City of Bradford Metropolitan District Council Strategic Flood Risk Assessment

Level 1

February 2011
(amended February 2014)

FINAL DRAFT REPORT

JBA Consulting
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
UK
t: +44 (0)1756 799 919
f: +44 (0)1756 799 449
www@jbaconsulting.co.uk

City of Bradford Metropolitan District Council
Jacob's Well
BRADFORD
West Yorkshire
BD1 5RW

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REVISION HISTORY

Revision Ref./ Date Issued	Amendments	Issued to
1st Draft Level 1 Report February 2009		Jane Scott (Bradford MDC) 1 electronic copy
1st Draft Level 1 Report July 2009		Sam Kipling, Gary Cliff (EA) 1 electronic copy
Draft Level 1 report – Chapters 2 to 10 August 2010 (Provided for BMDC to assist in drafting policies for LDF.)	Report incorporated responses to EA comments on July 2009 report.	Jane Scott (Bradford MDC) 1 electronic copy
Interim Draft Level 1 Report - Provided to BMDC for internal review of available sections for their LDF timetable. Feb 2011	Report revised in response to EA comments on July 2009 Draft. Guidance sections restructured an updated.	Jane Scott (Bradford MDC) 1 electronic copy
Final Level 1 report – September 2013	Report incorporating comments from Jane Scott (BMDC)	Jane Scott (Bradford MDC) 1 electronic copy
Revised Final Draft Level 1 report February 2014	Revised report including comments from Environment Agency (November 2013) requested by Jane Scott (February 2014)	Jane Scott (Bradford MDC)

CONTRACT

This report describes work commissioned by City of Bradford MDC under the consultancy agreement dated 13 November 2008. City of Bradford MDC's representative for the contract was Jane Scott (Planning). Helen High, Zdenka Rosolova, Joanne Harvatt, Ian Gaskell, Judith Stunell and Mike Williamson of JBA Consulting carried out the work.

Prepared by: ..... Helen High, BSc, PhD, FRGS. CGeog
Senior Analyst

Prepared by: ..... Judith Stunell, BSc, PhD, CWEM, CEnv
Principal Analyst

Reviewed by: ..... Steve Rose, BSc MSc C.Geog (Hydrol) FRGS
Principal Analyst

Reviewed by: ..... Jonathan Cooper BEng MSc CEng MICE MCIWEM MIoD DipCD
Divisional Manager

PURPOSE

This document has been prepared solely as a Level 1 Strategic Flood Risk Assessment for City of Bradford MDC. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

ACKNOWLEDGMENTS

JBA would like to thank all those people who provided information and data for this report including staff at Bradford MDC, the Environment Agency and the Pennine Water Group.

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EXECUTIVE SUMMARY

The Bradford SFRA Level 1 update has been ongoing since 2008. Draft versions of sections of the report have been provided to the council (in August 2010) to assist in drafting policies for the LDF and reissued as a draft in February 2011. BMDC officers reviewed this and an interim draft was provided in September 2013 to assist with development of planning policy. This amended version was provided in February 2014 following Environment Agency review.

It must be noted that this work was carried out pre-National Planning Policy Framework (NPPF) implementation in 2012. NPPF replaces PPS 25 and all other planning policy statements though essentially follows the same principles and guidelines as PPS 25. The report has been updated to reflect these changes in national policy. As of February 2014 the PPS 25 Practice Guide is still to be used alongside NPPF and the NPPF Technical Guidance document, this is due to be incorporated into the technical guidance and users of the SFRA should ensure that they are using the relevant guidance document in the future.

An SFRA may potentially be used by people with a diverse background and range of expertise. The report can be divided into several sections:

- **Background to study and overview of flood risk concepts** – Sections 1 and 2
- **Flood Risk in the Bradford MDC area** – section 3
- **Overview of NPPF and its application in Bradford** – Sections 4, 5, 6 and 7. These summarise relevant parts of NPPF and its technical guidance for strategic planners, development managers and developers. As of February 2014 they should be used in conjunction with the relevant parts of PPS 25 and its Good Practice Guide, in future this will be incorporated into extended technical guidance. .
- **Managing flood risks** – Section 8. Overview of approaches to managing flood risk.
- **Mapping flood risk** – Sections 9
- **Conclusions** – Section 10. This section will be reviewed following the final sites analysis work by BMDC.

In addition, there are appendices outlining flood risk zones and vulnerability of development used in the sequential and exception testing process (Appendix A), the SFRA context of planning and flood risk management strategies (Appendix B) and information about Sustainable Urban Drainage Systems (Appendix C).

Key messages from the NPPF reflected in this SFRA are:

- Locate development to avoid flood risk wherever possible;
- Opportunities for management actions to avoid, substitute and/or mitigate flood risk can be taken at all levels of the planning process and for all development types in all locations;
- Only on completion of the Sequential Test should the Exception Test be used to justify allocations or developments in high risk areas. However, the Exception Test must not be used as a tool to place inappropriate development in high risk areas;
- Use a risk based sequential approach in all decision making to minimise flood risk; and
- All developments should be safe.

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ABBREVIATIONS

ABD	Area Benefiting from Defences
BAP	Biodiversity Action Plan
CFMP	Catchment Flood Management Plan
DC	District Council
CLG	Communities and Local Government
COW	Critical Ordinary Watercourse
CSO	Combined Sewer Overflow
Defra	Department for Environment, Food and Rural Affairs
DPD	Development Planning Document
EA	Environment Agency
EI	Essential Infrastructure
EU	European Union
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FZ	Flood Zone
HV	Highly Vulnerable
IDB	Internal Drainage Board
IDD	Internal Drainage District
LDD	Local Development Document
LDF	Local Development Framework
LDS	Local Development Scheme
LiDAR	Light Detection and Ranging
LPA	Local Planning Authority
LV	Less Vulnerable
MV	More Vulnerable
NFCDD	National Flood and Coastal Defence Database
ODPM	Office of the Deputy Prime Minister
OFWAT	Office of Water Services
OS	Ordnance Survey
PPG	Planning Policy Guidance
PPS	Planning Policy Statement
RFRA	Regional Flood Risk Assessment
RPB	Regional Planning Body
RPG	Regional Planning Guidance
RSS	Regional Spatial Strategy
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SuDs	Sustainable Drainage Systems
UDP	Unitary Development Plan
UHCS	Urban Housing Capacity Study
W	Water-compatible

1 INTRODUCTION

This section introduces the SFRA and confirms the study format, objectives and key outputs.

Key messages:

This SFRA reflects the requirements of NPPF and supersedes the previous SFRA dated March 2003; and

It is presented in one volume reflecting the general needs of Bradford MDC.

JBA Consulting have prepared the guidance, context, overview of flood risk in the Bradford MDC area and the SFRA GIS layers described in this report.

Bradford MDC will use this information to assess the proportion of each of their sites that is at risk of flooding.

1.1 Background

JBA Consulting was commissioned in November 2008 by Bradford Metropolitan District Council (MDC) to undertake a review of the existing Strategic Flood Risk Assessment (SFRA) and update it, in accordance with the current requirements of NPPF. Building on information already available, a Level 1 SFRA study was undertaken to identify and analyse current and future flooding issues for key locations in the Bradford MDC area to support its assessment of development allocation sites.

Key areas of work include:

- Taking account of advances in risk information from data collection and process;
- Identification of functional floodplain;
- Consideration of flooding from “other sources”; and
- A greater focus on the application of the NPPF Sequential and Exception Test.

As part of the SFRA process Bradford MDC will use the strategic flood risk information to assess the proportion of each of their sites that is at risk of flooding. This information will then be used to inform their sequential testing process.

There are considerable land use pressures for re-generation, inward investment and economic growth across the District, particularly in Bradford City Centre and the Canal Road corridor. This SFRA will inform, support and guide the Council in their strategies, policies and decision making for their Local Development Framework (LDF) and Local Development Documents (LDDs) including the Area Action Plans (AAPs) that are proposed in the City centre.

The study was carried out according to current best practice and the requirements of NPPF, its supporting guidance and “Development and Flood Risk: A Practice Guide Companion to PPS 25 – Living Draft”.

1.1.1 Flood Risk Assessment

Flooding is a natural process and does not respect political demarcations or administrative boundaries. It is controlled by natural elements of rainfall, tides, geology, topography, rivers and streams. It is also influenced by manmade interventions such as flood defences, roads, buildings, sewers and other infrastructure. Flood risk concepts are explored further in section 2 of this report

As was seen in the summer 2007 floods, flooding can cause massive disruption to communities, damage to property and possessions and even loss of life. Therefore, it is important to avoid developing in flood risk areas in the first instance. Where this is not possible, development should be directed to areas with the lowest possible level of flood risk. Having exhausted all opportunities to direct development away from areas of flood risk then the allocation of land for development must consider the vulnerability of the proposed land use to flooding and take measures to minimise flood

risk to people, property and the environment. This is the thrust of the risk based sequential approach to managing flood risk and it is the backbone of NPPF.

Current Government policy requires local authorities to demonstrate that due regard has been given to the issue of flood risk as part of the planning process. It also requires that flood risk is managed in an effective and sustainable manner and where new development is, as an exception, necessary in flood risk areas, the policy aim is to make it safe without increasing flood risk elsewhere and wherever possible reduce flood risk overall.

The SFRA fits into a hierarchy of Flood Risk Assessments, each at an increasing level of detail that are designed to inform different stages of the planning system, from large scale assessments by the lead local flood authority to site specific Planning Applications. More background on this is provided in section 2.6.

1.1.2 The Planning Framework

The land use planning process is driven by a whole host of policy guidance at national, regional and local levels. Most of these policies are not aimed at mitigating flood risk, however there are key links at strategic, tactical and operational levels between land use and spatial planning (Regional and Local Government), and Flood Risk Management (FRM) planning (Environment Agency). These should be considered as part of a planned and integrated approach to delivering sustainable development. Table 1-1 lists relevant legislation, plans, policies and strategies. More detail on these is provided in **Appendix B**.

Table 1-1: Relevant Legislation, Plans, Policies and Strategies

Flood risk	Planning
National level	
• EU Floods Directive – EU (2007) • Flood Risk Regulations (2009) • Flood and Water Management Act – Defra (2010) • Future Water – Defra (2008) • Improving Surface Water Drainage – Defra (2008) • Making Space for Water – Defra (2005) • Learning Lessons from the 2007 Floods – Sir Michael Pitt (2008)	• The Localism Act (2011) • National Planning Policy Framework (NPPF) (2012) • Technical Guidance for the National Planning Policy Framework (2012) • Planning Policy 25: Development and Flood Risk Practice Guide – DCLG (2008) • PPS1 Delivering Sustainable Development – ODPM (2005) • Planning Policy Statement: Planning and Climate Change, supplement to PPS1 – DCLG (2007)
Regional level	
• River Aire Catchment Flood Management Plan – Environment Agency (Draft 2008) • River Ouse Catchment Flood Management Plan – Environment Agency (Draft 2008)	• Regional Spatial Strategy – the Yorkshire and Humber Plan – Yorkshire and Humber Assembly (May 2008) – abolished February 2013
Local level	
• Bradford City Centre Regeneration and Masterplanning - Alsop Masterplan (Jan 2004) • Feasibility and outline design studies for regeneration schemes in the Bradford Canal Corridor, Mirror Pool City Park and Beckside Park (referred to as appropriate in SFRA report). • Flood risk assessments for development sites (referred to as necessary in SFRA volumes)	• Replacement Unitary Development Plan (RUDP) Saved Policies (October 2008) • Emerging Local Development Framework for Bradford MDC area (to supersede RUDP)
All legislation, plans, policies and strategies were relevant as of February 2014	

1.2 Study Objectives

The Level 1 SFRA has been prepared in one volume reflecting the general needs of Bradford MDC. SFRA flood risk GIS map layers of the Council area have been provided for comparison with sites/ areas with development potential.

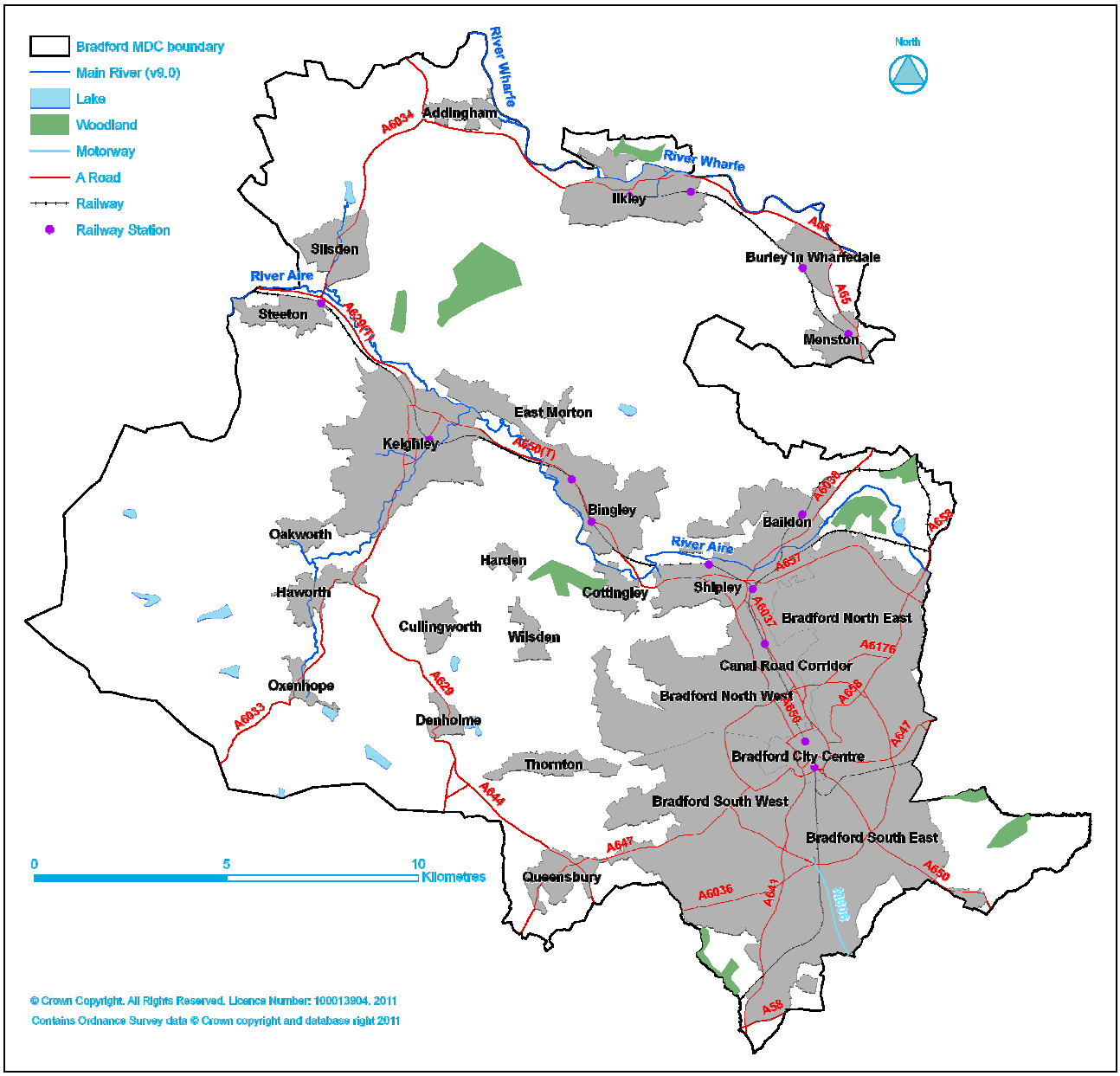
The key objectives of this SFRA are to:

- Understand the nature of flood risk from all sources – Section 2 describes general principles of flood risk and section 3 describes flood risk in the Bradford MDC area.
- Provide strategic flood risk guidance and advice to planners and developers to help them better understand flood risk and planning related issues, both generally and for specific locations across the study area (Sections 4, 5 and 6);
- Provide data and guidance in the application of the Sequential and Exception Tests for LPAs to assess specific development sites (Sections 4 and 5);
- Supplement current policy guidelines by providing guidance on flood risk assessment requirements and a risk based approach to development considerations. This is to help ensure that areas allocated for development can be developed in a safe and sustainable manner and is aimed at both councils and developers (Sections 6 and 7);
- Investigate and identify the extent and severity of flood risk to the area. This assessment will help councils/Local Planning Authorities (LPAs) to strike an appropriate balance of various sustainable development drivers and factors whilst sequentially steering development away from areas at highest risk (Sections 8 and 9 plus GIS mapping of key Flood Risk information);
- Help LPAs to identify specific locations where further and more detailed flood risk data and assessment work is required as part of a Level 2 SFRA, prior to the allocation of specific developments (Section 10);
- Contribute to the council's Strategic Environmental Assessment (SEA) and LDF. The SEA will be used to inform the council's Sustainability Appraisal (SA), which will aid the selection of suitable land allocations; and
- Be used as a reference document to which all parties involved in planning and flood risk can reliably turn to for initial advice.

1.3 Study Area

Bradford MDC is located within the River Aire and River Ouse catchments. Flood processes and flood risk issues across the Council area are inextricably linked by the Rivers Aire and Ouse plus their many tributaries. Communities in the Bradford SFRA area include the City of Bradford, Keighley, Ilkley, Bingley, Shipley and Silsden. There are a number of smaller settlements in the more rural parts of the area. The risk of flooding from rivers, surface water, sewers, groundwater, canals and reservoirs has been explored for the Bradford MDC area as part of this SFRA. This is described in Section 3 and GIS layers mapping key Flood Risks are described in Section 9 of this report.

Figure 1-1: Bradford SFRA Study Area



1.4 SFRA Update and Review

The Bradford SFRA was produced using the most up to date guidance and flood risk data; however, it is recommended that this be updated on a regular basis. Since development of the Draft SFRA the national planning policy framework has been revised, however the general principles applied to management of flood risk are similar. The Environment Agency has suggested that this is every 3 to 4 years, unless a significant flood event occurs giving rise to new information or areas at flood risk, or there are any major national policy changes.

There are a number of outputs and datasets, which are known to be regularly updated; these should be incorporated into any update of the SFRA. Table 1-2 contains a list of SFRA review triggers.

Table 1-2: SFRA review triggers

Trigger	Source	Possible Timescale
River Aire CFMP River Ouse CFMP	Environment Agency	Updated every 5 years
Flood Zones – significant change	Environment Agency	Updated quarterly
NFCDD	Environment Agency	Ongoing

Trigger	Source	Possible Timescale
Possible Flood Event	All	Unknown
Sewer Flood Data	Yorkshire Water	Unknown
Planning Policy	CLG	Unknown
Surface Water Management Plans	LPA	On completion
Multi Agency Flood Plans	Local Authority	Ongoing

2 UNDERSTANDING FLOOD RISK FROM ALL SOURCES

This section provides an introduction to flood risk including: Sources of flood risk, the impact of flooding on people property and the environment, the likelihood and consequences of flooding and an overview of flood risk assessment.

Key messages:

Flooding can result from many different sources;

Flood risk is increasing due to the impacts of climate change;

Continuing to build and improve flood defences will become increasingly more costly and difficult to achieve in the future;

The focus of activity and effort needs to move from flood defence to flood risk management

2.1 Introduction

Flooding is a natural process and can happen at any time in a wide variety of locations. It constitutes a temporary covering of land that is not normally covered by water and is a risk to people, human and environmental assets are present in the area that floods. Assets at risk from flooding can include housing, transport and public service infrastructure, commercial and industrial enterprises, agricultural land and the environmental and cultural heritage.

Climate change predictions are that flood risk will increase. This is due to more frequent and severe storms bringing higher intensity rainfall and increasing run-off from land and buildings. This will cause rivers and streams to experience higher than normal flood flows and levels, and sewers and drains to surcharge more frequently than at present. The focus of activity in meeting these challenges will in future be on flood risk management as opposed to simply providing flood defences. It is now widely recognised that whilst we cannot always prevent flooding occurring we can manage the risks of it happening and reduce the consequences when flooding does happen.

All operating authorities (Environment Agency, Local Authorities, Internal Drainage Boards), should embrace effective flood risk management issues and actions, and aim to reduce flood risks through a variety of measures including:

- Ensuring planning activities locate vulnerable land uses away from high flood risk areas;
- Providing flood warning and emergency planning activities in flood risk areas;
- Generally raising awareness of flood risks amongst vulnerable communities;
- Constructing and maintaining appropriately designed surface water sewers and culverts;
- Using temporary and demountable flood defences and various flood prevention systems to buildings where appropriate;
- Constructing new flood defences where they are sustainable, and improving and maintaining those already existing and;
- Constructing appropriate weirs, sluices and other flood flow control/management structures.

Pro-active land use planning has a key role to play in flood risk management. Land Use planning can result in the avoidance of flood risk as opposed to other activities that can only reduce it. Effective flood risk management through the planning system is achieved through a hierarchy where **Avoidance** of inappropriate development in high risk zones must take priority, before **Substitution** of lower vulnerability uses and **Control** through flood risk management measures such as flood defences, sustainable drainage systems (SuDS) and appropriate design are considered where avoidance is not possible. Only if avoidance, substitution and control are not possible, should **Mitigation** of the risks be considered. Flood risk assessment at all levels of planning and for all

major developments is critical to inform decision making by planners and developers. This is explained further in sections 7 and 8 of this report.

2.2 Sources of Flooding

Flooding can occur from many different and combined sources and in many different ways. Different types and forms of flooding present a range of different risks and the flood hazards of speed of inundation, depth and duration of flooding can vary greatly. See Figure 2-1 below.

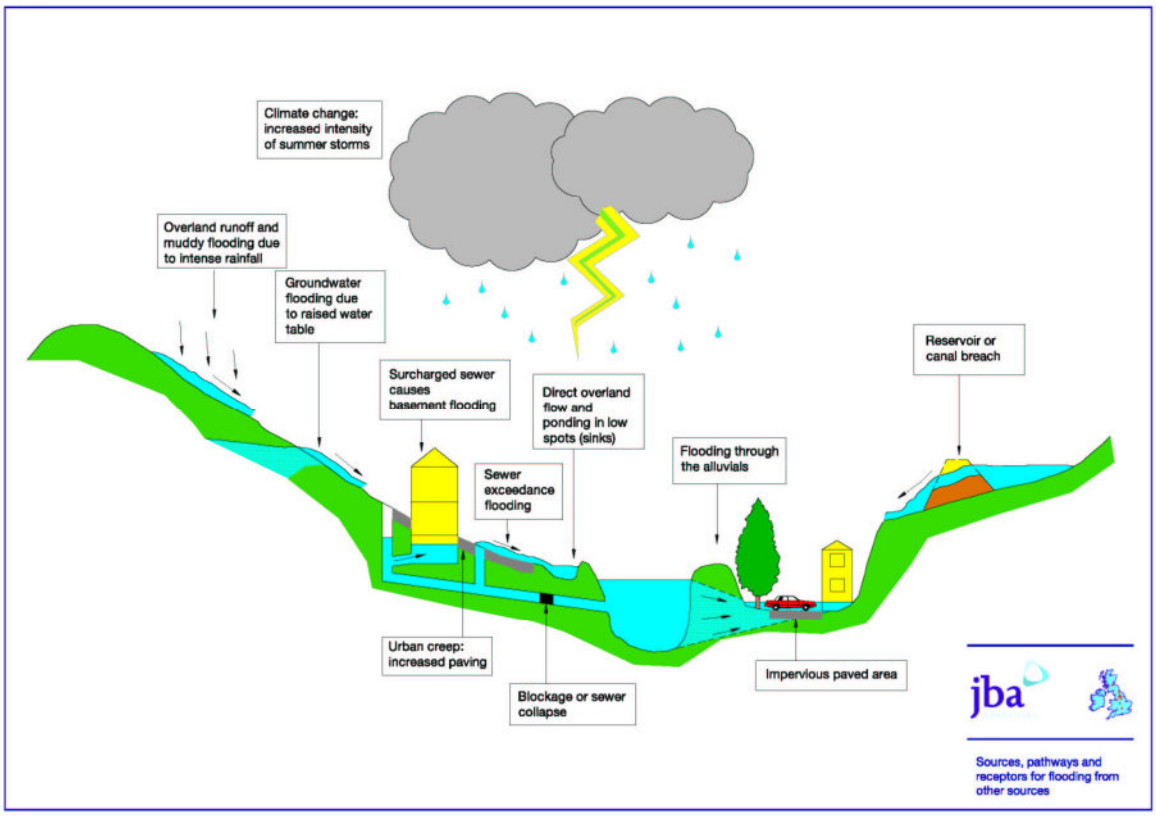
With climate change, the frequency, pattern and severity of flooding is expected to change and become more damaging.

Major causes of flooding are:

- Coastal flooding is caused by higher sea levels than normal resulting in the sea overflowing onto the land;
- Inland flooding is caused by prolonged and/or intense rainfall resulting in excess water flowing overland, ponding in natural hollows and low-lying areas or behind obstructions;
- River flooding occurs when the capacity of a watercourse is exceeded or a channel is blocked and excess water spills out from the channel onto adjacent low-lying areas (the floodplain);
- Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its discharge capacity, it becomes blocked or it cannot discharge due to a high water level in the receiving watercourse;
- Groundwater flooding occurs when the level of water stored in the ground rises as a result of prolonged rainfall to meet the ground surface and flow out over it;
- Estuarial flooding may occur due to a combination of tidal and fluvial flows, with tidal levels being dominant in most cases; and

A less frequent form of flooding arises from the failure of infrastructure designed to store or carry water (e.g., the breach of a dam, a leaking canal, or a burst water main), or to protect an area against flooding (e.g., breach of a flood defence, failure of a flap valve or pumping station or blockage of a pipe or culvert). Because of the sudden onset, the impacts of this form of flooding can be severe.

Figure 2-1: Flooding From All Sources



Prior to the major flood events in summer of 2007, non Main River flooding was based on anecdotal evidence or described with Critical Ordinary Watercourse (COW) investigations undertaken by the Environment Agency. Little data could be abstracted from the water companies on sensitive drainage catchments where runoff impacts of new development could be significant on combined sewer systems. However, a significant proportion of recent flood insurance claims are due to flooding from non main river sources, so this issue is likely to become more important in the future.

Historically the adopted approach in many SFRAs has been not to consider other sources of flooding as a spatial or strategic issue. Through good design and attenuation of drainage inputs to sensitive watercourses, mitigation was the accepted way forward.

Summer 2007 provided a stark reminder that the significance of capacity exceedance of artificial and natural drainage systems can be severe for many communities. This provided a clear reminder that flooding from all sources should be scoped into a SFRA, and that new methods of rapid screening of these risks are required. The Pitt review into the 2007 floods recommended that the Environment Agency should proceed in developing a map of these sources and surface water and groundwater maps were published in 2008.

Increases in flooding affecting people and property, due to development can be caused:

- Upstream by restricting the capacity and conveyance function of the watercourse and floodplain system;
- Downstream by decreasing the volume available for flood storage on the floodplain, altering flow routes on the floodplain or by changes to the channel which can increase the flow discharged to downstream locations; and
- By increasing run-off from reduced permeability surfaces, such as roads, roofs and car parks.

2.3 Flooding Impacts on People Property and the Environment

2.3.1 Flooding Impacts on Property

Flooding impacts on property can cause severe damage. Flood water is likely to damage internal finishes, contents, electrical and other services and possibly cause structural damage. The physical effects can have significant long-term impacts, with re-occupation sometimes not being possible for over a year. The costs of flooding are increasing, partly due to increasing amounts of electrical and other sophisticated equipment within developments. Flooding Impacts on People

Impacts on people can be severe. In small urban or steep upland catchments which have a very rapid response to rainfall, or with flooding due to infrastructure failure, flood waters can rise very quickly and put life at risk. Even shallow water flowing at 2 metres/second can knock children and many adults off their feet and vehicles can be moved by water of 300mm depth. The risks rise if the flood water is carrying debris. The impact on people as a result of the stress and trauma of being flooded, or even of being under the threat of flooding, can be immense. This also extends to whole communities. Long-term impacts can arise due to chronic illnesses and stress. Flood water contaminated by sewage or other pollutants (e.g. chemicals stored in garages or commercial properties) is particularly likely to cause such illnesses, either directly as a result of contact with the polluted flood water or indirectly as a result of sediments left behind.

2.3.2 Flooding Impacts on Transport Infrastructure

Impacts on transport infrastructure can include flooding of major and minor roads, motorways, railways and bridges. Flooding can cause damage to infrastructure as well as delays to travellers with road closures and diversions required while flood water subsides and / or remedial works are carried out.

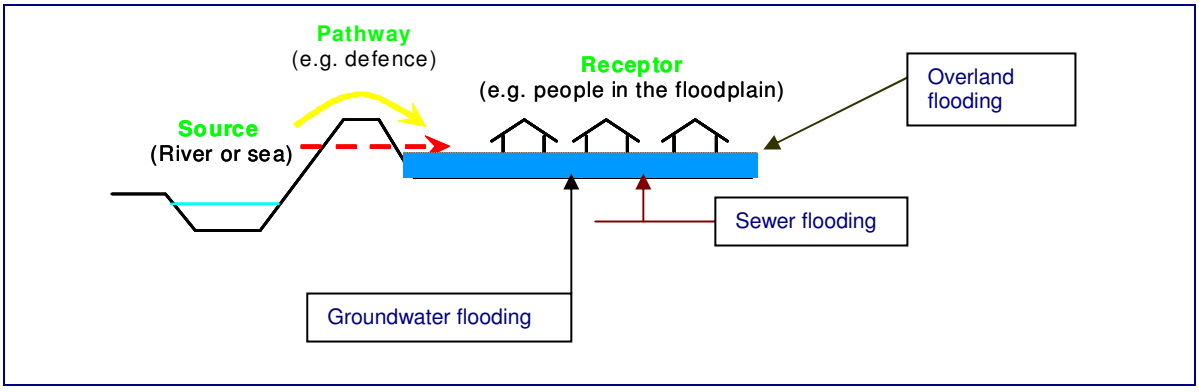
2.3.3 Flooding Impacts on the Environment

Environmental impacts can be significant and include soil erosion, bank erosion, land sliding and damage to vegetation as well as the impacts on water quality, habitats and flora and fauna caused by bacteria, pathogens and other pollutants carried by floodwater.

2.4 Flooding Likelihood and Consequence

Flood risk is generally accepted to be a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the **source – pathway – receptor** model as shown in Figure 2-2 below. This is a standard environmental risk model common to many hazards and should be starting point of any flood-risk assessment. However, it should be remembered that flood risk could occur from many different sources and pathways and not simply those shown in the simple form below.

