for North Warwickshire

Policy Unit 6	**Mid Staffs and Lower Tame**
Problem / risk	**Physical characteristics:** • South East Lowland area of upper Trent is predominately pasture with open arable areas, wooded heights above the wide, shallow central valley. Arden area wooded farmland landscape with rolling hills. North eastern industrial area based around former Warwickshire coalfield. Lower broad flat flood plains of the Tame and Trent confluence. • Triassic mudstones dominate the geology within this Policy Unit. • Soil Predominantly loamy with small areas of sandy soil. Area vulnerable to high run-off rates and soil erosion. • Cannock Chase Area of Outstanding Natural Beauty (AONB). Area of high sandstone heather and bracken heathland with birch woodland and extensive pine plantations.
	Flood mechanism: • The watercourses within the policy unit are relatively natural with few flood defences. Flooding occurs as a result of overtopping banks or embankments.
	Receptor (Areas affected): • Main towns at risk are Rugeley, Tamworth and Rocester. • Special Area of Conservation (SAC) – Pasturefields Salt Marsh, River Mease. • SSSI – Whitacre Heath, Middleton Pool, Alvecote Pools, Blithfield Reservoir, River Blythe. • NNR – Chartley Moss • Landscape designations: Cannock Chase – Area of Outstanding Natural Beauty (AONB)
	Flood risk: • Flood risk is assessed as generally low, but medium at Tamworth due to the number of relatively high number of properties located behind the existing defences. **Potential source of future flood risk** • Climate change • Land use change • Urbanisation
	Opportunities and constraints: *Opportunities:* • Improved efficiencies and more effective flood risk management. • Flood risk reduction through changes in land management. • Improved efficiencies through more focused and targeted maintenance. • Utilise disused aggregate workings for flood risk management. *Constraints:* • Large number of small settlements potentially at risk. • Existing aggregate extraction.

Policy Unit 6	**Mid Staffs and Lower Tame**
	Policy unit objectives: • Minimise disruption to people and communities caused by flooding in Tamworth and other smaller settlements along the Trent corridor, taking into account future climate change and development pressure. • Reduce the disruption caused by flooding to transport and infrastructure. • Sustain and protect cultural and social heritage in the policy unit. • Sustain and improve the status of environmentally designated areas through appropriate frequency, extent and duration of flooding, including using rivers and floodplains to benefit nature conservation. • Reduce soil erosion resulting from rapid surface water run-off, particularly where there has been significant ground disturbance caused by mining (Staffordshire) and where sandy soils are prone to erosion such as Cannock Chase. • Return watercourses to a more natural state, increasing biodiversity and opening up green river corridors through urban areas. • Sustain and increase the amount of Biodiversity Action Plan (BAP) habitat in the catchment. • Support and encourage land management and drainage practices, particularly from Staffordshire coal mining areas that will protect and improve water quality.
Policy selected	**Policy option 6 -** Take action
Justification	Large rural area, with low flood risk (Annual Average Damages (AAD) = £17.8m) Future flood risk is unlikely to increase significantly in the future (Future scenario AAD = £26.9m) – main driver for change is climate change. Main source of flood risk is Tamworth which can be managed by attenuation elsewhere and by allowing more space for flood plain inundation through Tamworth itself. Flooding downstream in policy unit 5 (Burton, Derby and Nottingham) can be reduced in parts by applying policy 6 in this policy unit. Policy 6 meets policy unit objectives downstream in policy unit 5.
Alternative policies considered	Policy 1 - do nothing. The current level of management is considered justifiable to prevent an unacceptable increase in flood risk. Policy 2 – reduce current level of flood risk management. As with policy option 1, the potential damages and losses would be unacceptable under a 'do less' policy. Policy 3 – maintain current level of flood risk management. Although the current level of flood risk is considered acceptable, it has been shown that flood damages will increase in the future. Policy 4 – maintain the current level of flood risk into the future. The current level of risk is not considered excessive and so this policy is not justified.
Uncertainties and dependencies	This policy selection is largely dependant on our assessment of current and future flood risk being relatively low, and that more sustainable flood risk management options will be sufficient to maintain an acceptable level of flood risk within the policy unit. The success of this policy depends on being able to manage flood risk in Tamworth effectively.

Relevant Trent CFMP Policy Units for Nuneaton & Bedworth

Policy unit 9	**Upper Soar and Upper Anker**
Problem / risk	**Physical characteristics:** • The Leicester Vales consist of clay ridges and valleys with little woodland; distinctive river valley of Soar with flood plains; terraces; the large town of Leicester dominates much of the landscape, but creates a diversity to the rest of the landscape. • The predominant geology of the Soar catchment is Keuper Marl interspersed with beds of Triassic Sandstone. • Soil drainage is impeded by the loamy clay soil which overlies the geology. Therefore quite a high percentage of the rainfall that falls on the catchment runs off.
	Flood mechanism: • Flooding results from channel capacity being exceeded and the flood plain being inundated. Leicester and Nuneaton are near the headwaters of their respective catchments and, as a result, response rates are relatively fast. • Flooding also occurs through Leicester resulting from ponding surface water and urban drainage unable to enter the local watercourses due to surcharging.
	Receptor (Areas affected): • People, property and infrastructure within Loughborough, Leicester and Nuneaton, although Nuneaton has recently benefited from a by-pass channel which reduces the probability of flooding by 1%. • As an area identified for further significant urban growth, it is possible that areas at risk of flooding within the policy unit may increase.
	Flood risk: • Current flood risk is generally considered to be medium across the policy unit as a whole, but parts of Leicester have been assessed as potentially high. • It is expected that flood risk may increase significantly across the policy unit in the future. **Potential source of future flood risk** • Climate change • Land use change • Urbanisation
	Opportunities and constraints: *Opportunities:* • Long-term opportunities to move development away from the floodplain and create green river corridors through parts of Leicester. *Constraints:* • Urban growth and development pressure.

Policy unit 9	**Upper Soar and Upper Anker**
	Policy unit objectives • Minimise disruption to people and communities caused by flooding, taking into account future climate change and urban growth. • Reduce the disruption caused by flooding to transport, particularly the A50 and A47, and several 'B' roads around Leicester. • Minimise the increase in the cost of flood damage in Nuneaton, Leicester and Loughborough, tanking into account future climate change and urban growth. • Return watercourses to a more natural state, increasing biodiversity and opening up green river corridors through urban areas of Leicester. • Sustain and increase the amount of BAP habitat in the catchment.
Policy selected	**Policy option 4 –** Take further action to sustain current scale of flood risk into the future (responding to the potential in flood risk from urban development, land use change and climate change).
Justification	Current flood risk is considered to be acceptable, future flooding is expected to increase considerably.
Alternative policies considered	Policy 1 – do nothing. The level of flood risk in this policy unit is currently being managed at an appropriate level. There is, however, a considerable amount of work carried out to make sure this level is maintained, without which, flood risk would be considerably greater. Policy 2 – reduce current level of flood risk management. As with policy option 1, the potential damages and losses in the future would be unacceptable under a 'do less' policy. Policy 3 – maintain current level of flood risk management. Although the current level of flood risk is considered acceptable, it has been shown that flood damages could increase considerably in the future. This policy, therefore, does not apply. Policy 5 – reduce the level of flood risk, both now and in the future. The current level of risk is considered appropriate and so this policy is not justified. Policy 6 – increase flooding to reduce flood risk elsewhere. There are local opportunities for this approach within the catchment, but selecting this policy is not driven by an objective to reduce flood risk.
Uncertainties and dependencies	The assessment of flood risk within the policy unit is based on the broadscale model developed for the CFMP, and relies on the coarse, low resolution Side Aperture Radar (SAR) based Digital Terrain Model (DTM). Flood risk in Leicester in particular may contain considerable uncertainty. The future increase in flood risk is based on forecasts of climate change and future increase in urban extent. Both these forecasts are very uncertain, but are critical to the policy selection process. The approach adopted however is conservative, and may actually underestimate the future increase in flood risk. The policy selected would then be confirmed as the correct choice.

Only very small portions of the Borough of Rugby and the Districts of Warwick and Stratford-on-Avon are covered by the Trent CFMP. Within the Borough of Rugby the River Anker is the only watercourse that drains directly into the River Trent (via the River Tame). It is therefore unlikely that the Borough will be significantly affected by the policies within the Trent CFMP. Within the District of Warwick, there are no watercourses within the District that drain directly into the River Trent; however, the River Blythe drains into the River Tame which ultimately drains into the River Trent. Similarly,

within the District of Stratford-on-Avon there are no watercourses that drain directly into the River Trent; however, the Spring Brook drains into the River Blythe which drains into the River Tame which ultimately drains into the River Trent. It is therefore unlikely that these two Districts will be significantly affected by the policies within the Trent CFMP.

