Bath & North East Somerset Council

Strategic Flood Risk Assessment of Bath and North East Somerset

Level 2 SFRA for Keynsham

May 2009

CAPITA SYMONDS

successful people | successful projects | successful performance

Contents

The B&NES SFRA is a 'live' document. The current version has been developed using the best information and concepts available at the time. As new information and concepts become available the document will be updated and so it is the responsibility of the reader to be satisfied that they are using the most up-to-date information and that the SFRA accounts for this information. All revisions to this summary document are listed in the table.

Version	Issue Date	Issued by	Issued to
First Draft	05/09//2008	Capita Symonds Ltd	B&NES
Draft Final	07/11/2008	Capita Symonds Ltd	B&NES
Final	23/01/2009	Capita Symonds Ltd	B&NES
Final v2	06/04/2009	Capita Symonds Ltd	B&NES
Final v3	26/05/2009	Capita Symonds Ltd	B&NES

Annex A - Maps

Overview maps

Map O	Overview of Keynsham
Map T2	Topography
Map H(a)	Recorded historic incidents of flooding – by source of flooding
Map H(b)	Recorded historic incidents of flooding
Map N	Potential new development sites (as per the B&NES Local Plan - 2007)

Sources of Flood Risk

Flooding from rivers (fluvial)

Map F	Flood zones (As per Table D1 in PPS25)
Map FF	Functional Floodplain
Map A2	Depth of flooding during 1% AEP river flood event
Map A3	Velocity of flooding during 1% AEP river flood event
Map C	Extent of flooding from rivers with allowance for climate change

Flooding from land

Map L1	Areas prone to flooding from land (surface water flooding)

Flooding from groundwater

Map G3	Land more prone to groundwater flooding

Flooding from sewers

Map S	Historic incidents of sewer flooding

Flooding from artificial sources

Map R	Location of potential artificial sources of flooding

Managing flood risk today

Flood defences and flood warning

Map D1	Draft Environment Agency 'System Asset Management Plan' units
Map D2	Flood defences in Keynsham (from NFCDD)
Map W	Flood Warning Areas

Foreword

Bath and North East Somerset (B&NES) Council are required to prepare a Strategic Flood Risk Assessment (SFRA) to support the production of their Local Development Framework (LDF).

The SFRA creates a strategic framework for the consideration of flood risk when making planning decisions. It has been developed in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25), PPS25 Practice Guide, as well as additional guidance provided by the Environment Agency.

The guidance provided in PPS25 requires local authorities and those responsible for development decisions to demonstrate that they have applied a risk-based, sequential approach in preparing development plans and considered flooding through the application of a Sequential Test. Failure to demonstrate that such a Test has been undertaken potentially leaves planning decisions and land allocations open to challenge during the planning process.

The underlying objective of the risk-based sequential allocation of land is to reduce the exposure of new development to flooding and reduce the reliance on long-term maintenance of built flood defences. Within areas at risk from flooding, it is expected that development proposals will contribute to a reduction of flood risk.

A SFRA is essential in enabling a strategic and proactive approach to be applied to flood risk management. The assessment allows us to understand current flood risk on a wide-spatial scale and how this is likely to change in the future.

The SFRA is presented in a number of documents:

Level 1 SFRA for the whole of B&NES

- Non technical summary leaflet
- VOLUME I – decision support guide
- VOLUME II – technical report and flood maps
- VOLUME III – management and update guide

Level 2 SFRA for key areas

- Level 2 SFRA Report for each key area (Part 1)
- Sequential Test Report (Part 2)
- Scoping Study for Flood Risk Management Strategy (Part 3)

The partitioning of the SFRA into this series of reports enables B&NES to assess flood risk in increasing detail as they progress their Local Development Framework (see Figure A).

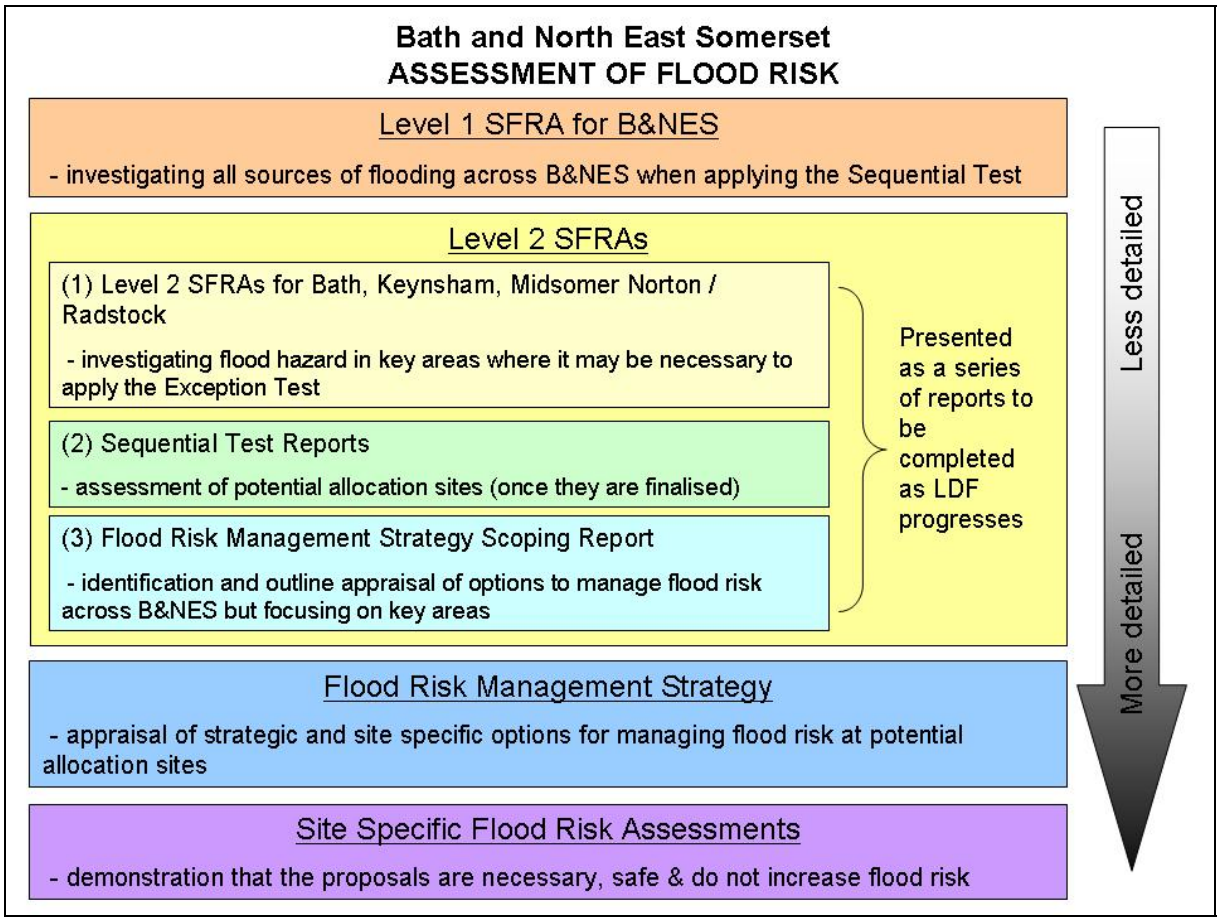

Figure A. Hierarchy of flood risk investigations

The SFRA are live documents which are intended to be updated as new information and guidance becomes available. The outcomes and conclusions of the SFRA may not be valid in the event of future changes. It is the responsibility of the user to ensure they are using the best available information when making a land planning decision.