Figure 2-2: Source – Pathway – Receptor Model



The principal **sources** are rainfall or higher than normal sea levels, the principal **pathways** are rivers, drains, sewers, overland flow and river and coastal floodplains and their defence assets and the **receptors** can include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation measures have little or no effect on sources of flooding but they can block or impede pathways or remove receptors. **The planning process is primarily**

concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk.

It is important to define the components of flood risk in order to apply this guidance in a consistent manner. Flood risk is a combination of the likelihood of flooding and the potential consequences arising.

2.4.1 Likelihood

Likelihood of flooding is normally expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% probability indicates the flood level that is expected to be exceeded on average once in 100 years, i.e. it has a 1 in 100 chance of occurring in any one year.

2.4.2 Consequence

Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development , nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc).

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

Flood risk = Probability of flooding x Consequences of flooding

Vulnerability of development to flooding depends on the nature of the development, its occupation and the construction methods used. A sheltered housing complex would be more vulnerable than a retail unit. A broad classification of vulnerability is contained in Table 1 of NPPF Technical Guidance) and Appendix A: -of this report and a key objective of the spatial planning process is to avoid flood risk to an inappropriate land use. NPPF

Transport and strategic utilities infrastructure can be particularly vulnerable to flooding because interruption of their function can have widespread effects well beyond the area of flooding. For example, flooding of primary roads or railways can deny access to areas for the duration of the flooding, as well as causing damage to the road or railway. Flooding of water distribution infrastructure such as pumping stations or of electricity sub-stations can result in loss of water or power over large areas. This can magnify the impact of flooding beyond the immediate community and reinforces why decisions to locate development in the floodplain should be taken very carefully.

Further consideration of flood risk is contained within Section 8 and 9 of this report.

2.5 Climate Change

Climate change impacts continue to provide an increasing challenge to sustainable flood risk management for government and operating authorities. The severe flooding experienced across the country in recent years and in particular during the summer of 2007 were, in the words of Sir Michael Pitt, “a wake up call”.

Flood risk related climate change issues are extremely important to the future management of flood risk in the UK and beyond. These issues need to be taken seriously and mitigation and adaptation measures planned and adopted by Local Authorities.

Principle adverse flood risk effects of climate change threatening people and property include:

- More frequent and intense rainfall events causing flash flooding to low lying areas;
- More and faster surface water runoff and overland flows causing sewers, drains, rivers and streams to overflow;
- Increased sea level rise, storminess and frequency of storm surges threatening low lying coastal communities; and
- Rising groundwater levels causing increased spring source activity and higher spring flows increasing the risk of flooding.

If not addressed, these effects are likely to have a significant impact on many communities and in particular new developments in areas at high risk of flooding.

2.6 Flood Risk Assessment

Understanding flood risk enables a suitable flood risk assessment to be carried out. These may be regional, strategic or site specific. This tiered approach ensures that the level of information is appropriate to the scale and nature of the flood-risk issues and the location and type of development proposed, avoiding expensive flood modelling and development of mitigation measures where it is not necessary. The main levels of assessment comprise:

- Regional Flood Risk Appraisal (RFRA) – a broad overview of flood risk issues across a region to influence spatial allocations for growth in housing and employment as well as to identify where flood risk management measures may be required at a regional level to support the proposed growth;
- Strategic Flood Risk Assessment (SFRA) – an assessment of all types of flood risk informing land use planning decisions. This will enable the LPA to apply the Sequential Test in NPPF and allocate appropriate sites for development, whilst identifying opportunities for reducing flood risk; and
- Site Specific Flood Risk Assessment (FRA) – site or project specific flood risk assessment to consider all types of flood risk associated with the site and propose appropriate site management and mitigation measures to reduce flood risk to and from the site to an acceptable level.

In a plan-led system, implementation of the sequential risk-based approach requires that forward planning policy decisions in LDFs/LDDs are guided by information on flood risk to ensure that allocating inappropriate development does not unnecessarily raise expectations of landowners and developers. This should be achieved through the use of RFRAs and SFRAs, which are generally broad-brush assessments of the risk of flooding, to guide strategic planning decisions. They involve the collection and collation of data on flooding and flood-risk management from all available sources to provide information to the necessary level of detail to allow decision-makers to:

- Prepare appropriate policies for flood-risk management within LDFs;
- Produce a strategic understanding of the scale, extent and nature of the flood risk at a community level and how that would alter with any proposed development;
- Apply a risk-based, sequential approach, providing risk data to inform the Exception Test and to confirm the compatibility between the flood risk vulnerability of the proposed development areas / sites and the Environment Agency Flood Zones;
- Inform the strategic environmental assessment of LDFs;
- Translate the national guidance into locally specific guidance, including the identification of areas of floodplain that should be safeguarded for flood management purposes
- Identify the level of detail required for site-specific flood-risk assessments in particular locations; and
- Determine the acceptability of flood risk in relation to emergency planning capability and how the existing and proposed community would respond to a flood event.

2.7 Roles and Responsibilities in Relation to Flood Risk

The Local Planning Authority (LPA) is responsible for carrying out a Strategic Flood Risk Assessment. A range of staff within the local authority have a role in addressing flood risk including planners, drainage engineers, highways officers and emergency planners.

Spatial planners are responsible for following a sequential approach to decision making in relation to identifying sites for development; this means avoiding risk, substituting lower risk land uses and as a last resort controlling and mitigating risk. Flood risk needs to be a key factor in relation to the spatial distribution and vulnerability of development.

Development management planners, working within the LPA, are the main decision-makers in relation to applications for new development. The Environment Agency assists the planning and development management process through the provision of information and advice regarding flood risk and flooding related issues. Development management planners must assess whether the development is sound in relation to flood risk i.e. whether it has passed the exception test where applicable and that it is supported by a coherent flood risk assessment that meets requirements.

The role of **drainage engineers** involves promoting and requiring flood resilient and resistant buildings and infrastructure, appropriate management of surface water and water sensitive design. They provide advice and assistance to emergency planners and development management officers within the local authority.

The role of **emergency planners** involves contingency planning for flood events, including evacuation and rescue plans and liaising with emergency services, providing flood warnings at a local level and responding to emergencies.

Landowners and developers have the primary responsibility for protecting their land against the risk of flooding. They are also responsible for managing the drainage of their land such that they do not adversely impact upon adjoining properties.

The Environment Agency has a statutory responsibility for flood management and defence in England and has a strategic overview of all forms of flooding. The Environment Agency is responsible for delivering sustainable flood management solutions and for working with other partnership bodies, including local authorities, to achieve solutions. They are the competent authority for the Water Framework Directive, produce Catchment Flood Management Plans and aim to assess how land management practices can deliver flood risk management benefits.

Yorkshire Water are responsible for the public sewerage system and for water supply. As the local water company, they must investigate flooding from sewers and carry out improvement and/ or maintenance where appropriate and affordable, in accordance with guidance from Ofwat (The Water Services Regulation Authority).'

3 FLOOD RISK IN BRADFORD MDC AREA

This section contains information and guidance on: the Aire and Ouse catchments; flood risk issues from different sources; identification of watercourses; and historical flood events.

Key messages:

Significant lengths of rivers and watercourses exist in the study area which can give rise to flooding problems;

Whilst many urban areas are outside the flood plain some built up areas are at risk of flooding from a number of different sources;

SFRA Flood Risk Maps provide a valuable starting point in considering flood risk as a material consideration in land use planning decisions;

Detailed FRAs need to explore the condition and longevity of flood defences thoroughly; and

Close liaison should be maintained with the Environment Agency to always ensure specific FRM data and information used is the latest and most recent available.

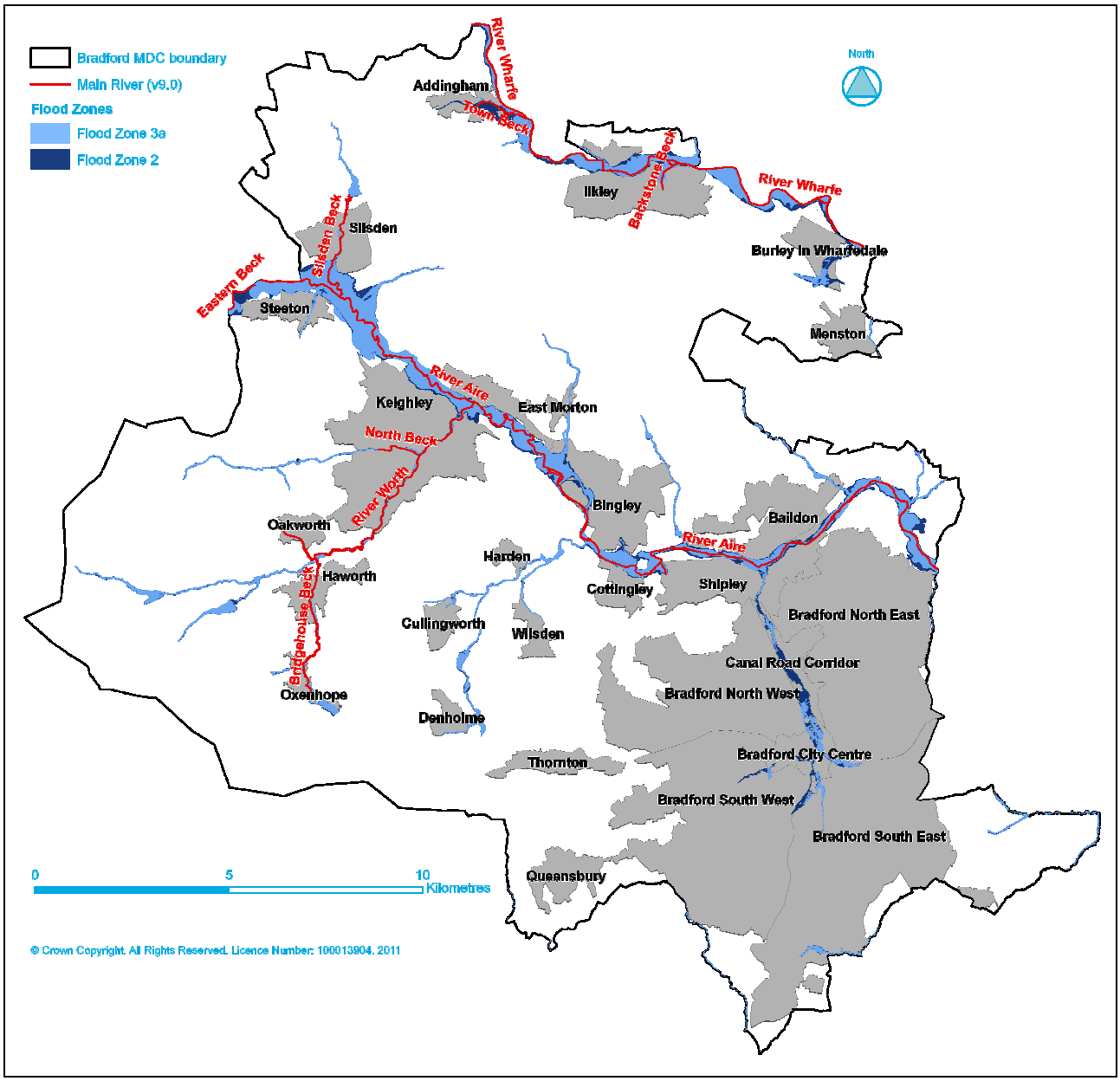
3.1 Introduction

Flooding can occur from many different sources further detail can be found in section 2 of the SFRA. NPPF requires that all of these flood risks are considered at all stages of the planning process. The Aire and Ouse catchments all have their own unique characteristics and flooding issues that are relevant to the land use planning process. This section of the report provides an overview of these factors. This is to help planners understand the location and nature of flood risk as they carry out the Sequential and Exception Tests as part of the risk-based sequential approach and when allocating proposed development sites in these catchments.

The Bradford MDC area includes the catchment areas of the River Aire and the River Ouse (small section in the north of the Bradford MDC area). The Bradford MDC area includes reaches of the following main rivers, which are shown in Figure 3-1:

Aire Catchment	Ouse Catchment
• River Aire	• River Wharfe
• River Worth	• Town Beck
• North Beck	• Backstone Beck
• Silsden Beck	
• Bridgehouse Beck	
• Eastburn Beck	
• Providence Lane	

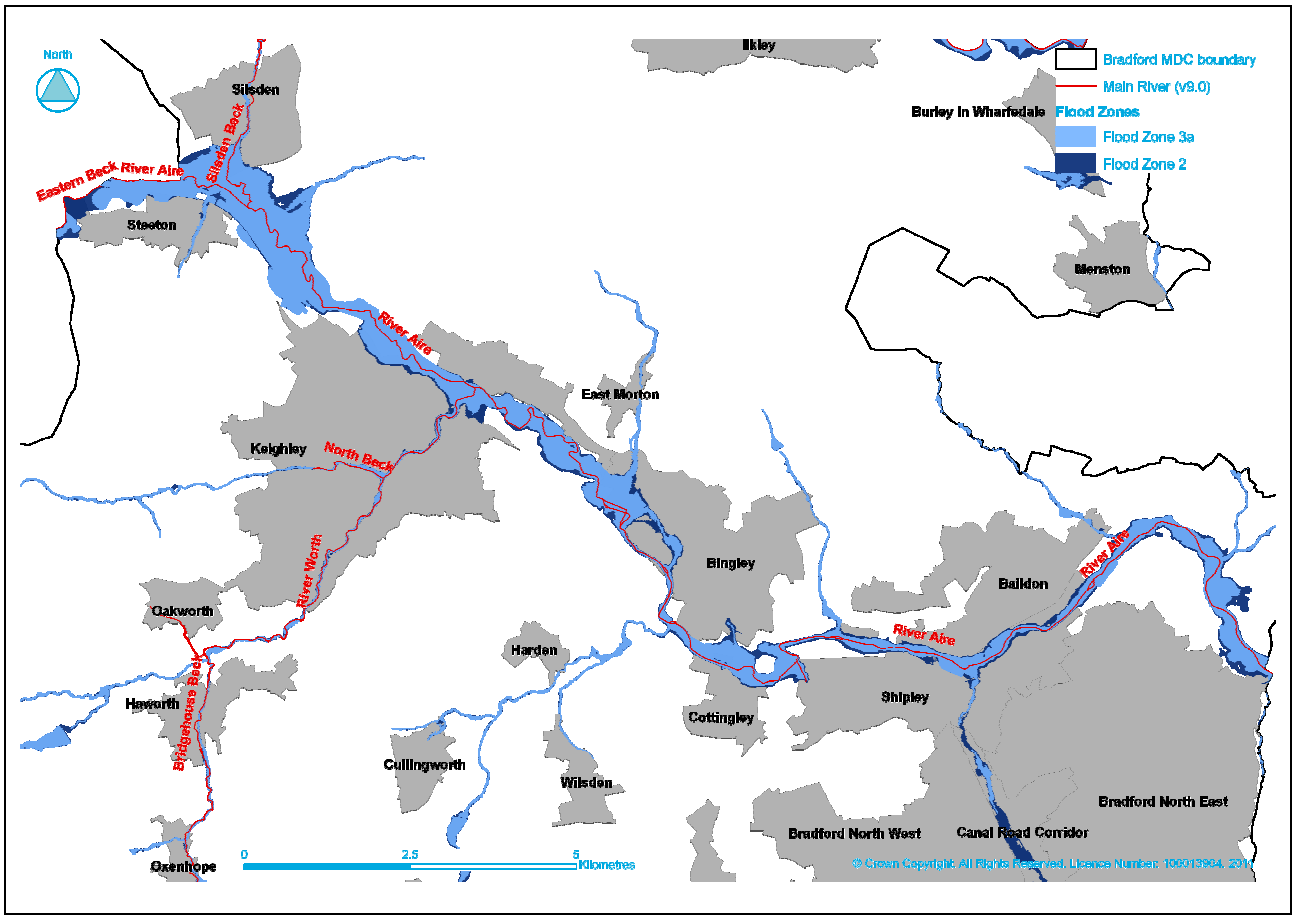
Figure 3-1: Main Rivers in the Bradford MDC Area



The key catchment characteristics and flooding issues from different sources are discussed in sections 3.2 (River Aire) and 3.3 (River Ouse /Wharfe) below.

3.2 Aire Catchment

Figure 3-2: River Aire Catchment



The River Aire rises in the Yorkshire Dales near Malham at a height of around 350m above sea level and flows downstream to its confluence with the River Ouse near Goole. The River Worth is one of the larger contributing catchments and joins the River Aire at Keighley. The upper River Aire is predominately rural with small urban settlements scattered throughout the valley bottoms whilst the middle reaches of the Aire are heavily urbanised and contain the towns of Keighley, Bingley, Shipley and the City of Bradford. The urban nature of the middle reaches of the Aire results in significant restrictions to the natural floodplain due to dense development.

The headwaters of the Aire are characterised by swift-flowing upland streams that then flow through a series of former mill towns nestling in the narrow valley bottoms. The topography is generally high due to the headwaters of the river being located close to the Pennine Hills. Between Gargrave and Keighley the Aire's glaciated valley opens out to over 1km wide in many places. This forms an extensive area of floodplain, which is an important feature of the upper catchment. Between Keighley and Leeds the valley floor steepens and becomes narrower, with the valley sides restricting floodplain width from 100 to 200m.

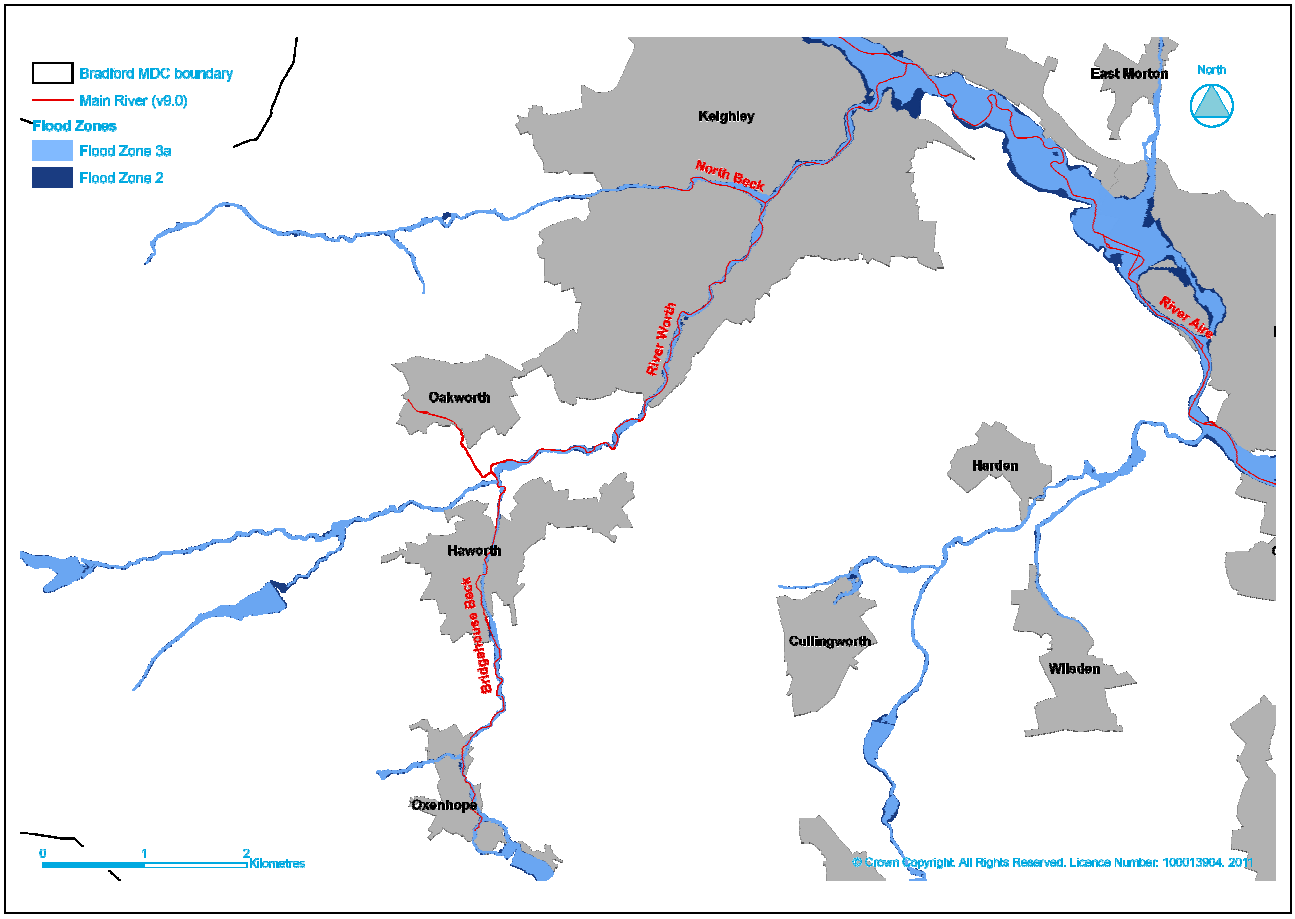
There are two flood storage areas in the form of controlled washlands in the upper Aire catchment at Skipton and Cononley. These washlands are flooded on several occasions throughout the year and significantly reduce levels during medium and high floods through Bingley, Shipley and Leeds. In some flood events, the distribution of rainfall produces high flows on the tributary catchments between Keighley and Leeds. The most urbanised catchments, like the River Worth and Bradford Beck, can react very quickly to rainfall, with a time to peak of 1 to 3 hours. These tributary flows cannot be attenuated by the washlands upstream of Keighley.

On some of the tributaries of the River Aire there is a risk of localised bank side walls collapsing. This is due to a combination of undermining by erosion and poor maintenance by private landowners. Damaged or breached walls will greatly increase the risk of flooding to properties

situated behind the affected area. Possible locations where this could occur include Silsden Beck and the upper reaches of the River Worth.

3.2.1 River Worth

Figure 3-3: River Worth Catchment



The River Worth is 6.67km in length. It flows from its source near Oxenhope through Haworth to Keighley where it joins the River Aire. The catchment area is generally urban to the east and rural in the uplands although some development has taken place within the upland valley which confines the floodplain. This situation is repeated within the urban low lands of the River Worth in Keighley. There are a number of tributaries of the River Worth. These include three 'Main Rivers', North Beck, Bridgehouse Beck, and Providence Lane covering a length of 13.3 km and 31km of 'Non Main River'.

Watercourses in the Worth catchment are largely impounded in the upper reaches by four reservoirs, including Keighley Moor, Water Sheddles, Ponden and Lower Laithe. There are a large number of washlands located in this area designed to fill from the lower end of the river and fill in a downstream to upstream pattern rather than the normal upstream to downstream pattern like the rest of the washlands in the catchment.

3.2.2 History of Flooding in the Aire Catchment

The River Aire and its tributaries (within the Bradford MBC area) have a long history of flooding, as shown in Table 3-1.

Table 3-1: Major Flood Events in Bradford MDC (Aire Catchment)

Date	Source of flooding	River/ Area Affected
December 1672	Unknown	Exact source, location and its consequences are unknown
December 1762	Unknown	Bradford. Exact source, location and its consequences are unknown
July 1768	River	Bradford. Two people lost their lives at Broadstones. Commercial damages reported
December 1790	River	Leeds and Bradford. Record of commercial damages. Exact location and consequences are unknown
January 1805	Unknown	Bradford. Exact source, location and consequences are unknown
December 1815	Unknown	Bradford. Exact source, location and consequences are unknown
December 1822	River	Meadow-Lane, Water-Lane, and Hunslet-Lane in Leeds as well as Bradford and Wakefield. One death
December 1837	River	Bradford, Thornton Road. Three lives lost
February 1838	Unknown	Bradford reported flooding. Exact location and consequences are unknown
June 1859	River	Bradford. Damages estimated as over £33,000
November 1866	River	Bradford and Leeds, exact location and consequences are unknown
May 1886	Unknown	Flooding noted on the River Aire. Exact location and consequences are unknown
July 1900	River	Bradford, Morton, Wilsden, Allerton, in Leeds, Dewsbury, Keighley, Ripponden, Wakefield and Otley. Heavy damages to residential, commercial and agricultural property. Sewage works at Frizinghall overflowed and a total of 21 lives lost
December 1909	River	Shipley. Exact location and its consequences are unknown
February 1910	River	Saltaire. Exact location and consequences are unknown
1936	River	Significant flooding observed on the River Aire at Stockbridge
1946	River	Significant flooding observed on the River Aire at Stockbridge
March 1947	River	Aire Valley. Exact location and consequences are unknown
October 1967	River	River Aire caused flooding of roads and properties in Skipton, Cononley, Earby, Apperley Bridge, Bingley, Shipley and Stockbridge
July 1968	Unknown	Bradford including subways and Guiseley. Exact source, location and consequences are unknown
April 1970	River	Tributaries of the Aire affected including Silsden Beck. Consequences are unknown

Date	Source of flooding	River/ Area Affected
October 1980	River	16 properties flooded between Skipton and Shipley. Flooding also reported at Kildwick and Bingley
1994	River	Flooding observed at Silsden from Silsden Beck
1995	River	Flooding observed at Silsden from Silsden Beck
1998	River	Flooding observed at Silsden from Silsden Beck
2000	River	Flooding observed at Silsden from Silsden Beck
October-November 2000	River	Over 300 properties flooded in area from the River Aire, and Silsden Beck including 25 in Skipton, 370 in Stockbridge, 16 in Brotherton, 7 at Shipley, 58 at Bingley, 6 at Apperley Bridge, and 105 in Gowdall. Evacuation of Keighley, Stockbridge, Mickleton, Gowdall and Snaith
February 2002	River	Flooding reported in Bingley, Earby and Goose Eye
July- August 2002	River	Properties flooded in Gargrave, Bingley, Apperley Bridge, and Holmfirth
	Surface Water	Properties flooded in Bingley, Marsden. Hospital Ward evacuated in Marsden
September 2008	River	Between 5th and 8th September, 14 flood watches and 9 flood warnings were issued. There was flooding to 36 properties. 34 properties at Flanshaw Wakefield from Alverthorpe Beck and 2 properties flooded at Castlefields on the River Aire at Shipley
Source: Chronology of British Hydrological Events; June 2000, Performance, review summary and action plan; July – August 2002 Summary Regional Report; Upper Aire Flood Risk Management Strategy (2006).		

October / November 2000 floods

The Aire catchment was already fully wetted following a sustained summer of wet weather. This precondition led to high river levels caused by the widespread and heavy rainfall across the whole catchment. The events were triggered by abnormally high rainfall sustained over a period of hours in the upper part of the main Aire valley. The high rainfall led to flows and levels in the upper Aire that were higher than any on record with return periods perhaps in excess of 100-years. As the flood peaks moved downstream they were still amongst the largest ever observed, with evidence that in the middle and lower reaches of the river only the 1946, and possibly the 1866, event exceeded them.

Table 3-2 shows the consequences of this event on communities within the Aire catchment area. As this table shows, the majority of those areas affected were flooded from river overtopping. As well as residential and commercial properties being flooded, roads were significantly affected in the upper and middle Aire valley and in Bradford. The East Coast mainline was severely disrupted and damaged, with the main line to Keighley and Skipton being flooded for several days.

July – August 2002 floods

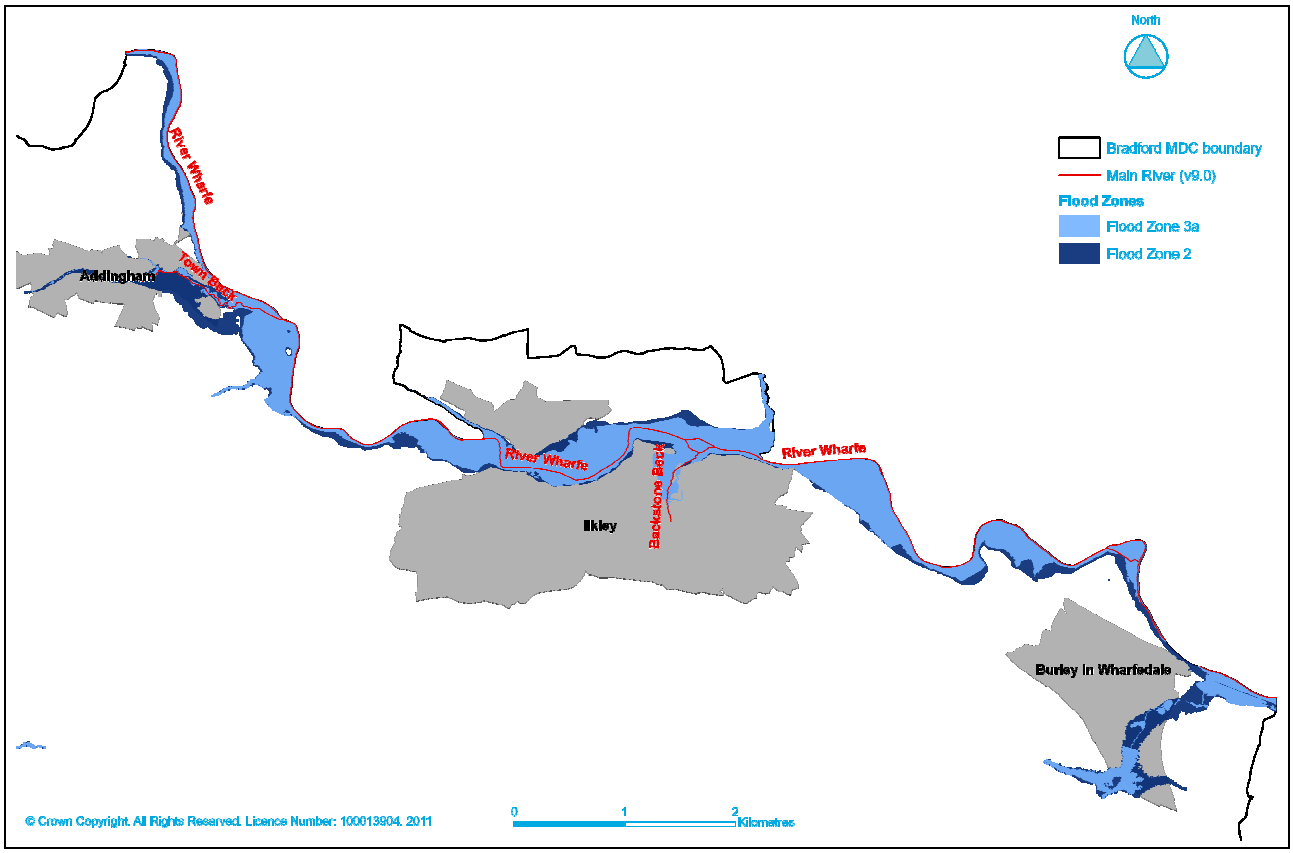
The flooding of late July / early August was caused by intense and localised rainfall generated by a series of convective rainfall events. The first storms caused relatively limited flooding problems but critically, saturated the upland parts of a number of catchments. During the second period of storms, a number of locations experienced the equivalent of two months average rainfall in two days. Due to the intensity of the rainfall the result was rapid runoff that caused flooding in the upper reaches of some catchments. A further two periods of rainfall occurred on the 7 and 10 August, when flooding was caused by surface water. Within the Aire catchment area a number of properties were flooded. However, the main impact of this event was on roads and railways. Several roads were closed on both Tuesday 30 July and Friday 2 August, due to surface water flooding.