River Severn CFMP

The Severn CFMP is a document which aims to identify flood risk management policies for the Severn catchment. Being a high-level document, it does not stipulate how the policy should be achieved, but does indicate the types of response that could be implemented to deliver a policy. The excerpts referred to below are from the current Severn CFMP which was undertaken as a pilot project. The whole document is currently being revised and there are likely to be significant changes. The revised document is expected to be completed late 2008 and will be available through the Environment Agency's website.

The generic flood risk management policies which were considered for the Severn were:

- Do nothing – no active intervention, including flood warning and maintenance
- Do minimum – continue with maintenance of river channel and existing flood defences, including asset surveys and inspections, and continue with the existing flood warning service; it is accepted that flood risk may change over time. Activities such as promotion of local self help types of response and individual property protection would also continue
- Maintain the current level of flood risk in the face of future changes. This is likely to require intervention during the life of the Plan, such as improving existing flood defence infrastructure or introducing upstream storage
- Intervene to reduce the current level of flood risk and to maintain this level in the face of future changes
- Intervene to increase the level of flood risk in specified areas in order to gain benefits locally or elsewhere, for example flooding farmland upstream of a community to provide storage for floodwater.

For the purposes of the CFMP, the Severn catchment was divided into 20 sub-catchments. The sub-catchment(s) relevant to Warwickshire include:

- The Avon – relevant to the Boroughs of North Warwickshire Borough, Nuneaton and Bedworth (only a small part of these council boundaries fall within this catchment) and, the Districts of Warwick and Stratford-on-Avon
- The Leam – relevant to the Borough of Rugby and the Districts of Warwick and Stratford-on-Avon
- The Arrow – relevant to the Districts of Warwick and Stratford-on-Avon

Given the 50-year timescale of the Plan, and the potential effects of future change scenarios, policies for short and long term for each sub-catchment have been identified. Short term policies cover the first 10 years of the Plan period, while long term policies take into account future change scenarios

and cover the remaining 40 years of the Plan. The policies identified for these catchments are shown in the tables overleaf (with more detail on how these could be achieved contained in the report itself).

River Severn CFMP catchment policies

Catchment	Short Term Policy (0-10 years)	Long Term Policy (11 - 50 years)
Avon Defended areas	➢ Maintain current level of flood risk	➢ Maintain current level of flood risk
Avon North Littleton, Sedgeberrow	➢ Reduce current levels of flood risk	➢ Maintain the level of flood risk that will be obtained over the short term
Avon Remainder	➢ Do minimum	➢ Reduce level of flood risk for larger settlements ➢ Maintain current level of flood risk for smaller communities ➢ Recognise that the level of flood risk will increase for agricultural and undeveloped land and isolated properties
Leam Long Itchington	➢ Maintain current level of flood risk	➢ Maintain current level of flood risk
Leam Remainder	➢ Do minimum	➢ Reduce level of flood risk for larger settlements ➢ Maintain current level of flood risk for smaller communities ➢ Recognise that the level of flood risk will increase for agricultural and undeveloped land and isolated properties
Arrow Defended areas	➢ Maintain current level of flood risk	➢ Maintain current level of flood risk
Arrow Remainder	➢ Do minimum	➢ Reduce level of flood risk for larger settlements ➢ Maintain current level of flood risk for smaller communities ➢ Recognise that the level of flood risk will increase for agricultural and undeveloped land and isolated properties

Thames Region CFMP

The Thames Region CFMP is a document which aims to identify flood risk management policies for the Thames catchment. The CFMP covers the fluvial part of the River Thames basin and its tributaries. This is from the source of the Thames in Gloucestershire, through to Teddington weir, as well as the Lee Basin and the smaller rivers in London. The draft CFMP was issued for consultation between February 2007 and April 2007, with analysis of the responses currently being undertaken.

The excerpts referred to below form the main messages of the Thames Region CFMP:

- Flood defences cannot be built to protect everything
- Climate change will be the major cause of increased flood risk in the future
- The floodplain is our most important asset in managing flood risk
- Development and urban regeneration provide a crucial opportunity to manage the risk

Only a very small portion of the upper Thames catchment falls within Stratford-on-Avon along the south-eastern boundary, the floodplains here are identified as 'narrow floodplains and mixed land use.' For this category it is recommended that there does not need to be a radical change in the way we manage the risk in these areas. We should continue to maintain watercourses, increase flood awareness and provide appropriate flood warnings. The main messages for this category are that PPS 25 should be closely followed to make sure that flood risk is considered in new developments as advocated in this SFRA.

7.1.2 Flood Risk Management Strategies

The Environment Agency advocates a strategic approach to flood risk management on a 'whole catchment' basis. In line with this thinking, a number of flood risk management strategies have been undertaken by the Environment Agency within the Midlands region of which three cover the County of Warwickshire: the River Tame, River Trent and River Severn.

The River Tame Strategy covers the Borough of North Warwickshire; the River Trent Strategy covers the Boroughs of North Warwickshire, Nuneaton and Bedworth and the District of Warwick; and, the River Severn Strategy which covers the whole of Warwickshire.

River Trent Strategy

In 2005, the Environment Agency produced a Flood Risk Management Strategy for the River Trent, which has been reviewed for inclusion in this study. The study spanned from Stoke-on-Trent, where the River Trent's Head of Main River is located, to the tidal limit at Cromwell Weir downstream of Newark, a distance of some 200km. The principal aim of the Fluvial Trent Strategy is to identify the preferred high level approaches for sustainable management flood risk along the River Trent corridor over the next 50 years.

The strategy is limited to the Trent corridor only, and while local catchment wide solutions (i.e. of the tributaries) are appraised in some instances, flood risk along the Trent corridor is mainly considered. Within Warwickshire there is only one direct tributary of the Trent, the River Tame which is located within the Borough of North Warwickshire. However, a number of tributaries of the Tame flow through

the County including the Rivers Bourne, Anker, Blythe and Cole. There is, therefore, little in the strategy which refers directly to the Trent's uplands tributaries which characterise the fluvial setting in Warwickshire. The strategy tends to focus on flood risk management measures for the headwaters of the River Trent main river, located in neighbouring Stoke-on-Trent City Council. For this reason, flood risk management measures which would affect rivers in Warwickshire do not feature in the strategy.

Nonetheless, the strategy identifies a number of options which are considered best practice and are recommended. These recommendations are supported by PPS 25 requirements and indeed the main messages of this SFRA, which considers these options in more detail. These include:

- SUDS: either retrofitted or on new developments
- Development Control: appropriate measures to restrict inappropriate developments
- Land Management: Appropriate land management techniques that could reduce surface runoff

Floodplain Obstructions: the removal of such obstructions, where appropriate, to improve local conveyance.

River Severn Strategy

The Fluvial Severn Strategy was issued in October 2006 and has been reviewed for inclusion in this study. The study covered the area of influence around the Severn corridor to the downstream limit of the weirs at Gloucester. The principal aim of the Fluvial Severn Strategy is to provide a 50-year framework for the management of flood risk within the fluvial Severn study area and a 5-year plan for capital investment on project level flood defence/management.

Like the Trent Strategy, the Severn Strategy is focused on the Severn corridor only. Flood risk management options are therefore only appraised for implementation on the River Severn corridor, which for the purposes of the Strategy was taken as being just beyond the extent of the Environment Agency's current Flood Map. Therefore the wider catchment, which affects Warwickshire, does not feature in the Strategy.

7.2 Flood Defences

Flood defences are structures which affect flow in times of flooding and therefore prevent water from entering property. They generally fall into one of two categories: 'formal' or 'informal'. A 'formal' defence is a structure which has been specifically built to control floodwater. It is maintained by its owner (this is not necessarily the Environment Agency) so that it remains in the necessary condition to function. An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

A study of informal defences has not been made as part of this assessment. 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.

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 Environment Agency's National Flood and Coastal Defence Database (NFCDD). This 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).

A number of locations at risk of flooding are currently protected by permanent defences within Warwickshire, and can be viewed in Volume 2, Tiles A1-A20 and are detailed below.