1. Introduction

Purpose of this report

This Bath and North East Somerset (B&NES) SFRA has been developed to inform the Local Development Framework (LDF). The SFRA must be robust and be evidence-based so that it does not leave planning decisions and land allocations open to challenge through the land use planning process. It is crucial that there is transparency in the data and methods used in the assessment.

This volume of the Bath & North East Somerset Strategic Flood Risk Assessment is the:

Level 2 Strategic Flood Risk Assessment for Keynsham

This report is the first of a series of reports to provide Level 2 SFRA information for key areas within B&NES. This report builds upon all of the technical information and methods used in the Level 1 assessment of flood risk across the study area. This report is intentionally partitioned from the Level 1 SFRA, as it does not repeat guidance contained within the Level 1 SFRA. However, it is intended that the reader of this document refers to the Level 1 SFRA for further technical guidance where appropriate.

The other Level 2 SFRA reports (Sequential Test and Scoping Reports) will provide more specific flood risk information for potential allocation sites, and an outline appraisal of flood risk management options available to B&NES.

The need for a Level 2 SFRA for Keynsham is primarily driven by the new housing requirements proposed in the draft South West Regional Spatial Strategy. A Level 2 SFRA has been undertaken to provide greater understanding of the factors contributing to the probability of flooding both in and around Keynsham.

A Level 2 SFRA has been undertaken to provide greater understanding of the factors contributing to the probability of flooding in the potential development areas, provide guidance for LDF policy to ensure that the development would be safe from flooding and would not increase flood risk elsewhere, and identify the need for additional more detailed assessment to reduce uncertainty. The scope of the Level 2 SFRA is defined in PPS25 (December 2007), and expanded in the recently published PPS25 Practise Guide (June 2008). This Level 2 assessment is structured to address the requirements of PPS25 and the Practice Guide and in doing so includes sections on sources of flood risk, managing flood risk today, and in the future, and recommendations for implementing the Level 2 SFRA.

The user is referred to Volumes II and III of the SFRA for guidance on how to interpret the information in this technical report and how to update the SFRA following improvements in data or changes in guidance. The SFRA is based on a range of data from different sources and of various degrees of certainty. It is the responsibility of the user to understand and take account of the source and certainty of the data when referring to the flood risk summaries and flood maps.

Overview of Keynsham

This section is intended as a very brief contextual summary. A full description and associated maps are presented in the Level 1 SFRA for B&NES.

Location

Keynsham lies west of Bath at the edge of the B&NES unitary area boundary. It is adjacent to the River Avon, and is dissected by the River Chew. The confluence of these two rivers lies one kilometre

North East of Keynsham near to the A4175, Keynsham Road. Map O in the Annex of this document shows the location of Keynsham in relation to the district and the river network.

Physical characteristics

Much of the urban conurbation of Keynsham lies on ground that is relatively high when compared to the steeply incised River Chew and the broad expanse of the poorly draining River Avon floodplain. The River Avon is a major river in South West England and is the largest river within B&NES. It rises in Wiltshire and flows through Bath and Bristol before joining the River Severn at Avonmouth. The River Chew valley is comprised of a mixture of impermeable and semi-permeable geological formations that underlie the relatively steep topography of the Northern Mendip Hills. The head of the valley contains the Chew Valley Reservoir. Map T2 provides an indication of the ground topography in the vicinity of Keynsham.

Human influences

Keynsham lies between Bath and Bristol and is a town with a population of approximately 16,000. It is well connected locally, regionally and nationally via the London – Bristol railway and the A4 highway. Local employment is dominated by commuting to neighbouring employment centres, local retail and agriculture, some light industry and by the Cadbury Chocolate Factory at Somerdale (due for closure by 2011).

Future Growth

Map N shows the potential development sites allocated in Bath & North East Somerset's Local Plan (Adopted 2007). In addition to these sites, long term planning for Keynsham requires additional development to be considered.

2. Sources of flood risk

Introduction

Keynsham and the surrounding locality contains localised areas that are prone to flooding from a range of sources including rivers, sewers, land, and groundwater. The type of flooding is dependent on the interaction of rainfall, catchment characteristics and the sea. PPS25 identifies six sources of flooding to be investigated in an SFRA as flooding from rivers, the sea, groundwater, land, sewers and artificial sources.

Summary of flood risk in Keynsham

The dominant sources of flood risk in Keynsham are rivers, sewers and artificial sources, although there is very minor risk from tidal and groundwater sources. The main areas at risk are:

- Rivers - Map F shows the Flood Zones within Keynsham as per PPS25. Map FF shows the functional floodplain (land that would be flooded during an event with a 5% annual probability of exceedance (AEP)). The Environment Agency advises that no formal flood defences exist in Keynsham.

  Map A2 indicates the depth of flooding during a 1% AEP event. Relatively few properties are at risk of flooding in Keynsham town as they occupy higher ground that lies outside the floodplain of the River Avon, or the deeply incised River Chew. Map A3 indicates the velocity of flooding during a 1% AEP event. The highest velocities can be expected along the steeper upper reaches of the River Chew and through structures.

- Sewers/Land – Map L shows the areas potentially more prone to flooding from land. Within urban areas the management of surface water relies on sewer systems and therefore for the purposes of this assessment flooding from land has been defined as potential areas of inundation as a consequence of direct runoff from agricultural land on the edges of urban areas.

  The majority of the urban area of Keynsham is shown to be highly prone to flooding from runoff from the land, due to the topography and soils characteristics in the area, however there are no recorded incidents of surface water flooding within Keynsham. A more detailed technical assessment of the performance of the influential drainage infrastructure would be required to more precisely define the level and spatial distribution of risk (see Recommendation 5 in Section 5).

  Map S shows the recorded incidents of sewer flooding within Keynsham. There is a higher than average number of recorded incidents of sewer flooding in Keynsham, indicating that the sewer infrastructure plays an important part in surface water flooding within the town.

  The predicted increases in rainfall intensity will place greater pressure on the existing drainage system within Keynsham, which has a history of sewer flooding.

- Artificial sources – a significant source of flood risk lies at the head of the River Chew Catchment in the Chew Valley Lake, and to a less severe scale, the Chew Magna Reservoir. The probability of failure for these reservoirs is low, however the Chew Magna Reservoir did overtop in 1968 when an intense rainfall event caused the water in the lake to exceed capacity, causing a cascade effect downstream. There is no histroy of flooding from the Chew Valley Lake, however the consequences of failure would be severe. Map R of the Level 1 SFRA provides an indication of the area that may be affected by failure of the Chew Valley Lake.