Table 3-2: Consequences of the Autumn Floods in 2000

Location	No of properties flooded	Mechanism of flooding	Type of property flooded
Kildwick	3	River overtopping	Residential
Stockbridge, Keighley	100	River overtopping	Residential
Crossflats	6	River overtopping	Residential
Bingley	58	River overtopping	Residential

3.3 Ouse Catchment and the River Wharfe

Figure 3-4: River Wharfe Catchment



The River Wharfe is a main river and part of the Ouse catchment area. The River Wharfe rises north of Hubberholme and flows in a south-easterly direction through the towns of Grassington, Addingham, Ilkley, Collingham, Wetherby, Boston Spa and Tadcaster, where it confluences with the River Ouse north of Cawood. The gently sloping valley sides lead down to the urbanised areas in the floor of the valley. The River Wharfe is a fast reacting river with flood flow rapidly passed downstream.

There are numerous smaller streams and becks descending from the moors that can be a source of flood risk in extreme rainfall events. Tributaries of the River Wharfe within Bradford MDC area include Backstone Beck in Ilkley and Town Beck. There is a history of flooding from Town Beck, specifically where high local flows cannot be discharged when high river levels exist in the Wharfe. The beck also has a restricted capacity.

3.3.1 History of Flooding within Bradford MDC on the River Wharfe

The Table 3-3 below sets out a chronology of the major flood events to affect the River Wharfe catchment within the Bradford MDC.

Table 3-3: Major Flood Events in Bradford MDC (River Wharfe)

Date	Source	Area Affected
August 1917	Fluvial – River Wharfe	Ilkley
January 1910	Fluvial – River Wharfe	Ilkley, Otley and Tadcaster
1950	Fluvial – River Wharfe	Burley
1965	Fluvial – River Wharfe	Ilkley
1965	Fluvial – River Wharfe	Burley
1975	Fluvial – River Wharfe	Burley
1982	Fluvial – River Wharfe	Burley
1990	Fluvial – River Wharfe	Burley
July 1990	Fluvial – River Wharfe	Otley, Ilkley
1991	Fluvial – River Wharfe	Ilkley
1994	Fluvial – River Wharfe	Burley
November 2000	Fluvial – River Wharfe	Ilkley, 3 properties affected

3.4 Defended Area – Aire Catchment

There are a number of defences and structures in place to help reduce the risk of flooding within the Aire catchment area. These range from flood walls and embankments to trash screens and culverts. A breakdown of Environment Agency maintained defences found within Bradford MDC can be seen in Table 3-4. Key defended areas within the Bradford MDC include Stockbridge, Sewage Treatment Works (Aire Valley Road), Burley (Manor Park) and Saltaire. There are man-made defences located at the confluence between the Aire and the River Worth, some of which are privately owned. There are also man-made defences which are privately owned at Hirst Mill, Shipley and upstream of Bingley. There is a very small length of man-made defences in Bradford located at the confluence of Bradford Beck and the River Aire. There are no flood defences along Bradford Beck as most of the watercourse is culverted.

Though few areas within Bradford MDC are constituted as 'defended areas', flooding from the River Aire is modified by a substantial system of washlands upstream of Bradford. During periods of high flow, water spills in to these washland areas reducing maximum flood levels downstream (i.e. within residential communities). Should these areas become lost to development in future years, the frequency and severity of flooding in the Bradford MDC area is likely to increase considerably.

Table 3-4: Summary of Environment Agency Flood Risk Management in Aire catchment (Bradford MDC)

Area	Environment Agency raised man-made defence (km)	Environment Agency Maintained Channel (km)
Bradford	0.26	14.83
Millshaw		
Esholt	1.55	15.38
Shipley	1.42	28.75
Bingley		
Keighley Aire	5.31	5.88
Keighley Worth	1.80	23.33

Area	Environment Agency raised man-made defence (km)	Environment Agency Maintained Channel (km)
Silsden	17.85	22.20
Kildwick		

3.4.1 Defence Standard of Protection and Condition

There is a varying standard of protection within the Aire catchment. Around Keighley overall it is estimated as a 1.25% (1:80 yr) standard of protection. In the mid Aire and Bradford area the standard of protection is estimated to be between 2% (1:50yr) and 1% (1:100 yr).

Substantial flood damage was sustained within the Stockbridge areas during the November 2000 event as a result of structural failure of the River Aire defences. Subsequently, a considerable amount of money has been spent to reinstate and improve the standard of defence provided to residents of this community to a 1% (1:100 yr) standard of protection (completed 2002).

3.5 Defended Area – The River Wharfe

In Ilkley there are no formal defences on either bank of the River Wharfe resulting in a number of residential and commercial properties being at risk. A scheme has previously been rejected by local residents who were concerned about visual intrusion and who perceived the risk to be lower than that identified in the study.

3.6 Flood Warning Areas

There are currently 25 Flood Warning Areas within the Bradford MBC area

3.7 Localised Watercourse Flooding

Ordinary watercourses are those rivers and streams that are not designated 'Main River', and therefore the responsibility for maintenance and mitigation (where deemed necessary) falls with the local authority.

A number of the ordinary watercourses within Bradford MDC area were previously designated by the Environment Agency as 'Critical Ordinary Watercourses' (COWs). This designation reflected a known issue with respect to flooding and is generally associated with, for example, limited channel capacity, channel constrictions and/or a poor maintenance regime.

In 2006/7 the Environment Agency enmained all remaining COWs and took over responsibility for their maintenance and management. All the previous COWs are now defined as 'Main Rivers'. Bradford MDC is an overseer, requiring the riparian owners to carry out the necessary maintenance.

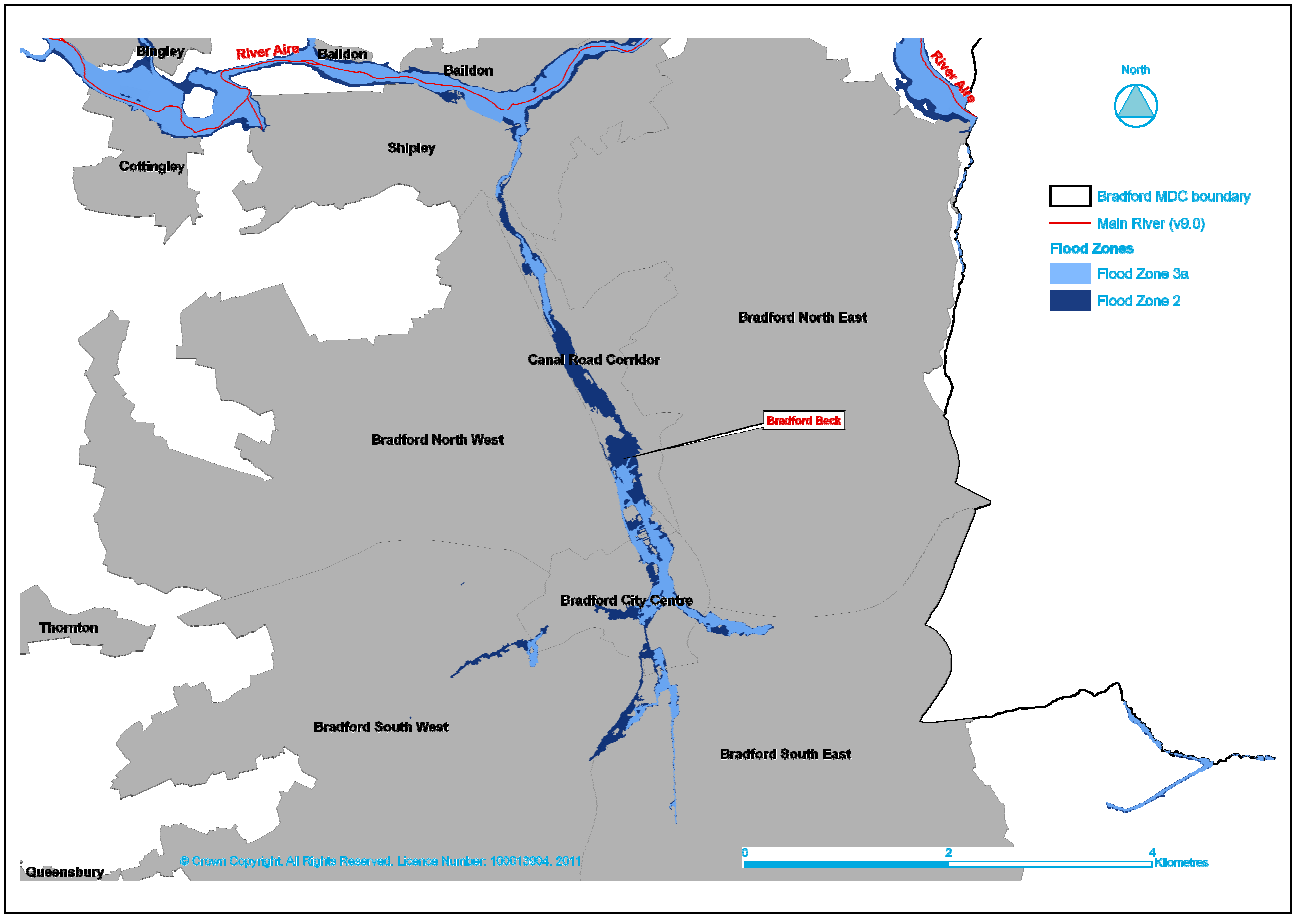
A summary of previously designated COWs within Bradford district are presented in Table 3-5 below. There are no previously designated COWs within the portion of the Bradford MDC in the Ouse Catchment.

Table 3-5: Previously Designated Critical Ordinary Watercourses

Catchment	Watercourse	Location
River Aire	North Beck	Keighley
	Bridgehouse Beck	-
	Providence Lane	Keighley
River Ouse	None within Bradford MDC area	

3.7.1 Bradford Beck

Figure 3-5: Bradford Beck Catchment



Bradford Beck is a highly urbanised catchment characterised by steep gradients and rapid response to rainfall. Bradford Beck rises to the west of Bradford and initially flows eastwards to the city centre. At the city centre it turns and flows northwards to join the River Aire at Shipley. To the west of the city centre, upstream of the diversion tunnel, most of the system is open and lies in mainly natural channels. However, downstream of the inlet to the diversion tunnel, the beck and its tributaries are, with the exception of Red Beck, heavily modified and much of the system is hidden in culverts. The implication this has on flood risk is not fully understood, including restrictions caused by blockages, incapacity and aging infrastructure. Flow information at key locations is limited with the nearest flow gauge at Shipley. The Beck is estimated to flow at a rate of 0.2-0.3 m3/s (200 to 300l/s). However this flow rate can rise substantially and quickly in response to sustained or heavy rainfall with peak flows of 0.56 m/s (560l/s) measured (Ove Arup, 2008). Bradford MDC are currently developing new modelled flood event data which takes into account both the sewer system and diversion channel and this has been used to produce SFRA flood zones in the Bradford Beck area.

The Beck runs through the City for most of its length in culvert. While the original culvert dates back over 100 years, a significant proportion has been replaced in recent times, particularly under recently built buildings and roads. Where the original culvert still exists, it is generally in a good condition and is regularly inspected. The culvert typically runs in two channels both through the original and newer sections. In several places there is a significant amount of debris, but none of the channels appear to get fully blocked (Ove Arup, 2008). In fact, Ove Arup (2008) found that in several sections there was a considerable amount of debris, resulting in an increase in depth of flow. However, there was no sign of debris at a high level (i.e. trapped on the flanges of the metal work or within the brickwork above waist height) This indicates that the flow rarely, if ever reaches the capacity of the culvert.

The Beck is known to have caused serious flooding in the city centre in the past. However with the construction of the flood alleviation tunnel in 1993, the risk of flooding has significantly reduced. Generally, water flows a few centimetres in depth but flow can rise substantially with a rise to peak

as short as 1-3 hours in response to sustained or heavy rainfall. This results in flood risk along the length of Bradford Beck and its significant tributaries which join the Beck in the city centre (all on the right bank):

- Westbrook;
- Bowling Beck;
- Eastbrook.

Downstream of the city centre, the Beck is joined by Bolton Beck, Trap Sike and Red Beck.

The typical standard of defence for the Bradford District is 1% (1 in 100yr) flood event. The Bradford Beck diversion was designed to cater for the 2% (1in 50yr) flood event with freeboard provisions enabling a 1% (1in 100yr) capacity upstream of Bradford City centre, a critical 300m culverted reach of the Beck remains beneath Canal Road which potentially limits the defence standard for the city centre to approximately 5% (1 in 20yr) flood event. A JBA study (JBA, 2005) suggests that the 'pinch' point appears to have less of an impact on the standard of flood protection than previously thought. The standard of protection was at least 50 years, probably 75 years, especially if the beneficial effects of flood storage constructed on the sewer system are taken in to account. The area with the lowest standard of protection is Perseverance Mill, just upstream of the Bradford Beck gauging station in Shipley. This is estimated to have a standard of protection of around 5-10% (10-20 years).

3.8 Surface Water Flooding

Development allocations often represent an infill into an existing urban environment. As such, the development of that allocation has the potential to alter flood risk on local watercourses and drainage infrastructure. The impact that the development may have upon the current flooding regime is varied, and is dependant largely upon the existing catchment hydrology (e.g. topography, percentage urbanised, drainage system capacity etc.).

Surface water flooding occurs where high rainfall events exceed the drainage capacity in an area and these events can lead to serious flooding of property and possessions as demonstrated by the summer 2007 floods. In addition, large amounts of surface water runoff can lead to water quality problems and potential health risks to people. These impacts can typically be mitigated through the implementation of established 'best practice' drainage techniques including Sustainable Drainage Systems (SuDS) at the planning application stage. However, in some circumstances site constraints dictate that a catchment-wide, holistic approach to surface water flood management is required through urban catchment planning and strategic consideration of the design, construction, maintenance and improvement of sewers and watercourses. Close liaison between Water Companies, Local Authorities and the Environment Agency is essential to ensure a consistent and co-ordinated approach to surface water management and this may be best achieved by the production of appropriate surface water management plans as discussed in the Pitt Review.

Some modelling of the possible surface water flooding within the urban areas for the 200 year rainfall event has been undertaken in order to provide an indication of areas where surface water will naturally flow towards and possibly pond. These areas naturally vulnerable to surface water flooding (discussed in more detail in Section 9 of this report) provide an indication of the surface water flood extent and variation in flood depths due to an extreme rainfall event.

Most common in urban areas, the shape of the local landform can result in water flowing across hard impermeable surfaces in such volumes as to cause flooding or to pond in low spots where significant volumes of water can collect resulting in localised or widespread flooding. This type of flooding can be as, and sometimes more, devastating than fluvial or tidal flooding. The topography of the Bradford MDC area, especially in and around a number of the built-up areas make them potentially prone to flooding caused by direct rainfall due to the amount of impermeable surfaces and the lack of sufficient sewer capacity.

Surface water and drainage related issues are known to cause flood risk in the following locations:

- Idle (Haigh Beck) - Residential properties affected by flooding within lower reaches. Complex combined sewer network of unknown capacity;
- Apperley Bridge (Carr Beck) - Properties affected by watercourses within lower reaches near the confluence with the Aire;
- Addingham (Town Beck) – Residential properties affected by watercourse and drainage flooding

within constrained upper reaches;

- Silsden (Silsden Beck Tributaries) - Residential properties affected by localised flooding within constrained upper reaches;
- Cross Hills on Skipton Road;
- Bradford City Centre (Bradford Beck) - High value commercial properties affected by localised flooding within the city centre. Complex combined sewer network upstream. System capacity constrained by culvert.

Surface water flooding can also occur in rural areas where either land management or the intensity of rainfall results in water running straight off fields without entering the drainage or river systems. This situation has been noted to occur in:

- Keighley;
- Castlefields industrial estate, Bingley.

Defra's Making Space for Water programme has a number of key themes, one of which is urban flood risk and integrated drainage. This project aims to test new approaches to reduce the impact of urban drainage flooding. There are 15 pilot studies aimed at investigating and developing methodologies for the production of surface water management plans being carried out throughout the country one of which is located within the Bradford MDC area within the Aire catchment.

The management of surface water flows to minimise flood risk is an important issue for all new development, therefore the drainage system must be designed so that:

- unless an area is designated to flood as part of the design, flooding does not occur on any part of the site for a 1in 30 year rainfall event.
- flooding does not occur during a 1 in 100 year rainfall event in any part of a building including basements, or any utility plant susceptible to water within the development.
- the capacity of the drainage system takes account of the likely impacts of climate change and likely changes in impermeable area within the development over the design life of the development.
- they ensure as far as is reasonably practicable, that flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed by overland conveyance routes that minimise the risk to people and property.

3.9 Sewer Flooding

To meet legal commitments set by OFWAT, water companies must keep records of sewer flooding in the 'DG5 register'. This defines internal flooding as 'flooding that enters a building or passes below a suspended floor'. External flooding is defined as 'flooding which is not classed as internal'. Properties at risk are 'properties that have suffered or are likely to suffer internal flooding from public foul, combined or surface water sewers due to the sewerage system being overloaded'. The water company must register all flooding, with the exception of that which has resulted from extreme weather conditions. Buildings normally occupied and used for residential, public, commercial, business or industrial purposes are registered.

Within many areas of the Bradford MDC area surface water runoff is channelled into the combined sewer system. During periods of wet weather, the capacity of the sewer system is often exceeded, and this is managed through a form of 'controlled' release via a Combined Sewer Overflow (CSO). The number of CSOs in operation throughout the Bradford MDC area is considerable, and the frequency and volume (and hence flood risk) of overflows at each individual CSO location is not fully understood. For this reason, it is imperative that local drainage issues (above and beyond the strategic flooding issues addressed as part of this SFRA) are explicitly considered at the planning application stage.

The Keighley Drainage Study (Babtie, 2000) was commissioned by Bradford MDC to investigate explicitly the potential impact that the current sewer system represents upon the local environment (considering both water quality and flooding issues). The study also considers the capacity of the current sewer infrastructure to adequately support future development within the Keighley area. In summary, a small proportion of the existing sewer system was highlighted as exhibiting a less than desirable capacity (i.e. sewer overflows expected during storm conditions resulting in poor water

quality and/or localised flooding) under current and/or future development conditions within the study area. At the time of writing no information has been provided by Yorkshire Water to confirm (or otherwise) whether future capital improvement schemes have been carried out since the Drainage Study or are intended to address these potential problem areas.

The DG5 register shows that the number of properties reported as flooded due to limited capacity in the sewerage system has increased in recent years after a decline. Within Yorkshire there have been 96 reported properties affected in the report year which is above the 2009-10 target of 90 properties. It is widely acknowledged by many climate change studies and NPPF that the frequency and duration of extreme rainfall events is likely to increase under climate change. If this is the case, and unless sewer drainage and combined flooding issues are addressed, then it should be expected that sewer and surface water flooding incidents would also increase.

3.10 Groundwater Flooding

Groundwater flooding is caused by the emergence of water originating from underground. This may be at point or diffuse locations. The occurrence of groundwater flooding is usually very local and governed by the local geology.

Unlike flooding from rivers and the sea, groundwater flooding does not generally pose a significant risk to life but is more associated with significant damage to property, with flooding persisting over a number of weeks for some types of groundwater flooding. Groundwater flooding is a significant but localised issue that has attracted an increasing amount of public concern in recent years. Groundwater flooding can also exacerbate fluvial flooding in certain circumstances.

Groundwater flooding arises from:

- Natural exceptional rises in groundwater level, reactivating springs and short lived watercourses (often referred to as 'clearwater' flooding);
- Rising groundwater (rebound) following reductions in historic abstraction;
- Mine water recovering to natural levels following cessation of pumping; and
- Local shallow drainage/flooding problems unrelated to deep groundwater responses.

Key issues are:

- Groundwater flooding is sporadic in time and location, but when it occurs it usually lasts longer than surface water flooding and interferes with property and infrastructure (such as roads);
- In most cases groundwater flooding cannot be easily managed or lasting solutions engineered.

There are many other localised and site-specific reasons for water to emerge at the surface or to appear in basements, for example, leaking water mains and sewers, blocked drains, and impedance of natural drainage routes by urban development or deepening of cellars to below the natural water table.

Groundwater flooding has been the focus of one of the key projects under Defra's making space for water programme and the outputs are available on the Defra website.

Within the Bradford MDC area there are a number of locations where groundwater flooding has been reported. Between 1999 and 2004, Bradford MDC received between 550 and 725 calls per year regarding flooded cellars. Possible sources of this flooding include:

- Rising groundwater;
- Springs;
- Defective drains or sewers;
- Burst water mains.

Bradford has a high proportion of properties with cellars compared to many other cities in the UK. Although the number of registered calls in relation to cellar flooding within the Bradford district has been ascertained, it has not been possible to determine the exact source of this flooding. As well as these unconfirmed records of groundwater flooding within Bradford, Keighley is known to suffer from groundwater flooding. In general, however, groundwater flooding within the Bradford MDC area is not thought to be a major problem due to the geology of the catchment.

3.11 Reservoir Flooding

There are a number of reservoirs located within the boundaries of Bradford MDC, these include, Keighley Moor, Water Sheddles, Ponden, Lower Laithe, Thornton Moor, Rev, Doe Park and Hewenden. Reservoirs can both store and attenuate flows in a similar manner to washlands and floodplains, depending upon how they are managed. At present these reservoirs are often full in winter and therefore provide little potential attenuation for flooding.

Reservoirs can also act as a major source of flood risk, as experienced recently during the 2007 summer floods in England and Wales, when 18 reservoirs were affected.

Whilst the probability of dam failure or breaching occurring is very small, the consequences of such an event can be devastating hence presenting a risk of flooding which has to be considered. Reservoirs are classified on a 'consequence of failure' basis outlined below in Table 3-6 and the Pitt Review suggests that a better risk-based approach to reservoir safety is needed, focusing on those reservoirs that pose the greatest risk to the public.

Table 3-6: Reservoir Consequence Classification

Dam Category	Potential Consequence of Reservoir Failure
A	At least 10 lives at risk and extensive property damage
B	Fewer than 10 lives at risk or extensive property damage
C	Negligible risk to human life but some property damage
D	Negligible risk to human life and very limited property damage

Currently the Water Act 2003, which amended the Reservoirs Act 1975, requires all reservoir undertakers to prepare reservoir flood plans for those reservoirs where the dam failure could put people's lives at risk or lead to major damage. These plans are expected to become a legal requirement in spring 2009. Defra is currently funding a project to produce a 'Guide to Emergency Planning for UK Reservoirs', which will ultimately use the reservoir flood plans.

The reservoir flood plan will include:

- An inundation analysis to identify the extent and severity of flooding which could result from an uncontrolled release of water (i.e. breaching or failure);
- An on-site plan setting out what the undertaker would do in an emergency to try and to contain and limit the effects of the incident;
- A communications plan with external organisations, mainly the emergency services.

3.12 Flooding from Canals

Non-natural or artificial sources of flooding can include canals where water is retained above natural ground level. Canal flooding may occur either as a result of the facility being overwhelmed or as a result of dam or bank failure. This can happen suddenly resulting in rapid-flowing and deep water that can cause significant threat to life and major property damage. Flooding has been recorded when the River Aire overtops into the canal causing increased flood risk to communities located close to the canal network. Shipley has been identified as an area at risk.

3.13 Effects of Future Land Management on Future Flood Risk

The Bradford MDC area includes significant amounts of rural, particularly agricultural, land. Changes in land management practices can have either a negative or a positive impact on flood risk. Although the quantification of this effect at a catchment scale is still the subject of research, improved agricultural drainage and agricultural intensification tends to increase peak flows and results in a faster response of river levels to rainfall inputs.

Less intensive agricultural production, which minimises soil compaction, conversion from arable to trees or grassland or various river/wetland restoration techniques may reduce runoff and flood risk.

For example, land management changes promoted upstream, in upper Wharfedale, could balance out the expected increase in flood risk from the River Wharfe.

The long term sustainable policies and action plans that will be forthcoming from the Aire and Ouse CFMPs will provide some guidance on where in the catchments there might be opportunities for river restoration, wetland restoration and different land management activities to reduce flood risk and provide other multiple benefits.

3.14 Condition of Flood Defences

The condition of existing flood defences is an important consideration for local authority planners when allocating new development. NPPF considers that defended areas (i.e. those areas that are protected to some degree against flooding by the presence of a formalised flood defence) are still at risk of flooding, and therefore sites within these areas must be assessed with respect to the adequacy of the defences.

The location and condition of all flood defences is provided by the Environment Agency via the National Flood and Coastal Defence Database (NFCDD).

The condition of existing defences is provided in the form of a 'rating' (1 to 5), and is a reflection of any signs of 'obvious' structural problems. The condition rating is determined on the basis of visual inspection, focussing on obvious signs of structural defect (e.g. slippage, cracking, poor maintenance), designed to inform the maintenance programme. A summary of the NFCDD condition rating allocations is shown in Table 3-7 below.

Table 3-7: NFCDD Condition Ratings for Flood Defences

Condition Rating	Condition	Condition Description
1	Very Good	Fully serviceable
2	Good	Minor defects
3	Fair	Some cause for concern. Requires careful monitoring
4	Poor	Structurally unsound now or in the future
5	Very Poor	Completely failed and derelict

Even for defences in 'very good' condition according to NFCDD residual risks such as overtopping or failure of defences will still exist (see section 3.15). The condition of existing flood defences, whether they will continue to be maintained and/or improved in the future and the level of residual risk need to be considered as part of the risk based sequential approach and, in the light of this, whether proposed land allocations are appropriate and sustainable. In addition, detailed FRAs will need to explore the condition of defences thoroughly, especially where these defences are informal and contain a wide variation of condition grades.

3.15 Residual Flood Risk

Residual risks are the risks that remain after all risk avoidance, substitution and mitigation measures have been taken. The residual risks in the catchment are therefore related to the occurrence of events of low probability, such as extreme flood events greater than the design capacity of the constrained river system or failure of these flood defences.

In the case of the Aire catchment, the quality of the river defences are generally reasonable and the probability of flooding in these areas is quite low. However, the consequences of flooding are very large. The topography of the land behind defences, flow routes, land use and access and egress are all key factors in identifying these higher flood risk areas. Areas directly adjacent to the defences can be subject to high flow velocities should the defence overtop or fail, known as rapid inundation zones, whilst low lying areas further away from the defences can be at risk from the sheer depth of flooding.

A typical range of defence standard for much of Aire catchment is between a 2% (1 in 50 year) and a 1% (1 in 100 year) flood event. However, there is always the possibility of a larger event occurring and overtopping the defence, which must be investigated, especially considering potential climate change effects.

Whilst Environment Agency Flood Maps provide a sufficient starting point in investigating flood risk in the Aire and Ouse catchments, they do not provide the level of detail needed to assess the residual risk, especially relating to existing flood defences.

This SFRA has provided sufficient data and information to Bradford MDC to apply to Sequential Test. However, it may be appropriate for Bradford MDC to undertake a Level 2 SFRA in specific development locations to gain a better understanding of current and future residual risks and floodplain mechanisms, including some 2-d overtopping and breach modelling.

4 THE SEQUENTIAL AND EXCEPTION TESTS

4.1 Introduction

Flooding is a natural process and does not respect political demarcations or administrative boundaries; it is influenced principally by natural elements of rainfall, tides, geology, topography, rivers and streams and man made interventions such as flood defences, roads, buildings, sewers and other infrastructure. As was seen in the summer 2007 floods, flooding can cause massive disruption to communities, damage to property and possessions and even loss of life.

For this reason, it is important to avoid developing in flood risk areas in the first instance. Where this is not possible, development should be directed to areas with the lowest possible level of flood risk. Having exhausted all opportunities to direct development away from areas of flood risk then the allocation of land for development must consider the vulnerability of the proposed land use to flooding and take measures to minimise flood risk to people, property and the environment. This is the thrust of the risk based sequential approach to managing flood risk and it is the backbone of the approach in NPPF.

NPPF takes a risk based approach to management decisions and actions using the following steps:

Table 4-1: Risk Based Sequential Approach

Step	Action	
1	Avoid Flood Risk	Locating new development outside areas at risk of flooding
2	Substitute	Change land use of a site to a less vulnerable one if there is a risk of flooding
3	Control and Mitigate Risks	Implement a range of flood risk management measures to reduce the impact and mitigate remaining residual risks. This should only be used as a last resort

This is known as the risk based sequential approach and should be considered throughout the planning process to ensure that opportunities are taken to minimise flood risk at every stage. The main aim of this approach is to ensure that risks to people, property and the environment are reduced to acceptable levels.

The risk based sequential approach is delivered using the Sequential and Exception Tests. The Environment Agency's Flood Zones are a starting point for this.

The **Sequential Test** is applied first and is a key driver for the level 1 SFRA. The Sequential Test is applied to demonstrate that there are no reasonably available sites, which would be appropriate for that type of development or land use where there is a lower probability of flooding. At a strategic level, the Sequential Test process is used to allocate development to areas with lower risk of flooding. It should also inform the development of policies within the Core Strategy and other DPDs. It should also be applied within a single site during the design stage to ensure that the more vulnerable parts of the development are located in the areas where the risk of flooding is lowest. The Sequential Test is discussed in more detail in section 4.2.

Following the Sequential Test and the Sustainability Appraisal which takes account of other wider sustainability objectives, it may not be possible for all development to be located in areas where the risk of flooding is low. In these cases, the **Exception Test** may be applied. This assesses whether the development has wider sustainability benefits and that the development will be safe. This is discussed in section 4.3.

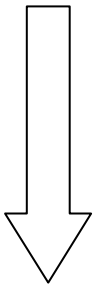
4.2 The Sequential Test

To apply the Sequential Test the LPA needs to know the location of proposed development sites and the vulnerability of the proposed use. At a strategic level it will also need to consider the broader spatial distribution of development. The LPA also needs to know the spatial extent of flood risk in the SFRA area. The SFRA provides this information as a set of maps which are based on the Environment Agency's Flood zones (see Appendix A: -) and information about other sources of flood risk.