7.2.1 Flood Defences within the Borough of North Warwickshire

Along the River Tame there are a series of Environment Agency maintained defences through Water Orton including an earth bank located along the right bank upstream of the Water Orton FRC (SP 169 912), Marsh Lane Embankment on the right bank opposite Marsh Lane Pond (SP 178 915) and Old Marsh Embankment on the left bank of the watercourse near the M42 opposite Marsh Lane (SP 184 918). All of these defences are thought to protect to the 1 in 100 year event.

Downstream of Water Orton a floodbank is located along the right bank of the River Tame opposite Coleshill Sewage Treatment Works (SP 192 914). The NFCDD states that a report produced by the STW indicates that the works are flooded regularly and that the current standard of protection offered by the defence is to the 1 in 50 year event.

There are a series of earth embankments and concrete revetments opposite Hams Hall Power Station and near Station Road on the left bank of the River Tame. NFCDD indicates that the defences offer protection up to the 1 in 50 year event.

There are a series of flood banks along the right bank of the River Tame at Whitacre Heath and Lea Marston. These flood defences are thought to provide protection to the 1 in 100 year event. Also there is a flood embankment adjacent to the railway and Lea Marston Lake also providing protection to the 1 in 100 year event.

The Coleshill FAS on the River Cole consists of a series of flood defence walls, earth embankments designed to provide a standard of protection up to the 1 in 100 year event. The defences are located along the left and right bank of the River Cole to the rear of the factories on Station Road (SP 200 895). Additional Environment Agency maintained permanent flood defences are located at Grendon Road (SK 288 006) and Ratcliffe Bridge (SK 318 985) and take the form of bridge abutments.

The NFCDD also identifies a number of Local Authority and privately owned defences. These are located along the River Anker at Shuttington Bridge, the M42 road bridge at Polesworth and railway abutments at Polesworth.

7.2.2 Flood Defences within the Borough of Nuneaton & Bedworth

Within Nuneaton, the River Anker/Nuneaton FRC provides protection to a number of residential and commercial properties in Nuneaton. The inlet weir and the Anker cut off embankment and throttle structure at Attleborough Fields (SP 3786 9166), and a series of channel and floodwalls and pilling by Weddington Road (SP 3652 9271) are recognised as formal defences by the NFCDD database. According to modelling undertaken in May 2006, the standard of protection provided by the Nuneaton

FRC varies through the town centre of Nuneaton. The majority of the town centre, within the boundary of the A444 ring-road, is thought to be protected up to a 1 in 100 year flood event. However, the museum and Sainsbury's buildings in Riversley Park, and buildings adjacent to the watercourse in Attleborough, are shown to have a lower standard of protection, in some instances less than a 1 in 25 year event.

A number of residential properties along The Long Shoot (SP 3910 9281) are protected by a series of flood walls, banks and a pumping station constructed adjacent to a small ditch which joins the Harrow Brook (SP 3910 9281). The defences were installed in 2006 following major flooding that occurred in 1999.

7.2.3 Flood Defences within the Borough of Rugby

Environment Agency maintained formal flood defences identified within the NFCDD database include a series of weirs, channel walls and bridge abutments between the Oxford Canal (SP 5163 7655) and Hunters Lane (SP 5000 7626); and a series of floodwalls and embankments on the left and right banks of the River Avon between the School Playing Fields at Grange Road (SP 4918 7676) and the Post Office downstream of Bradley Bridge (SP 4899 7712). These defences are thought to protect up to the 1 in 100 year event.

The NFCDD layer also identifies a number of privately owned defences within the Borough of Rugby. These include earth embankments of the left and right bank of the River Swift at Swift Industrial Park (SP 5042 7729), and a series of bridge abutments and aqueduct pier walls along the River Avon. The NFCDD database states that these defences protect up to the 1 in 100 year event.

7.2.4 Flood Defences within the District of Warwick

Only a few locations at risk of flooding are currently protected by permanent defences within the District of Warwick. At Mill End Kenilworth the NFCDD database identifies a stone block wall on the right bank of the Finham Brook which provides protection to a number of residential properties on the new housing development (SP 2961 7283) and, two privately owned defences taking the form of a flood wall adjacent to Mill End Sewage Treatment Works pumping station and an embankment at Woodmill Meadow (SP 2955 7281). The standard of protection offered by these defences is not known.

A number of council maintained defences have been identified within the NFCDD database as part of this study. Tiles A1-A20 in Volume 2 demonstrates the locations of council maintained defences. The defences include Common Lane Road bridge abutment and Bridge Street abutment in Kenilworth. In addition to the information in NFCDD, the Council have provided details of the Pingle Brook FAS constructed by the District Council in 2002 in the grounds of Cubbington CE Primary School following the Easter 1998 floods. During the June 2007 flood event, the Pingle Brook FAS was overtopped. The scheme worked correctly to maximum design capacity however, the intensity of the storm exceeded the overall capacity of the works and overtopping of the system occurred with some water entering the school play ground.

The NFCDD layer also identifies a number of privately owned defences within the Warwick District. These include walled banks to private property on the left and right banks of the Finham Brook at Bridge Street, Kenilworth (SP 2876 7235), and, a timber piled bank to rear gardens on the left bank of the Finham Brook at Gloster Drive Kenilworth (SP 2893 7256).

It has been noted that there is a defence located along the River Avon at Mercia Way, Warwick (SP 2950 6520). Consultation with the Environment Agency indicated that this defence is not a formal defence maintained by the Environment Agency, and, no further details were received as part of this study regarding the defence at this location. However concern has been raised about the defence during the consultation process and therefore this should be considered when taking into consideration any potential development adjacent to this location.

7.2.5 Flood Defences within the District of Stratford-on-Avon

Only a few locations at risk of flooding are currently protected by permanent defences within the District of Stratford-on-Avon. The NFCDD database identifies a number of formal defences along the River Avon. These include: earth banks and flood walls at Alveston weir and sluice (SP 4233 2571); a series of walls and sheet piling through Stratford (SP 4202 2542); and, earth embankments and flood walls along the left bank of the River Avon at Barton by Birdford-on-Avon (SP 1075 5120) opposite the caravan park. The defences located along the River Avon are thought to provide protection up to the 1 in 100 year event.

A number of formal defences maintained by the Environment Agency are located along the River Alne through Henley-in-Arden. These include an embankment with floodwall and natural high ground on the right bank adjacent to railway yard and running to the railway embankment alongside the Birmingham Road/High Street (SP 1529 6657), and a flood wall on the right bank between the bifurcation channel at Back Lane and Beaudesert Lane (SP 1517 6607). These defences are thought to protect up to the 1 in 100 year event. At Wootton Wawen, there is also a series of earth embankments on the right bank adjacent to Wootton pool (SP 1577 6389) and Wootton Hall (SP 1569 6335) providing protection up to a 1 in 50 year event.

The NFCDD database also identifies Environment Agency maintained defences along the River Arrow through Alcester. These include an earth embankment running along garden boundaries of properties along School Road (SP 0897 5774), a series of floodwalls and earth embankments running from Colebrook Close to Stratford Road (SP 0913 5731) and, downstream of Stratford Road there are a series of privately owned and Environment Agency defences running parallel to Bleachfield Street (SP 0887 5700) and Newport Drive (SP 0872 5691). These defences are thought to provide protection up to the 1 in 100 year event. There are also a series of Environment Agency owned defences at Arrow Mill (SP 0825 5615) on both the left and right banks of the River Arrow, taking the form of earth embankments and flood walls and providing protection up to the 1 in 100 year event.

At Wellsbourne (SP 2789 5521) there is an Environment Agency maintained defence located along the left bank of the River Dene. This defence takes the form of an embankment and wall and is thought to provide protection up to the 1 in 75 year event.

At Snitterfield part of the channel of an unnamed watercourse by Waterworks Cottage is a walled channel and there is a walled defence between the channel between Brookside and Bell Lane (SP 2147 6003). At Long Itchington there are also some Environment Agency maintained defences on the right bank between Manor Farm (SP 4126 6504) and the campsite downstream of Bascote Road (SP 4097 6510). These defences take the form of earth embankments and floodwalls and provide protection up to the 1 in 100 year event.

Sections of culverted watercourse within Warwickshire as identified within NFCDD have been demonstrated in Volume 2, Tiles A1-A20. These are owned both privately and by the Environment Agency.

In some areas, particularly for proposed development 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.

7.3 Residual Risk

Residual flood risks can arise due to:

- The failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system
- A severe flood event that exceeds a flood management design standard and results in, for example, overtopping.