Flood risk statistics in Keynsham

Table 2.2 provides a summary of the key flood risk statistics across Keynsham.

Table 2.2 Key flood risk statistics for the urban area of Keynsham

	Approximate area or number	Percentage of total area or number
Keynsham statistics		
Keynsham town area	4 km^2	100%
Flood statistics		
Flooding from rivers and sea		
Area of Keynsham within Flood Zone 3b (Functional Floodplain)	0.15 km^2	3.8%
Area of Keynsham within Flood Zone 3a (High probability)	0.17 km^2	4.2%
Area of Keynsham within Flood Zone 2 (Medium probability)	0.16 km^2	3.9%
Area of Keynsham within Flood Zone 1 (Low probability)	3.67	91.8%
Area of Keynsham within Actual Risk floodplain (1% AEP flood outline with defences in place)	0.17 km^2	4.2%
Area of Keynsham covered by a flood warning service	0.14 km^2	3.5%
Area of Keynsham covered by a flood emergency plan	4 km^2	100%
Other sources of flooding		
Area of Keynsham potentially prone to flooding from land (high)*	3.2 km^2	80%
Area of Keynsham potentially prone to flooding from groundwater (high)*	0 km^2	0%
Area of Keynsham known to be affected by flooding from sewers (high)	11 incidents	N/A
Area of Keynsham potentially at risk of flooding from artificial sources (high)	0.15 km^2	3.75%

* based on the broadscale spatial analysis undertaken during the Level 1 SFRA

Flood risk from rivers

Flooding from rivers occurs when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (floodplain). The main reasons that water levels can rise in rivers are:

- intense or prolonged rainfall causing runoff rates and flow to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet antecedent conditions and where there are significant contributions of groundwater;
- constrictions in the river channel causing flood water to backup;
- blockage of structures or the river channel causing flood water to backup; and
- high water levels and/or locked flood (tide) gates preventing discharge at the outlet of the river.

The consequence of river flooding depends on how hazardous the flood waters are and what the receptor of flooding is. The hazard of river flood water is related to the depth, velocity, speed of onset and rate of rise which depends on the:

- magnitude of flood flows;
- size, shape and slope of the river channel;

- width and roughness of the floodplain;
- types of structures that cross the channel; and
- the hydrological characteristics of the catchment.

Flood hazard can vary greatly throughout catchments and even across floodplain areas. The most hazardous flows generally occur in steep catchments and towards the bottom of large catchments. Hazardous river flows can pose a significant risk to exposed people, property and infrastructure.

Whilst low hazard flows are of less risk to life, they can disrupt communities, require significant post-flood cleanup and can cause superficial and possibly structural damage to property.

The hydraulic models and methodologies used to estimate flood risk are documented in the main technical report of the level 1 SFRA. The following sections contain a more detailed description of the results of these assessments with reference to Keynsham.

Flood Zones

The definition, data used and approach for establishing Flood Zones for the Level 1 SFRA across the whole of B&NES is outlined in the Level 1 Technical Report (Vol II). This methodology was reviewed during the Level 2 SFRA so that flood risk in the potential expansion areas within Keynsham could be assessed.

The review of the methodology and results found an area of uncertainty in the Level 1 SFRA flood outlines along Broadmead Brook (east of Keynsham) (NGR 366940 167570). The flood outlines in this area were prepared by projecting water levels modelled in a 1D model in 2003, onto more recently collected LiDAR data. The modelled water level at one cross-section of the Broadmead Brook was found to be artificially elevated due to an erroneous surveyed cross-section, which resulted in a substantial area being shown as flooded (Flood Zone 3a and 3b) on the Level 1 SFRA maps. This flood extent was not consistent with other flood information, including the Environment Agency Flood Zones, historic flood information or local knowledge. The area shown as being flooded has thus been removed from the Level 2 SFRA mapping, with a recommendation added that further investigation be undertaken prior to permitting development in that area (see Recommendations 1 in Section 5).

The process for projecting modelled water levels onto topographic data provided information on the extent of the floodplain along the Charlton Bottom watercourse, west of Keynsham. This flood extent has been included in the SFRA mapping, and it is recommended that it is included in the Environment Agency's Flood Zone maps (see Recommendation 11 in Section 5).

The flood information prepared for the SFRA is based on version 3.5 of the Environment Agency's Flood Zone maps and additional modelling information as of October 2008. Further details of the source of information used in preparing the SFRA can be found in the Level 1 SFRA Technical Report. It is the responsibility of the user to confirm that this data is the latest available when undertaking further flood risk assessments.

Map F in the annex to this document presents the Flood Zones for Keynsham, as revised during the Level 2 SFRA. To avoid confusion through the issue of inconsistent datasets, the Level 1 SFRA maps have been updated with these revised flood outlines. It is recommended that a note be drafted to explain that the maps have been updated without amendment to the Level 1 SFRA report (see Recommendation 7 in Section 5).

Most of the existing built up area of Keynsham lies outside the area which would flood with an annual probability of 1 in 100 (1%) or greater in any given year. This is due to both historic and contemporary development being focussed on relatively high ground to the South of the Avon and East / West of the Chew Valley.

The Keynsham urban area does have a history of flooding, and flooded regularly prior to the construction of the Chew Valley Lake and Keynsham Lock / Weir. Flooding most frequently occurs on the extensive natural washlands and 'functioning floodplain' adjacent to the Avon and on the land between the raised embankment of the A4 and Keynsham town centre (this area contains the rugby club).

Maps H(a) and H(b) in the annex to this document presents a record of the historic flood events for Keynsham.

Events have been recorded in the Chew catchment in 1960, 1968, 1979, 1981, 1995, 2000 and 2002. The village of Stockwood Vale lies on the Charlton Bottom has flooded on many occasions in the past, the most recent of which occurred on 30 October 2000.

Functional floodplain

Flood Zone 3b (the functional floodplain) comprises land where water has to flow or be stored in times of flood. The PPS defines the Functional Floodplain as:

> *'SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5 %) or greater in any given year or is designated to flood in an extreme (0.1 %) flood, or at another probability to be agreed between the LPA and Environment Agency, including water conveyance routes.'*

Map FF in the annex to this document illustrates just the Functional Floodplain for Keynsham (which has been revised from the Level 1 SFRA for reasons outlined under the Flood Zones sub-heading of this chapter).

A tiered modelling approach was used in preparing the Level 2 SFRA for Keynsham. This approach made use of more detailed Environment Agency model data to define Flood Zone 3b in areas of interest or perceived higher risk and other information to define this zone in other areas. There was no suitable model data available to define Flood Zone 3b on the Broadmead Brook east of Keynsham (as discussed under Flood Zones sub-heading) or Charlton Bottom (west of Keynsham). These areas are predominantly rural and as such a detailed hydraulic model was not developed to define Flood Zone 3b.

In the absence of more detailed model data a precautionary approach should be adopted whereby Flood Zone 3a is used as an indication of functional floodplain. Any application for development in these areas will require a site specific flood risk assessment to provide more detailed flood risk data (see Recommendations 1 and 2 in Section 5).