4.2.1 Assessing Flood Risk from Rivers

The flood zones define the risk of flooding from rivers or the sea in a particular area, and are updated regularly by the Environment Agency. The following table shows how risk increases from Flood Zone 1 to Flood Zone 3b.

Table 4-2: Flood Zones and the Sequential Test

	Description	Source	Risk
Flood Zone 1	Low Probability: less than 1 in 1000 year fluvial flood event	Environment Agency	 INCREASE IN FLOOD RISK
Flood Zone 2	Medium Probability: between a 1 in 100 and 1 in 1000 year fluvial flood event	Environment Agency Flood Zone 2	
Flood Zone 3a	High Probability: a 1 in 100 year or greater fluvial flood event	Environment Agency Flood Zone 3	
Flood Zone 3b	Functional Floodplain: land where water has to flow or be stored in times of flood	Defined in SFRA based on Flood zone 3a and other detailed studies provided by the Environment Agency and BMDC	

The site testing stage will assess the proportion of each site that is in Flood Zones 1 to 3b. It will also assess the proportion of each site at risk of flooding. This allows the flood risk at each site to be compared. This information is required to carry out the Sequential Test and direct development to areas where flood risk is lowest.

4.2.2 Including Flood Risk from Other Sources

Flood risk can also vary within a Flood Zone as there may be flooding from other sources. These should be considered when taking a sequential approach to land use within a Flood Zone or a development site. Alternative sites within the same flood zone do not always have the same level of risk and may be differentiated based on other flood risks (e.g. depth or hazard, susceptibility to surface water flooding or scale of future increase in flood risk due to climate change).

These other sources are relevant when considering substitution of sites for those in lower risk Zones but where there may a high risk from another source of flooding.

The Sequential Test is purely based on the Flood Zones as defined by the NPPF, but these zones only take account of fluvial and tidal flooding and do not take account of defences. Other sources of flooding are one of the key challenges faced by the LPA in applying the Sequential Test in accordance with NPPF. It can be difficult to map the spatial extent of flooding from other sources and match the risk associated with different sources of flooding to the Flood Zones. For instance, Flood Zone 3 cannot be directly related to an area at high risk of surface water flooding as the probability and consequences are significantly different.

It may not be appropriate to avoid development at risk from other sources of flooding but risk should be considered when taking a sequential approach to land use or the substitution of lower development vulnerability in higher risk areas within a development site.

The LPA should clearly record decisions about how risk from other sources is considered during the sequential testing process. Where necessary policies to provide additional protection to areas at risk from both river flooding and flooding from other sources should be developed.

Bradford MDC should consider whether to recommend sequential testing and a Flood Risk Assessment for sites (<1Ha) in Flood Zone 1 which are vulnerable to other sources of flooding or the impacts of climate change.

4.2.3 Applying the Sequential Test

The Sequential Test may be applied by:

Spatial Planners as they carry out the strategic allocation of preferred sites and Sustainability Appraisal for the Local Development Framework and as they develop policies for the Core Strategy and other DPDs - see section 5, Guidance for Spatial Planners

Development Management as they assess applications for development - see section 6, Guidance for Development Management

Understanding the Sequential Test is also important for **Developers** on a particular site who may need to take a sequential approach when designing the layout of a site - see section 7, Guidance for Developers. Developers will also have an important role to play in pulling together the information required to enable to LPA to apply the Sequential Test.

4.3 The Exception Test

4.3.1 Identifying when the Exception Test is needed

If the Sequential Test has been applied and development cannot be allocated in areas of lower flood risk due, for example, to wider sustainable development needs and/or where other constraints are present (e.g. landscape, heritage and nature conservation) the Exception Test may be required.

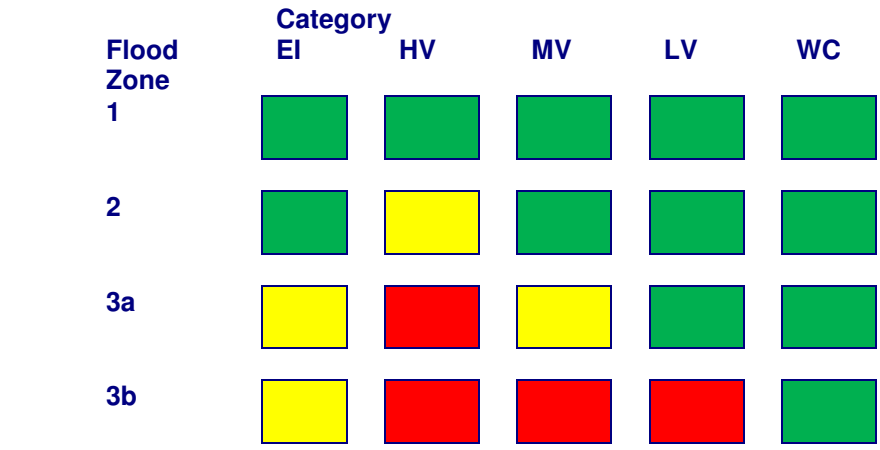
Government policy aims to make it safe without increasing flood risk elsewhere and where possible reducing overall flood risk. This is in accordance with paragraph 102 of NPPF, which states that if, following the Sequential Test:

"it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception test can be applied if appropriate. . ."

The vulnerability of the proposed development and the level of flood risk at a site determine the need for the Exception Test. This can be defined using Table 2 of NPPF provided in Appendix A: -.

The vulnerability category is compared with the level of flood risk (using Flood Zone information) to identify whether development is permitted, whether the Exception Test is required or whether development is not permitted. This is shown in Figure 4-1 which has been produced from Table 3 of NPPF Technical Guidance.

Figure 4-1: Where the Exception Test Applies



EI = Essential Infrastructure, HV = Highly Vulnerable, MV – More Vulnerable, LV – Less Vulnerable, WC = Water Compatible

Development would be permitted. An FRA would be required in Zones 2 and 3 to demonstrate that the development will be safe and may be required in Zone 1 sites

The Exception Test is required

Development should not be permitted in this zone

4.3.2 Applying the Exception Test

Once the need for the Exception Test has been identified, two conditions must all be passed in order to pass the Test (paragraph 102 of NPPF).

1. *It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.*
2. *A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

The Exception Test can only be passed following completion of a site specific FRA to determine if the site and its occupiers will be safe during times of flood.

At a **Spatial Planning** stage, sites likely to require the Exception Test can be identified and only the likelihood of passing the Exception Test can be assessed. At some sites further detail and a level 2 SFRA may be required - further information about the role of the Spatial Planner is given in section 5.

Development Management officers must make sure all parts of the Exception Test have been passed in granting planning permission - further information is given in Section 6.

Developers must carry out a detailed Flood Risk Assessment to determine whether a site can pass the Exception Test - further guidance is given in section 7.

4.4 Management Decisions and Actions

Throughout the risk based sequential approach, management actions to avoid, substitute, control and mitigate flood risk should always be kept in mind and opportunities taken to minimise flood risk at every stage of the planning process.

Whilst avoidance is clearly the preferred solution for new development, there are already substantial areas of development within flood-risk areas and some new development will have to take place there. In these situations, control and/or mitigation measures will be needed to reduce flood risks to an acceptable level. This can comprise community protection, for example flood protection barriers (flood walls or embankments), flood-detention reservoirs to attenuate flow upstream from the receptors at risk, increasing the flow capacity of rivers through dredging and construction of diversion channels. It can also include protection to individual properties using flood-resistance measures, such as temporary flood barriers to be installed on receipt of flood warning, and flood-resilience measures to make properties more easily repairable after a flood. Managing and mitigating flood risk is discussed in more detail in section 8.

The fact that mitigation measures are discussed in this SFRA should not be taken as a presumption that the Sequential Test has been short circuited. It is included to give improved understanding of the consequences associated with allocation of a site for development, or assessing development proposals on a site in high risk areas. It is also used to provide additional indicative evidence for assessment of the Exception Test. Mitigation measures must be designed to provide an appropriate level of flood mitigation to a site for the lifetime of the development. At most sites it is technically feasible to mitigate or manage flood risk (if potential off-site impacts are ignored). However, where the depth of flooding is substantial, these mitigation measures may result in practical constraints to development with significant financial implications. The Exception Test needs to explicitly understand offsite impacts of development as well as the limiting factors that influence flood risk.

Often the determining factor in deciding whether a particular development can proceed is the financial feasibility of flood risk mitigation rather than technical limitations. It is important that recommendations for allocation should not be made when there is little or no chance of feasible and cost effective mitigation measures being realised. Demonstrating that a site can be developed is, however, difficult without a detailed Flood Risk Assessment.

At the SFRA stage broad assumptions need to be made about the feasibility of flood risk mitigation so that sites with realistic development potential are put forward. It is assumed that floor level raising will continue to be the traditional mitigation measure, however, it should be noted that the Environment Agency consider land raising to be a final option rather than a desired approach to flood risk management and only then when it would not increase flood risk elsewhere.

The following screening factors may be used:

- Depth of flooding;
- Speed and direction of flooding;
- Ability to achieve safe access and egress;
- Emergency Services' ability to undertake safe and effective evacuation;
- Risk from multiple and combined flooding sources;
- Existing flood warning arrangements in place and/or potential for further application;
- Level of community awareness; and
- Impacts on local essential services infrastructure etc.

It is recognised that in some locations urban regeneration and redevelopment will be essential to maintain the long-term viability and vitality of communities and the balance of planning considerations may support redevelopment. These social and economic considerations may justify some flexibility of the screening criteria set out above and the retention of housing and employment sites in certain areas. In these instances the commercial viability of the development and risks to public safety will need to be given careful considerations during the planning of the development. A range of flood management and flood proofing measures are available that can reduce the financial impacts of flooding.

Flood mitigation measures can be implemented on most sites; however it is worth noting that in some instances the findings of individual Flood Risk Assessments may determine that the risk of flooding to a proposed development is too great and mitigation measures are not feasible. In these instances, the development will be subject to an objection by the Environment Agency. Further

details on avoidance, substitution and mitigation are contained in the recent Department for Communities and Local Government publication *"Improving the flood performance of new buildings - Flood resilient construction - May 2007.*

5 GUIDANCE FOR SPATIAL PLANNERS

The aim of this Section is to provide guidance on the use of the SFRA in Spatial Planning. Planners should also refer to the guidance on SFRA maps, background to the SFRA and flood risk concepts sections of this report.

Spatial Planners should use the Guidance in this SFRA User Guide, and where necessary NPPF together with its Technical Guidance and the PPS 25 Practice Guide to:

- ***Scope the Sustainability Appraisal***
- ***Demonstrate a sequential approach to the distribution of growth***
- ***Avoid strategic sites at high risk of flooding where no other planning objectives outweigh flood risk***
    - *Using Sustainability Appraisal and Sequential Test Spreadsheet*
- ***Carry out the Sequential Test on proposed development sites***
    - *Using information provided in the Bradford SFRA report and Sequential Test Spreadsheet to avoid sites at high risk*
- ***Identify those sites where a greater understanding of flood risk is required***
    - *These should include key development sites at high risk of flooding*
- ***Identify the likelihood of sites passing the Exception Test***
    - *Using the Sustainability Appraisal to assess development sites with regards to other planning objectives and assign weight given to flood risk as an environmental constraint*
    - *Further information may be required for some sites in a Level 2 SFRA to assess level of risk to each site and likelihood of it remaining safe. If a site cannot pass all the criteria of the Exception Test, it cannot be approved.*
- ***Identify potential allocations***
    - *Produce evidence that both Tests have been applied by noting the outcome and decisions made to avoid, substitute or allocate the site*
- ***Draft flood risk policies and develop guidance within development plan documents***
    - *Guidance should include the need for site-specific FRAs to pass Part C) of the Exception Test*

5.1 Introduction

The National Planning Policy Framework (NPPF) and associated technical guidance provides the basis for the sequential approach. NPPF policies require that the LPA consider flood risk, its mechanisms, spatial distribution and vulnerability of development in all stages of the development planning process. The Practice Guide also provides further advice on how flood risk should be taken into account in the Local Development Framework (LDF).

NPPF requires those responsible for making development decisions to follow a sequential approach (Avoid Risk - Substitute - and as a last resort control and mitigate risk).

The sequential approach is achieved through the successive application of the Sequential Test and Exception Test (section 4 of this volume). The Bradford SFRA provides the evidence base for this decision making process and should form part of the baseline information for the Sustainability Appraisal of LDDs for the scoping and evaluation stages.

The SFRA provides the relevant flood risk information to allow the LPA to:

- Produce appropriate policies for the allocation of sites and Development Management which avoids flood risk to people and property
- Produce appropriate flood risk indicators to inform the Sustainability Appraisal
- Undertake the Sequential Test and inform the Exception Test (further Level 2 SFRA detail may be required to complete the Exception Test in some locations).
- Inform the identification of land for development and appropriate land uses

It is recommended that a supporting stand alone document is prepared by the LPA, clearly recording all decisions for each proposed development site (to avoid, substitute, control, mitigate) and the evidence that they used to make the decision. This should then be used as the evidence that the Sequential Test and Exception Test have been applied.

5.1.1 Including Flood Risk in LDDs

Figure 5-1 illustrates the process of taking account of flood risk within LDDs and the use of SFRAs. This divides the process into four stages, which are colour coded.

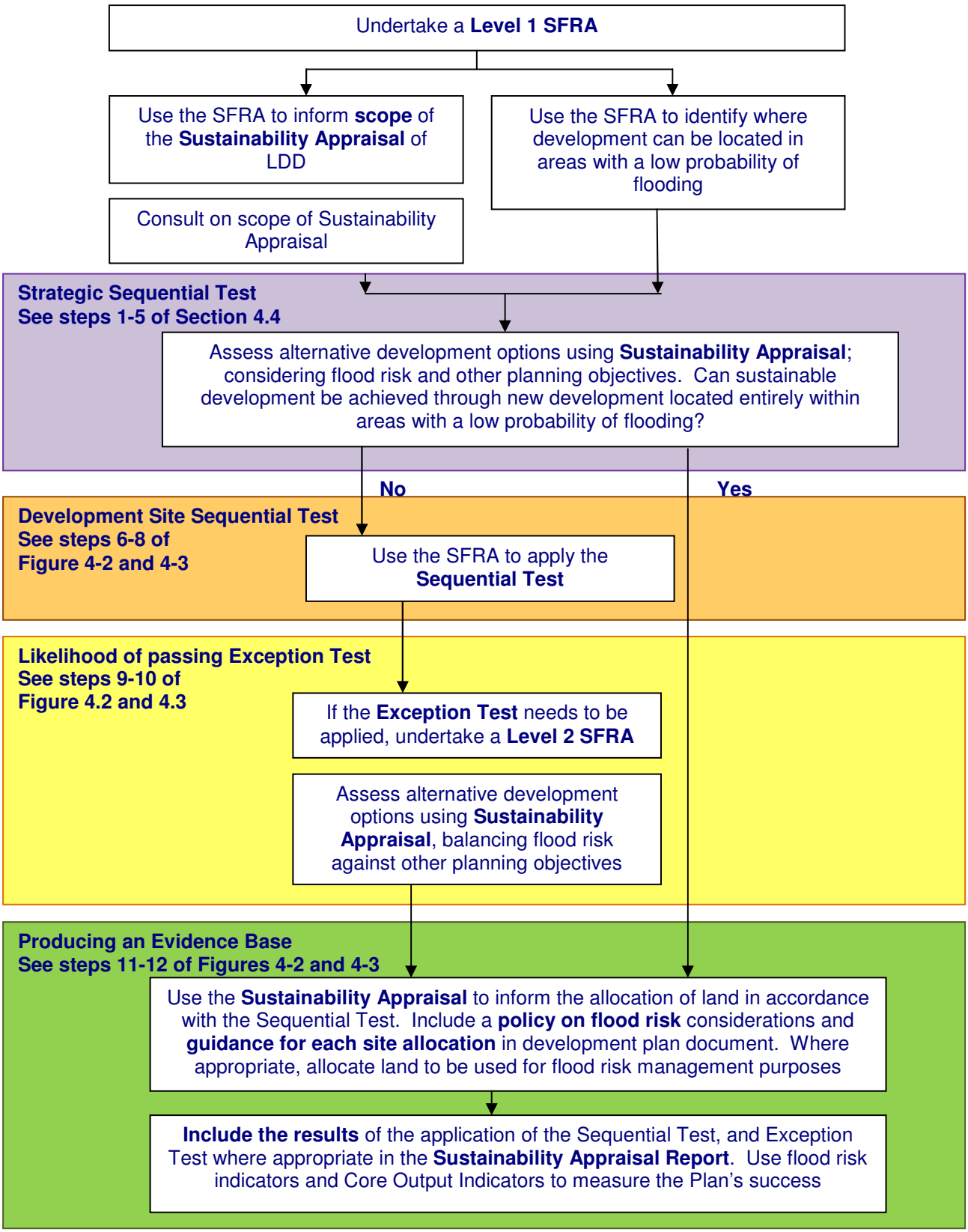
These stages are:

Strategic Sequential Test
Development Site Sequential Test
Likelihood of Passing Exception Test
Producing an Evidence Base

The same colours are used in Figure 5-2 and Figure 5-3 which illustrate the steps in the process of applying the Sequential and Exception tests.

The guidance provided in this Bradford SFRA should not supersede NPPF or other plans and policies, but should be seen as a practical approach to the application of the Sequential Test and Exception Test during preparation of the LDF.

Figure 5-1: Taking flood risk into account in LDDs



5.2 Carrying out the Sequential Test and assessing the likelihood of passing the Exception Test

Section 4 of this volume provided a short overview of the Sequential and Exception Tests. Figure 5-1 identified how flood risk is taken into account in LDDs and introduced the use of the Sustainability Appraisal in applying the Sequential and Exception Tests.

NPPF does not provide step-by-step guidance on how to apply each Test. This section provides more detailed guidance about how Spatial Planners should apply the Sequential and Exception Tests within the Sustainability Appraisal of LDDs. Following these steps will produce clear and transparent evidence that both the Sequential and Exception Test have been applied. This can feed into the Sustainability Appraisal process of LDDs. The evidence can either be reported within the Sustainability Appraisal itself or a supporting stand alone document which then feeds into the Sustainability Appraisal.

5.2.1 Spatial Planning Flow Diagrams and Tables

The following diagrams provide a recommended approach for Spatial Planners when applying the two tests.

During this process the Spatial Planner must identify which sites should be avoided or substituted and which sites can go forward. Once the Sequential Test has been applied the planner may need to assess how likely it is that the site will remain safe by considering the Exception Test.

This is a step wise process and must be documented. It is also a challenging one as a number of the criteria used are qualitative and based on experienced judgement.

Four diagrams have been provided which give an overview of the process. The stages in the process are colour coded (as described in section 5.1) and the colours can be used as a link between the diagrams.

Figure 5-1 is a flow diagram illustrating the **application of the Sequential and Exception Tests**. This links the inputs from the SFRA (including more detailed Level 2 SFRA information where it would be required), the development plan document and Sustainability Appraisal with the desired outputs. The process:

- starts with the LPA assessing alternative development options using the Sustainability Appraisal
- works down using evidence provided in the Level 1 SFRA (and that may be required in a Level 2 SFRA) to avoid inappropriate development sites, substitute development within the site boundary and identify those sites requiring the Exception Test.
- Update the development plan document under preparation

This is closely linked with **Figure 5-3** which provides more information for each of the steps outlined in **Figure 5-2**.

Figure 5-4 provides more guidance on using **the Sequential Test Spreadsheet**

Figure 5-5 provides guidance on how to **assess the likelihood of sites passing the Exception Test** using key questions and evidence provided in the SFRA in assessing whether a site is likely to remain safe or not. This is discussed in more detail in section 4.

Spatial Planners should use the Sustainability Appraisal process to assess alternative sites against flood risk indicators and other planning considerations. Once this has been completed, the final steps can be carried out, producing the evidence base for the Sustainability Appraisal, allocating appropriate development sites, producing flood risk policies and development guidance.

Figure 5-2: Sequential and Exception Test Flow Diagram

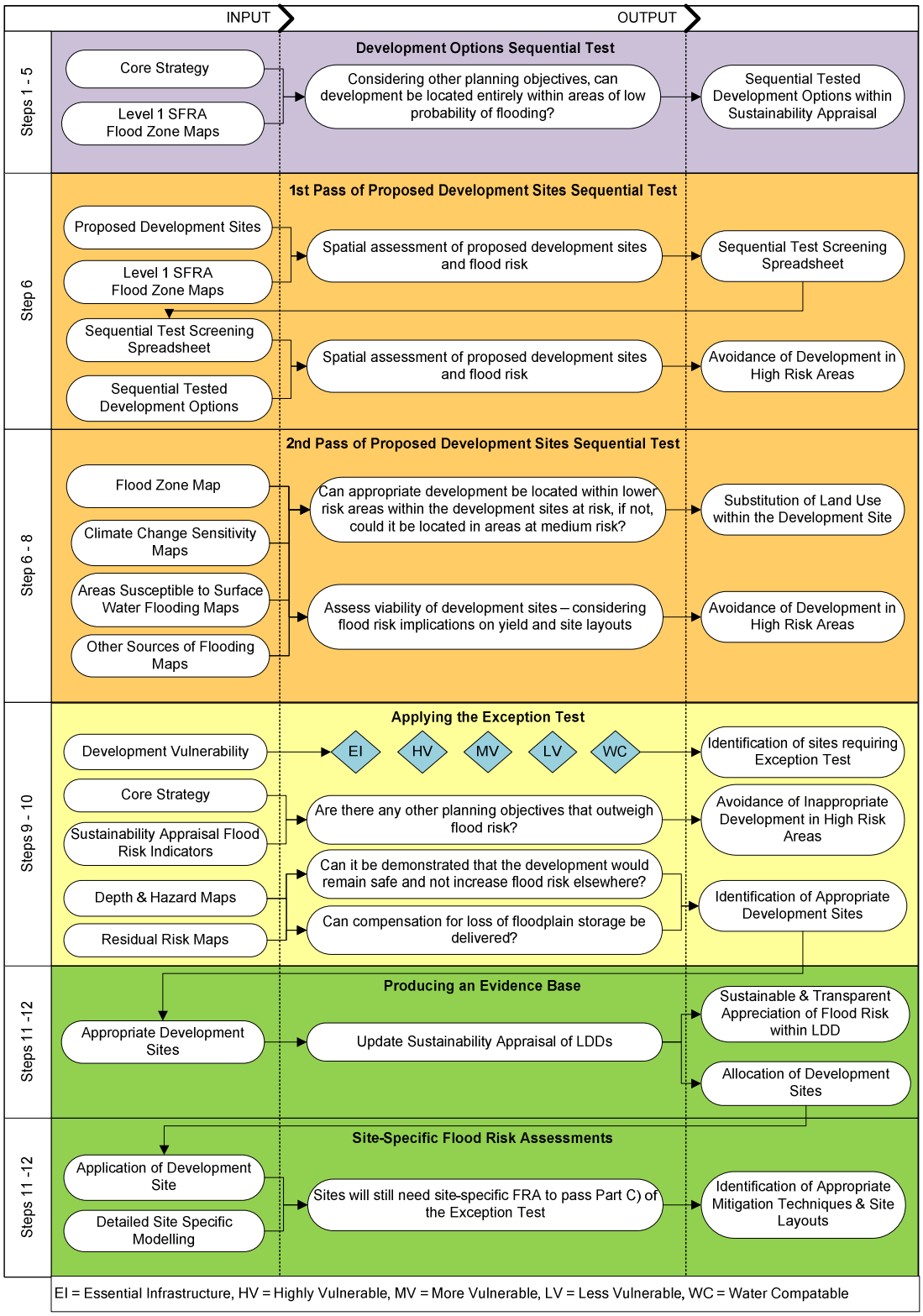


Figure 5-3: Sequential and Exception Tests key steps

Applying the Sequential Test

Step 1 State the **geographical area** over which the Sequential Test is to be applied. This can be over the entire LPA area but will usually be reduced to communities to fit with functional requirements of development or objectives identified in DPD

Step 2 Identify reasonably available areas of strategic growth/ sites

Step 3 Identify the presence of **all sources of risk** using the evidence provided in this SFRA

Step 4 **Screen available land** for development in ascending order from Flood Risk Zone 1 to 3, including the subdivisions of Flood Risk Zone 3

This can be achieved using the information in a spatial assessment of each proposed development site provided by the LPA against Flood Zones and Environment Agency surface water susceptibility zones

Step 5 Could all development be located in lower risk areas? If not, move onto the next Steps

1st and 2nd Pass of the Proposed Development Sites Sequential Test

Follow Figure 5-4 to:

Step 6 Identify those sites which should be **avoided** where risk is considered too great and there are no critical planning objectives identified in DPD

Step 7 Identify those sites in which the consequence of flooding can be reduced through **substitution** within the site boundary

Step 8 Assess yield and layout issues for remaining high risk sites to check whether development is viable

Identify the Likelihood of passing the Exception Test

Follow Key Questions imbedded within Figure 5-5 and SFRA evidence to identify the likelihood of those sites remaining at risk passing the Exception Test.

Step 9 Assess the compatibility of the **development vulnerability** using Table 2 of NPPF technical guidance and identify the requirement of passing the **Exception Test** using Table 3 of NPPF technical guidance

Step 10 Use the SA to assess alternative development options by balancing flood risk against other planning constraints. Proposed sites should be avoided and removed if it is unlikely to pass the Exception Test i.e. if:

key Questions in Figure 5-5 suggest significant problems

development will require significant mitigation measures to make the site safe and to reduce impacts downstream

the requirement to provide floodplain compensation cannot be delivered

Producing an Evidence Base

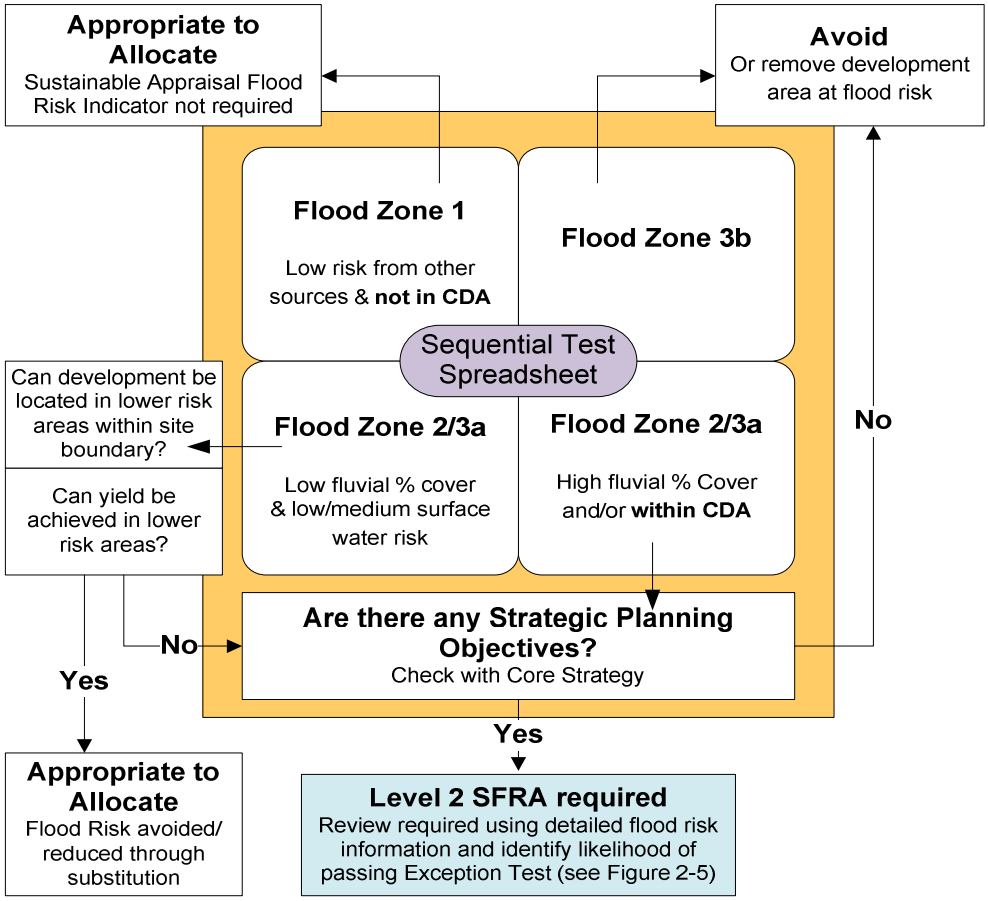
The following steps should be used to produce the evidence that all Tests have been applied

Step 11 Produce a supporting stand alone sequential testing document recording all decisions made during Steps 1 to 10. Each proposed development site should be referenced and the decisions made to avoid, substitute, or allocate the site and the evidence used. This can be incorporated within the appendix of the SA

Step 12 Allocate development allocations within the DPD, including appropriate flood risk policies and development guidance on each allocated site. Guidance should include the need for appropriate site-specific FRAs.