Within Warwickshire there are only a few ABDs contained within the Environment Agency's ABD database. There are two major formal flood defences within the Borough of North Warwickshire which provide protection to local communities. These are: the Marsh Lane Embankment, and a series of flood embankments and raised ground by Whitacre Heath and the Nature Reserve With each of these there is a residual risk of overtopping, breach or blockage, which could result in significant damage to buildings and highway infrastructure as well as posing danger to life. There is also one major formal flood defence identified within the Borough of Nuneaton and Bedworth, the River Anker cut off embankment and throttle structure at Attleborough Fields (SP 3773 9158). Although the Nuneaton FRC along the River Anker has been confirmed as a formal defence by the Environment Agency (JBA, 2006), the ABD guidance document states that channels, even implemented for flood defence, are not to be treated as formal flood defences during the mapping process, therefore, ABD maps were not produced for the Nuneaton FRC as part of the flood mapping study undertaken in May 2006. With each of these defences there is a residual risk of overtopping, breach or blockage, which could result in significant damage to buildings and highway infrastructure as well as posing danger to life.

No further ABDs were identified within the Environment Agency's ABD database. There are however several major formal flood defences within Warwickshire details of which can be found in Section 6.2. With each defence there is a residual risk of overtopping, breach or blockage, which could result in significant damage to buildings and highway infrastructure as well as posing danger to life.

Information received from BW has indicated that there is a risk of overtopping or breach from a number of canals within Warwickshire. Within the Borough of Rugby, a breach has been recorded in the Oxford Canal by Ansty Embankment (SP 4172 9158). Although this is currently in a rural location with no large residential areas or major infrastructure adjacent, if any future development is proposed adjacent to the canal at this location the possibility of a breach occurring should be taken into consideration. Similarly, within the District of Warwick, Information received from BW and the District Council has indicated that there are a number of locations where there is a risk of breaching or

overtopping from the Grand Union Canal which could affect both residential and commercial property. These locations include: the Warwick and Napton Canal branch by Bridge Street (SP 2997 6552), Grand Union Canal by Hatton (SP 2486 6660), Lower Cape Road (SP 2769 6605), Lock Lane by the Yuassa Commercial Unit (SP 2791 6606), Exham Close (SP 2808 6618) and Lyton Close. The latter five of these locations experienced a breach from the canal during summer 2007.

Within the District of Stratford-on-Avon a residual risk of overtopping or breach of the Grand Union Canal by Long Itchington (SP 4136 6462) and the Stratford-upon-Avon Canal near Preston Baggot (SP 1729 6505) has also been identified by BW. Although no property is located within the vicinity of the canal at the recorded breach locations, any development proposed adjacent to these locations should take into the consideration the potential for a breach to occur.

Major residual risk zones have been shown in Volume 2, Tiles A1-A20. These are treated uniformly and are represented in the GIS as a simple outline of the expected affected area. 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 the Exception Test needs to be applied to specific site allocations, the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood hazard in these locations. For locations where there are currently no available ABDs it is possible that future modelling work undertaken by the Environment Agency may lead to the availability of such information and therefore the flood maps should be updated if this information becomes available.

All culverts and defences are also shown in Volume 2, Tiles A1-A20. 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.

7.4 Storage Areas

A number of purpose-built storage areas have been identified within Warwickshire.

Two purpose-built storage areas have been identified within the Nuneaton and Bedworth Borough: Barpool Valley Balancing Lake/ Camp Hill storage balancing area at Camp Hill and, a balancing pool located to the north of The Willows at SP 3442 8685. The Barpool Valley balancing pond is designed to accommodate flows from the Barpool Brook and overland flow from the Camp Hill Estate. The first two phases of the construction of the balancing pond have been completed and were funded by developments within the Barpool catchment. It was the intention that surface water from new developments within the area would be discharged into the existing balancing pond; however, flood events that occurred on the 21st July 2007 suggest that the sewer infrastructure that discharges into the lake is inadequate. Phase 3 of the works involving work to bring the balancing pond up to the required standard are thought to be in progress. This will possibly involve stream improvements. At the time of this SFRA specific details of the proposed works were not available however; any works undertaken at the balancing pond should be incorporated into this SFRA when they become available.

Within the Borough of Rugby one purpose built storage area has been identified at Draycote Water (SP 4586 6964) which is owned by Severn Trent Water. Draycote Water is used as a storage reservoir which is filled by pumping water from the River Leam during winter months to help reduce flooding. During the consultation process, plans for further flood attenuation works at Draycote and

Broadwell were identified. However, following discussion with the Council it was confirmed that schemes proposed for Broadwell and Draycote exist only as plans at this stage and that no design work has commenced. Any development to the plans should however be incorporated into this SFRA when they become available.

There are a number of flood attenuation areas within the District which are shown on the District Council's flood plain maps. A digital GIS layer of this information was not available for incorporation into this study. The District Council commented that a study has been undertaken on attenuation areas and defences within the District which provides details of standard of protection of defences and storage area volumes.

No formal storage areas have been identified within the District of Stratford-on-Avon however, a number of Flood Meadows have been identified. These include: Sherbourne (SP 2420 6180), Welford Field (SP 1390 5280) and Racecourse Meadows (SP 1850 5360). Flood Meadows are areas of grassland or pasture located adjacent to a river that are subject to seasonal flooding. Although not artificially created storage areas, flood meadows form part of the functional floodplain and should therefore be protected from future development.

No formal storage areas were identified within the Borough of North Warwickshire. However, it is imperative that any natural storage areas used as a means of attenuation of flood waters should be 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.

7.5 Existing Flood Warning System

The Environment Agency is the lead organisation on flood warning and its key responsibilities include direct remedial action to prevent and mitigate the effects of an incident, to provide specialist advice, to give warnings to those likely to be affected, to monitor the effects of an incident and to investigate its causes. This requires the Agency, local authorities and the emergency services to work together to protect people and properties. Warwickshire falls mainly within the Central area of the Midlands Region of the Environment Agency. Prior to the Environment Agency's boundary re-organisation of the Midlands Region which occurred in April 2007, most of Warwickshire fell in Upper Trent Area, with a small proportion to the west of the County falling in Upper Severn Area.

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, to the public and to the flood wardens. It is the responsibility of individuals in the community to receive flood warnings via Flood warnings Direct (FWD) which passes messages over the telephone network.

Flood warning will be important for site workers on minerals and waste sites which will be located in high and medium flood risk areas, to ensure that evacuation can be achieved prior to the occurrence of flooding.

A flood warning system is in operation for the Main Rivers within Warwickshire and is outlined below in four stages.

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

Flood watch areas are in operation within Warwickshire and include:

Borough of North Warwickshire:

- Midlands Central Area – Tamworth and Nuneaton including Lichfield, Hinckley and Ashby
- Midlands Central Area – Birmingham including Solihull, Walsall and Sandwell
- Midlands Central Area – Upper Avon Valley including Coventry, Rugby, Warwick and Leamington Spa

Borough of Nuneaton & Bedworth:

- Midlands Central Area – Tamworth and Nuneaton including Lichfield, Hinckley and Ashby
- Midlands Central Area – Upper Avon Valley including Coventry, Rugby, Warwick and Leamington Spa

Borough of Rugby:

- Midlands Central Area – Tamworth and Nuneaton including Lichfield, Hinckley and Ashby
- Midlands Central Area – Leicester including Leicester City, Melton Mowbray and Loughborough
- Midlands Central Area – Upper Avon Valley including Coventry, Rugby, Warwick and Leamington Spa

District of Warwick:

- Midlands Central Area – Birmingham including Solihull, Walsall and Sandwell

- Midlands Central Area – Upper Avon Valley including Coventry, Rugby, Warwick and Leamington Spa
- Midlands Central Area – Lower Avon Valley including Stratford, Redditch, Evesham, Shipston and Alcester

District of Stratford-on-Avon:

- Midlands Central Area – Birmingham including Solihull, Walsall and Sandwell
- Midlands Central Area – Upper Avon Valley including Coventry, Rugby, Warwick and Leamington Spa
- Midlands Central Area – Lower Avon Valley including Stratford, Redditch, Evesham, Shipston and Alcester
- Thames West Area – Cherwell Catchment
- Thames West Area – Evenlode Catchment

2. **Flood Warning:** Flooding of homes and businesses is expected. 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

The flood warning areas in Warwickshire are illustrated in Volume 2, Tile F1. The service is currently set up to warn properties within the 1% Annual Exceedance Probability (1 in 100 year event) and the 0.1% Annual Exceedance Probability (1 in 1000 year event). The following locations are currently covered by the Environment Agency Flood Warning System:

Borough of North Warwickshire:

- River Cole from Shard End to Coleshill
- River Tame from Water Orton to Lea Marston
- River Tame from Lea Marston to Drayton Manor
- River Anker from Nuneaton to Tamworth
- River Blythe from Cheswick Green to Coleshill

Borough of Nuneaton & Bedworth:

- River Anker from Nuneaton to Tamworth

Borough of Rugby:

- River Avon from Rugby to upstream of Warwick
- River Leam from Marton to Royal Leamington Spa
- River Avon from Stanford on Avon to upstream of Rugby

District of Warwick:

- River Avon from Warwick to Stratford-Upon-Avon
- River Avon from Rugby to upstream of Warwick
- River Leam from Marton to Royal Leamington Spa

District of Stratford-on-Avon:

- River Stour from Shipton-on-Stour to Clifford Chambers
- River Avon from Warwick to upstream of Stratford-Upon-Avon
- Sor and Bloxham Brooks, Edgehill to Adderbury
- River Cherwell, Charwelton to Lower Hayford
- River Avon from Stratford-Upon-Avon to upstream of Evesham
- River Arrow from Studley to Salford Priors

3. **Severe Flood Warning:** Severe flooding is expected. 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

4. **All Clear:** Flood Watches or Warnings are no longer in force. The following is recommended:

   - Flood water levels receding
   - Check all is safe to return
   - Seek advice

7.6 Flood Response Plan

Warwickshire County Council's Emergency Planning Unit (EPU) performs a vital role in facilitating the preparation for such incidents and events and assisting in the co-ordination of the response. The EPU works closely with the Districts and Boroughs of Warwickshire to ensure a co-ordinated and joined approach.

The work of the EPU falls into four broad categories:

- **Planning:** The EPU is continually assessing the risks posed within Warwickshire and developing and maintaining plans to, where possible prevent an emergency occurring or ensuring that procedures are in place to control and mitigate their impact.
- **Training and Exercising:** The EPU conducts a continuous programme of training for partner agencies and other relevant persons to make them aware of the need to plan, and to provide them with the necessary advice and guidance to do this. The Unit also provides a means to validate their procedures, on a regular basis through exercises to assure maximum preparedness.
- **Liaison –** The EPU works closely with partner agencies and stakeholders to ensure harmonisation of plans and procedures so to ensure a co-ordinated and integrated response to emergency incidents as they arise.
- **Operational –** During times of emergency the work of the unit goes beyond production of plans, with an active role in co-ordinating the response, and provision of logistical support. The unit will likely lead any reconstruction or recovery to restore the community.

The operational role of the EPU has been tested on many occasions including the July 2007 flood events. In order to improve response to such events within Warwickshire the Emergency Planning Unit has developed a 'Residents Flood Pack' offering information, advice and contacts to assist the public during and after flooding, and this can be found on the website. The website also gives details of flood warnings in place at any one time, and gives the public information on how to protect homes and what to do during a flood event, as outlined in Section 6.5.

It is recommended that the Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the MWDF 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 (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.

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. 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

8 Flood Risk Management Policy Considerations

8.1 Overview

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

The policy recommendations provided in this chapter are not exhaustive and it is therefore recommended that the Councils refer 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.
- **River Trent Catchment Flood Management Plan** - strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years. The Trent and Severn CFMPs have been issued in draft with consultation due to end in January 2008. It is recommended that the Council reviews its content once produced to ensure policies are in line with those outlined in the CFMP.
- **River Severn Catchment Flood Management Plan** - strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years. The Severn CFMP is currently being revised and there are likely to be significant changes. The revised document is expected to be completed late 2008 and will be available through the Environment Agency's website. It is recommended that the Council reviews its content once produced to ensure policies are in line with those outlined in the CFMP.
- **The Thames Region Catchment Flood Management Plan –** strategic planning document through which the Environment Agency will work with other stakeholders to identify flood risk management policies for the Thames catchment for the next 50 to 100 years. The Thames Region CFMP was issued for consultation between February 2007 and April 2007. This document is now complete and available from the Environment Agency.
- **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

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.

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

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

- Use the Sequential Test to locate new minerals and waste sites in least risky areas, giving highest priority to Flood Zone 1
- Use the Sequential Test to ensure compatibility between the Flood Zone and the vulnerability classification of the development
- 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, in instances where mineral workings are located in Flood Zones 3a and 3b, it is imperative 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.
- Ensure development is 'safe'. For mineral and waste sites to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible for on-site employees. The Environment Agency states that dry pedestrian access/egress should be possible for the 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 1 in 1000 year event, should also be 'safe'.

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

- SUDS required on all new development (Section 10.3 outlines appropriate SUDS techniques for the County)
- All sites require the following:

  - SUDS
  - Greenfield discharge rates with a minimum reduction of 20% as required by the Environment Agency
  - 1 in 100 year on-site attenuation taking into account 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

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

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- 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. Where practical, all new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit
- Set development back from rivers, seeking an 8 metre wide undeveloped buffer strip for development by all watercourses including those where the Flood Zone does not exist. This is an Environment Agency requirement.

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

- Identify opportunities to restore completed sand and gravel workings to flood storage areas, increasing the capacity of the floodplain and reducing flood risk to areas downstream of the site, as well as adding biodiversity benefits.
- 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

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 Flood Warnings Direct service operated by the Environment Agency
- Ensure robust emergency (evacuation) plans are implemented for new minerals and waste sites, particularly those where employees will be working in high risk Flood Zones

8.3 Development Control Policies

For the purposes of development management, 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. The following reflects the minimum requirements under PPS 25 (reference should be made to Tables D.1-D.3 in PPS 25).

Future Development within Flood Zone 1

In this zone, developers and local authorities should realise opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development. There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1, although for sites larger than one hectare, the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

Typically, a Drainage Impact Assessment will be required to demonstrate that runoff from the site is reduced, thereby reducing surface water flood risk. This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency.

Future Development within Flood Zone 2

Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category. 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. The following should be considered:

- A detailed site-specific FRA should be prepared in accordance with PPS 25 and Council planning policies
- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm
- The development should be safe, meaning that dry pedestrian access to and from the development should be possible above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency, for both Greenfield and Brownfield sites. Space should be set-aside for SUDS.
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.

Future development within High Probability Flood Zone 3a

Land use with High Probability Flood Zone 3a should be restricted to the water compatible or '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. The following should be considered:

- A detailed site-specific FRA should be prepared in accordance with PPS 25 and Council planning 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 Environment Agency.

- 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 can be achieved by developing land sequentially, with areas at risk of flooding favoured for green space.

- Floor levels should be situated above the 1% (100 year) plus climate change predicted maximum level plus a minimum freeboard of 600mm. Within defended the areas the maximum water level should be assessed from a breach analysis.

- The development should allow dry pedestrian access to and from the development above the 1 in 100 year plus climate change flood level and 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 Environment Agency.

- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For all sites, the post development runoff volumes and peak flow rates should be attenuated to the Greenfield discharge rates with a minimum reduction of 20%, as required by the Environment Agency, for both Greenfield and Brownfield sites. Space should be set aside for SUDS.

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

Future development within Functional Floodplain Zone 3b

Development should be restricted to 'water-compatible uses' and 'essential infrastructure' that has to be there. Table D2 from PPS 25 (reproduced in Section 1.5.1 of this report) outlines the types of development included within this classification. It should be noted that 'essential infrastructure' includes essential transport infrastructure (including mass evacuation routes) which may have to cross the area at risk as well as strategic utility infrastructure such as electricity generating power station and grid and primary substations. Reference should be made to Table D2 of PPS 25 when considering development within Flood Zone 3b to ensure only appropriate development is considered.

'Essential infrastructure' in this zone must pass the Exception Test and be designed and constructed to remain operational in times of flood and not impede water flow.

8.4 Council Specific Policy Issues

It is recommended that the aforementioned policy considerations are included in the Council's policies. It is also recommended that the Severn and Trent CFMP flood risk management policies are reviewed and incorporated.

8.5 Avoiding Increased Flood Risk Elsewhere

It is important that future site allocations and windfall sites are guided by PPS 25 to ensure that new developments are placed in the appropriate flood zone, in line the vulnerability classification of the development. It is also important that the recommendations provided in this report are taken up as a means of ensuring that development does not significantly affect flood risk elsewhere.

The creation of minerals and waste sites can increase flood risk in the following ways:

- Mineral activity can alter the topography and terrain of a local area. For example, fluvial drainage paths can be altered and the risk of groundwater flooding can be increased by the exposure of low-lying land.
- Backfilling and landfilling with impermeable materials can cause an increase in surface water flooding, as well as groundwater flooding.
- The creation of new roads for minerals and waste sites, as well as the creation of increased industrialisation and impermeable surfaces with regard to waste processing sites can increase surface water runoff.
- Overland flow from mineral extraction sites can contribute increased sediment to nearby watercourses, causing increased sediment to be carried downstream and cause increased sedimentation of the river bed or culvert.