Climate Change

It is expected that the influence of climate change will lead to increased river flows, and some increase in flood extent within Keynsham. However, flood depths and the time to peak on the River Chew are expected to increase more than flood extents.

Map C in the annex to this document illustrates the predicted flood outlines for the 1% AEP with an increase in flood risk over 100 year time horizon to take into account the impact of increased flow magnitudes generated by potential climate change effects (which has been revised from the Level 1 SFRA for reasons outlined under the Flood Zones sub-heading of this chapter).

Flood Hazard

Map A2 shows the flood depth expected during a 1% AEP flood event in Keynsham. The deepest floodwaters are shown on the River Avon and upstream of structures on the River Chew. As per the

latest Environment Agency/Defra guidance[1] on assessing flood risk to people, all flood waters deeper than 1.25m which are still and free of debris are considered dangerous for some. In times of flooding the watercourses in Keynsham will not be still or free of debris and as such velocity and debris need to be considered when assessing flood hazard.

Velocity information which is detailed enough for mapping is only available in areas where detailed 2D hydraulic models have been prepared. This type of information is available for the River Avon and Map A3 shows that the velocity of the flood water during a 1% AEP flood event is generally low (0-0.5m/s) with the exception of where water is accelerated through structures (1-1.5m/s). The flood risk to people guidance[1] indicates that for a velocity of 0.5m/s, the depth of flood water only needs to be 0.75m for it to be considered dangerous for some. The majority of the River Avon is expected to experience a depth in excess of 0.75m during a 1% AEP flood event.

Using the tiered approach outlined above the 1D hydraulic model on the River Chew to provide an indication of the velocities that may be experienced during a 1% AEP flood event (note: the 1D model only provides averaged velocities for each cross-section).

The maximum velocities in the upper reach of the River Chew through Keynsham (from the weirs at St Clements Road to the sluice gate and weir downstream of Bath Hill Road) are expected to be lower than 1.4m/s, reflecting the "backing up" causing by the sluice gate. By considering flood depth alongside velocity, the most hazardous flows are expected to be in-channel, and in the floodplain surrounding the weirs near St Clements Road.

The maximum velocities of the River Chew flood waters is expected to be larger downstream of the sluice and weir at Bath Hill Road due to a steeper topography and unrestricted flow (subject to water levels on the River Avon). Here maximum velocities may reach more than 3m/s, indicating that all floodwater is considered dangerous to some.

Site specific flood risk assessments should use this or more detailed flood depth and velocity information to assess flood hazard at potential development sites within the floodplain of Keynsham (see Recommendation 8 in Section 5).

Flood risk from the sea (tidal)

The tidal limit of the River Avon extends as far as Keynsham Weir during high spring tides. Tidal flooding needs to be considered both now and in the future given the predicted increase in sea level.

The Level 1 SFRA for B&NES contains the methodology and results of hydrological and GIS based modelling to determine the impact of tidal flooding upon B&NES.

A summary of the conclusions are presented below for completeness.

Under present conditions the MHWS tide has a negligible impact on modelled water levels within B&NES. When MHWS tide levels are increased to account for climate change, the influence on modelled water levels increase, but the effects reduce significantly upstream of Keynsham weir.

The baseline 0.5 and 0.1% AEP extreme tide events increased peak levels by approximately 0.3m and 0.45m during a 20% AEP river flood event downstream of Keynsham weir. However, water levels are only increased by 0.1m upstream of the weir

Flooding from the sea is not expected to present a risk to Keynsham now or in the near future. Flooding from rivers is the dominant source in the Lower Avon. As such, any flood defence measures should be designed for this source of flooding.

[1] Defra/Environment Agency (2006) "Flood Risks to People Guidance Document" Technical Report FD2321/TR1

Climate Change

Whilst the impact of tidal events on their own is low, tidal events combined with river events may have a more significant impact. This impact may increase given the current predictions for sea level rise.

With climate change adjustments, the modelled water levels increased by 0.9m downstream of Keynsham weir compared to the baseline Mean High Water scenario. However, water levels only increased by 0.4m upstream of the weir. Furthermore, only 0.12m was attributed to the tide with the remainder attributed to the climate change increase in flows.

Climate change may increase the tidal limit of the Lower Avon to within the B&NES study area. As such, the design and management of river flooding around Keynsham should include a joint probability assessment of tidal and river flooding.

Flood risk from land (surface water)

Flooding from land (surface water flooding), occurs when intense, often short duration rainfall is unable to soak into the ground or enter drainage systems. It is made worse when soils are saturated so that they cannot accept any more water. The excess water then ponds in low points, overflows or concentrates in minor drainage lines that are usually dry. This type of flooding is usually short lived, localised and associated with heavy downpours of rain. Often there is limited warning before this type of flooding occurs.

Urban areas usually have extensive drainage or sewer systems. In urban areas it is complicated to determine whether flooding has been caused by surface water or sewers. For the purpose of the SFRA, any flood risk associated with direct runoff from surrounding land onto the urban area has been considered as flooding from land (surface water). Any flooding within the urban area itself where a comprehensive sewer system exists has been considered flooding from sewers.

As Keynsham is located in a relatively flat low-lying area, the spatial analysis undertaken during the Level 1 SFRA indicated that much of the urban area would potentially be affected by flooding from land (surface water flooding). This analysis did not consider the impacts of the sewer system in the area and as such may have over-estimated this source of flooding. The Environment Agency do not hold any records of flooding from land within Keynsham or surrounds, which indicates that this source of flooding may not be significant. A more detailed study would be necessary to precisely understand the extent and frequency of such flooding (see Recommendation 5 in Section 5).

The data provided by Wessex Water for sewer flooding indicates that there have been a number of incidents of sewer flooding within the urban area (as described in the Flooding from Sewers section of this report). It is probable that some of these flood incidents could have been attributed to both flooding from land (surface water) in combination with flooding from sewers.

Given the extensive urban drainage system within Keynsham all flooding within the urban area has been addressed as sewer flooding. And flooding from land is considered low subject to the outcome of a more detailed drainage assessment.

Surface Water Management Plans should be prepared where a more strategic approach is required to effectively manage surface water disposal and flood risk. The requirement for SWMPs within Keynsham is discussed further in Chapter 4.

Flood risk from sewers

Flooding from sewers occurs when rainfall exceeds the capacity of networks or when there is an infrastructure failure. For the purpose of this SFRA sewer flooding is defined as any flooding which occurs in an urban area with a comprehensive sewer network. This includes combined, and surface

water sewers, culverted minor watercourses (lost watercourses), sewer pumping stations and water treatment facilities. It does not include flooding from over land drainage systems in rural areas.

A probabilistic assessment of the risk of flooding from sewers is not within the scope of this document. Instead the likelihood of flooding from sewers has been assessed using historic flooding information and consultation with relevant stakeholders.

The Environment Agency Flood Reconnaissance Information System (FRIS) does not contain any records of flooding from sewers, however Wessex Waters 'Flood Properties Register' contained 11 incidents of flooding (note: Wessex Waters' register is a live document, a property is added to the register when a problem is encountered, and it is removed from the register when the problem is resolved).