The Environment Agency and other relevant stakeholders (such as Yorkshire Water or British Waterways) should be consulted on any policies drafted that inform the application of the Exception Test and the production of FRAs within the LPA area

Figure 5-4: 1st and 2nd pass of proposed development sites Sequential Test



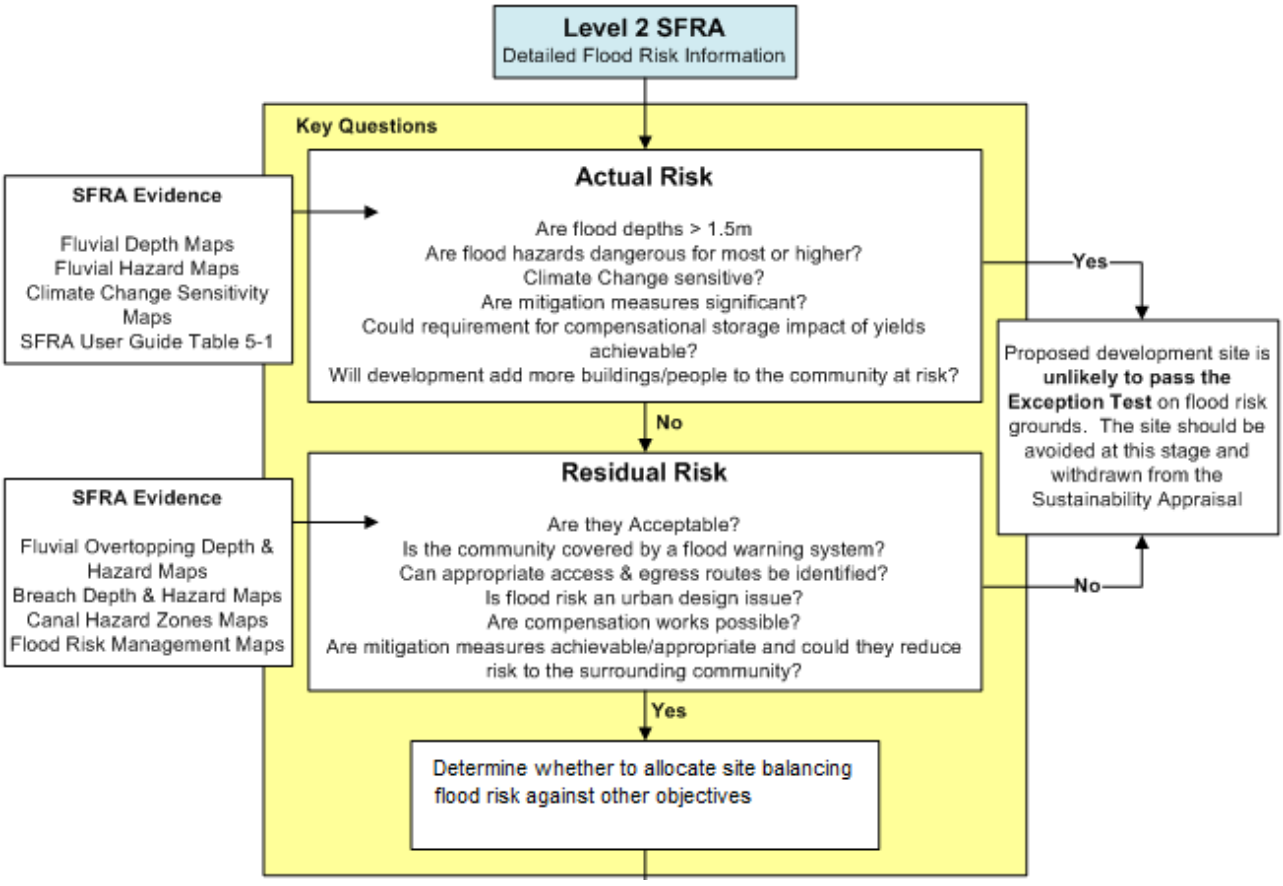
5.2.2 Assessing the Likelihood of Passing the Exception Test

The Sequential Test process may identify that some development has to be allocated in sites at risk of flooding where risk cannot be substituted within the site. Spatial Planners will need to assess the likelihood of sites passing the Exception Test. This is seen as a critical part of the spatial planning process by avoiding inappropriate development being allocated. The Environment Agency and/or Development Management are likely to object to inappropriate development. A balance is required but the Exception Test can be a show stopper in that planning permission can only be granted if all criteria of the Exception Test are met.

This is a Level 1 SFRA and further detailed information may be required (via a Level 2 SFRA investigation) at some locations to assess whether a site is likely to pass the Exception Test. The SFRA information can be used to identify where there are issues which would require further investigation before assessing the likelihood of passing the Exception Test (for example presence of flood defences).

Figure 5-5 outlines the key questions that Spatial Planners should consider in order to understand the level of flood risk present at a site and identify the likelihood of a site passing the Exception Test.

Figure 5-5: Identifying the likelihood of passing the Exception Test



5.3 Flood Risk and other Land Use Policies

Flood risk is an important consideration in land use planning and can greatly impact on the sustainability of various land uses in all locations. Once the Sequential Test and Exception Test (where necessary) have been applied, the assessment of associated flood risk information will then influence the land use planning decision at whatever level it is being considered.

Land use policies and wider strategic decisions involving social and economic development in the LDDs will be influenced and shaped by the sequential approach informed by this SFRA.

Green Infrastructure (GI) is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe consisting of:

- Open Spaces – parks, woodlands, nature reserves, lakes
- Linkages – River corridors and canals, pathways and cycle routes and greenways
- Networks of "urban green" – private gardens, street trees, verges and green roofs.

Green spaces can be used to manage flood risk including storm flows. It may also free up water storage capacity in existing infrastructure to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. GI can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity. It can also reduce the urban heat island effect, reduce erosion and improve water quality.

GI should be incorporated into master planning and individual sites, directed by the need to retain exceedance flood paths and natural attenuation of flood flows.

The evidence provided in this SFRA should be used to enhance the green infrastructure in Bradford MDC area by identifying opportunities for delivering FRM measures through GI. River corridors identified as functional floodplain are an excellent linkage of GI and can provide storage during a flood event. Areas identified within the urban environment or upstream of a critical surface water flood areas should be incorporated into council GI strategies. Opening up land to create flow paths or flood storage areas can help protect current and future developments.

6 GUIDANCE FOR DEVELOPMENT MANAGEMENT

The aim of this Section is to provide guidance on the use of the SFRA by Development Management. Planners should also refer to the guidance on SFRA maps, background to the SFRA and flood risk concepts.

When it comes to individual planning applications, Planners should use the Guidance in this SFRA User Guide, PPS 25 and its Practice Guide to:

- ***Check local plan website to see whether the Sequential Test and/or the Exception Test have already been applied through the preparation of a local development plan document and supporting evidence***
- ***Apply the Sequential and Exception Test if necessary, using evidence supplied by the developer, referring them to the following***
    - *Bradford SFRA to inform Sequential Test*
    - *The Bradford SFRA to inform Exception Test*
    - *The Bradford SFRA maps to review scale and nature of flood risk*
    - *The Environment Agency flood maps to check for changes in flood risk as a result of subsequent modelling studies*
- ***Consult with Environment Agency and other relevant stakeholders to***
    - *Assess flood risk constraints identified on site*
- ***Scope an appropriate FRA***
    - *What is the scale and nature of risk from all sources?*
    - *Does the site lie within a CDA?*
    - *Refer developers to Section 4, 5 and 6 of this SFRA User Guide*
- ***Consult with Environment Agency over FRA acceptance/approval***

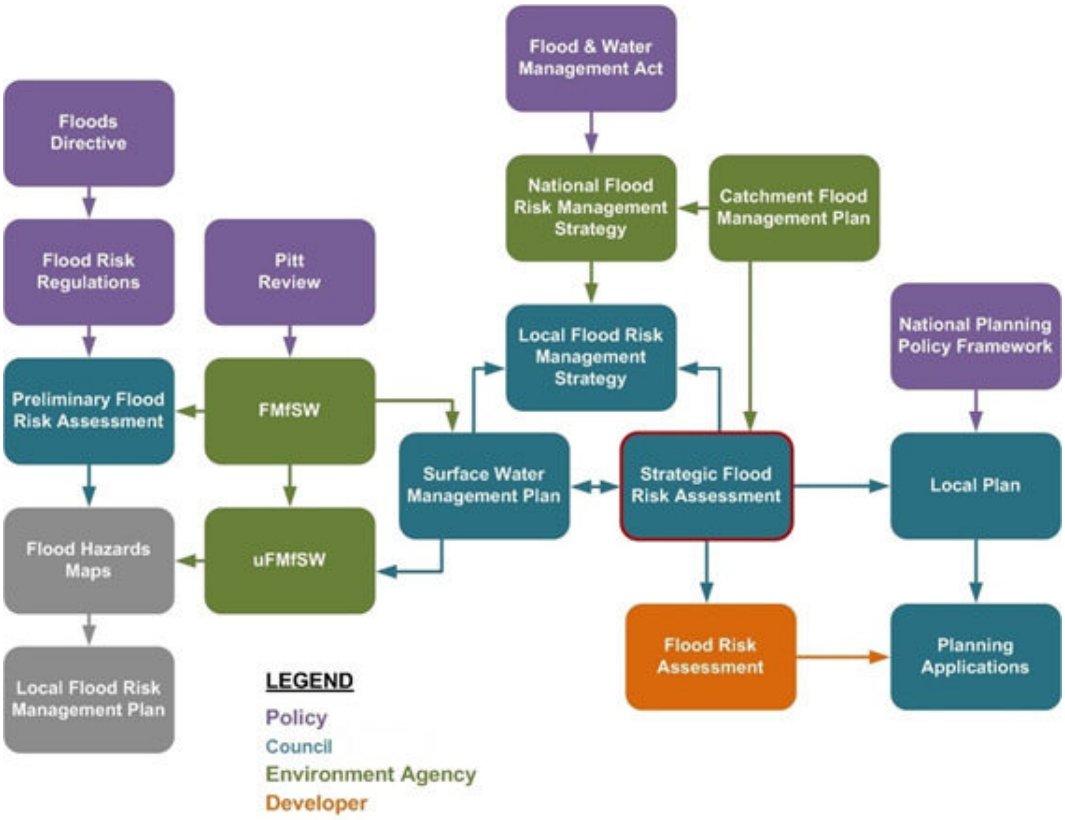
6.1 Role of Development Management

The LPA are the main decision-makers on applications for new development. This is carried out through Development Management. It is the overall responsibility of the developer to carefully consider flood risk issues regarding their development site but the LPA should be involved at the earliest possible stage during pre-application discussions.

The Pitt Review has recommended that Development Management must take some roles and responsibilities from the Environment Agency as the first point of contact for Flood Risk Management and planning applications.

The consideration of flood risk within the context of an individual site planning application is shown on Figure 6-1 which shows how planning applications sit within the other flood risk management roles and responsibilities.

Figure 6-1: Planning Applications and Flood Risk



6.2 Taking a Strategic View of Development

Development Management officers must always consider development from a strategic view point even though applications for proposed developments are submitted at a site level. Some communities may require a strategic approach when it comes to planning development, due to the possibility of large off site impacts caused by piecemeal development. It should not be presumed that flood risk has been understood at the strategic high level and each application should fit within any flood risk management strategy for an area and flood risk policies in LPA LDDs.

If an individual site has been identified for development, Development Management must check that the development is sound regarding flood risk i.e. it has passed the Sequential Test and it is likely to pass the Exception Test where applicable and that it is supported by a coherent FRA which meets the requirements of NPPF.

6.3 Applying the Sequential Test and Exception Test

An overview of the Sequential and Exception Tests is provided in section 4 of this volume. These follow the key principles to manage flood risk by:

- Avoid
- Substitute
- As a last resort Control and Mitigate

Section 4.20 to 4.39 of the PPS 25 Practice Guide provides more detail on how to apply the Sequential Test and Exception Test to individual planning applications, windfall sites, existing and single properties and change of use. As of February 2014 this must be referred to, however the information is due to be incorporated into the NPPF technical guidance document and in future this should be consulted. The local planning authority will consider the need to provide further technical guidance on this issue.

6.3.1 Sites in a Sequentially Tested DPD

The site may have been through the Sequential Test during the preparation of a DPD. The developer must still apply the sequential approach to site layout and match land use vulnerability to flood risk areas as described in NPPF.

6.3.2 Windfall Sites

If a site has not been identified in a Sequentially Tested LDD, the Sequential Test will need to be applied. The developer will need to provide evidence to the LPA that there are no other reasonably available sites where the development could be located. The LPA will then use this information to apply the Sequential Test. This applies particularly to Windfall Sites that have not been allocated in the LDF.

The overview of flood risk provided in the Level 1 SFRA should help Development Management identify where windfall development may be appropriate on flood risk grounds. Development in certain communities may find it difficult to pass both the Sequential Test and Exception Test due to the nature of flood risk and/or the scale of mitigation which would be required in order to make the development safe. Further Level 2 SFRA detail may be required for some locations with potential for development.

6.3.3 The Exception Test

Developers will need to provide evidence that the Exception Test can be passed if it is required. This evidence will be needed for both allocated and windfall sites, depending on the vulnerability of the proposed land use, areas requiring redevelopment or regeneration, redevelopment of existing single properties or changes of use.

Development Management will then need to review the evidence provided and decide whether a site passes the Exception Test. Development in certain communities may find it difficult to pass both the Sequential Test and Exception Test due to the nature of flood risk and/or the scale of mitigation which would be required in order to make the development safe.

More detail about mitigation options is provided in section 8 of this report.

6.3.4 Supporting the FRA Process

All development applications within Flood Zones 2 and 3 must be supported by an appropriate site-specific FRA. In addition those sites within Flood Zone 1 that are greater than 1 ha in area must also be supported by an appropriate site-specific FRA. All developments are required to consider the effect of the proposed development on flood risk with respect to its size, nature, location and nearby development or land. The Council may set more stringent local requirements where the situation requires them; such local requirements shall be decided within the framework set by the National Planning Policy Framework.

Further guidance is also provided in sections 7 and 8 of this SFRA.

Development Management should recommend that:

- At the first possible stage developer should refer to the flood risk mapping in the Bradford SFRA and the Environment Agency Flood maps which are updated quarterly.
- The developer refers to the appropriate LDD and flood risk policies which could potentially influence their proposed development.
- The Environment Agency Standing Advice should be used at this stage. This can be accessed online at http://www.environment-agency.gov.uk /research/planning/82584.aspx

The Environment Agency is a statutory consultee for specific categories of development where flood risk is an issue. Table 6-1 outlines when a more detailed FRA may be required on which the Environment Agency should be consulted.

If the site or community has been identified at risk of flooding from any source, Development Management and the developer should consult the Environment Agency and other relevant flood risk consultees, such as Yorkshire Water or British Waterways, to identify known flood-related site constraints and agree the scope of an appropriate FRA.

Table 6-1: FRA Considerations

Statutory Considerations [a]	**Supporting evidence in the SFRA**
The development, other than minor, development[b] is situated in Flood Zone 2 and 3	Flood Zone Maps
The development exceeds 1ha in size	-
The development is within 20m of the bank top of a Main River – works within 8m of a main river will need the consent of the Environment Agency who are likely to object in principle to any development within these areas.	-
The development involves culverting or controlling flow in any river or stream - the Environment Agency must be consulted	-
Other Considerations	
The development is situated in Flood Zone 1, but there are critical drainage problems or the site has been identified as being at risk of flooding from other sources	
The development is at risk of flooding from other sources of flooding	Surface water maps
The development is situated behind flood defences (possibility of overtopping during extreme flood event or breach)	Defences Maps Depth and hazard May need Level 2 SFRA evidence

Note a: Consultation with the Environment Agency required under Town and Country Planning (General Development Procedure) Order, 2010

Note b: The Development Management Procedure Order (DMPO) definition of minor development is:

- Minor non–residential extensions: Industrial/Commercial/Leisure etc. extensions with a footprint less than 250 m^2.

- Alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
- 'Householder' development: e.g. sheds, garages, games rooms etc. within the curtilage of the existing dwelling in addition to physical extensions to the existing dwelling itself. This definition EXCLUDES any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.

7 GUIDANCE FOR DEVELOPERS

The aim of this Section is to provide guidance on the use of the SFRA by Developers. Developers should also refer to the guidance on SFRA maps, background to the SFRA and flood risk concepts

Developers should use the Guidance in this SFRA, PPS 25 and its Practice Guide to:

- ***Assess whether the site is a***
    - *Windfall site,*
    - *an allocated site which has already been sequentially tested (and where the proposed development is consistent with the allocation),*
    - *within a regeneration area where regeneration has begun and the proposed development contributes towards that regeneration,*
    - *replacement of a single dwelling with another single dwelling,*
    - *a straight change of use application,*
    - *considered a minor development,*
    - *constitutes a use requiring the Exception Test under table D3 of PPS 25.*
    - *to identify if Sequential and Exception Tests are required*
- ***Check website to see whether the Sequential Test and/or the Exception Test have already been applied in this area***
    - *If not, provide evidence to allow the LPA to undertake the Tests.*
- ***Consult with LPA Development Management and the Environment Agency to scope an appropriate FRA if required***
    - *Also refer to Environment Agency Standing Advice, CIRIA Report C624, PPS 25 and its Practice Guide*
    - *Guidance on FRAs provided in this SFRA*
    - *Are there any strategic mitigation requirements identified in the Bradford SFRA and/or LDD?*
    - *Consult LPA emergency planners if required*
- ***Submit FRA to Development Management and Environment Agency for approval***

7.1 Introduction

The SFRA provides the evidence base for developers to assess the flood risk to a site at a strategic level and scope an appropriate site-specific Flood Risk Assessment.

Developers should liaise closely with the LPA to determine if a site is suitable for development, and if so what type of development is appropriate, given the application of the Sequential Test and likelihood of passing the Exception Test as required by NPPF. If a site is suitable then developers should prepare a site-specific Flood Risk Assessment, in close liaison with the LPA and Environment Agency.

Developers should consider all sources of flood risk when assessing whether a site is suitable for development.

Figure 6-1 in the Guidance for Development Management (Section 6.1) provides a useful overview of the consideration of flood risk within the context of an individual site planning application.

7.2 The Sequential Test and Exception Test

The Sequential Test and Exception Test are fundamental to NPPF in determining the suitability of land for development in regard to flood risk. These tests may still be required at an individual site level. **Table 7-1** identifies when the Sequential and Exception Tests are required for certain types of development and who is responsible for providing the evidence and those who need to apply the tests. Further information is provided in Section 4 of the PPS 25 Practice Guide, as of February 2014 this is current but due to be incorporated into the NPPF technical guidance.

Table 7-1 Development types and application of Sequential and Exception Tests

Development/ PPS 25 Practice Guide Section *(Note that PPS 25 Practice Guide is due to be incorporated into the NPPF Technical Guidance)*	Sequential Test Required	Who Applies the Test?	Exception Test Required	Who Applies the Test?
Allocated site **Sect. 4.20-4.29**	Yes	LPA, developer must provide evidence they need to undertake Sequential Test a	Dependent on vulnerability of land use (see Appendix Appendix A: -)	LPA assesses likelihood of test being passed. Developer provides evidence that the test can be passed through a detailed FRA
Windfall site **Sect. 4.30 - 4.32**	Yes	LPA, developer must provide evidence they need to undertake Sequential Test a	Dependent on vulnerability of land use (see Appendix Appendix A: -)	LPA assesses likelihood of test being passed. Developer provides evidence that the test can be passed through a detailed FRA
Regeneration sites identified in LDD **Sect. 4.33 - 4.35**	No - if regeneration has begun as part of a formal regeneration plan and the development		Dependent on vulnerability of land use (see Appendix Appendix A: -)	Developer provides evidence that the test can be passed to the LPA through a detailed FRA

Table 7-1 Development types and application of Sequential and Exception Tests				
Development/ PPS 25 Practice Guide Section *(Note that PPS 25 Practice Guide is due to be incorporated into the NPPF Technical Guidance)*	**Sequential Test Required**	**Who Applies the Test?**	**Exception Test Required**	**Who Applies the Test?**
	contributes towards the regeneration.			
Redevelopment of existing single properties **Sect 4.36**	No		Dependent on vulnerability of land use (see Appendix Appendix A: -)	Developer provides evidence that the test can be passed to the LPA through a detailed FRA
Changes of use **Sect. 4.38**	Yes if change to a caravan, camping or chalet site, mobile home or park home site		Dependent on vulnerability of land use (see Appendix Appendix A: -)	Developer provides evidence that the test can be passed to the LPA through a detailed FRA
Minor Developments	No	-	No	-

a. PPS 25 Practice Guide section 4.24 provides some guidance, as of February 2014 this is current but due to be incorporated into the NPPF Technical Guidance document.

b. Development Management Procedure Order (DMPO) defines minor development as:

-minor non residential extensions (with a footprint of less than250m^2)

-alterations that do not increase the size of buildings

-'Householder' development (e.g. sheds, garages) within the curtilage of the existing dwelling in addition to physical extensions of the dwelling (excluding proposed developments that would create a separate dwelling within the curtilage of the existing dwelling.

7.3 Site specific Flood Risk Assessments

The preparation of site specific Flood Risk Assessments (FRAs) are the responsibility of those proposing development. The main aims of a FRA are to determine the acceptable management of flood risk to the proposed development and any impacts elsewhere, and to ensure that the development and its users/occupants remain safe in times of flood.

Once the site has been through the Sequential Test a site-specific FRA should be undertaken. The LPA and Environment Agency should be consulted in order to scope the content and level of the FRA.

There are three levels of FRA:

- **Level 1-** Screening study, to identify whether there are any flooding or surface water management issues that need to be considered further;
- **Level 2** - Scoping study, to be undertaken if the Level 1 FRA indicates that there are flood risk issues needing further consideration and these risk can be readily quantified; and
- **Level 3** - Detailed study, where further quantitative analysis is required to appropriately assess flood related issues and determine any effective mitigation measures needed to be put in place.

The detail required for each level of FRA is highlighted in Figure 7-1. This figure also links the evidence provided in the Bradford SFRA which can aid the decision making process. Section 8 should also be referred to regarding appropriate mitigation measures.

It should be recognised that the SFRA has assessed flood risk at a strategic level, which can be used to provide evidence for a Level 1 and Level 2 FRA. A FRA for a site needs a more detailed assessment. The SFRA can be used to scope out flood risk issues and referring to the guidance in the SFRA User Guide, NPPF and its associated technical guidance, and CIRIA Report Development and Flood Risk.

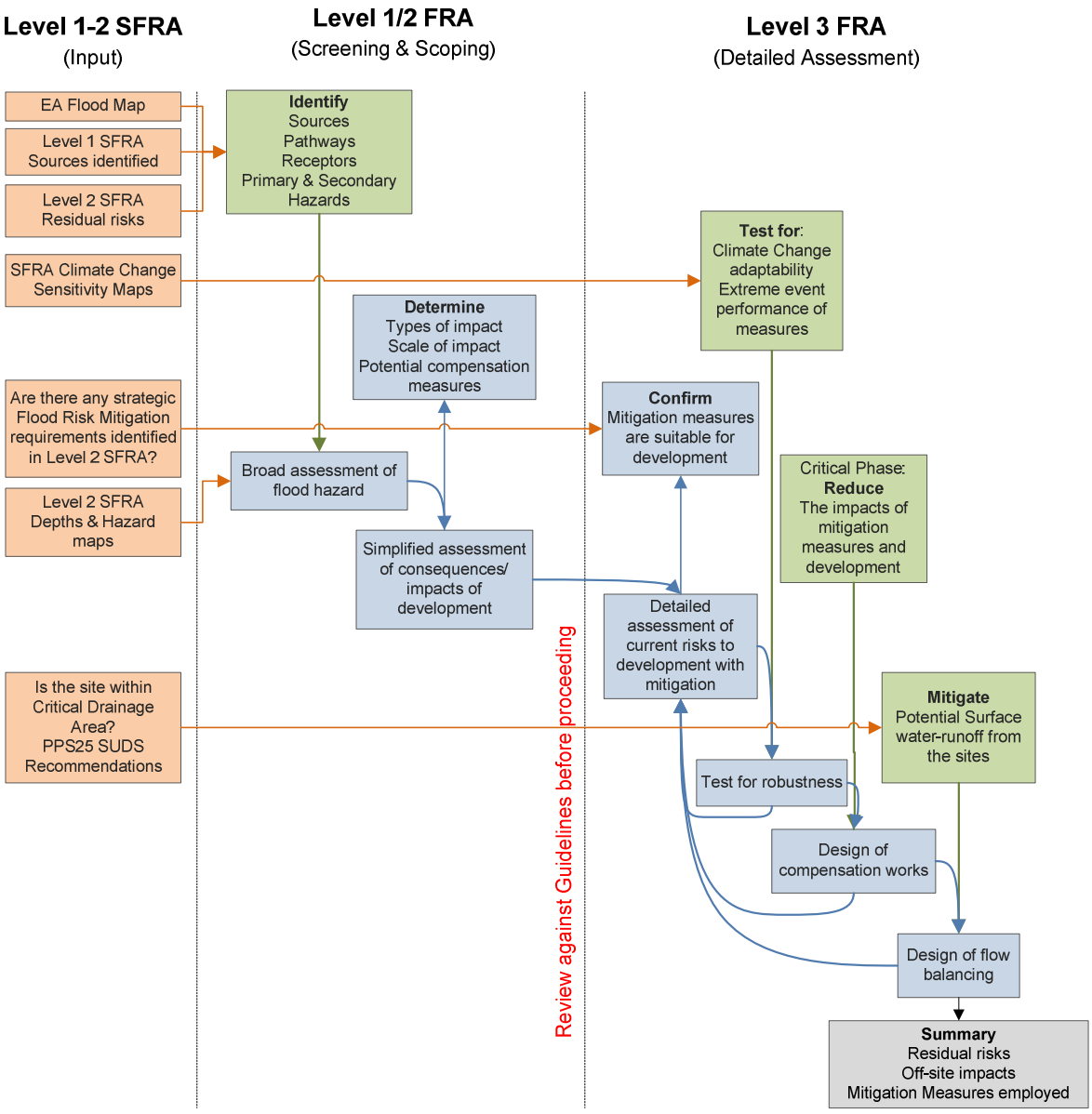
Figure 7-1 scopes when a more detailed FRA is likely to be required. The actual scope of the FRA should be agreed between the developer, LPA and Environment Agency before it is undertaken.

In addition, typical outputs of a Level 1 or Level 2 FRA, supported by guidance notes and a FRA pro-forma are contained in the Practice Guide and these include:

- Development description and location;
- Definition of flood hazard;
- Probability of flooding;
- Effects of climate change;
- Detailed development proposals;
- Flood risk impacts and management measures; and
- Consideration and management of off site and residual risks.

For all levels of FRA developers are advised to make early contact with the Environment Agency, the LPA, the Lead Local Flood Authority (LLFA) any relevant IDB and Yorkshire Water to discuss their proposals in outline and consider the site in respect of the risk based sequential approach contained within the SFRA.

Figure 7-1: FRA Preparation



7.4 FRA Guidance

Annex E of PPS 25 provided information on the general principles of flood risk assessment and states the minimum requirements for all stages of the planning process. These included:

- Be proportionate to the risk and appropriate to the scale, nature and location of the development;
- Consider the risk arising from the development in addition to the risk of flooding to the development;
- Take the impacts of climate change into account;
- Be undertaken as early as possible in the planning process;
- Consider potential adverse and beneficial aspects of flood risk management infrastructure;
- Consider the vulnerability of the users of the development;
- Consider and quantify difference types of flooding from all sources;
- Include the assessment of residual risks;
- Consider surface water drainage systems; and
- Be supported by appropriate data and information.

The NPPF Technical Guidance is due to be updated to include additional information from the PPs 25 Practice Guide. Developers should ensure that they are following the current version of the guidance with the approach recommended by:

1. The Environment Agency Standing Advice – this can be found at the website below (http://www.environment-agency.gov.uk/research/planning/82584.aspx)
2. CIRIA Report C624 Development and Flood Risk – Guidance for the Construction Industry
3. NPPF and its associated technical guidance

These documents describe when a FRA is required and what it should contain. They guide developers to produce a "fit for purpose" FRA. The FRA should answer the following questions:

Table 7-2: Flood Risk Assessment Questions

FRA Questions	SFRA and other Sources of Information
Development Description and Locations	
What is the type of development and where will it be located?	
What is the vulnerability classification of the current and future use of the development site?	Table 2 of the NPPF Technical Guidance
Has the development site been assessed during the Level 1 SFRA? Is Level 2 SFRA assessment required at the site? Have the Sequential and Exception Test already been applied?	SFRA Sequential Test. Guidance in section 2 about Sequential and Exception Test
Definition of Flood Hazard	
What sources of flooding could affect the site?	SFRA Mapping
For each source, how would flooding occur, referencing any historical records where these are available?	SFRA Mapping
What existing surface water drainage requirements are present on the site?	Consult with LPA, Environment Agency and Yorkshire Water
Probability	
Which Flood Zones are present within the site?	SFRA and Flood Zone Maps
What actual and residual risks are associated with the site?	SFRA FRM, indicative depth and hazards
What are the existing rates and run-off volume generated by the site?	
Climate Change	
How is flood risk at the site likely to be affected by climate change?	See climate change maps
Flood Risk Management Measures	

How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?	Developers should refer to section 8 for details on appropriate mitigation
Off Site Impacts	
How will the proposed development be designed to not increase flood risk elsewhere and where achievable reduce flood risk to the surrounding community? Will measures be implemented to protect the site from flooding and prevent run-off affecting other areas?	
Residual Risks	
What flood-related risks will remain after mitigation measures have been implemented to protect the site from flooding?	
How, and by whom, will these risks be managed over the lifetime of the development?	Consult with Emergency Planners to obtain guidance on developing an Emergency Flood Plan for a development site.

7.5 Considering 'other' sources of flooding

Flood Risk Assessments must take account of flood risk from all sources, rather than concentrating on fluvial, tidal or surface water flood risk. The Bradford SFRA has gone some way in identifying the presence of these sources. This SFRA has carried out some detailed assessment of surface water flooding and collected information from Yorkshire Water which indicate locations where flooding from other sources may be important. Detailed Level 2 SFRA investigations may be required in some locations.

7.5.1 Canals

The Leeds and Liverpool canal runs through the SFRA area, following the River Aire valley. The route of the New Bradford cut follows Bradford Beck to from Shipley into the City centre. The residual flood risk associated with these should be considered in an appropriate FRA. Assessment of the residual risk associated with these canals is recommended in a level 2 SFRA. The developer should liaise with the LPA and British Waterways to determine applicable emergency planning arrangements. Level 2 SFRA investigations should include liaison with British Waterways to identify residual risks from the canals.

7.5.2 Reservoirs

As part of a FRA, the developer should undertake a zone of search around their site to identify any reservoirs that lie on higher land. Where larger reservoirs are identified, that fall within existing legislation, the developer should liaise with the LPA, Environment Agency and reservoir undertaker to determine applicable emergency planning arrangements.

Where this identifies smaller reservoirs, the FRA should determine the owner and maintenance regime of the reservoir. A more detailed investigation of the effects of the reservoir overtopping or failing should be undertaken. The developer should then liaise with the LPA and reservoir owner to determine applicable emergency planning requirements or mitigation needs. Where there is significant flood hazard identified to the site from such failure, and especially from unmaintained reservoirs, the developer should liaise closely with the LPA about the suitability of the site for development.

7.5.3 Groundwater

Groundwater flooding has been reported in the Bradford MDC area and the FRA should consider the potential mechanisms that could affect the development site, as outlined in Volume II. If a risk of groundwater flooding is found, developers should consult with the LPA and Environment Agency at an early stage as to the next steps. Further detail is found in 3.10

7.5.4 Sewers

Where the SFRA has identified that there is a risk from surface water flooding, any water that surcharges the sewer system would be expected to follow similar flow paths and pond in similar low spots. The volume of water that emerges from the system will depend on the reason for the network surcharging (e.g. rainfall beyond the design level of the sewer system, sewer capacity issues or blockage or failure).

Developers should take account of the guidance for developing in CDAs where appropriate and liaise closely with Yorkshire Water over any localised sewer flooding problems that could affect the site. Known sewer flooding locations are prioritised for investment by Yorkshire Water and may be the subject of future investment. Future development should be designed so that it does not contribute to existing sewer flooding problems.