It is therefore important to assess, at the site-specific level, whether this activity will increase flood risk in vulnerable locations, and mitigating measures that should be put in place to reduce this increased flood risk.

This study has identified locations within Warwickshire which have localised flood risk issues. It is in these locations in particular where additional development could increase flood risk, and where particular regard to risk reduction should be focused. These are:

- Within the District of North Warwickshire it has been noted that flooding from field run-off is a problem, particularly in rural areas (see Volume 2, Tiles B1-B20).
- Within the Borough of Nuneaton and Bedworth consultation with key stakeholders has indicated that there is potential for increased flow into the Sketchley Brook from potential new development in the Stretton Fields area. It is therefore recommended that SUDS are properly implemented here.
- Within the District of Warwick, Cubbington has experienced flooding from a number of sources including fluvial flooding, surface water and artificial drainage. The drainage systems in the area (public, private, highway or land drainage) were not designed to cope with exceptional conditions and as a result widespread flooding has occurred, with the worst locations affected being in the bowl of New Street and Knightly Close and the valley bounded by Ladycroft, Price Road,

Offchurch Road. In addition overtopping of the Pingle Brook FAS scheme has occurred in recent events and much of the existing drainage infrastructure is thought to be of insufficient capacity to cope with such a large volume of water.

In general, throughout the study area, any development (including developments in Low Probability Flood Zone 1) which does not incorporate SUDS may increase the risk of surface and/or fluvial flooding both on-site and off-site (downstream). As such effective planning policies should be implemented in accordance with the SUDS recommendations provided in this report.

9 Guidance on the Application of the Sequential Test

This chapter provides guidance on how to apply the Sequential Test.

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

The recommended initial step is to determine the extents of potential minerals and waste site allocations on large scale maps showing the most up-to-date Flood Zones, in accordance with PPS 25. Summary tables of flood risk issues should then be prepared for each location, indicating if the potential areas overlap Zones 2, 3, localised flooding areas or if there are records of previous flood incidents shown in the maps. 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.

9.2 Step Two: Flood Risk Issues in Zone 1

The next step should be to analyse all potential sites within Zone 1 by identifying those that have any flood risk issues (for example those affected by other sources of flooding or those that do not have dry access routes during flood events).

For the sites with flood risk issues, an assessment of likely significance of flood risk should then 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 an 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 - high probability of flooding and significant flood damages with deep flooding and high velocities which could result in loss of property and potentially loss of life.

If a site with significant flood risk is identified within Zone 1, this would be considered as if it was in the High Probability Zone 3a, for further application of the Sequential Test in Zone 3a (see Section 9.3), bearing in mind that if a more vulnerable land use is required for the site, it will have to pass the Exception Test.

For those sites within localised flooding areas or with flood incident records where flood risk issues are not significant (for example shallow flooding and non-frequent blockages, etc), development should still be acceptable provided that adequate measures are put into place for mitigating the risk (for example contributions may be required from the developer for the upgrade of the surface water system in the area).

It is important to note that most potential sites that pass the Sequential Test in Zone 1 will still require site-specific FRAs. For development proposals on sites comprising one hectare or greater, 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, 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 still produced for Zone 1 sites of less than one hectare, at locations where there are records of previous flood incidents.

9.3 Step Three: Sequential Test in Zones 2 and 3

The third step is to sequentially allocate sites as described in Section 4.3 and 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 (see Section 5.1) by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, for those cases where the loss of site area is acceptable.

b) Provisionally adopting land uses that are fully compatible with the vulnerability classification of PPS 25, to try to avoid the need to apply the Exception Test where possible.

The Flood Risk Vulnerability and Flood Zone 'Compatibility' Table D.3 of PPS 25, has been adapted to reflect mineral and waste land uses as follows:

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

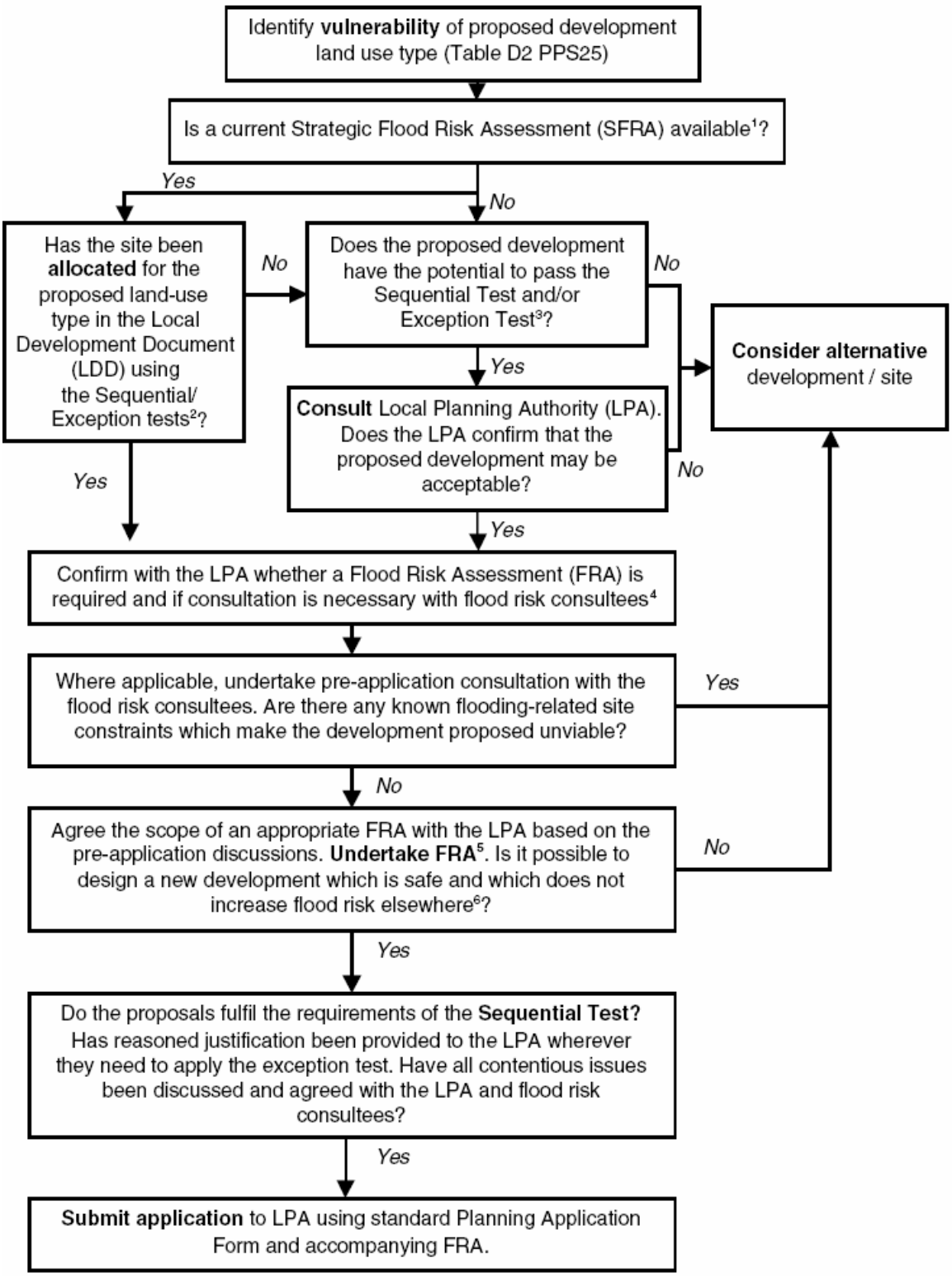
✓ : Development is appropriate

X : Development should not be permitted

10 Guidance for Developers

A SFRA is a strategic document that provides an overview of flood risk throughout the study area. 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 PPS 25). The onus is on the developer to provide this information in support of a planning application.

Since the release of PPS 25 in December 2006, should an LPA wish to disregard the advice of the Environment Agency and approve an application for major development where the Environment Agency has objected on flood risk grounds then the planning application will be referred to the Secretary of State who will determine whether to call in the application. 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 and guidance 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 PPS 25 (the figure overleaf shows the recommended process of undertaking an FRA as part of an individual planning application).