Results from analyses of sewerage systems using hydraulic models provided by Wessex Water has also been used to assess areas more susceptible to sewer flooding. These were available for foul and combined sewer systems only, therefore do not provide full information on the capacity and flood risk from surface water sewers. Sewer systems which rely on pumps can also be more susceptible to flooding, so the assessment has included consideration of the location of these pumping stations.

The assessment of hydraulic models and the location of sewerage pumping stations indicated that the majority of sewers within Keynsham do not have spare capacity to accept additional runoff from new development and/or climate change.

The sewers that are more likely to flood are concentrated in the town centre, along the River Chew, where the system is also reliant on a number of pumping stations. The mechanism for flooding in this area is likely to result from the lack of capacity in the existing sewer system in conjunction with 'locked' outlets when water levels on the River Chew are high. Floodwater is likely to follow major flow paths such as roads towards low-lying areas and flood depths may be relatively high.

As well as the town centre, the topography of Keynsham indicates a preferential flow path west of Charlton Road, running in a north-easterly direction (see Map T2). This path is likely to have conveyed surface water runoff from the western part of Keynsham towards the River Avon before the urban sewer system was installed. With the urban sewer system now in place, the flow path is only likely to convey water if the capacity of the urban sewer system or inlets to the system was exceeded due to very intense rainfall. The hydraulic model results provided by Wessex Water do not suggest that the system has a high probability of flooding due to lack of capacity, so flooding in this area is more likely to occur due to exceedance of the inlet capacity. Properties along St George's and St Ladoc roads may be at risk of this type of flooding.

Flood risk from artificial sources

Two artificial sources of flood risk do influence the risk profile of Keynsham, namely the Chew Valley Lake and Chew Magna Reservoir.

The communities upstream of Keynsham, and the town of Keynsham itself, have had a direct experience of flooding from the Chew Valley Lake in 1968.

The precise details of the event are documented in the technical report to the Level 1 SFRA, and can be summarised as follows;

- Flooding occurred on the 10th of July 1968 after very heavy rainstorms caused the water level in the reservoir to exceed the designed capacity and resulting in overtopping of water;
- A 10 feet tall (3.0m) wave reached Keynsham carrying with it a cargo of debris;

- Eight people lost their lives, and according to the (then) clerk of the town council, 24 properties were substantially damaged, with 177 flooded to a lesser degree; and

- Long standing road bridges at Pensford, Woollard and Keynsham were destroyed.

This flood event is testament to the fact that it is not simply the volume and speed of water that poses a risk, but the debris contained within the water, and the potential for that debris to block structures and bridges leading to immense physical pressure being applied to the structure, before it fails.

The Environment Agency is now responsible as the Enforcement Authority under the Reservoirs Act 1975 in England and Wales. As well as the Environment Agency, the Health and Safety Executive and B&NES have a responsibility for regulating reservoirs.

The Water Act 2003 requires that flood plans be produced for specified reservoirs by Autumn 2007. Bristol Water and B&NES Council have advised that inundation maps have been produced for the reservoirs in B&NES. For security reasons, these maps were not available for use in the SFRA.

The Environment Agency has just commissioned a National "Reservoir inundation Mapping" programme to prepare further information on reservoir inundation and provide information requested in the Draft Flood and Water Management Bill (www.defra.gov.uk/corporate/consult/flood-water-bill/index.htm). The maps are expected to be available by November 2009.

Modelling was undertaken during the Level 1 SFRA for B&NES to provide some indication of the area that may be affected by reservoir flooding (Map R). In the event that a reservoir could cause a flood after an uncontrolled release of water, it is important that arrangements are in place so that emergency services and local authorities can provide effective assistance (see Recommendation 4 in Section 5).

Flood risk from groundwater

For the purpose of the SFRA, groundwater flooding has been defined as flooding from sub-surface water. There are a number of mechanisms that can cause this type of flooding including regional groundwater rise, underground barriers to flow and rebound when pumping from mining activities ceases.

The spatial analysis undertaken for the whole of B&NES in the Level 1 SFRA (Map G3) indicated that there was a low to medium risk of groundwater flooding in Keynsham. The main reason for a medium likelihood was due to the low-lying topography of the urban area, however it is likely that with such a close proximity to the River Avon the chance of this type of flooding is lower than predicted by the outline assessment.

The Environment Agency does not hold any records of groundwater flooding in this area and does not consider it a significant issue in Keynsham.

3. Managing flood risk today

Introduction

Structures and defences are built to help reduce the occurrence, and therefore consequences of flooding. These assets can be owned, operated and maintained by the Environment Agency, Local Authorities, private business and/or local residents.

In some instances, river processes have been modified over time by these defences (such as river walls, flood storage areas, flood alleviation channels and embankments) and by undertaking maintenance activities (such as river dredging).

The Environment Agency manages flood defences as groups of structures, rather than individual assets. These groups are termed 'management units' and will be identified and managed through System Asset Management Plans (SAMPs). The SAMPs that cover Keynsham are shown in Map D1 and include:

ID and map reference	Name	Description	Draft FRM Systems Standard
FR/14/S079 Map D1f	Lower Bristol Avon C	The River Avon (between Bath and Keynsham), Newton Brook, Corston Brook, and Broadmead Brook	Medium
FR/14/S078 Map D1g	Chew and Catchment	Includes the Chew Valley Reservoir, Winford Brook, Chew Stoke Stream and River Chew.	High
FR/14/S075 Map D1h	Lower Bristol Avon B	The River Avon from Keynsham to Netham (beyond the boundary of B&NES). The lower reaches of the Charlton Bottom and the Scotland Bottom watercourses	High

According to the data contained in the Environment Agency National Flood and Coastal Defence Database (NFCDD) and following consultation with the Environment Agency, no formal defences exist at Keynsham (see Map D2).

Notwithstanding the River Chew does contain sections of sheet piling, bank re-enforcements, channel deepening and widening. These ‘informal’ flood defences can usually be accessed via fields in the adjacent floodplain for checking and maintenance purposes.

In addition the sluice gates and weirs downstream of Bath Hill Road (B3116) on the River Chew and an impounding structure at the bottom of Chew Valley Lake which may be considered as a flood defence.

Current condition and upkeep of flood defences

The 1968 flood in Keynsham destroyed a number of bridges and infrastructure in the flood plain of the River Chew. Works were required after the flood to restore the river, including deepening and widening of the channel and sheet pilling and bank reinforcements. The restored river and floodplain now plays an important flood storage function and is not considered a defence but rather part of the river system in this area. The bank reinforcements and sheet piling along the River Chew is mostly of fair condition, with a few isolated areas considered to be poor (often where the reach of the river is in private ownership).

Up until 8 years ago the sluice gate on the River Chew was in poor condition with an outdated ratchet system for operating the structure. This structure was both unsafe and was no longer able to adequately stop flow. The sluice gate has now been replaced with a more modern sluice gate which is more water-tight and easier to operate. The sluice gate is operated fairly regularly and considered to be in good condition.