7.5.5 Drainage and Surface Water

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure. It should be borne in mind that the sewer network in places across the Bradford area was designed to drain less development than exists today. Development has added flow over time and the network capacity in not know in certain areas. Flooding of residential properties from surface water has been recorded in Idle, Apperley Bridge, Addingham, Silsden, Cross Hills and Bradford City centre.

Managing surface water discharges from new development is therefore crucial in managing and reducing flood risk to new and existing development downstream.

Bradford MDC advice for limiting Runoff for Greenfield Sites is:

- The peak runoff rate from the development to any highway drain, sewer or surface water body for a 1in1 year rainfall event and the 1in100 year rainfall event must not exceed the peak Greenfield runoff rate from the site for the same event.
- Where reasonably practicable, the runoff volume from the developed site to any highway drain, sewer or surface water body in the 1in 100 year, 6 hour rainfall event must not exceed the Greenfield runoff volume for the same event.

For previously developed sites:

- The peak runoff from the development to any highway drain, sewer, or surface water body for the 1in1 rainfall event and the 1in100 rainfall event must be a close as is reasonably practicable to the Greenfield runoff rate from the site for the same rainfall event, but must not exceed the rate of discharge for the predevelopment scenario for that event.
- Where reasonably practicable, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in100, 6 hour rainfall event must be constrained to a value as close as reasonably practicable to the runoff volume for the same event, but must not exceed the rate of discharge for the predevelopment scenario for that event

Carefully planned development can also play a role in reducing the amount of properties that are directly at risk from surface water flooding.

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

Sustainable drainage and the use of Sustainable Drainage Systems (SuDS) is supported by the policy direction in Future Water, Making Space for Water, the Pitt Review and the Draft Flood and Water Management Bill that provides for more sustainable management of the water cycle, working in partnership across different agencies and new responsibilities for local flood risk management. In particular, the Draft Flood and Water Management Bill requires developers where practical, to include sustainable drainage in new developments to reduce flood risk and improve water quality. It includes '*a requirement on developers to demonstrate that they have met national standards for the application of SuDS techniques before they can connect any residual surface water drainage to a public sewer (amending section 106 of the Water Industry Act 1991).*' As part of their new responsibility for local flood risk management, local authorities will be responsible for approving SuDS for new developments and adopting and maintaining them.

Recognising the above, drainage from new developments should incorporate storage, with residual discharge of surface water to the following networks in order of preference:

- Infiltration drainage (e.g. soakaways)
- Discharge to a watercourse

- Discharge to a public sewer

The choice of system will be determined by local ground conditions (including groundwater levels). Whilst infiltration SuDS may be the most suitable for new development, developers must consider the risk of contamination to underlying aquifers.

Surface Water Flooding is discussed in more detail in section 3.8

Locations Susceptible to Localised Flooding

Certain locations known to be susceptible to localised flooding can be defined as Critical Drainage Areas (CDAs) and are based on areas of surface water flood risk and where the sewer network may be at capacity. While there are currently no CDAs in Bradford, work at a local level may identify locations susceptible to localised flooding where such advice might be applied in the future. The Council, in partnership with the University of Sheffield Pennine Water Group has started work on developing a local flood risk management strategy.

In CDAs, a detailed FRA would be expected regardless of which Flood Zone that applies. This should demonstrate that new development is not at risk from flooding from existing drainage systems. It should also demonstrate that the development would not adversely affect existing flooding conditions by the use of appropriate mitigation measures and should define and address the constraints that will govern the design of the drainage system and layout of the development site.

Category 4 of the Code for Sustainable Homes (DCLG (2006)) requires developers to ensure that peak run-off rates and run-off volumes will be no greater than the pre-development conditions as a minimum. The code recommends that attenuation should be related to the degree of flood risk in an area.

'*The percentage peak time attenuation should be provided as follows*

- *50% in low flooding risk areas*
- *75% in medium flooding risk areas*
- *100% in high flooding risk areas'*

Local planning authorities may be able to stipulate high levels of the code where there are local circumstances that allow and warrant it. Yorkshire Water hold information about sewer flooding incidents on their DG5 register. This identifies locations where there has been flooding (internal or external) of property in the past. It may include properties which benefit from recent improvements/ upgrades to the sewer network where the risk of flooding has now decreased.

Ideally the LPA should work closely with the Environment Agency, Yorkshire Water and developers to enable surface water runoff to be controlled as near to the source as possible. For Greenfield developments, the aim is not to increase runoff from the undeveloped situation and for Brownfield re-developments, to reduce existing runoff rates. Developers should liaise closely with the Environment Agency, Yorkshire Water and LPA to determine an appropriate reduction in runoff rate and volume with reference to discharge limits as laid down by any completed SWMP or drainage strategy for that area.

Wherever possible, this should be achieved through the implementation of Sustainable Drainage Systems (SuDS), constructed within the boundaries of the development site. (More detail on SuDs is available in Appendix C: -). Surface water flow paths should be identified in more detail as part of any Level 2 SFRA for CDAs. These should be opened up and water safely routed using Green Infrastructure. Opportunities should be taken where possible to hold back surface water within these areas, which can reduce surface water flood risk to existing properties downstream.

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

8 MANAGING FLOOD RISK

8.1 Introduction

Throughout the risk based sequential approach, the need to take a sequential approach when allocating land for development should always be kept in mind and opportunities taken to minimise flood risk at every stage of the planning process.

Mitigation measures should be seen as a last resort to address flood risk issues to new development.

Mitigation measures must be designed to provide an appropriate level of protection to a site for the lifetime of the development. At many sites it may be technically feasible to mitigate or manage flood risk. However, the potential impacts of mitigation measures on flood risk to the surrounding community must always be considered and where the depth of flooding is substantial, these mitigation measures may result in practical constraints to development with significant financial implications. There will always be a residual risk remaining that should be accounted for through effective emergency planning.

The minimum acceptable standard of protection against flooding for new property within flood risk areas is the 1 in 100 year flood event for fluvial flooding, with an allowance for climate change over the lifetime of the development.

8.2 Strategic Approach

Mitigation measures should be considered on a strategic basis that avoids a piecemeal approach and advocates partnership between the LPA and the Environment Agency and integration with wider Environment Agency flood risk management works and strategies (see Appendix B: -)

A strategic approach requires all that are involved in flood risk management consider:

- Avoidance of development in flood risk areas
- The sequential approach to site layout, substituting higher vulnerability development in lower flood risk areas and considering flooding from all sources
- Wherever possible, using open land or green infrastructure to reduce risk, provide compensatory flood storage or serve a sustainable drainage function
- Adopting mitigation solutions that fit with the wider vision of the community in managing flood risk. In significant flood risk areas, developers should aim to reduce risk to the wider community as provided for in the policy aims of NPPF
- Adopting SuDS (see Appendix C: -)
- Preparing emergency flood plans

8.3 Assessment and Mitigation of Fluvial Risk

The mitigation design criterion for development within floodplain areas are generally set to protect against the flood event coinciding with a 1% annual probability of occurrence, including the impact of climate change. Detailed consideration will need to be given to the impact these mitigation measures may have and it is a requirement to ensure that flood risk is not increased elsewhere as a result of development. Compensation measures may take the form of compensatory flood storage as mitigation for loss of floodplain, enhanced flood defences and flood compatible master planning. Compensatory flood storage may be required in undefended flood plains where water is likely to flow or be stored, other measures will be needed in both defended and undefended floodplains. This concept is included in NPPF and ensures that residual risk is appropriately managed in new and existing development.

Before embarking on detailed modelling, and in light of this SFRA, proposals for development should be discussed in detail with the Environment Agency at an early stage.

Detailed FRAs may need to be carried out using hydraulic models. However, before any modelling is undertaken a review of available information should be conducted to assess if modelling is necessary. For fluvial floodplains an assessment of the hydrological regime is required. This should be undertaken using available gauged records and Flood Estimation Handbook (FEH) techniques.

Where hydraulic modelling is necessary, it will need to include structures, such as bridges and weirs that influence flood levels. This modelling should also include floodplains to accurately determine the depth and extent of flooding.

Whenever possible models should be verified using historical records of flooding. Its sensitivity to modelling assumptions and climate change should also be investigated. Mapping the extent of flooding in a specific location will assist the risk of flooding to a specific development to be assessed.

Where allocations remain in high risk flood zone areas for other material considerations, it needs to be demonstrated that technically feasible flood mitigation options are available. A fuller appreciation of the sustainability of the site will be addressed via the Sustainability Appraisal. Mitigation measures must be designed to provide an appropriate level of flood mitigation to a site for the lifetime of the development. At most sites it is technically feasible to mitigate or manage flood risk (if potential off-site impacts are ignored), however the measures required may result in some practical constraints on development and/or require significant financial cost where flood risk is high. The detailed FRA should build on initial potential mitigation measures considered when determining the likelihood of the Exception Test being met as indicated earlier in Section 4.3 of this report.

8.4 Assessment of Surface Water Drainage Issues

Opportunities for developing an Integrated Water or Drainage Management Strategy across development site boundaries should be explored, and a catchment led approach should be adopted. This approach has been recognised in the consultation paper by Defra, Making Space for Water. An integrated approach to controlling surface water drainage can lead to a more efficient and reliable surface water management system as it enables a wider variety of potential flood mitigation options to be used. In addition to controlling flood risk, integrated management of surface water has potential benefits, including improved water quality and a reduction of water demand through grey water recycling.

Integrated drainage systems may be considered suitable for catchments where other development is being planned or constructed, and where on-site measures are set in isolation of the systems and processes downstream.

Surface water drainage assessments are required where proposed development may be susceptible to flooding from surface water drainage systems. The potential impact upon areas downstream of the development, including the impact on a receiving watercourse, also needs careful consideration.

Local drainage issues, together with the specific requirements for surface water drainage systems, will need to be discussed with the Environment Agency, the appropriate Water Utility Company, Local Authority Drainage Engineers and Internal Drainage Board Engineers. Consideration should be given to whether a “Greenfield runoff approach” to the assessment of source control is appropriate. This method is generally satisfactory in the cases where the development is relatively small, isolated from other planned sites and the runoff processes are fully understood.

The FRA should then conclude with an assessment of the scale of the impact, and the recommended approach to controlling surface water discharge from a proposed development.

The recent Government consultation on surface water drainage should be considered when assessing surface water drainage as part of the FRA. In addition, Guidance for Developers and Regulators in Scotland on Drainage Impact Assessments has been produced by the Scottish Environment Protection Agency (SPA) and others, and this is a valuable reference document.

8.5 Flood Zone 3b – The Functional Floodplain

In NPPF only the water compatible uses are allowed in this Flood Zone. Essential Infrastructure can be permitted after the Exception Test is passed. According to NPPF, developers and local authorities should:

- Reduce overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and
- Relocate existing development to land with a lower probability of flooding

In addition, according to NPPF, essential infrastructure should:

- Remain operational and safe for users in times of flood;
- Result in no net loss of floodplain storage;
- Not impede water flows; and

- Not increase flood risk elsewhere.

Functional floodplain should be considered as essential green space infrastructure and be retained for the natural use of flood water wherever possible.

8.6 Flood Zone 3a – High Probability

NPPF states that the water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the sequential process. According to NPPF, highly vulnerable development is not permitted. Essential infrastructure and more vulnerable development need to pass the Exception Test, while essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

Developers and local authorities should implement the following policy aims:

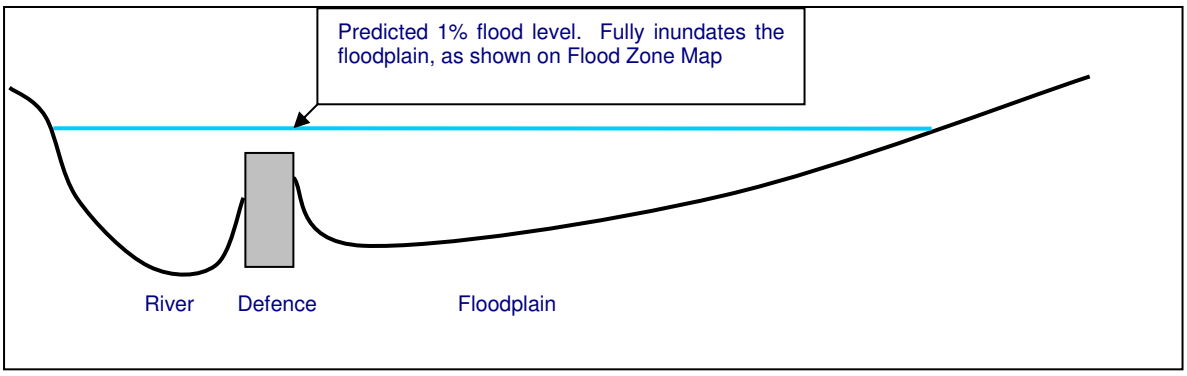
- Reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques;
- Relocate existing development to land in zones with a lower probability of flooding; and
- Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage

The delineation of the subset zones of High Risk Zone 3 may be sufficient to allow the spatial planning process to continue, with development steered away from these high risk zones. However, regeneration of land or change in land use behind existing defended areas in the High Risk Zone will continue to require a more detailed assessment of the flood risk (i.e. whether the scale of risk is worth taking, and how sustainable and effective the mitigation measures would be (i.e. whether the risk could be managed). Where, due to wider sustainable development reasons, there are no other suitable sites available in lower risk zones then an assessment of the current and future risk considering defences within Flood Zone 3 is required. NPPF Technical guidance includes some advice on managing residual flood risk.

It is for the developer to demonstrate how in planning terms this safety can be achieved and how the residual risks will be managed. A clear distinction between design flood standards of protection and the management of loss of life should be explored in the detailed FRA. A greater reliance on flood warning may be required, which is not always a tangible alternative to accepting a lower design standard of protection.

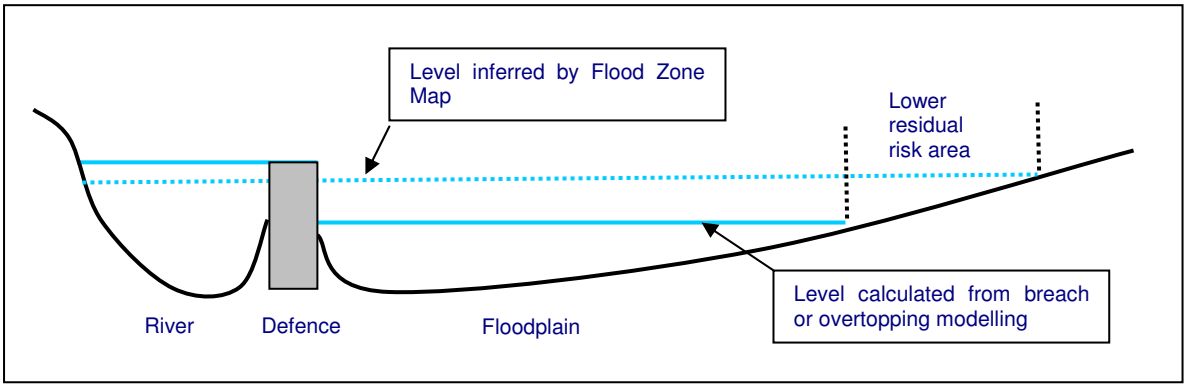
In the context of this discussion, an undefended area of floodplain as shown in Figure 8-1 below is considered to be an area where the water level for the 1% event will be similar to that in the relevant watercourse. These areas may be entirely undefended or if defences are present they are discontinuous or constructed to a low standard. Figure 8-1 illustrates the case where the standard of protection is low and floodplain small and fills to the same level as the river.

Figure 8-1: Illustration of the Undefended Area Case



A defended area as shown in Figure 8-2 below is considered to be an area of floodplain where the defences will result in a water level for the 1% event that is considerably lower than in the source watercourse. This means the defences substantially (but not necessarily completely) mitigate the flood risk associated with the 1% event. These areas will be defended to a minimum standard promoted by Defra, but not always necessarily to the 1% standard. Figure 8-2 illustrates the case where the overtopping or breach volume is small compared to the floodplain receptor and allows a refined assessment of residual risk.

Figure 8-2: Illustration of the Defended Area Case



8.6.1 Undefended Areas – Flood Risk Mitigation

Within undefended or poorly defended Zone 3a areas, floor levels for housing developments should be situated above the acceptable standard of safety with sufficient additional freeboard to account for uncertainties in flood level prediction and climate change.

In accordance with NPPF, development within Zone 3a may require flood risk management measures, constructed with the operating authority's satisfaction with a dedicated financial sum to fully fund whole life maintenance and future climate change adaptability costs. The following paragraphs help to define an appropriate standard of flood risk mitigation in undefended areas in the context of this SFRA.

The Sequential Test should be applied within the development site area, and it is considered appropriate to direct more vulnerable land uses to parts of the site at less probability and residual risk of flooding. The lower floors of buildings in areas at both medium and high probability of flooding should seek to develop water-compatible and less vulnerable land uses, including car parks or other public areas.

Housing developments (more vulnerable development) should provide a minimum habitable space floor level above the estimated 1% year water level with the addition of allowances for modelling uncertainty and climate change (i.e. the freeboard). This may be achieved by providing car parking or other public areas at ground floor level.

Employment development (less vulnerable development) should provide a similar standard of flood defence as housing developments. Within undefended or poorly defended Zone 3a areas, employment development should remain dry during the 1% event (or breach scenario where defences are in poor condition), with sufficient freeboard to account for uncertainties in flood level prediction and climate change. Developers will need to carefully consider the commercial viability of developing in these areas. In exceptional circumstances, where there is significant planning justification for development and the provision of this standard of defence is not feasible, a greater acceptance of flood risk may be permitted for less vulnerable development in areas of high probability of flooding with the focus on providing safety to occupants, flood proofing and designing buildings to minimise flood damage.

Flood proofing may be considered in circumstances where there is a low probability of limited shallow depth water entry and buildings are not subjected to severe inundation depths. This type of construction is designed to reduce the consequences of flooding and facilitate recovery from the effect sooner than conventional buildings.

This may be achieved "through the use of water-resistant materials for floors, walls and fixtures and the siting of electrical controls, cables and appliances at a higher than normal level." and flood resistant construction to either reduce the amount of water or prevent entry of water into a building where resistant techniques are used. A means of safe access and egress in times of flooding must be provided, especially when considering those with restricted mobility.

Further information on resistance and resilience techniques is provided by Defra in their recent publication titled "Improving the Flood Performance of New Buildings – Flood Resilient Construction" and this is available on their website.

Whilst the basic level of protection afforded to residential and commercial development is the same, it is clear that approaches to how residual risk is managed may differ between these two types of

developments. For residential development residual risk is a societal issue, for which a presumption of avoidance and removal is appropriate. Hence a significant freeboard should be incorporated into housing development floor levels, whereas for a commercial property the end user and insurer can assess and transfer this residual risk as appropriate. Therefore commercial and employment uses have a suitably different approach to the management of the residual risk, above that provided by the basic mitigation works. The onus would be on the local authorities to determine whether these risks are acceptable, in conjunction with advice from the Environment Agency. NPPF advocates a risk based approach linked to vulnerability, and does not provide a prescriptive set of flood protection standards. Wherever possible as high a standard should be provided, but in exceptional circumstances, where alternative or complementary flood risk management measures can be taken and are sustainable, a lower standard may be acceptable. Care must be taken that such an approach would not result in future public expenditure on retrospective flood alleviation measures. Therefore this approach is exceptional and only applicable in limited locations where the flood risks are fully understood.

Isolated small greenfield developments may be sustainable in terms of their impact on floodplain storage and conveyance, however the cumulative effects of many small developments can be large and greenfield sites must be viewed within a wider perspective.

8.6.2 Defended Areas

Within defended areas flood risk is primarily associated with overtopping and breach of defences (and localised flooding associated with drainage systems in some locations). These risks are related to the likelihood (standard of protection and structural integrity of defences) and consequences of flooding (depth, speed and duration of flooding, velocity of flood waters, and land use within defended area).

The likelihood of overtopping can be estimated by comparison of modelled water levels (where available) and defence crest levels. An indication of the likelihood of defence breach can be gained by reviewing the flood defence condition data held within the National Flood and Coastal Defence Database (NFCDD), as discussed in Section 3 of this report, and more detailed surveys and investigations undertaken by the Environment Agency and/or others. The consequences of defence overtopping or breach failure can be estimated using flood inundation modelling and mapping.

For developments to proceed it must also be shown that the development will not increase flood risk elsewhere through a loss of breach storage or conveyance.

8.7 Residual risks in Defended Areas

8.7.1 Overtopping

Where assessments show an area to be at risk of defence overtopping in the 1% event (with climate change), measures should be employed to mitigate the risk. Where floor level raising is the preferred mitigation technique, minimum floor levels for housing developments should be set above the estimated water level that would result behind the defences (with an allowance for uncertainty and climate change). In exceptional circumstances, where there is significant planning justification for development and the provision of this standard of risk mitigation is not feasible, a lower degree of flood risk mitigation may be permitted in employment developments with the focus on providing safety to occupants, flood proofing and designing buildings to minimise flood damage.

Assuming it can be demonstrated that occupants remain safe a maximum inundation depth of 0.6 m may be considered appropriate for the 1% event with the addition of allowances for modelling uncertainty and climate change. Minimum floor levels may be lower than the main river level if the floodplain is large.

Where the defences consist of earth embankments, overtopping of the defences is likely to lead to erosion and weakening of the defence structure. In these circumstances failure of the defences is considered highly probable and an assessment of the consequences of defence breach is also required.

8.7.2 Breach

NPPF requires a consideration of residual risks over the lifetime of the development. For a defended site these risks include the risk of defences breaching.

Breach of defences is more likely if they are in poor or very poor condition. The condition and standard of defences may change over the lifetime of the development depending on their maintenance and management. Defences which are currently in good condition are less likely to breach in the short term but should they deteriorate the development could be at risk of flooding due to breach in the future.

Flooding following a breach in defences can be very quick with high velocity floodwaters leading to deep flooding which may remain for some time depending on the site drainage and topography. Occupants and users of a site need to remain safe and identification of the rapid inundation zone is required. Inundation areas would typically be assessed in a Level 2 SFRA.

Design of a site can help to reduce risks from defence breach for example minimum floor levels in housing developments should be set above the estimated maximum breach water level for the 1% event with allowance for climate change and other uncertainties

The effects of land raising within defended areas on potential breach risk also warrants careful consideration in the flood risk assessment. The potential for increasing breach related flood risk elsewhere is directly related to the loss of breach storage volume and conveyance, and single, small-scale developments are less likely to have a significant impact. However, the cumulative effect of individual development proposals needs to be considered. Quantitative assessment of these effects may require detailed breach modelling to be undertaken in individual flood risk assessments. This guidance is not restricted to Zone 3a and applies to any site that is located with a defended area that is at risk of flooding from defence failure.

8.8 Public Safety and Rapid Inundation

For all Zone 3a allocations, and particularly in defended areas where a development site is close to a defence (i.e. within 500m), consideration must be given to residual risks and the risk to public safety associated with access and egress from properties. Residual risks are those associated with very low likelihood events, such as events of frequency less than 1% annual exceedance probability and failure of defences where defences provide a high standard of protection.

Development should not be sited where these risks unduly threaten public safety and/or the structural integrity of buildings and infrastructure. Early discussion with the Environment Agency, LPA and County Emergency Planning Officer is required in the consideration of the depth of flooding, flow velocity, rate of inundation and safe access / egress to assess these risks. This assessment is particularly applicable to areas at risk from both breach and overtopping.

There is a range of research and guidance available on flood hazards and public safety. Defra / Environment Agency Flood and Coastal Flood Defence Research and Development Programme, Project FD2317, Flood Risks to People consolidates flood hazard research from many sources.

The most recent flood hazard formula proposed by Phase 2 of the Risks to People Project is:

$$\text{Flood hazard} = d\,(v+0.5) + DF$$

Where:

- d is depth m
- v is velocity ms-1
- DF is the debris factor with a value between 0 and 1

A number of flood hazard thresholds have been identified these are based on a combination of flood depth and velocity and are shown in Table 8-1 below.

Table 8-1: Flood Hazard Thresholds[a]

Flood Hazard (d(v+0.5)+DF)	Description
0	No Hazard
0 to 0.75	Very Low Hazard
0.75 to 1.5	Dangerous for some – includes children the elderly and the infirm
1.5 to 2.5	Dangerous for most – includes the general public
Over 2.5	Dangerous for all – includes the emergency services

a. From FD 2320 Flood Risk Assessment Guidance for New Development Phase 2. DEFRA/ EA Flood and Coastal Defence programme TR2 (Technical reports 2), October 2005. (Available from http://www.hydres.co.uk/)

For the purpose of the SFRA it is considered appropriate to provide a low hazard environment in access and egress routes associated with new housing developments. Environment Agency guidance suggests that all development should have a dry access and egress in the 1% event.

8.9 Other Known Flood Risk Areas Including Internal Drainage Districts

Sites that are situated upstream of an area that is known to be susceptible to localised flooding (e.g. as a result of problematic surface water drainage) must be managed effectively to ensure that the impact upon downstream properties is fully mitigated. Wherever possible, this should be achieved through the implementation of a sustainable drainage or flow retention system, constructed within the boundaries of the development site.

The capacity of drainage infrastructure is often limited and at or near capacity under existing conditions. Development that leads to increased peak runoff within the drainage catchments may lead to infrastructure capacity being exceeded, with the potential for increased flood risk. In adopting the precautionary approach it is therefore considered prudent to manage all development within Internal Drainage Districts (IDDs), to ensure peak discharges do not increase and potential impacts on downstream properties are fully mitigated. Wherever possible, this should be achieved through the implementation of a sustainable drainage or flow retention system, constructed within the boundaries of the development site. Early discussion is needed with the Environment Agency and the Internal Drainage Board (IDB) where appropriate.

A flood risk assessment will be required in each instance to design appropriate mitigation measures and demonstrate that the development will not adversely affect existing flooding conditions. The FRA should define and address the constraints that will govern the design of the drainage system.

The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography, geology (soil permeability), and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined, and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential. In these areas a flood risk assessment will be required that demonstrates that the proposed development will not adversely affect existing flooding conditions.

Prior to the planning application stage, discussions should be held with the Environment Agency, LPA, IDB and Water Company to ascertain the specific nature and most appropriate means of managing the flood risk.

The integration of drainage management is highlighted within the Defra strategy for flood and coastal erosion risk management in England, detailed within the consultation document 'Making Space for Water'. As discussed elsewhere in this report, the strategy aims to achieve better overall management of surface water drainage through better co-ordination between the different bodies.

Where development is proposed within an IDD or may impact upon its drainage, the relevant IDB should be consulted in each instance to ensure the development is compatible with all drainage systems. There may be instances where additional drainage system capacity is available and increased peak runoff is acceptable, but these areas are exceptional, can only be identified by the relevant IDB and development proposals will still require a detailed flood risk assessment.

8.10 Mitigation Techniques

Table 8-2 provides links to the evidence in the Bradford SFRA, to identify what development could be seen as appropriate within a certain flood risk area and what mitigation measures could potentially be adopted to reduce the level of risk. As above, all mitigation measures should fit in with the wider strategic approach advocated for a community and ensure that there is no increase in flood risk to the surrounding community. The developer should liaise closely the Environment Agency and Development Management as to what mitigation measures may be suitable.

8.10.1 Reducing Flood Risk through Site Layout and Design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. This includes flood risk from rivers and surface water management (see section 3.8).

NPPF Technical Guidance outlines a sequential, risk-based approach which should be applied to try to locate more vulnerable land use to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas.

Waterside areas, or areas along known flow routes, can be used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

The Environment Agency will have to consent to any works within 5 metres of a main river. It is likely that they will object in principle to any development within these areas.

The Royal Institute of British Architects (RIBA) have produced a guidance document *'Designing for Flood Risk'* which can aid this process. The guidance document can be found at: http://www.architecture.com/FindOutAbout/Sustainabilityandclimatechange/Flooding/DesignGuide.aspx

8.10.2 Modification of Ground Levels

Modifying ground levels to raise the land above the required flood level is a very effective way of reducing flood risk to the site in question.

However, in most areas of fluvial flood risk, conveyance or flood storage would be reduced by raising land above the floodplain, adversely impacting on flood risk downstream. Compensatory flood storage must be provided, and should be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary (unless the site is strategically allocated).

Where the site is entirely within the floodplain it is not possible to provide compensatory storage at the maximum flood level and this will not be a viable mitigation option. Compensation schemes must be environmentally sound.

The need for compensatory storage must been discussed at the earliest stage of planning as this will be a major constraint as this requirement may have significant implications for the yields achieved for individual sites due to the associated land take this may require.

8.10.3 Raised Defences

Construction of raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain.

Temporary or demountable defences are not acceptable flood protection for a new development unless flood risk is residual only.

8.10.4 Developer Contributions to Flood Defences

In some cases, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both the development in question and the local community.

8.10.5 Building Design

The raising of floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood. If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable, they should be raised to 600mm above the maximum water level during a 1 in 100 year flood event plus climate change. This additional height that the floor level is raised is referred to as the 'freeboard'.

Depth maps can be produced from flood modelling studies and would provide an indication of the height of land raising required to lift the development out of the 1 in 100 year event plus climate change. Whilst this would provide an early indication, detailed and up to date modelling would still be required to define these levels further.

Making the ground floor use of a building water compatible (for example a garage), is an effective way of raising living space above flood levels.

Putting a building on stilts is not considered an acceptable means of flood mitigation for new development. However it may be allowed in special circumstances if it replaces an existing solid building, as it can improve flood flow routes. In these cases attention should always be paid to safe access and egress and legal protection should be given to ensure the ground floor use is not changed.

8.10.6 Resistance and Resilience

There may be instances where flood risk remains to a development. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk in a 1 in 1000 year event. In these cases (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not be relied on as the only mitigation method.

The 2007 document 'Improving the Flood Performance of New Buildings' provides further details on possible resistance and resilience measures (Communities and Local Government (2007) *Improving the Flood Performance of New Buildings – Flood Resilient Construction).*

Temporary Barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale temporary snap-on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

Wet-proofing

This involves designing interiors to reduce damage caused by flooding, for example:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level
- Water-resistant materials for floors, walls and fixtures

Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA.

8.11 Making Development Safe

8.11.1 Safe Access and Egress

The developer must ensure that safe access and egress is provided to an appropriate level for the type of development. This may involve raising access routes to a suitable level.

As part of the FRA, the developer should review the acceptability of the proposed access in consultation with the Environment Agency.

For the purpose of the SFRA it is considered appropriate to provide a low hazard environment in access and egress routes associated with new housing developments. Environment Agency

guidance suggests that all development should have a dry access and egress in the 1 in 100 year event.