Guidance for developers for individual planning applications

10.1.1 Proposed Developments within Functional Floodplain Flood Zone 3b

In line with PPS 25, 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 (refer to Section 1.5.1 of this report) details the type of developments classified as 'water compatible' or 'essential Infrastructure.

10.1.2 Proposed Developments within High Probability Flood Zone 3a

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 vulnerability of the development to flooding from other sources (e.g. surface water drainage, groundwater) as well as from river flooding. This will involve discussion with the Council and the Environment Agency to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change), i.e. maximum water levels, 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 hard 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.
- The localised risk of flooding that may occur. This is typically associated with local catchment runoff following intense local rainfall. This localised risk of flooding must also be considered as an integral part of the FRA.
- 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. All levels should be stated relevant to Ordnance Datum.

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.

10.1.3 Proposed Development within Medium Probability Zone 2

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 a significant flood risk from other sources (e.g. groundwater or sewer flooding) is 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.

10.1.4 Proposed Development within Flood Zones 1 and 2

The risk of alternative sources of flooding (e.g. surface water, sewage, and/or groundwater) must be considered, and SUDS techniques must be employed to ensure no worsening of existing flooding problems elsewhere within the area.

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

10.1.5 Development Behind Defences

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.

Consideration of flood risk behind defences should be made as part of detailed FRAs. Developers should review Volume 2, Tiles A1-A20 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
- 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

In addition, where new development is proposed in a defended flood area, the potential cumulative impact of loss of storage on flood risk elsewhere should be considered.

10.2 Developer Contributions

If new developments are placed on Flood Zones 2 or 3, it might be necessary for local infrastructure to be increased. With regards to flood risk, it might also be necessary to extend flood warning system coverage, or increase the maintenance of flood defences. Where this is the case, the LPA should consider whether to secure increased local infrastructure by planning condition or a financial contribution under a planning obligation to cover any direct added cost/s.

11 Guidance for the Application of Sustainable Drainage Systems

11.1 Introduction

PPS 1 and PPS 25 requires that LPAs should promote SUDS. LPAs should therefore include policies within their LDF to encourage sustainable drainage practices. 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 County.

11.2 Types of SUDS Systems

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 green space and wildlife habitat;
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

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 affect from a number of sites could be significant.

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, the Environment Agency 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 the table in Section 3.5.

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, 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).

The Environment Agency requires both greenfield and brownfield sites to achieve greenfield discharge rates with a minimum reduction of 20%, to account for the future effects that climate change will have on runoff volumes.

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

- PPS 25
- Practice Guide Companion to PPS 25
- The SUDS Manual – CIRIA C697 (2007) 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
- www.ciria.org.uk/suds/

11.3 Application of SUDS for Minerals and Waste Sites

SUDS techniques will be required for most, if not all, proposed land allocations, and will indeed be possible on any site. Dewatering and pumping during mineral extraction and the construction of impermeable landfill sites for example, do require the use of appropriate SUDS techniques to ensure

no increase in flood risk elsewhere. The use of SUDS techniques and attenuation to greenfield (undeveloped condition) discharge with a reduction of 20% will be required in these cases. Developers should consult with the Environment Agency about their SUDS proposals to ensure that they are adopting the most effective methods for their site.

Certain measures can be taken to protect more sensitive areas by considerably reducing or prohibiting infiltration. In marginal areas, where polluted water may have an impact on the groundwater, the runoff can pass through one or more treatment stages, depending on the possible level of pollution and the hydro-geological conditions. If all infiltration was prohibited it is likely that a SUDS system would still represent an improvement over a traditional system drained using pipes, the SUDS system could still attenuate flow from the site and improve the surface water runoff quality.

The Environment Agency has identified Groundwater Source Protection Zones (GSPZ) which are concerned with protecting the catchment area for public and private water supply from potential polluting sources. If mineral resources of interest in the plan area coincide with GSPZs, great care will need to be taken to ensure that groundwater sources are protected. Certain types of waste development can also pose a potential risk of contamination to groundwater and therefore it is essential to use information provided by the Environment Agency to advise the suitable location for specific waste developments.

The sections below outline geological, soil and groundwater conditions across Warwickshire.

11.4 Application of SUDS for North Warwickshire Borough Council

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

The entire Borough has been highlighted by defra as a Nitrate Vulnerable Zone (NVZ) and there is one area in the north of the Borough classified as a GSPZ by the Environment Agency. Any boreholes, water wells or other extraction points should also be identified and taken into account in the design process.

NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

The GSPZ is situated over a local aquifer and is designated as inner, outer and total catchment areas. The Inner Zones of the GSPZ are the most sensitive areas and vary in diameter from 0.3 to 0.9 kilometres. The Outer Zones are also sensitive to contamination and vary in diameter from 1.1 to 3.6 kilometres. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination.

Two GSPZ Inner Zones have been identified by the Environment Agency in North Warwickshire and they are both situated in the north of the Borough near Donisthorpe.

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

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

11.5 Application of SUDS for Nuneaton & Bedworth Borough Council

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

The entire District has been highlighted by defra as a NVZ and there are no areas classified as GSPZs by the Environment Agency. Any boreholes, water wells or other extraction points should be identified and taken into account in the design process.

NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

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

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

11.6 Application of SUDS for Rugby Borough Council

This Borough has predominantly slowly permeable, seasonally wet, slightly acid, but base-rich loamy and clayey soils. More permeable sites should have priority given to infiltration drainage techniques, as opposed to discharging surface water to watercourses. Where less permeability is found and infiltration techniques that rely on discharge into the existing soils are not viable (also due to a high water table, source protection zones, contamination etc), discharging site runoff to watercourses in a controlled manner is preferable to the use of sewers. Integrated urban drainage should also be used throughout the design process.

The entire Borough has been highlighted by defra as a NVZ and there are no areas classified as GSPZs by the Environment Agency. Any boreholes, water wells or other extraction points should be identified and taken into account in the design process.

NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

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

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

11.7 Application of SUDS for Warwick District Council

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

The entire District has been highlighted by defra as a NVZ and there are areas in the west and north classified as a GSPZ by the Environment Agency. Any boreholes, water wells or other extraction points should also be identified and taken into account in the design process.

NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

The GSPZ is situated over the local aquifers and is designated as inner, outer and total catchment areas. The Inner Zones of the GSPZ are the most sensitive areas and vary in diameter from 0.1 to 0.4 Kilometres. The Outer Zones are also sensitive to contamination and vary in diameter from 0.4 to 1.8 Kilometres. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination.

Seven GSPZ Inner Zones have been identified by the Environment Agency in the Warwick District and they are situated in the following areas:

- North-west area: Shrewley and Little Shrewley
- Northern area: Two in Kenilworth

- Western area: Hampton on the Hill
- Central area: Cubbington and Campion Hills

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

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

11.8 Application of SUDS for Stratford-on-Avon District Council

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

The entire District has been highlighted by defra as a NVZ and there are locations in the centre and east of the area classified as a GSPZ by the Environment Agency. Any boreholes, water wells or other extraction points should also be identified and taken into account in the design process.

NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

The GSPZ is situated over the local aquifers and is designated as inner, outer and total catchment areas. The Inner Zones of the GSPZ are the most sensitive areas and vary in diameter from 0.1 to 0.5 Kilometres. The District has no designated Outer Zones. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination.

Eight GSPZ Inner Zones have been identified by the Environment Agency in the Stratford-upon-Avon District and they are situated in the following areas:

- Central: Shottery, Alveston, Alveston Hill and two at Clapton Tower
- Eastern area: Wellesbourne, Wasperton and Snitterfield

Runoff which is likely to be heavily contaminated must be treated by a proprietary device, which should be carefully considered to ensure the correct system is selected to remove pollutants. PPG 3 (2006) states that source control SUDS must be considered and incorporated where suitable. For

example; surface water drained from a car park should implement a filter bed wherever possible before considering an interceptor device to remove contaminants.

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

12 Recommendations

A number of recommendations have been made throughout this report on the basis of the findings of the SFRA. These are summarised below.

12.1 Site Allocation Process

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). All opportunities to locate new water-compatible 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. It is acknowledged that sand and gravel sites are typically found in abundance within floodplains, and as such might be the only available areas for mineral working and processing. As sand and gravel workings are classed as a 'water-compatible' use they can be worked in the highest risk areas, Flood Zones 3a and 3b. However, the site should be designed in such as way as to enable any storage and office accommodation to be located outside Flood Zones 3a and 3b.

Where development cannot be located in Flood Zone 1, the Council should use the flood maps to apply the Sequential Test to their remaining land use allocations. 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.