There are currently no formally documented inspection, maintenance or operational procedures for the bank works, river channel or sluice gate at Keynsham. When staff are available, informal inspections and maintenance and undertaken on an ad hoc basis. When there is a flood warning, a member of staff will open the sluice gate. The sluice gate is also opened periodically to flush the sluice gate of silt and debris. On a larger scale, desilting is undertaken every 4 to 5 years on the concrete channel under the A4 (T) Keynsham Bypass.

The impounding structure for the Chew Valley Lake is not a formal flood defence however plays an important role in preventing flooding from the lake in Keynsham. The lake falls under the Reservoirs Act (1975) which requires that regular inspections and maintenance of the impounding structure is undertaken by an appropriately qualified engineer. Given the stringent requirements under this Act, it is assumed the structure is maintained in good condition.

Probability and consequences of overtopping or failure

The probability of the sheet piling and bank re-enforcements failing on the River Chew is moderate given the lack of regular maintenance and isolated areas of bank in poor condition. If this infrastructure were to fail, there may be a reduction in the capacity of the channel locally and potentially downstream due to sediment transport and deposition. Given the significant width of the floodplain and the bypassing of the sluice gate it is unlikely that the small reduction in channel capacity would have any significant impact on fluvial flood risk within Keynsham within the short to medium term.

Elevated river levels, even if short-term and localised may affect the outfalls of the surface water drainage system, causing backing of the system and more incidents of secondary flooding in urban areas some distance from the river itself.

In the long term if regular maintenance and upkeep is not undertaken, the channel dimensions of the River Chew could be subject to significant change, especially near to the A4(T) Bypass where significant desilting is required. This change would probably increase fluvial flood risk to properties nearest the river.

The probability of the sluice gate failing on the River Chew has been defined as the sluice gate not being opened during an event. The chance of this happening is moderate as the sluice gate is manually operated and there are no formal operational procedures. However modelling work has shown that the sluice gate is bypassed during large flood events and so there are no significant consequences to flooding even if it is not opened.

The Chew Valley lake impoundment structure was overtopped in 1968 and therefore overtopping and / or failure of the structure may occur. As the lake falls under the Reservoir Act it is expected that it will have been designed so that overtopping and particularly failure of the structure are unlikely (and should be designed to a standard in equal to or in excess of a 1 in 10,000 year return period event). An assessment of the consequence of failure of the structure was completed for the Level 1 SFRA, as shown in Map R. Within Keynsham, the area at risk falls mainly within the defined flood plain area adjacent to the River Chew.

The potential impact of blockage of the sluice gate on the River Chew upon flood risk

The probability of the sluice gate structure becoming blocked is high as there is currently no formal inspection or maintenance procedures in place and no staff assigned to undertaking these tasks in an informal manner. Modelling work has shown that the sluice gate is bypassed during large flood events and so there are no significant consequences to flooding if the sluice gate was blocked during a flood event.

In addition to the sluice gate there are a few bridges which cross the River Chew, which have the potential to block. However the chance of blockage is considered relatively low as these were rebuilt after the 1968 flood events with more modern larger openings. Notwithstanding the low probability of

blockage, the River Chew has a relatively wide and undeveloped flood plain, therefore the localised flooding that may be caused by blockage is not considered likely to have a high consequence.

Summary of flood warning and emergency planning

PPS25 states, 'the receipt of and response to warnings of floods is an essential element in the management of the residual risk of flooding'. Thus it recognises that flood warning and emergency planning is an important measure for managing flood risk from extreme events.

The Environment Agency is responsible for monitoring flood events and to issue warnings to people in properties and businesses at risk of flooding. Forecasting uses a combination of Meteorological Office weather forecasts and real-time data (rainfall, flow, level and soil moisture).

The Environment Agency provides a warning services for Keynsham, and the communities upstream on the River Chew. Map W in the annex to this document outlines the areas included in the Flood Warning services. The codes for the Environment Agency Flood Warning Services are:

Area code	Flood warning area
112FWF3H1A	Bristol Avon (lower) from Twerton to Bristol
112FWF3G8a	Winford Brook at Chew Magna
112FWF3H1A	Low lying properties on the River Chew from Chew Stoke to Keynsham
112FWF3G2A	River Chew from Chewstoke to Keynsham

B&NES are encouraged to work with the Environment Agency to ensure that as many homeowners as possible as signed up to this service, and that any new properties are also aware of the service.

The Civil Contingencies Act 2004 classifies Local Authorities as Category 1 responders along with other organisations such as the Police, Fire, Ambulance services. The role and responsibilities for emergency planning is set out by legislation following the implementation of the Civil Contingencies Act 2004. The Act defines the term 'emergency' as:

- *'an event or situation which threatens serious damage to human welfare;*
- *an event or situation which threatens serious damage to the environment, or*
- *war, or terrorism, which threatens serious damage to security'.*

During flood incidents the Environment Agency issues warnings to those likely to be affected, operates flood defences on certain rivers and advises the emergency services on the expected level of flooding. The Environment Agency and Local Authority also liaise closely during a flood incident, and B&NES will implement a range of contingency plans which detail how local services will work together to respond to any type of incident or disaster. These plans include but are not limited to a Civil Emergency Manual, Flood Plan, and Emergency Communications plan.

Further details on the Flood Warning and Emergency Planning procedures are contained in the Technical Report of the Level 1 SFRA.

4. Managing flood risk in the future

Flood defences

Likely future flood management policy regarding maintenance and upgrade

The River Avon Catchment Flood Management Plan (CFMP) covers most of the B&NES District. The CFMP is divided into management units which have a policy assigned to provide an overall direction in the way flood risk should be managed in each unit. The urban area of Keynsham is defined as its own policy unit and has a policy of "sustain the current level of flood risk". This means that works can be undertaken to ensure that the current level of flood risk today is maintained into the future (given the potential impacts of climate change). Or conversely implement measures so that the existing level of flood risk is not increased in the future.

The Environment Agency prepares System Asset Management Plans for the flood defence infrastructure under its responsibility. These are regularly reviewed and updated, and should be referred to for up to date information on planned maintenance and upgrades.

Managing surface water flood risk

Identifying the scope and need for a surface water management plan

The responsibilities for surface water management fall to a number of bodies including the Environment Agency, B&NES, Wessex Water and the highways authority. Management of surface water is therefore a complex issue, best dealt with using a strategic and co-ordinated approach. SWMPs therefore have an important role in developing a coordinated strategic approach to managing surface water drainage and reducing flood risk and provide a platform so that climate change effects do not give rise to exacerbation of urban flooding.

The PPS25 Practice Guide outlines the key purposes of Surface Water Management Plans (SWMP) as:

- ensuring that allocations within an area are properly supported by adequate surface water management;
- providing a common framework for stakeholders to agree responsibilities for tackling existing drainage problems and preventing future problems;
- where development pressures are high it can be part of a Water Cycle Strategy; and
- demonstrating how capital investment, infrastructure and maintenance can deliver the required surface water management.