Greater depth and velocity may be permitted where elevated and safe access / egress to safe ground are provided.

8.11.2 Flood Warning and Evacuation

Emergency/evacuation plans should be in place for all properties, large and small, at residual risk of flooding; developments which house vulnerable people (i.e. care homes and schools) will require plans that are more detailed.

8.12 Making Space for Water

8.12.1 Opportunities for River Restoration and Enhancement

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should look at opportunities for river restoration and enhancement as part of the development. Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

8.12.2 Opportunities for Floodplain Restoration

One objective NPPF is to safeguard from development land that may be required for current or future flood management. In areas of very high flood risk there may be a strong case for allowing previously developed sites to return to Functional Floodplain in urban areas where they can act to convey and store flood water and reduce risk to current development. Information has been provided in this SFRA to allow BMDC subdivide flood zone 3a into 3a and 3ai, where 3ai is existing developed areas in flood zone 3a that are at risk of flooding a 5% (1 in 20 year) annual probability flood event. This highlights areas where existing development could be restricting flood flows and water storage. Should sites in flood zone 3ai become available for new or further development (e.g. as brownfield sites) then both the risk at the sites and their role in managing flood risk in the surrounding area should be carefully considered

8.12.3 Buffer Strips

Developers should set back development from the landward toe of fluvial defences (or top of bank where defences do not exist) and this distance should be agreed with the Environment Agency. This provides a buffer strip to ‘make space for water’, allow additional capacity to accommodate climate change and ensure access to defences is maintained for maintenance purposes. Buffer strips are also beneficial to enable protection and enhancement in the river corridor.

Table 8-2: Possible mitigation measures

Flood Source	SFRA Data Source	Risk Zone	Appropriate Development [1]	Comments	Possible Mitigation
Fluvial Depths and Hazards	Depth and Hazard Maps	Flood Zone 1	EI, WC, HV, MV and LV	All development is viable within Flood Zone 1; however other sources of flooding should be investigated.	None required for fluvial but may be for other sources. Refer specifically to CDAs.
		Flood Zone 2, <0.3m depths and/or Very Low Hazard	EI, WC, HV, MV and LV	Low depth and hazards can be manageable with minor mitigation required	Sequential approach to site layout.
		Flood Zone 2, >0.3 depths, Dangerous for some and/or Dangerous for all	EI, WC, MV and LV	All development must be designed to remain safe up to the 1 in 100 + climate change event, however residual risks must be considered if the development is situated behind defences.	Sequential approach to site layout. Raising floor levels may be a possibility. Additional measures can be put in place to reduce damage to existing properties and increase the speed of recovery (i.e. temporary and permanent barriers and wet-proofing). These measures should not be relied on as the only mitigation method. Emergency planning must be considered and safe access and egress routes should be identified.
		Flood Zone 3, 0.3–1m depths and/or Dangerous for some	EI, WC, MV and LV	Sustainable mitigation and flood risk management may be feasible for both housing and employment purposes. There is a greater likelihood of passing the Exception Test. Areas may still have residual risks	Sequential approach to site layout. Raising floor levels is acceptable and they should be raised to 600mm above the maximum water level during a 1 in 100 year flood event plus climate change. Compensatory flood storage must be provided, and should be on a level for level, volume for volume basis. Emergency planning must be considered and safe access and egress routes should be identified.
		Flood Zone 3, 1–1.5m depths and/or Dangerous for most	EI, WC and LV	Mitigation is likely to be costly and may not be economically justifiable for low value land uses. Housing allocations are not suitable. The likelihood of passing the Exception Test is lower.	Floor level raising for employment purposes is unlikely to be economically viable and employment allocations should be reconsidered in favour of alternative lower risk sites. Emergency planning must be considered and safe access and egress routes should be identified. Opportunities for floodplain and river restoration and/or buffer strips should be investigated.

Flood Source	SFRA Data Source	Risk Zone	Appropriate Development [1]	Comments	Possible Mitigation
		Flood Zone 3, >1.5m depths and/or Dangerous for all	None	Flood risk mitigation measures are unlikely to be economically justifiable and all development should be avoided. Development is unlikely to be sustainable and the likelihood of passing the Exception Test is low.	Large mitigation schemes would be required including raised defences. However, this is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. Emergency planning must be considered and safe access and egress routes should be identified. Opportunities for floodplain and river restoration and/or buffer strips should be investigated.
Surface Water	EA National Surface Water Map	High, Medium and Low Critical Drainage Areas	EI, WC, HV, MV and LV	Although surface water flooding will not directly impact on the spatial allocation of development, it should be considered within site layout. Surface water will also need to be controlled on site.	Opportunities should be sought to open up land were surface water is expected to flow or pool. SuDS should also be adopted to reduce risk on site and to the surrounding community by first storing water and managing run-off rates. The additional guidance for developing in CDAs should be considered if appropriate.
Canals	Residual Risks (needs Level 2 SFRA)	Direct and Indirect	EI, WC, HV, MV and LV	Flood risk from canals is residual. Although this will not directly impact on the spatial planning of development, it should influence building design and finished flood levels.	The risk of canals should be mitigated through increasing the freeboard of proposed development finished floor levels. Possible increase in flood level if a breach occurs. If a development is situated directly adjacent to a canal, flood warning would not be beneficial as breaching would be sudden. However, raising the awareness of the risk is critical.
Reservoirs		-	EI, WC, HV, MV and LV	Flood risk from reservoirs is residual. Although this will not directly impact on the spatial planning of development, it should influence site emergency planning. Smaller reservoirs could potentially pose the greatest risk.	The risk of flooding should be assessed as part of the FRA. Smaller reservoirs should be assessed to identify the risk and appropriate mitigation put in place.

[1]EI = Essential Infrastructure, WC = Water Compatible, HV = Highly Vulnerable, MV = More Vulnerable, LV = Less Vulnerable

Check with Table 3 of NPPF Technical Guidance to see if Exception Test is required.

9 MAPPING SFRA FLOOD RISK

This section contains information and guidance on the reason for using GIS layers, types of SFRA flood risk layers available, what they show and how they may be interpreted to assist the sequential approach.

Key messages:

SFRA flood risk GIS layers provide a valuable source of current and future flood risk information, to assist with the sequential approach sieving process.

The suite of GIS layers should be viewed collectively and not as individual layers in isolation.

These layers are appropriate for early and strategic consideration of potential development areas / sites and related broad scale management decisions.

9.1 Introduction

The investigation and identification of the extent and level of flood risk to an area is assessed primarily geographically. Whilst the Environment Agency's Flood Zone Maps are very useful in this respect in showing indicative land use planning zones as required by NPPF, they are a starting point in the consideration of flood risk in a particular area.

These Flood Zone Maps should be used primarily to enable the sequential test to be carried out, firstly in avoiding inappropriate development and then secondly, to seek compatibility between flood risk vulnerability and flood zones as required in Table 3 of NPPF Technical Guidance.

However, consideration of other flood risk factors is also needed such as:

- Presence of defences
- Functional floodplain
- Flooding from other sources

At this SFRA level, it is not appropriate to look at flood risks in detail for individual development allocations, as this is a requirement of the site specific FRA and will be undertaken by developers in respect of specific development proposal and prior to submitting a planning application.

However, there is a need to undertake a broad assessment of flood risk issues, at the SFRA level, to assist the LA in making the spatial planning decisions required. This will enable a degree of certainty that the proposed development put forward in the LDD, can comply with the sequential and exception tests in NPPF and importantly the developments will be safe for occupants and users.

This broad assessment is assisted greatly by the use of SFRA flood risk layers. A description of the Environment Agency Flood Zone Maps, together with these supporting SFRA Flood Risk Layers and how they may be interpreted is given below.

9.2 Environment Agency Flood Zone Maps

Environment Agency Flood Maps provide an overview of areas considered susceptible to flood risk in the study area as a result of fluvial and tidal flooding. These maps have been prepared in a consistent manner across England and Wales and provide an estimation of the extent of flooding for both the 1% and 0.1% events.

NPPF divides the country into three basic flood zones, Flood Zones 1, 2 and 3, corresponding to areas of low, medium and high flood risk, respectively. The flood zones are based on the Environment Agency's published Flood Maps (which undergo regular updates). Therefore they refer

to the probability of flooding from rivers, the sea and tidal sources (where appropriate) and ignore the presence of existing defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development. They do not consider other forms of flooding and do not take account of climate change.

The Flood Zone Maps, a fundamental part NPPF, are used to determine the need for Sequential Tests and more detailed flood risk assessments.

Version 3.17 of the Environment Agency Flood Zones, provided in June 2010, are the latest Flood Zones in this area.

The Agency Flood Zone layers illustrate:

- Flood Zone 3
- Flood Zone 2

These key layers should be used, for the facilitation of the Sequential Test by planners and developers. This includes classification of vulnerability of development subject to the sequential test.

Table 9-1: Definition of SFRA Flood Zones

Flood Zone		Risk	Annual Probability of Flooding	Comment
Flood Zone 1		Low	Less than 0.1%	Can be defined as areas within the District/Borough Council area located outside either Flood Zone 2 or 3
Flood Zone 2		Medium	Between 0.1% and 1% (fluvial flooding) (or between 0.1% and 0.5% (tidal flooding))	
Flood Zone 3	Flood Zone 3a	High	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	Defined in Table 1 of NPPF Technical Guidance
	Flood Zone 3a(i)	High (Developed area where flood water would flow if not already constrained by develop-ment)	This zone is land with a 1 in 20 or greater chance of flooding.	Defined in section 9.5
	Flood Zone 3b	High (Functional Floodplain)	This zone comprises land where water has to flow or be stored in times of flood	Defined in Table 1 of NPPF Technical Guidance. See section 9.4

9.2.1 Flood Zones 2 and 3 in Bradford Beck

The Environment Agency Flood maps do not take detailed account of drainage and sewer flow and in Bradford Beck these are an important part of the flood risk. With agreement from the Environment Agency, the flood zones in the Bradford Beck area that are used in this SFRA analysis have been

produced for Bradford MDC using a more detailed model. These are appropriate for the SFRA analysis but note they should not be used in their current form for detailed flood risk assessments.

The output from the Bradford Beck model was merged with the EA flood zones (v3.17) at the downstream end of Bradford Beck where it is overwhelmed by flooding from the River Aire. The Bradford Beck 1 in 100 (Flood Zone 3) and 1 in 1000 (Flood Zone 2) outlines had dry islands (<750m^2) and wet islands (<250m^2) removed before being merged with the EA flood Zones 2 and 3.

Other SFRA Layers discussed below should be used to support the Environment Agency Flood Zone Layers in Sequential Testing, particularly where sites within the same Flood Zone must be compared against one another.

9.3 SFRA Layers: Overview

The following GIS Layers have been produced in support of the Environment Agency's latest Flood Zone Maps. These are:

- Functional floodplain (FZ3b) (see Section 9.4);
- Flood Zone 3ai (see Section 9.5);
- Flood Zone 3 plus climate change;
- Naturally Flooded Areas (NFA) – these are areas which would naturally flood and could be safeguarded for flood management purposes;
- NFCDD (version 2.14) defences layer.
- Areas benefitting from defences (ABD)

These layers should be considered as a complementary suite of broad-scale flood risk information sources in support of the Environment Agency Flood Zone Maps and no one layer should be considered in isolation without reference to the others.

The Environment Agency also map:

- Areas Naturally Vulnerable to Surface Water Flooding

This information is not included in the SFRA GIS layers but is discussed in Section 9.6. Bradford MDC have access to this information and surface water flooding should be considered as part of the potential wider flood risk at a site.

The detail provided in the SFRA layers will also facilitate the application of the Exception Test where applicable.

9.4 Delineation of the Functional Floodplain – Flood Zone 3b

NPPF considers the functional floodplain as areas compromising land within Flood Zone 3 where water has to flow or be stored in times of flooding. SFRAs should identify this Zone 3b as land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or at another probability to be agreed between the LPA and the Environment Agency (EA).

The functional floodplain (Flood Zone 3b) has been defined in this SFRA by the following criteria:

- Broad Scale Modelling S2Q20 flood outlines – 5% (1:20 year) flood event, assuming no defences
- Land which provides a specific function for flood conveyance or flood storage (i.e. designated washlands / flood storage areas)
- 1 in 20 year flood outline from detailed Bradford Beck model

This SFRA uses the combined outline for the above datasets to define the Flood Zone 3b extent.

- Developed land is not considered as functional floodplain but is included in the 3ai layer (see below). Built up areas were defined using an urban boundary derived from 1: 10 000 OS mapping and removed from Flood Zone 3b.
- With the exception of Bradford Beck, non main rivers were removed from Flood Zone 3b to avoid uncertainty in floodplain extent due to scale and misalignment, these were left as Flood Zone 3a.

- Major transport infrastructure (e.g. motorways and railways) have been excluded from functional floodplain areas, as well as the removal of 'dry islands' defined using the 'size standards' within the Environment Agency SFRM Specification for Flood Risk Mapping.
- Flood zone 3b was clipped to flood zone 3a

Therefore, as it is critical that the outline for the functional floodplain is as accurate as possible, those areas which are designated as functional floodplain using the above technique but fall on non-main rivers have been removed (except in Bradford Beck).

9.5 Flood Zone 3ai

Flood Zone 3ai comprises **developed land** within Flood Zone 3 where water would flow or be stored in times of flooding if not already constrained by development. In NPPF terms this is part of the formal flood zone 3a but following discussions with the Environment Agency it was agreed that for this SFRA flood zone 3a should be subdivided. Identification of zone 3ai allows Bradford MDC to assess risk within 3a in more detail showing areas where existing development is likely to be restricting flood flows and water storage. Should sites in flood zone 3ai become available for new or further development (e.g. as brownfield sites) then both the risk at the sites and their role in managing flood risk in the surrounding area should be carefully considered. Flood Zone 3ai includes the areas of land that would be in Flood Zone 3b if not already developed. Flood Zone 3ai should therefore be used as an indicator of flood risk, from a modelled 1 in 20 year event, to existing development sites.

Flood Zone 3ai has been defined in this SFRA by the flowing criteria:

- Broad Scale Modelling S2Q20 flood outlines – 5% (1:20 year) flood event, assuming no defences
- 1 in 20 flood outlines from the detailed Bradford Beck model.
- Land which provides a specific function for flood conveyance or flood storage (i.e. designated washlands / flood storage areas)

This SFRA uses the combined outline for the above datasets to define the Flood Zone 3ai extent.

- Developed land included in the 3ai layer were defined using an urban boundary derived from 1: 10 000 OS mapping and removed from Flood Zone 3b.
- Where there is uncertainty in floodplain extent on unmodelled river systems or on minor watercourses, in particular, non-main rivers due to scale and misalignment, the areas are left as Flood Zone 3a.
- With the exception of Bradford Beck, non main rivers were removed from Flood Zone 3b to avoid uncertainty in floodplain extent due to scale and misalignment, these were left as Flood Zone 3a.
- 'Dry islands', defined using the 'size standards' within the Environment Agency SFRM Specification for Flood Risk Mapping, have been removed.
- Critical infrastructure including major transport infrastructure (e.g. motorways and railways) has been included in Flood Zone 3ai areas.
- Flood zone 3ai has been clipped to Flood Zone 3

9.6 Naturally Flooded Areas (NFA)

This SFRA has also identified where it might be appropriate to extend the 5% (1 in 20 year) (or higher) flood outline to areas within Flood Zone 3 to restore or expand the functional floodplain. The ability to identify and safeguard large enough areas against development in rural areas means that existing open land can potentially be used for flood storage, effectively reducing flood risk downstream (see Section 8.12.2). This process assists Flood Zone 3a policy aims, identified in Table 1 of NPPF Technical Guidance, which include:

1. "Reduce the overall level of flood risk in the area through the layout and form or the development and the appropriate application of sustainable drainage systems,"

2. "Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocation and safeguarding open space for flood storage."

In many cases the extent of natural floodplain brought into use during a 5% (1 in 20 year) annual probability flood event is very similar to that used in a 1% (1 in 100 year) event. Differences observed and recorded are usually in terms of increased depth and speed of flow and this is dependent on the topography and shape of land on which water flows through.

It is generally accepted that undeveloped land that floods between a 5% (1 in 20 year) event and a 1% (1 in 100 year) event can be considered as Naturally Flooded Areas. NFA have therefore been defined in this SFRA by the following criteria:

- Flood Zone 3 – 1% (1 in 100 year), assuming no defences.
- Developed land including major transport infrastructure and dry islands have been excluded.
- Areas of functional floodplain have been excluded.

There are small areas of NFA along the outer boundaries of the functional floodplain in a number of locations. These small areas exist where the outline of functional floodplain is very similar to that of Flood Zone 3a and these areas have not been removed from the NFA.

9.7 Areas Naturally Vulnerable to Surface Water Flooding

The areas naturally vulnerable to surface water flooding maps produced by the Environment Agency show surface water flood extent and variation in depths, assuming a 0.5% (1:200yr) rainfall event. The flood water depths are colour coded to represent various depth ranges.

This information is extremely helpful in supporting the Environment Agency Flood Zone Maps to assess where there are potential surface water issues and where more detailed modelling may be required. There are many areas of land outside Flood Zone 3, that are at risk from deep surface water flooding and this needs to be considered as an integral part of the assessment.

It is usual however; that surface water flood risks alone can be effectively mitigated, whereas fluvial flood risks or combined surface water and fluvial flood risk at a particular location can cause serious risks to people and property.

9.8 Climate Change Layer

NPPF requires the sensitivity to new developments of climate change to be considered as part of an appropriate FRA and these layers provide an early indication of this sensitivity. In addition emergency evacuation routes and "high point" areas can be identified at this broad scale and planned for outside of the flood extent, so as not to be overwhelmed and put at risk in the future.

The sensitivity of a particular location and land use to climate change can be factored into decisions regarding floor levels, building uses and safe access and egress etc. Greater changes in depth can be associated with greater increases in flood risk and in these areas (where this risk cannot be avoided, substituted or controlled) mitigation measures are likely to be extensive and, for some developments, the FRA may not be able to demonstrate continued safety for occupants as required by the Exception Test in NPPF.

The sequential approach requires early consideration of the effects of climate change on flood risk. As such, Flood Zone 2 has been used in this SFRA to represent climate change for the 1 in 100 year (1%) flood event apart from in Bradford Beck where the detailed model has been used to provide a 1 in 100 year (1%) plus climate change flood extent.

10 CONCLUSIONS

10.1 Overview of SFRA Outcomes

Bradford MDC is embarking on the development of its LDF to replace their existing UDP. Amongst other things the LDF will provide a policy framework for decisions about the use and development of land. To ensure that the LDFs fully address the requirements of NPPF, this SFRA was commissioned. The SFRA will form part of the SEA which, in turn, will feed into the SA of the forthcoming LDF. As part of the appraisal, the results of the SFRA can be used as an indicator to determine the sustainability of policies and allocations. The use of the word 'sustainable' within the SFRA is in connection with flood risk only. An individual application will need to address other planning issues to be considered sustainable.

Bradford MDC is located within the River Aire and River Ouse catchments. Flood processes and flood risk issues across the Council area are inextricably linked by the River Aire, Ouse and their many tributaries.

This SFRA has taken a significant step forward from the original SFRA undertaken by JBA under PPG 25 in its review of flood risk, to take account of recent guidance and approaches in NPPF. Firstly, Environment Agency Flood Zones have been updated and mapped across the district to provide a broad-scale, high level filter for assessing flood risk in developing areas. In combination with the generic policies set out throughout the SFRA these maps allow for consistent assessment of flood risk and the adoption of sustainable allocations supported by NPPF.

Secondly, this SFRA provides additional information and has been able to develop the understanding of flood risk throughout the council area by providing an array of GIS layers, which include:

- Areas Naturally Vulnerable to Surface Water Flooding; and
- Climate Change layers.

These layers along with the Environment Agency Flood Maps supply the detail and understanding of flood risk across the district, providing the level of detail needed to assess current and future allocations in line with NPPF.

The Council is now able to implement the Sequential Test as a sieving process to avoid inappropriate development in high risk zones. Where this may not be possible due to wider social and economic reasons, substitution of more appropriate development would be appropriate. After the many repetitions of the Sequential Testing and sites have been identified as requiring the Exception Test, SFRA Flood Risk Maps can be used to gain a better understanding of the likelihood of sites passing the test and the level of appropriate mitigation needed to make the site safe.

It is highlighted that there are a range of local and national planning policy which LPAs must consider in the allocation of land for development. NPPF is only one of these policies and is not considered to preclude development within flood risk areas. Where the risk is considered unacceptably high however, the exclusion of development may be deemed to be the only sustainable solution. As discussed the SFRA process is a journey, which involves many iterations of the Sequential Test. This SFRA follows the whole journey without being distracted by the justification of the development under wider drivers which will be considered in the SA. Hence, a discussion and consideration of mitigation measures is included in the SFRA.

When spatially distributing land to broad locations or allocating land in development plans or deciding applications for development at any particular location, those responsible for the decision would be expected to demonstrate through the SEA and SA in combination that there are no reasonable options available in a lower-risk category consistent with other sustainable development objectives. Only once this process has been undertaken can land within the flood zones be considered for development. No allocations for built development will be permitted in Flood Zone 3b apart from water compatible or essential infrastructure when justified by the Exception Test. Development within Flood Zone 3a will only be allowed by the Environment Agency under exceptional circumstances. Climate Change will increase the probability of flooding in the future and

as a result land within High Risk Zone 3 should be safeguarded from development where possible, to obviate the need to return at a later date to upgrade its standard of flood protection.

These are all elements that will need to be considered in the delivery of the Exception Test, but an SFRA needs to be suitably precautionary, applying a longer term holistic approach to ensuring development does not compromise future flood management measures and *vice versa*. The site testing work and application of the sequential/exception test will be carried out in house by Bradford MDC. This level of assessment will support appropriate policies and would provide the evidence for the LPA in reviewing any subsequent planning applications that decide to use the Exception Test to justify the need for alternative land uses in these areas.

It is appropriate to consider undertaking a Level 2 SFRA in specific locations where flood risk has been identified as a critical issue but development is still required to meet the wider sustainable objectives of Bradford MDC.

A Level 2 SFRA will help provide the next stage of information and will further collate the evidence base to facilitate the application of the Exception Test. The investigations carried out within the Level 2 SFRA will also support inform the sequential approach to site layout and the design of possible mitigation measures. Sequential testing to be carried out by BMDC will identify sites and issues from for a Level 2 SFRA and these may include:

- Flood risk from canals
- Flood risk from reservoirs

The SFRA used the most appropriate data and flood risk models to assist in the application of the Sequential Test. However, the detail of flood risk still requires improvement and local investigations. Where uncertainty exists in these datasets a precautionary approach should be taken, and in these circumstances there is merit in more detailed assessments within the context of a FRA. However, for the spatial decision making to be consistent the information in the SFRA is sufficient to apply the Sequential Test. Continued use of the SFRA, engagement of the planning and emergency planning teams in the SFRA development process will ensure that flood risk is considered with the appropriate weight and scale throughout the planning cycle.

Whilst this SFRA has been produced using the most up-to-date national guidance and flood risk data (including climate change), it is recommended that the SFRA should be reviewed and updated on a regular basis. Bradford MDC intend to review the SFRA approximately every 4 years, unless there is a significant flood affecting the areas, giving rise to new information or areas at flood risk, or there are any major national policy changes.

Key messages:

Locate development to avoid flood risk wherever possible;

Opportunities for management actions to avoid, substitute and/or mitigate flood risk can be taken at all levels of the planning process and for all development types in all locations;

Only on completion of the Sequential Test should the Exception Test be used to justify allocations or developments in high risk areas. However, the Exception Test must not be used as a tool to place inappropriate development in high risk areas;

Use a risk based sequential approach in all decision making to minimise flood risk; and

All developments should be safe.

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APPENDICES

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Appendix A: - Flood Risk Zones / Flood Risk Vulnerability Classification

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A.1 FLOOD RISK ZONES

Table A- 1 : Flood Risk Zones - Table 1 of NPPF Technical Guidance

Zone 1: Low Probability

Definition

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

Appropriate uses

All uses of land are appropriate in this zone

FRA requirements

For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea 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 run-off, should be incorporated in an FRA [Flood Risk Assessment]. This need only be brief unless the factors above or other local considerations require particular attention.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development and the appropriate application of sustainable drainage techniques.

Zone 2: Medium Probability

Definition

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

Appropriate uses

The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure listed in…[the Flood Risk Vulnerability Classification, see Table A-2] are appropriate in this zone.

FRA requirements.

All development proposals in this zone should be accompanied by a FRA,. **Policy Aims**

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques.

Zone 3a: High Probability

Definition

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

Appropriate uses

The water-compatible and less vulnerable uses of land listed in Table 2 of NPPF Technical Guidance and Table A-2 of this report) are appropriate in this zone.

The highly vulnerable uses listed in Table 2 of NPPF Technical Guidance and Table A-2 of this report) should not be permitted in this zone.

The more vulnerable and essential infrastructure listed in the Table 2 of NPPF Technical Guidance and Table B-2 of this report) should only be permitted in this zone if the Exception Test is passed. Essential Infrastructure permitted in this zone should be designed and constructed to remain operational and safe for user in times of flood.

FRA requirements

All development proposals in this zone should be accompanied by a FRA, **Policy Aims**

In this zone, developers and local authorities should seek opportunities to:

i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques;

ii. relocate existing development to land in lower Flood Zones; and

iii. Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocation and safeguarding open space for flood storage.

Zone 3b: The Functional Floodplain

Definition

This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 25 (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).

Appropriate uses

Only the water-compatible uses and the essential infrastructure listed in Table 2 of NPPF Technical Guidance and Table B-2 of this report) that has to be there should be permitted in this zone. It should be designed and constructed to

– remain operational in times of flood;

– result in no net loss of floodplain storage;

– not impede water flows; and

– not increase flood risk elsewhere.

Essential infrastructure in this zone should pass the Exception Test.

FRA requirements

All development proposals in this zone should be accompanied by a FRA,. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to:

i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and

ii. Relocate existing development to land with a lower probability of flooding.

Note 1: These Flood Zones refer to the probability of river and sea flooding ignoring the presence of defences

A.2 FLOOD RISK VULNERABILITY CLASSIFICATION

Table A- 2 Flood Risk Vulnerability Classification (Table 2 of NPPF Technical Guidance)

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

Note 1: This classification is based on advice from the Environment Agency on the flood risks to people and the need of some uses to keep functioning during flooding.
Note 2: Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood sensitivity.

(1)DETA Circular 04/00 – para. 18: Planning controls for hazardous substances. www.communities.gov.uk/index.asp?id=1144377
(2)See Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10 for definition. www.communities.gov.uk/index.asp?id=1500757

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Appendix B: - Planning Framework

This section contains information and guidance on: Key links between FRM activities and the wider planning system; current relevant National, Regional and Local planning policies; overview of PPS 25: Development and Flood Risk and the Practice Guide Companion; and the need for a balanced approach when considering flood risk alongside other key sustainable development factors.

Key messages:

- Flood risk is a material planning consideration and should be taken into account early, and at all stages of the planning process;
- Effective land use planning can avoid flood risk to people, property and the environment;
- The needs of flood risk management should be balanced with other social, economic and environmental sustainable development factors in delivering sustainable development; and
- Impacts of climate change need to be planned for and adaptation measures incorporated at all levels of the planning process.

INTRODUCTION

The land use planning process is driven by a whole host of policy guidance on a national, regional and local level. Whilst the majority of these policies are not aimed at mitigating flood risk, there are key links at strategic, tactical and operational levels between land use and spatial planning (Regional and Local Government), and FRM planning (Environment Agency), which should be considered as part of a planned and integrated approach to delivering sustainable development. The sustainability appraisal will help draw together these links and balance the application of wider social, economic and environmental planning policy and guidance. The assessment of flood risk is required at all levels of the planning process and plays an increasingly important role in assisting effective delivery of key planning objectives.

KEY STRATEGIC LINKS BETWEEN FRM AND PLANNING

Making Space for Water recognises the importance of understanding current and future flood risks, and their drivers, including the need for community growth, re-generation and inward investment to deliver sustainable development. Maximising flood risk management opportunities presented by the land use planning system is essential to achieve this objective. However, this is best achieved as part of an integrated planning framework for operating authorities to join forces and adopt a strategic approach as opposed to operating in an uncoordinated way. This planning framework supports the implementation of statutory guidance from Defra and CLG to contribute towards sustainable development, and Government guidance on the management of environmental risks.

The primary reasons of the Environment Agency's strategic assessment of flood risk are to inform their own strategic planning for flood risk management and to inform and influence the decisions and actions of other organisations and the public, in respect of flood risk reduction. Strong links between this process and the local authority planning process are essential.

SFRAs help provide this strong link and are an important vehicle to integrate flood risk management planning, land use development planning and sustainability appraisals. They enable the consideration of key flood risk infrastructure and other flood risk investment decisions and delivery plans, to influence spatial planning considerations and vice-versa. This can be achieved at RSS, LDF/D and Planning Application scales and levels. The SFRA assists the land use spatial planning system to play its vital role in delivering sustainable development by taking full account of flood risk. The SFRA is not a policy document but acts as an evidence base for Bradford MDC.

Further information on the role of SFRAs is available in the joint Defra and EA R&D Report FD2320 and this can be accessed via the Defra website.

A further key role for SFRAs has been suggested by Defra in their "Improving Surface Water Drainage" consultation – February 2008, to identify critical drainage areas and inform the development of surface water management plans to help reduce risks from surface water flooding in urban areas. Flood risk management is not an issue of infrastructure provision, but a constraint that needs a careful hierarchical approach to location, land use and finally mitigation. Further information of levels and content of FRAs is provided in Sections 6 of this report.

NATIONAL PLANNING POLICY

National Planning Policy Framework (NPPF) - 2012

The NPPF is a key part of the UK Government's planning reforms. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs).

The NPPF concentrates on high level national policy and avoids prescriptive guidance. However, some technical guidance has been published alongside the NPPF. As of February 2014 the PPS 25 Practice Guide still applies, however this is due to be incorporated into expanded NPPF Technical Guidance which will then supersede the PPS 25 Practice Guide.

The NPPF is guidance for LPAs to help them prepare Local Plans and take development management decisions.

Flood risk is one of many of policy constraints placed upon the local planning system. Development must facilitate the socio-economic needs of a community, and spatially must sit within an existing framework of landscape and infrastructure. For this reason, a balance must be sought between development need and the risk posed to existing and future development in an area. The role of the Environment Agency is to provide advice to LPAs to ensure the management of flood risk in an effective manner as part of the planning process. The Government has set an objective for the Environment Agency to reduce the risks to people and to the developed and natural environment from flooding. In response to this the Environment Agency has set a target to seek to influence planning activities to prevent 100% of inappropriate development inside floodplains.

