Barnsley Strategic Flood Risk Assessment

Level 1

September 2010

FINAL REPORT

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CONTRACT

This report describes work commissioned by Barnsley MBC under the consultancy agreement dated 19 October 2007. Barnsley MBC's representative for the contract was Kevin Swift (Planning Policy). Steve Rose, Zdenka Rosolova, Abigail Taylor and Stephen Baxter of JBA Consulting carried out the work.

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PURPOSE

This document has been prepared solely as a Level 1 Strategic Flood Risk Assessment for Barnsley Metropolitan Borough Council (MBC). 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

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EXECUTIVE SUMMARY

The purpose of this Level 1 Strategic Flood Risk Assessment (SFRA) is to identify and analyse current and future broad scale flooding issues for proposed development allocation sites/areas in Barnsley Metropolitan Borough Council (MBC) and provide support for further assessment and sequential testing of proposed development allocations. It will form a key component of the council's Strategic Environmental Assessment (SEA), as required for the production of their Local Development Framework (LDF). In turn the SEA will be used to inform each council's Sustainability Appraisal (SA) and selection of specific development allocation sites/areas. The SFRA will be reviewed at an approximately 4 year cycle.

Planning Policy Statement 25 (PPS25) and the accompanying Practice Guide provide the latest Government thinking on development and flood risk. The Departments for Communities & Local Government, and Environment, Food & Rural Affairs came together to produce this policy and guidance in December 2006, in recognition of the critical role that land use planning can play in avoiding and protecting people and property from flooding from all sources, and helping communities to adapt to a changing climate.

Flood risk is a material consideration in planning and Barnsley MBC has a policy in its draft Local Development Framework Core Strategy that reflects the increasing nature of flood risk (from all sources of flooding) within the borough and the importance of a balanced and sustainable approach to ensuring necessary safe re-generation, growth and economic investment across the area

Council members and officers play a critical role in furthering the integration and synergies of land use planning and flood risk management. In order to help better identify these synergies and assist them with their planning and development control decision making; better risk data and information for existing and future communities is required on actual flood risk (as opposed to theoretical risk); this is one of the primary objectives of the SFRA.

The SFRA maps show Fluvial Flood Extent and Depth, Areas Naturally Vulnerable to Surface Water Flooding and Climate Change. They are an essential element to the effective delivery of the flood risk Sequential and Exception Tests for proposed land use allocations, as required by PPS25. They provide a valuable source of broad scale, current and future flood risk information and assist with early and strategic consideration of development allocations and related planning management decisions. In addition they provide valuable information to emergency planners and emergency services organisations in the planning and delivery of their duties and responsibilities. Surface water flooding, in particular, and its greater frequency of occurrence is a growing concern to many local authorities and many are now in the process of developing Surface Water Management Plans to mitigate and manage the impact of this type of flooding.

This SFRA explains current National, Regional and local land use planning and flood risk management policy drivers in respect of potential flooding from all sources. It provides information on key rivers and watercourses and current Environment Agency flood risk management plans, strategies and schemes. The Sequential and Exception Tests are essential requirements of PPS25 and this SFRA explains the Risk Based Sequential Approach in which these tests are carried out for proposed development allocations; and recommends the use of flood risk indicators and a flood risk balance sheet to assist planners in their strategic land use considerations. A suite of SFRA maps across the borough is provided to supplement the Environment Agency's Flood Maps along with information on their use and interpretation. In order to assist local authority planners, development control teams and developers, guidance is provided on undertaking detailed flood risk assessments for specific development proposals and planning applications.

The Barnsley MBC area is experiencing both regeneration and growth pressures and there is a need to provide sufficient homes and jobs to support this growth. This need for growth, re-generation and economic development presents both opportunities and challenges for flood risk management (from all sources of flooding). PPS25 requires that new development should be made safe and not increase flood risk elsewhere and with careful planning, appropriate design and layout (including drainage) etc. developments can meet these requirements.

In order to evaluate sites for development allocation, Barnsley MBC should consider the following:

- Sites put forward for development should be assessed against the SFRA maps. Sites should be selected at lower risk of flooding in preference to higher risk areas. Developers will need to provide sufficient information to enable the Council to assess a Sequential Test

which will demonstrate that there are no reasonably available, alternative sites that are situated in a lower flood risk zone. Where phased development is planned, Sequential Testing for the development should be used to identify those areas where development should be discouraged or avoided.