SWMPs are required for a number of reasons including:

- to identify locations where there is evidence of existing problems with the drainage infrastructure and therefore a requirement for upgrade to deal with surface water now and into the future;
- consideration of the implications of potential large-scale development where surface water may be best managed with a strategic approach, rather than on an individual development scale; and
- the evaluation of the potential opportunities to implement a coordinated approach by several bodies to plan infrastructure improvements.

The preparation of the SWMP should be specific to the location and nature of the drainage surface water infrastructure and flooding mechanisms.

We have identified critical drainage areas in a number of ways, including;

- An analysis of historic flooding information and existing capacity assessments;
- An assessment of potential allocation sites; and
- Consultation with key stakeholders including Wessex Water, Highways Authority, the Environment Agency and B&NES technical specialists.

The following specific drivers for SWMPs have been identified in Keynsham, which should be addressed through the preparation of SWMPs and subsequent drainage strategies:

- The majority of the existing sewer infrastructure throughout Keynsham is unlikely to have sufficient capacity to cope with additional runoff resulting from climate change and future developments. A SWMP for the town is recommended, which should consider appropriate policies and strategies to prevent additional load on the existing system and a co-ordinated investment strategy for future improvements. A separate SWMP and / or drainage strategy may be required for the town centre, along the River Chew (particularly in the vicinity of Bath Hill and Dapps Hill) where the likelihood of flooding is higher and a more comprehensive upgrade may be required. The historic flow path west of Charlton Road should also be considered. The SWMPs should consider appropriate policies for encouraging water cycling at existing properties and any new infill properties.
- Any potential urban extension of Keynsham will require a SWMP to examine the potential impacts of the development and determine an approach to managing water on the site. The SWMP should aim to ensure that different land owners and land managers can contribute to the system to ensure that the new development as a whole is safe from flooding and would not exacerbate surface water flooding elsewhere. Where possible the SWMP should include appropriate policies and strategies to prevent surface water runoff from new developments contributing to the existing drainage system, and if possible reduce the existing load on the system. The SWMP should also consider options for managing water on site which could be used to reduce the requirement for other water resources within the area.

There are a number of mechanisms for delivering the SWMPs, including through the location and design of new development, preparing for emergencies, and investment in capital infrastructure and maintenance.

Using the planning process to reduce flood risk

Policies for sites which will need to satisfy Part C of the Exception Test

Proposals which are required to satisfy Parts a) and b) of the Exception Test have, by definition, been located in an area which is not generally considered to be appropriate for development. Part c) of the Exception Test requires that these developments are safe, do not increase flood risk elsewhere and, where possible, reduce flood risk overall.

A Flood Risk Assessment (FRA) will be required to demonstrate that Part c) of the Test has been passed. The specific requirements will depend on the development and location in question, however general items to consider are outlined below.

‘Safe’ development requires that development is designed such that the likelihood of flooding at the development, and the consequences of flooding that does occur are not too severe and in particular are unlikely to lead to loss of life and disruption to normal living. The flood hazard, related to flood depths and flood velocities is one of the most important considerations for safe development with respect to access and egress during a flood for the public or attendance of emergencies by the Fire Rescue

Service. Guidance and advice on acceptable flood hazard for different circumstances is regularly updated and therefore it is advisable that B&NES set policies that refer to using up to date guidance rather than setting fixed policies within the LDF. B&NES may wish to consider policies for the following items:

- Development layout – the development layout should be designed so that where possible more vulnerable (e.g. residential) land uses are located at the lower risk areas of the site.

- Basement dwellings within a flood risk area can be at particular risk and therefore should be avoided where possible.

- Development and floor levels may need to be raised for safety. Development levels set above the estimated flood level (to remain dry during an event) are the safest however developments that flood can still be considered safe. FRAs should refer to the latest guidance when assessing acceptable flood depths, velocities and freeboard allowances.

- Safe access is a requirement stated in PPS25. Dry vehicular access is preferable, although pedestrian and flooded access may also be acceptable provided it is safe. FRAs should refer to the latest guidance when assessing acceptable flood depths, velocities and freeboard allowances.

- The potential impact of residual risk events (high intensity rainfall events) should be analysed and proposed information should be designed so that it is not harmed by surface water or land flooding episodes.

Developments can increase flood risk elsewhere through three main flood mechanisms:

- Increase in surface water runoff

- Loss of flood plain storage

- Impacts on flood flow routes

FRAs should demonstrate that the development will not adversely impact on flood plain storage or flood flow routes, and that where necessary competent mitigation measures are provided. SuDS systems should be employed to manage surface water runoff, according to the system priority as set out in the User Guide. Alternatively, surface water management should be in accordance with a relevant SWMP.

FRAs should provide evidence that the possibility of reducing flood risk through the development has been considered. This could be by providing additional flood plain storage to enhance the existing capacity, reducing surface water runoff below existing levels and replacing more vulnerable land uses with less vulnerable land uses. The FRA should provide justification why it is not possible to reduce flood risk if this is the case.

Flooding from sewers (and the ‘backing up’ of the sewer network when the river is in flood) should be managed by the development control process. Further collation of all relevant data, such as sewer capacity, past events and consultation with water companies and operating authorities should be undertaken when preparing site specific flood risk assessments, particularly for extensive development.

Guidance on the preparation of FRAs

The Flood Risk Assessment (FRA) will be required to demonstrate that flood risk to the development and from the development can be managed now and in the future. Planning applications for development proposals of 1 hectare or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3 require a FRA.

The FRA is required whether the site is a windfall site or an allocated site (i.e. in the Local Plan). Furthermore, a FRA is still required if a site has been subject to a sequential test and, if necessary, an exception test. FRAs should consider all sources of flooding and where appropriate, mitigation measures and should evaluate conditions for the proposed lifetime of the development so that climate change effects are considered. Where risk of flooding from sources other than the sea or rivers has been identified such as groundwater or surface water flooding the FRA needs to consider the risk of flooding at the site. FRAs should also consider the impact of the development on flood risk elsewhere. Residual risks should also be assessed.

The SFRA User Guide (Volume II of the Level 1 SFRA) contains detailed advice on the scope of the FRA (section 5.3) and advice for developers in undertaking the FRA (section 5.2).

The scope of the FRA should always be consummate with the scope and scale of flood risk, the scope should be determined in consultation with the Environment Agency and B&NES at the earliest opportunity. The scope must always include a statement of the existing flood risk, details of the proposed development, a statement on the flood risk management measures and their affects upon the baseline risk and finally a statement of residual risk. Consideration must always be given to both the site, and potential off site impacts.

PPS25 advocates a three tiered approach to undertaking a FRA (Table 2.3, 2.4) that is presented in CIRCA publication C624 Development and Flood Risk – guidance for the construction industry. The three tiers are;

- Screening study
- Scoping study
- Detailed study

More details of the scope of each study can be found in the PPS25 Practice Guide.

Screening study in Keynsham

The screening study for Keynsham is captured in the content of this document, and the Level 1 SFRA for B&NES. These documents define the Flood Zones, and in doing so the areas where there are further flooding or surface water issues that warrant further consideration. Furthermore, the site specific assessments presented in the annex to the User Guide (volume I of the level 1 SFRA) include screening studies for specific sites identified in the B&NES adopted local plan.