Local Plans should take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. Local Plans should be supported by Strategic Flood Risk Assessments and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as lead local flood authorities and internal drainage boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change, by:

- applying the Sequential Test;
- if necessary, applying the Exception Test;
- safeguarding land from development that is required for current and future flood management;
- using opportunities offered by new development to reduce the causes and impacts of flooding; and
- where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to facilitate the relocation of development, including housing, to more sustainable locations.

The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding. If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate. For the Exception Test to be passed:

- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Both elements of the test will have to be passed for development to be allocated or permitted. When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the

Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location;
- and development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and
- it gives priority to the use of sustainable drainage systems.

For individual developments on sites allocated in development plans through the Sequential Test, applicants need not apply the Sequential Test. Applications for minor development and changes of use should not be subject to the Sequential or Exception Tests but should still meet the requirements for site-specific flood risk assessments. In coastal areas, local planning authorities should take account of the UK Marine Policy Statement and marine plans and apply Integrated Coastal Zone Management across local authority and land/sea boundaries, ensuring integration of the terrestrial and marine planning regimes. Local planning authorities should reduce risk from coastal change by avoiding inappropriate development in vulnerable areas or adding to the impacts of physical changes to the coast. They should identify as a Coastal Change Management Area any area likely to be affected by physical changes to the coast, and:

- be clear as to what development will be appropriate in such areas and in what circumstances; and
- make provision for development and infrastructure that needs to be relocated away from Coastal Change Management Areas.

When assessing applications, authorities should consider development in a Coastal Change Management Area appropriate where it is demonstrated that:

- it will be safe over its planned lifetime and will not have an unacceptable impact on coastal change;
- the character of the coast including designations is not compromised;
- the development provides wider sustainability benefits; and
- the development does not hinder the creation and maintenance of a continuous signed and managed route around the coast

Local planning authorities should also ensure appropriate development in a Coastal Change Management Area is not impacted by coastal change by limiting the planned life-time of the proposed development through temporary permission and restoration conditions where necessary to reduce the risk to people and the development.

LEEDS CITY REGION GREEN INFRASTRUCTURE STRATEGY

The Leeds City Region Partnership has supported the production of a 'Green Infrastructure Strategy'. The strategy is not a statutory planning document. However, it identifies where we can add value to existing and future green infrastructure investment and interventions at a city region scale.

Four strategic objectives have been selected to ensure that the strategy delivers the city regions transformational vision for green infrastructure. The objectives identified are:-

- To promote sustainable growth and economic development
- To adapt to and mitigate climate change
- To encourage healthy living and
- To improve biodiversity.

One identified means of adapting to climate change is by enabling the city region to be more resilient to flooding. A range of initiatives and investment programmes were proposed in the strategy to maximise the potential impact of green infrastructure within the city region.

One of the initiatives is the Rivers for Life investment programme. This will establish a coordinated approach to river catchment management and enhancement across the city region. Its main focus will be on the restoration of river channels to reduce flood risk but will also deliver widespread access, recreation and biodiversity benefits through planning and designing for multifunctional benefit.

One of the strategic projects is Fresh Aire. This Project will be a major partnership initiative that will shape and help coordinate all activity within the Aire and Calder river valley system. It will bring together issues of environmental conservation, enhancement and land management. A delivery plan is currently being produced.

LOCAL PLANNING POLICY

Local Development Frameworks

Under the terms of the Planning and Compulsory Purchase Act 2004 each council is required to prepare a Local Development Framework (LDF) to replace its existing Unitary Development Plan (UDP). Amongst other things the LDF will provide a policy framework for decisions about the use and development of land.

The commissioning of this SFRA has been timed to provide flood risk information to assist in the allocation of sustainable development sites within emerging LDFs.

Bradford Metropolitan District Council - Replacement Unitary Development Plan

The Replacement Unitary Development Plan (RUDP), originally prepared under the provisions of the Local Government Act 1985 and the Town and Country Planning Act 1990, is currently in the process of being replaced by the Local Development Framework (LDF). The LDF will take the form of a portfolio of plans and documents made up of several Local Development Documents (LDDs). Some of them will have statutory status (Development Plan Documents) and others will be adopted as local guidance documents. When taken together, LDDs will set out the Council's policies for how it will assess development proposals and direct future growth.

Local Development Framework, Further Engagement Draft – Core Strategy for Bradford – October 2011

The strategy for locating development set out in the Further Engagement Draft Core Strategy identifies the City of Bradford (including Shipley and Lower Baildon) as the prime focus for housing, employment, shopping, leisure, education and cultural facilities. The principal towns of Ilkley, Keighley and Bingley will be the main local focus for a range of activities. However it has been recognised that the principal towns vary significantly in relation to size, setting, characteristics, available land supply, flood risk and impacts on biodiversity. Burley in Wharfedale, Menston, Steeton with Eastburn, Silsden, Queensbury and Thornton are identified as Local Growth Centres, as the most accessible and sustainable local centres located along key public transport corridors.

The basic elements in the hierarchy were first identified in the four spatial options presented within the Spatial Vision and Strategy document in 2008. The options related to the hierarchy in the Yorkshire and Humber Plan, early evidence base documents and an initial appraisal of the land supply. The strategy seeks to focus development in the areas of greatest population growth and housing need and to promote re-use of land and buildings. It also sets out to maximise use of existing infrastructure, reduce the need to travel and encourage use of public transport.

One of the biggest challenges facing the district in the period up to 2028 is how to accommodate a rapidly growing population whilst also responding to the effects of significant changes in its social and demographic profile. The Districts population was estimated to be 512,600 in 2010. It is forecast to be 630,000 in 2010.

Strategic Core Policy 2 relates to climate change and resource use and aims to plan for the adaptation and long term resilience to the impacts of climate change in the district. It commits the Council to working with partner organisations to appraise, reduce and manage all sources of flooding. Strategic Core Policy 6 relates to Green Infrastructure and identifies the river corridors of the Aire and Wharfe as strategic Green Infrastructure assets. The text identifies an 'aspiration to create space for both green and blue infrastructure within the city centre, the Canal Road Corridor and elsewhere within the densely developed urban area'. It recognises that 'creating space for water can manage flood risk, improve water quality and access to waterways, support regeneration and provide wetland habitats and landscape enhancement'.

Policy EN7 in the Environment section of the Further Engagement Draft Core Strategy relates to flood risk. It is based on the guidance in an early draft of the SFRA, the consultation response at the issues and options stage and sustainability appraisal work. The consultation response to the Further Engagement Draft stage is currently being evaluated and work on a paper setting out the approach to sequential testing at a strategic level is ongoing.

Policy EN7 Flood Risk

A The Council will manage flood risk pro-actively and in assessing locations for development will :

1. Integrate sequential testing into all levels of plan-making

2. Require space for the storage of flood water within Zones 2 and 3a
3. Ensure that any new development in areas of flood risk is appropriately resilient and resistant
4. Safeguard potential to increase flood storage provision and improve defences within the Rivers Aire and Wharfe corridors
5. Manage and reduce the impacts of flooding within the beck corridors, in a manner that enhances their value for wildlife
6. Adopt a holistic approach to flood risk in the Bradford Beck corridor in order to deliver sustainable regeneration in LDDs and in master planning work
7. Require that all sources of flooding are addressed, that run-off from new development is minimised and that any need for improvements in drainage infrastructure is taken into account
8. Require developers to assess the feasibility of implementing and maintaining SuDS in a manner that is integral to site design and maximises habitat value
9. Use flood risk data to inform decisions made about Green Infrastructure.

B The Council will not permit development in areas shown as functional floodplain in the Bradford SFRA with the exception of water compatible uses and essential infrastructure.

Draft interim strategy for flood risk management

A draft interim strategy for flood risk management has been produced by the Council and the University of Sheffield Pennine Water Group. The interim strategy describes a process for developing a long term strategy, aligned with the Pitt Review and the Government's response, to manage flood risk from surface runoff, groundwater and ordinary watercourses (small streams). The strategy seeks to develop the most effective ways of managing the different sources of risk and implementing the necessary measures. It provides an initial ranking of the different types of receptors that are vulnerable to flooding.

Balanced and Sustainable Approach

This need for growth and economic development presents both opportunities and challenges for flood risk management The LPA should provide appropriate weight to flood risk alongside other sustainable development factors and where for wider sustainable development reasons, development proceeds in high flood risk areas, NPPF requires that new development should be made safe and not increase flood risk elsewhere.

Having regard to the vulnerability of the site (e.g. residential use, offices, manufacturing etc.) and the nature of the flood hazard (e.g. slow/fast flowing and/or shallow/deep flood water etc.), and with careful planning, appropriate design and layout; developments can meet these requirements. Site use, topography, flood levels, flood defences, floor levels and various mitigation measures are key factors that should be brought together in the flood risk assessment to determine the appropriateness of the development.

Balancing and appropriately weighing key sustainable development factors including flood risk can deliver sustainable growth whist reducing overall flood risks to people and property. Further guidance on flood risk avoidance, substitution and mitigation and the Sequential and Exception Tests required by NPPF is provided in Sections 4 to 7 of this report.

The Shipley and Canal Road Corridor Area Action Plan

The Shipley and Canal Road Corridor Area Action Plan (AAP) is being prepared by the City of Bradford Metropolitan District Council as part of the Local Plan for Bradford. The AAP will provide the statutory planning framework for the area, guiding and co-ordinating future development over the next 15 years. The most recent stage in this process was public consultation on the Issues and Options Report that took place between March and May 2013.

The Shipley and Canal Road Corridor extends from the northern edge of Bradford City Centre to Shipley. It includes Shipley town centre and areas of housing, open space, industry and employment located alongside Canal Road. The Canal Road Corridor is a priority regeneration area in the Bradford district and has been identified as one of four Urban Eco settlement locations within the Leeds City Region.

Bradford Canal

The proposed re-introduction of the Bradford Canal has been a long term ambition for the Council and is identified on the Core Strategy as part of the vision for the regeneration of the City of Bradford. It remains to be established that a re-opened canal is the only, or even the best, means of using the canal alignment as a catalyst for development and a unifying spine for the Corridor. However, with the change in economic circumstances and competing development priorities, the reopening of the canal may not be economically feasible over the next ten years. Therefore, the AAP will explore alternative approaches, with less cost and risk, which could provide similar benefits to the proposed canal.

Bradford City Centre Area Action Plan DPD

The Bradford City Centre Area Action Plan (BCCAAP) is being prepared by the City of Bradford Metropolitan District Council as part of the Local Plan for Bradford. The Area Action (AAP) boundary includes the main shopping, civic, entertainment and central business district of the city centre and also more peripheral areas such as Little Germany, Goitside, and the College and University campuses.

Bradford City Centre is the number one priority regeneration area in the Bradford District and has been identified as an area for significant economic and housing growth in the emerging Local Plan-Core Strategy. The AAP will guide the transformation of the city centre regeneration area up to 2028. It will identify the location of new development and provide detailed policies to help make decisions on planning applications. It will also influence decisions about transport, infrastructure, community facilities, economic development and future investment.

Public consultation on the latest stage of work, Further Issues and Options, took place between March and May 2013. The Bradford City Centre AAP – Further Issues and Options Report built on previous work carried out earlier in the process to allow the Council to consult with key stakeholders with an interest in the area to help identify the key issues facing the city centre and suggested options for addressing these.

Proposed site allocations and boundaries have been identified on a series of plans, one for each of the six neighbourhoods identified as contributing towards the future vision for the City Centre. The neighbourhoods are; the channel, the market, the valley, the learning quarter and the southern gateway. The proposed site allocations will form the basis for sequential testing, following this stage.

Within The Bowl neighbourhood, City Park and the Mirror Pool have been implemented. Here, use of the space and the canvassing of opinion suggests that progress has been made in changing the public perception of water within the City.

The Bradford Beck Project

The Bradford Beck project is one of 25 pilot projects across the UK that have been funded by DEFRA in order to look at new ways of preparing catchment management plans. In order to plan a better future the initiative brought together a wide variety of stakeholders from across the city in early 2012 to create this plan and to align with the strategies of the Environment Agency, Yorkshire Water and Bradford Council. The plan is underpinned by hard data about water quality and the ecology of the Beck system and led by six qualitative visions on how to improve the Beck.

The visions are:

- clean (i.e. free of pollution)
- visible
- accessible
- thriving
- cared for becks
- in a water wise city

These visions came from engaging the people and institutions of Bradford in discussing the Beck and its tributaries as the assets that they are, a system of hidden treasures, instead of mere drainage problems to be culverted over, diverted, and forgotten about. In the next section of this report, these visions are explained and developed into possible actions. These actions are then

built up into a series of activity areas which are some of the first steps to renaturalise and improve the becks and provide an asset that the city can be proud of. They build on past successes with

water management in the city such as the City Park, the Flood Relief tunnel and wetland creation, and are designed to support other activities in Bradford which include the City Centre Plan, the Shipley and Canal Road Corridor Area Action Plan, the New Bolton Woods project, the District Flood Risk and water management approaches, and the Environment Agency's River Basin Management Plan

FLOOD RISK MANAGEMENT DRIVERS

Current Flood Risk Management (FRM) policy drivers are principally related to the need to take account of projected climate change implications and the availability of funding for all operating authorities to be able to invest in the provision of sustainable flood risk management. This includes avoidance, substitution, control and mitigation through land use planning, having regard to flooding from all sources (particularly surface water and not just from rivers), and improving and maintaining existing flood defences where justified, to protect increasingly vulnerable communities. Current key policy related documents provide LPAs with important and valuable knowledge on the strategic direction of flood risk management and assist their strategic land use planning decision making for re-generation, inward investment and growth etc.

Key documents currently influencing FRM policy are:

- Future Water – The Government's water strategy for England – HM Government/Department for Environment, Food and Rural Affairs (Defra) – Published in February 2008;
- Improving Surface Water Drainage – Consultation to accompany proposals set out in the Government's Water Strategy, Future Water – Defra – Published in February 2008;
- Making Space for Water - Taking forward a new Government strategy for flood and coastal erosion risk management in England First Government response to the autumn 2004 - Making space for water consultation exercise – Published in March 2005;
- Adapting to Changing Coastlines and Rivers – Making Space for Water: Strand SD2 Taking forward a new Government strategy for flood and coastal erosion risk management. Developing a Broader Portfolio of Options to Deliver Flooding and Coastal Solutions – Defra – Executive Summary published in July 2006;
- National Planning Policy Framework (NPPF) and accompanying Technical Guidance – published in March 2012;
- Planning Policy Statement 25 (PPS 25): Development and Flood Risk – A Practice Guide Companion to PPS 25 – Department for Communities and Local Government – Published in June 2008;
- Learning lessons from the 2007 floods – An independent review by Sir Michael Pitt – Final Report – Published in June 2008[4]; and
- Catchment Flood Management Plans (CFMPs) and Shoreline Management Plans (SMPs) – currently being produced by the Environment Agency.

NPPF and its associated technical guidance, and the Practice Guide Companion to PPS 25 are considered further in Section 4 to 7 of this report however; it is helpful to consider some relevant key aspects from the other documents at this point.

Improving Surface Water Drainage

The "Improving Surface Water Drainage" consultation document was produced in support of the Government's water strategy and in line with Sir Michael Pitt's initial conclusions. This consultation considers policy measures to improve the way surface water runoff is managed. In particular, it proposes:

(1) issuing Surface Water Management Plans as a tool to improve co-ordination between stakeholders involved in drainage and local management of flood risk;

(2) increasing uptake of sustainable drainage systems by clarifying responsibilities for adoption and management; and

(3) reviewing the ability for premises to connect surface water drainage automatically into the public sewer system.

Current roles and responsibilities are considered along with various options for improving the current surface water drainage situation. In particular, the document recognises that SFRAs and Surface Water Management Plans (SWMPs) already form part of the planning framework and there is an aim to enhance their role and make stronger links between surface water drainage and strategic planning.

Making Space for Water Strategy

The "Making Space for Water Strategy" is a milestone document that confirms the Government's strategic direction for flood and coastal erosion risk management (FCERM). Over the 20-year lifetime of the new strategy, Government will implement a more holistic approach to managing flood and coastal erosion risks in England. The approach will involve taking account of all sources of flooding, embedding flood and coastal risk management across a range of Government policies, and reflecting other relevant Government policies in the policies and operations of operating authorities for flood and coastal erosion risk management.

The 2004 consultation document "Making Space for Water" sets out the following vision:

"…we want to make space for water so that we can manage the adverse human and economic consequences of flooding and coastal erosion while achieving environmental and social benefits in line with wider government objectives."

In other words, the aim of the strategy is to balance the three pillars of sustainability, managing flood risk and ensuring that the social and economic benefits which accrue from growth and development are attained. This balanced approach, integrating sustainable development with responsible risk management, has underpinned this SFRA.

Section 7 of the consultation document deals with measures to reduce flood risk through land-use planning. This section emphasises the Government's commitment to ensuring that the planning system aims to reduce flood risk wherever possible and, in any event, should not add to it. However, it is acknowledged that 10% of England is already within mapped areas of flood risk and that contained within these areas are the brownfield sites which other areas of Government policy has identified as a priority for future housing provision. The document asserts that over the past five years, 11% of new houses were built in flood-risk areas. The document identifies three sets of measures which may be undertaken to manage flood risk when development is sited in such areas:

- Protection measures to provide, at minimum, the standards of protection specified in NPPF;
- Provision of features such as sacrificial areas and compartmentalisation to reduce the consequences of a flood event should one occur (such as functional floodplain); and
- Use of construction techniques that increase the flood resistance and resilience of buildings.

The document proposes that RSSs and LDFs should take full account of flood risk and incorporate the sequential approach in NPPF. Moreover, the document encourages integration with other planning systems, in particular Catchment Flood Management Plans. Use of European Union (EU) funding streams, such as Interreg IIIB is recommended where applicable, to enable Local Authorities to undertake trans-national projects aimed at advancing knowledge and good practice in flood risk management.

The "Making Space for Water: Programme of Work" was developed following consultation and will take account of any relevant recommendations that emerge from the independent lessons learned review into the 2007 floods that affected many parts of England**.** One of Defra's and Communities and Local Government's (CLG) early outputs from the Making Space for Water Programme was the publication, of PPS 25 in December 2006. PPS 25 was then superseded by the National Planning Policy Framework (NPPF) and its Technical Guidance document in March 2012. This work, together with the Practice Guide Companion to PPS 25, which is currently still valid and accompanies NPPF (as of February 2014 although due to be incorporated into the NPPF Technical guidance), forms the Governments required approach to managing and reducing flood risk through the land use planning system.

A valuable piece of work looking at "Developing a Broader Portfolio of Options to Deliver Flooding and Coastal Solutions" has been carried out as part of this programme and will be very useful to local authorities and other operating authorities, in their strategic planning of flood risk management. Outputs from this work are available from Defra.

Quarterly update reports are released providing details of progress made and key achievements. These reports can be access via the Making Space for Water website at http://www.defra.gov.uk/environ/fcd/policy/strategy.htm

The Pitt Review

The "Pitt Review" has been carried out following the severe floods of summer 2007 and is a key document for Local Authorities in their consideration of flood risk management. Sir Michael Pitt was asked by ministers to conduct an independent review of events and report on the lessons that should be learned.

The final report was published in June 2008 after 10 months of evidence collection and consultation. This included examining over 1000 written statements submitted by victims of the floods, considering the experiences of other countries and visiting the communities of the affected areas.

The report presents a schedule of conclusions, many of which relate to local authorities. These conclusions are intended to shape the National approach to flood management and can be accessed via the Defra website.

Pitt's findings, conclusions and recommendations for action are challenging but will be extremely important in guiding local authorities and other operating authorities in their consideration of future flood risk management activities, including land use planning.

ENVIRONMENT AGENCY FRM PLANS, STRATEGIES AND SCHEMES

A number of Environment Agency flood risk management plans, strategies and asset improvement schemes have been carried out over recent years and others are at the planning stage. The latest headline information gathered on these initiatives can be found in their relative Catchment Flood Management Plans (CFMPs) showing the Environment Agency's current Draft Long Term Plan. This plan includes the production of CFMPs and Strategies and delivering Improvement Schemes to rivers and structures.

CFMPs are strategic plans produced by the Environment Agency in consultation with key partners. They assess current flood risks from all forms of flooding across the whole catchment and how those risks may change in the long-term (50 to 100 years). These plans consider relevant multiple sustainability objectives, when exploring and appraising various potential policies for sustainable FRM. They then indicate appropriate FRM policies to help local authorities and other operating authorities to understand the scale and extent of current and future flooding problems from all sources; before taking key decisions on land use, production of FRM strategies and plans, and investment in flood risk management projects or actions, to protect existing and future communities. CFMPs are not designed to inform forward planning decisions on where new development should be located and offer no guarantees about the implementation of flood risk management schemes. However, recognition of these strategic plans is very important to local authority planners when planning for the future and considering long term land use options for re-generation, inward investment and growth.

The CFMPs help to prioritise activities, focus resources where there is greatest need, and determine what flood risk management responses need to be considered further (and which responses will not be effective). The responses to flood risk will be broader than those traditionally used for flood defence to reflect the full range of management options available. CFMPs support an integrated approach to spatial planning and river basin management, in line with the Water Framework Directive and the EU Directive on the assessment and management of flood risk; they cover all geographical areas in England and Wales and are crucial in the planning of sustainable flood risk management. CFMPs covering the Aire and Ouse catchments are still at the draft final stage however; these documents contain valuable information on current and proposed future flood risk management in these catchments and should be used by Councils in their initial planning considerations.

The River Aire and the River Ouse CFMPs are planned for completion by the end of April 2010 and are likely to be revised on a 5-yearly basis. These plans will be a major element in delivering an integrated approach to flood risk. The CFMPs contain a significant amount of flood risk management data and information and are a valuable reference for LPAs. They are strategic planning tools to identify and agree policies for sustainable flood risk management on a river catchment basis over a 50 to 100 year timeframe.

Strategies provide a more detailed understanding of flood process, appraisal of flood risk management measures including the consideration of residual risks such as defence overtopping or breach and a selection of preferences to deliver CFMP policies for specific areas within the catchment.

The Government emphasises the need for early support of RSSs and LDFs. CFMPs should be used at an early stage to inform the formulation of policy options, including allocation of land for development. CFMPs should also be used in SAs and SEAs to test and enhance the robustness of Spatial Strategies, Frameworks and Plans. Spatial planning documents should therefore include aspects of CFMPs that may affect land use e.g. areas at high risk of flooding, areas at residual risk of flooding, and areas where additional flood storage or flooding is necessary or where changes in land management are proposed.

Catchment boundaries often encompass many more than one planning district, therefore it is imperative that the planning process ensures that policies adapted within the current planning timeframe are consistent with the longer term vision for the wider catchment, and take account of the impacts that decisions may have upon adjoining districts.

River Aire and River Ouse Catchment Flood Management Plans

There are two CFMPs which cover the Bradford MDC area – The Aire CFMP and the Ouse CFMP. These CFMPs are investigating what factors influence flood risk at the catchment scale and will assess the impacts that climate change, land use change and urbanisation may have on flood risk over the next 50 to 100 years. The CFMPs will establish a policy framework for flood risk management across the catchment through which future flood defence management strategies and

programmes will be formulated by the Environment Agency and in partnership with key stakeholders. These flood risk management policies should:

- take into account the likely impacts of changes in climate and the effects of land use and land management;
- achieve multiple benefits;
- contribute towards sustainable development.

The CFMPs are currently at draft Final Stage (at the time of writing) and flood risk management policies have been proposed for specific areas of the catchment (called policy units). The CFMPs are programmed for completion by the end of April 2010 and are likely to be revised on a 5 yearly basis. The CFMPs have involved a programme of consultation whereby stakeholders have been given the opportunity to comment and input into the findings, catchment objectives and policies.

The Aire CFMP contains four policy units within the Bradford MDC area, namely:

- Upper Aire,
- Keighley,
- Mid Aire, and
- Bradford.

The proposed generic flood risk management policy option for the Upper Aire and Keighley Policy Units is P5: take further action to reduce flood risk. The Environment Agency's vision for the policy unit is that the communities of Silsden and Glusburn, Keighley and communities along the River Worth will become safer places to live, work and play. The Environment Agency will work closely with their partners to establish a sustainable approach to reducing the risk of flooding from all sources and raise the awareness of flooding to local businesses and home owners. The long term sustainability of the local economy will be safeguarded through our work to reduce the risk of flooding.

The proposed policy option for the Mid Aire Policy Unit is P5: take further action to reduce flood risk. The Environment Agency's vision for the policy unit is that communities along the River Aire will not see an increase in flood risk in the future and where possible flood risk will be reduced.

The chosen policy option for the Bradford Policy Unit is P4: Take action to sustain current level of flood risk into the future. The Environment Agency's vision for the policy unit is that communities will not see an increase in flood risk in the future. Bradford is under pressure for development and regeneration. This provides significant opportunities to work in partnership to manage the sources of flooding effectively and sustainably to ensure that risk to people and property does not increase further.

The Ouse CFMP policy unit present within the Bradford MDC area is 'Wharfe Rural Towns'. The proposed generic flood risk management policy option for this policy unit is P5: take further action to reduce flood risk. The current level of flood risk in this policy unit is such that action should be taken to reduce it. Future flood risk should also be addressed as the increase in properties affected as well as the increase in the number of people exposed to high hazard is substantial.

CLIMATE CHANGE

Recent climate change trends are contained within a UK Climate Impacts Programme document 'The Climate of the United Kingdom and Recent Trends' published in January 2009 and is available on their website. UK Climate Projections (UKCP09) were launched in June 2009.

In recognition of the Governments increasing concerns about the effects of climate change on flood risk management, Defra produced a "Supplementary Note to Operating Authorities – Climate Change Impacts" in October 2006 in which they updated the climate change policy for flood and coastal management. This document is available on the Defra website. In conjunction with Defra, CLG then provided the recommended climate change contingency allowances for sea level rise and precautionary sensitivity ranges for peak rainfall intensities and peak river flows etc. including the consideration of new developments and changes of land use in flood risk areas.

Appendix C: - Sustainable Drainage Systems

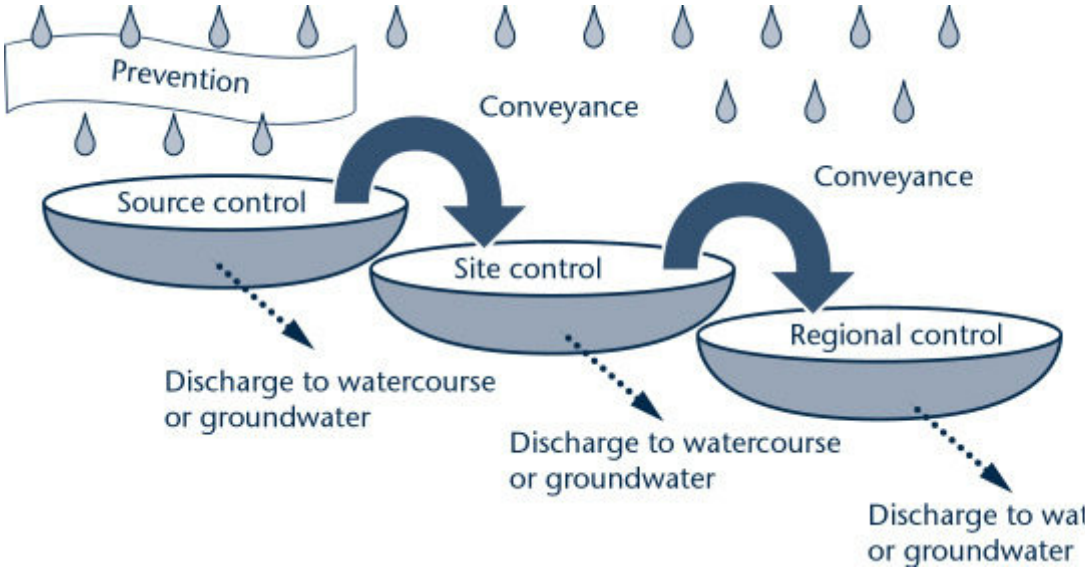
SUSTAINABLE DRAINAGE SYSTEMS

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner.

For Greenfield developments, the aim is to not increase runoff from the undeveloped situation; for Brownfield re-developments, the aim is to reduce existing runoff rates. Wherever possible, this should be achieved through the implementation of a sustainable drainage or flow retention system, constructed within the boundaries of the development site.

There are many different SuDS techniques which can be implemented. As a result, there is no one correct drainage solution for a site. In most cases, a combination of techniques, using the Management Train principle, will be required. Figure G1 shows the SuDS Management Train principle. This is a hierarchy of techniques starting with the need to prevent runoff and pollution using good site design, this is followed by source control (where runoff is controlled at or very near its source - examples include green roofs, soakaways and permeable paving for individual properties), the next stage is site control where runoff is managed at a site scale (e.g. routing runoff to a single soakaway or infiltration basin for the whole site). Finally, regional control is the management of several sites often using a detention pond or wetland [1].

Figure G1: SuDS Management Train Principle [2]



Regarding flood risk, those SuDS with a high/primary process for dealing with water quantity should first be investigated, before other benefits such as water quality and environmental befits are included. SuDS can reduce the amount and rate of runoff by a combination of:

- Infiltration;
- Storage; and
- Conveyance

There are a number of SuDS techniques which could be used individually or as part of a management train, however their suitability relies on the site and catchment descriptors discussed above but also their intended purpose (as shown in Table G1).

1.National SuDS Working Group (2004): Interim Code of Practice for Sustainable Drainage Systems. (www.ciria.org.uk/suds)

2.CIRIA (2008) Sustainable Drainage Systems: promoting good practice – a CIRIA initiative

Table G-1 Suitability of SuDS Techniques

SuDS Technique	Infiltration	Storage	Conveyance
Green Roofs	×	✓	✓
Permeable Paving	✓	×	✓
Rainwater Harvesting	×	✓	×
Swales	✓	✓	✓
Detention Basins	✓	✓	✓
Ponds	×	✓	✓
Wetlands	×	✓	✓

Source: PPS 25 Practice Guide

NPPF stresses that planning authorities should:

- Promote the use of SuDS for the management of run-off.
- Ensure their policies and decisions on applications support and complement the Building Regulations on sustainable rainwater drainage, giving priority to infiltration over first watercourses then sewers.
- Incorporate favourable policies within Regional Spatial Strategies.
- adopt policies for incorporating SuDS requirements in Local Development Documents
- Encourage developers to utilise SuDS wherever practicable, if necessary through the use of appropriate planning conditions
- Develop joint strategies with sewerage undertakers and the Environment Agency to further encourage the use of SuDS.

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