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitable sites for development within zones of lower flood risk, 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 as the need for the Exception Test is established, a Level 2 SFRA(s) is undertaken by a suitably qualified technical expert or engineer so as to provide timely input to the overall LDF process.

12.2 Council Policy

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 PPS 25.

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

- Use the Sequential Test to locate new minerals and waste sites in least risky areas, giving highest priority to Flood Zone 1
- Use the Sequential Test to ensure compatibility between the Flood Zone and the vulnerability classification of the development
- 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, in instances where mineral workings are located in Flood Zones 3a and 3b, it is imperative 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

- Directing vulnerable development (such as waste management facilities for hazardous waste and installations requiring hazardous substances consent) away from flood affected areas
- Ensuring all new development is 'Safe', meaning that dry pedestrian access to and from the site is possible without passing through the 1 in 100 year plus climate change floodplain, and emergency vehicular access is possible
- Identify opportunities to restore completed sand and gravel workings to on-line storage areas, increasing the capacity of the floodplain and reducing flood risk to areas downstream of the site
- Promoting the use of SUDS in all Flood Zones on all new minerals and waste sites

12.3 Emergency Planning

It is recommended that the County Council's Emergency Response Plans are 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 minerals and waste sites 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 and encourage communities at risk to sign-up to the Environment Agency Flood Warning Direct service.

12.4 Future Updates to the SFRA

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

- Second Severn CFMP
- Final version of the Trent CFMP
- Future flood risk mapping studies
- Future flood risk management strategies

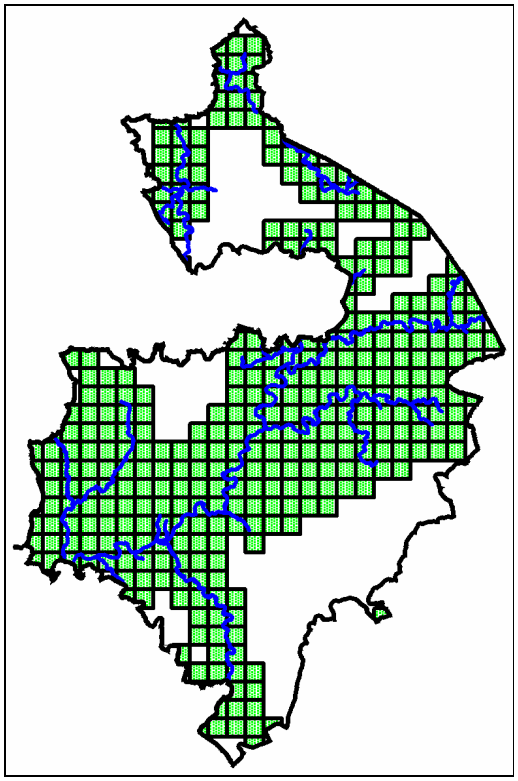
12.4.1 Missing or Incomplete Data

Data gaps have been assessed throughout the Level 1 SFRA data collection and review exercise. This has flagged the missing or incomplete data, which should be incorporated into the SFRA as it becomes available.

Receipt of the following data will further refine the SFRA.

Data	Description	Source
Flood outlines	20year return period (or similar) flood outlines for all rivers except the Anker and Cole. These would allow production of Flood Zone 3b.	Environment Agency (this data does not yet exist)
Flood outlines	River Tame updated flood outlines for all relevant return periods	Environment Agency (expected to be available end March 2008)
Flood outlines	20year return period (or similar) flood outlines for all rivers except the River Leam and River Itchen. These would allow production of Flood Zone 3b	Environment Agency (this data does not yet exist)
Flood outlines	20year return period (or similar) flood outlines for River Alne & Avon Middle. These would allow production of Flood Zone 3b. Also 1000 year return period for Flood Zone 2.	Environment Agency (this data does not yet exist)
Flooding History Data	Historical flood outlines for River Anker from Summer 2007 events	Environment Agency (this data does not yet exist)
Storage Area Data	Details of proposed extension to storage balancing pond at Barpool Valley / Camp Hill (Phase 3)	County Council (this data does not yet exist)
Severe Flood Warning	Severe Flood Warning Polygons	Environment Agency
CFMP	River Trent CFMP – Final version	Environment Agency (Document in production)
CFMP	River Severn CFMP – Second version	Environment Agency (Document in production – expected to be complete late 2008)
Surface water flooding records	Highways Agency records of flooding	Highways Agency

Light Detection and Ranging (LiDAR) data is detailed ground elevation data, which is extremely useful for Level 2 SFRAs. Among other uses, it primarily facilitates the creation of hazard maps, a Level 2 requirement for development in Flood Zones 2 and 3. Warwickshire County Council has good coverage of LiDAR data, as shown by the green boxes on the map below. This LiDAR data has been gathered from the Environment Agency as part of the data collection process, to assist in the production of the Level 2 SFRA if and when the need arises.



12.5 Level 2 SFRA

This Level 1 SFRA will allow the Council to assess the proposed mineral and waste site allocations using the Sequential Test. This will act as a 'sieving' process, allocating as many sites as possible to Flood Zone 1. There are no scenarios in which minerals sites would have to undergo the Exception Test, but for any waste management facilities for hazardous waste proposed in Flood Zone 3a, or any installations requiring hazardous substances consent proposed in Flood Zone 2, the Exception Test will need to be applied in line with table D3 of PPS 25. In order for developments to go ahead in such areas the criteria outlined in Section 1.5.2 will need to be satisfied. In these instances, a Level 2 SFRA will be required.

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.

The data required for a Level 2 SFRA within Warwickshire 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.

In instances where Flood Zone 3b does not exist (and therefore for the purposes of the Sequential Test Flood Zone 3b is deemed to be equal to 3a), and a 'less vulnerable' development has been allocated in Flood Zone 3a, it may be necessary to define Flood Zone 3b using flood mapping techniques. Halcrow is able to advise on further work required if this situation arises.

It is important that a Level 2 SFRA considers the variation of flood risk in a Flood Zone due to flood risk management measures i.e. flood defences. 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). It is not necessary to carry out such scenarios behind all existing defences, if no new development is to be located behind these structures. 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. Should sites become allocated behind defences, Halcrow can advise on the cost of such work, and whether existing data is suitable for this purpose.

Level 2 SFRA outputs would 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

13 References/Glossary

1) **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.

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

3) **Development Plan Document (DPD) -** 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.

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

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

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

7) **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.

8) **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. PPS 25 sets out strict requirements for the application of the Test.

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

10) **Flood Risk Management Hierarchy -** PPS 25 reaffirms the adoption of a risk-based approach to flooding by following stepped hierarchical measures at all stages in the planning process. Avoidance/prevention is the first measure, followed by substitution, control and then mitigation.

11) **Flood Risk Vulnerability -** PPS 25 provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone.

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

13) **Functional Floodplain Zone 3b -** Defined as areas at risk of flooding in the 1 in 20 year design event.

14) **Habitable Room -** A room used as living accommodation within a dwelling but excludes bathrooms, toilets, halls, landings or rooms that are only capable of being used for storage. All other rooms, such as kitchens, living rooms, bedrooms, utility rooms and studies are counted.

15) **High probability Zone 3a -** Defined as areas at risk of flooding in the 1 in 100 year design event.

16) **IDB –** Internal Drainage Board, responsible for non-Main Rivers and drainage within their boundary area.

17) **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).

18) **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.

19) **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.

20) **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.

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

22) **Low Probability Zone 1 -** Defined as areas outside Zone 2.

23) **mAOD –** Metres above Ordnance Datum

24) **Main River –** A section of watercourse (including the structures and devices on it used to regulate flow) which is maintained by the Environment Agency.

25) **'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.

26) **Medium probability Zone 2 -** Defined as areas at risk of flooding in events that are greater than the 1 in 100 year, and less than the 1 in 1000 year design event.

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

28) **Ordinary Watercourse (non-Main River)** – Any section of watercourse not designated as a Main River.

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

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

31) **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.

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

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

34) **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.

35) **Strategic Flood Risk Assessment (SFRA) –** An SFRA is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints, informing SAs and identifying locations of emergency planning measures and requirements for flood risk assessments.

36) **Supplementary Planning Document (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.

37) **Sustainability Appraisal (SA) -** Appraisal of plans, strategies and proposals to test them against broad sustainability objectives.

38) **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).

39) **West Midlands Regional Spatial Strategy -** This is a new Regional Spatial Strategy which identifies the vision for the region. It will set a new housing requirement for each District or borough.

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D