All sites greater than 1.0ha in size, even if located in an area with a low probability of flooding, are required to prepare a flood risk assessment that considers the implications of increased runoff rates from the site.

Scoping studies in Keynsham

According to Table 3.5 in the PPS25 Practice guide, the Scoping study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased run-off.

The scoping study should explore and assess whether there is sufficient existing quantitative information to undertake an appropriate FRA. The assessment should be based on the existing information presented in the full Level 1 SFRA for B&NES, and other documents listed in Table 3.6 of the PPS25 Practice Guide.

Preparing a FRA at this stage assumes that no new data is required. FRAs prepared for Keynsham, should pay particular attention to;

- the source and certainty of information as outlined in the Technical Report;

- variation of river flood depth, velocity and climate change information (Maps A1 and A2);
- design flood levels (as advised by the Environment Agency);
- the availability of a safe and dry access routes (safe) (Map F);
- whether the site may be at risk of reservoir flooding (Map R);
- whether the site may be affected by "backing up" of the sewer system when water levels on the River Chew or River Avon are high; and
- consideration of which SuDS features may be used in the development.

In any case, statements on the proposed development type and vulnerability of the intended residents and any flood risk mitigation / management measures will be required.

Detailed studies in Keynsham

According to Table 3.5 in the PP25 practice guide, a detailed study is to be undertaken if the Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. Usually this quantitative analysis will be based on extending or improving an existing flood risk model or by producing a new flood risk model where the development:

- is located in an area where the source and certainty of information is considered low;
- is located within 50m of an area already identified with a higher probability of flooding (following an assessment of the local topography);
- lies within the area at risk of flooding from failure of Chew Valley reservoir;
- is located within 100m upstream or downstream of a sluice gate; and
- is located in an area identified as a critical drainage area, and in particular if it falls under a surface water management plan (SWMP).

A detailed study would usually be required if any form of flood risk mitigation / management were required (even for sites in Flood Zone 1, where a Greenfield runoff calculation is usually made in preparation for the design of suitable sustainable urban drainage and / or compensatory storage).

Guidance on the use of Sustainable Drains Systems (SuDS)

Flooding from rivers, sewers, and surface water is likely to increase throughout B&NES in the future as a result of climate change. However in addition to this the impact of new development on flood risk needs to be considered, both at the new development site and existing developments within the catchment. SuDS aim to control surface water runoff as close to its origin as possible, before it is discharged to run over the surface, into a watercourse or sewer. This involves moving away from traditional piped drainage systems towards softer engineering solutions which seek to mimic natural drainage regimes.

Section 2-15 to 2-18 of the technical report in the Level 1 SFRA contains detailed documentation on what SuDS are, what options exist and their relative sustainability in terms of flood reduction, pollution reduction and wildlife / landscape benefit. A methodology for appraising the strategic suitability for SuDS as also been applied and a series of Maps (Map L2a to L2f) produced to accompany guidance on the capacity for using SuDS in B&NES, as outlined in the Level 1 assessment.

It is thought that significant areas of Keynsham and the land adjacent to the West and South could benefit from SuDS for individual properties where the ground is relatively permeable. There may also be some benefit to be realised in managing sustainable urban drainage using economies of scale, particularly for any new developments, by designing in larger community scale SuDS at the outline planning application stage.

5. Recommendations

The long term management of flood risk, from all sources of flooding, will require a multi-lateral, multi-agency approach. The following recommendations are made on the basis of the findings of this SFRA.

Understanding the sources of flood risk

1. Prior to any development being permitted on land adjacent to Broadmead Brook (east of Keynsham), the hydraulic model and in particular survey data of the model should be improved to provide a more accurate account of Flood Zones in that area.

2. Prior to any development being permitted on land adjacent to Charlton Bottom a detailed flood risk assessment should be undertaken to provide a more accurate account of Flood Zones in that area.

3. Flooding from the sea is not expected to present a significant risk to Keynsham now or in the near future. However, climate change may increase the tidal limit of the Lower Avon. As such, the design and management of river flooding around Keynsham should include a joint probability assessment of tidal and river flooding. For example, a situation where there is high flow on the River Avon at the same time as high water levels on the Severn Estuary. This should be considered in any flood mitigation work or flood risk assessments within the lower reaches of the Avon.

4. Bristol Water and B&NES advised that inundation maps have been produced for the reservoirs in B&NES, but they were not available due to security reasons. It is important that these inundation maps use the latest technology and reflect the wide range of potential scenarios for reservoir failure and blockage on the River Chew. Serious consideration should be given as to whether it is in the greater public interest to make this information available.

5. Further assessment is required of the potential of sewer / surface water flooding in Keynsham. This should consider the potential impacts of increased runoff from new developments south of the urban area, and the impacts of locked-outfalls in the development sites adjacent to the River Chew and Lower Avon.

6. Any new infill development proposed along the River Chew should consider the potential flood risk associated with lack of maintenance on reinforced banks, lack of desilting near the Keynsham bypass and failure to open the sluice gates during a flood.

7. A cover note should be added to the Level 1 SFRA report to outline the amendments that have been made to the Level 1 maps (as a consequence of this Level 2 Assessment) and explain that the Level 1 SFRA report has not been updated.

8. Site specific flood risk assessments should include an assessment of flood hazard[2] using both depth and velocity information for development proposed within the floodplain of Keynsham.

9. B&NES to prepare/commission a 'Sequential Test' report which provides an assessment of food risk at potential allocation sites, site-specific policy recommendations, and site-specific flood risk assessment guidance.

10. B&NES to prepare/commission a 'Scoping Report' for flood risk management to identify potential options for managing flood risk in key areas, and provide an outline assessment of these options.

11. Environment Agency to include revised flood extent along Charlton Bottom watercourse in their Flood Zone dataset.

[2] As defined in the Environment Agency/Defra (2006) "Flood Risk to People Guidance Document" Technical Report TR2321

Managing flood risk today

12. B&NES and the Environment Agency should continue to work together to ensure that all properties at risk of flooding in Keynsham are signed up to the Environment Agency Flood Warning Service.

13. A new flood risk/drainage officer to be appointed in B&NES and funded by new development.

14. Formalise current inspection, maintenance and operational procedures for the reinforced banks, sluice gates and dredging on the River Chew.

Managing flood risk in the future

15. Prepare a surface water management plan in Keynsham, considering flood risk from existing sewer systems and the additional pressures placed due to new development. This should consider the potential impacts of climate change and have a strong link to water cycle strategies. The SWMP should cover infrastructure improvements in the town centre, other low-lying areas (including the historic flow path west of Charlton Road) and the potential impact of new development to the south and south east of the town.

16. Undertake a detailed flood risk assessment on the River Avon to determine the potential impacts of climate change within the two sites of search.

17. Consider the potential for removing the bank reinforcement and sluice gates, and modifying desilting activities along the River Chew to achieve a more sustainable system in the longer term.

18. Review the capacity of the Fire Rescue Services to respond to residual risk events.

19. Ensure that any critical civil infrastructure that is implemented remains operational during residual risk events.