- Before some sites are allocated and if a site is considered to be critical to regeneration and/or the core strategy, the Council should opt to undertake a Flood Risk Assessment (including sequential and, where necessary, exception tests) in order to first justify the sustainability and the deliverability of the allocation
- Departures from the Sequential Flood Risk Test involving the need for development in higher risk zones need to be justified. A developer will need to work with the council and provide reasoned justification wherever the Exception Test needs to be applied to meet current land use policies.
- The SFRA is a strategic review of flood risk, based on existing available information and does not provide the site specific consideration of flood risk and mitigation measures required of a Flood Risk Assessment. The developer will need to undertake a detailed Flood Risk Assessment to address relevant parts of the Exception Test.
- The developable area may further be reduced by the need for a maintenance easement where there is a watercourse within or adjacent to a site. Typically an 8m access strip, void of development, is required along the bank top for maintenance purposes. This is likely to reduce the available developable area.
- Where residential development in Flood Zone 3 is proposed, passing the Exception Test is likely to be harder and applications are likely to be opposed by the Environment Agency, unless the area is well defended and the Environment Agency is committed to the appropriate maintenance of these defences. Any development planned within Flood Zone 3 will require a detailed Flood Risk Assessment to demonstrate that development is sustainable and safe.
- Where development sites encroach into Flood Zone 3, the Council should consider recommending that higher risk Flood Zone 3 areas should only be developed as water compatible uses or Public Open Space.
- Where employment or residential developments are proposed within higher risk zones, the site specific Flood Risk Assessment should consider the likely depth of flooding as this will indicate the likely extent of mitigation measures required. The depth of flooding can be used as an indication of whether or not the Exception Test is likely to be passed. This will be less likely where the depth of flooding is likely to require substantial mitigation.
- A site specific Flood Risk Assessment should consider all sources of flooding and mitigation measures will be required to compensate for loss of floodplain storage. Depending on the extent of flooding, mitigation measure in these instances may significantly reduce the developable area. Consideration should also be given to the likely impact of development elsewhere. For example, surface water drainage from greenfield development is likely to increase flood risk to neighbouring developments unless surface water drainage is effectively managed.
- The determination of acceptability remains with the Council, and will draw upon the advice of the Environment Agency and the Emergency Planning officer.

Balancing and appropriately weighing key sustainable development factors including flood risk can deliver sustainable growth whist reducing overall flood risks to people and property.

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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
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
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 PPS25 and
- It is presented in one volume reflecting the general needs of Barnsley MBC and incorporates specific flood risk maps for the Council area.

1.1 Background

JBA Consulting was commissioned by Barnsley Metropolitan Borough Council (MBC) to undertake a review of the existing Strategic Flood Risk Assessment (SFRA) and update it, in accordance with the current requirements of Planning Policy Statement 25 (PPS25). 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 each local authority area to support LPA assessment of specific development allocation sites.

Key additional areas of work building on the previous SFRA include:

- Taking account of advances in risk information from data collection and process;
- Inclusion of climate change mapping;
- Provision of flood extent, depth and hazard maps;
- Identification of functional floodplain;
- Consideration of flooding from “other sources”; and
- A greater focus on the application of the PPS25 Exception Test.

It is recognised that considerable land use pressures for re-generation, inward investment and economic growth exist across the borough and this SFRA will inform/support the Regional Spatial Strategy (RSS) and guide council’s in their strategies, policies and decision making in respect of their Local Development Frameworks (LDFs) and Local Development Documents (LDDs).

Much of the Barnsley MBC area is located within the River Dearne catchment, a tributary of the River Don. Western parts of the Council area drain directly to the upper Don. Flood processes and flood risk issues across the Council area are inextricably linked by the River Dearne, its tributaries (including the River Dove and Knoll Beck) and the Upper Don.

The study was carried out according to current best practice and the requirements of PPS25 and the supporting guidance entitled Planning Policy Statement (PPS) 25: Development and Flood Risk - Practice Guide. The emerging Yorkshire and Humber Regional Assembly’s Regional Flood Risk Appraisal and the current Yorkshire and Humber Regional Spatial Strategy (RSS) have also been referred to.

1.2 Study Objectives

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 exceptionally necessary in flood risk areas, the policy aim is to make it safe without increasing flood risk elsewhere. Where possible flood risks should be reduced overall.

The key objectives of this SFRA are to:

- 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;
- 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 wherever possible, sequentially steering development away from areas at highest risk;
- 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;
- Provide data and guidance in the application of the Sequential and Exception Tests for LPAs to assess specific development sites;
- 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;
- 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 Format of the SFRA and Key Outputs

The Level 1 SFRA has been prepared in one volume reflecting the general needs of Barnsley MBC. In addition, specific SFRA flood risk maps of the Council area are provided.

Content and key outputs include:

- Understanding flood risk from all sources;
- Integrating flood risk with local authority land use planning;
- Risk based approach to the SFRA;
- Overview of flood risks for LPAs;
- Data sources and interpretation of maps;
- General guidance for detailed FRAs; and
- SFRA flood risk maps for sites/areas with development potential.

Barnsley MBC intend to review the SFRA approximately every 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.

2 UNDERSTANDING FLOOD RISK FROM ALL SOURCES

This section contains information and guidance on: Key FRM policy drivers, climate change, technical assessment of flood risk and flood risk management activities.

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; and
- Local Authority Planners have a key role to play and can benefit greatly from current flood risk policy guidance and information.

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 presents a risk when people, human and environmental assets are present in the area which 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 due to more frequent 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 can't 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 as it is one of the few activities that can result in the avoidance of flood risk as opposed to other activities that can only hope to 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 where avoidance is not possible is

considered. Only if avoidance and substitution are not possible, **Mitigation** of the risks through a variety of techniques should be used. 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 further explained in Section 4 of this report.

2.2 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 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[1];
- 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
- Planning Policy Statement 25 (PPS25): Development and Flood Risk – Department for Communities and Local Government - Published in March 2010[2];
- Planning Policy Statement 25 (PPS25): Development and Flood Risk – Practice Guide. Department for Communities and Local Government – Published in December 2009[3];
- 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.

PPS25 and the PPS25 Practice Guide to are considered further in Section 3 of this report however; it is helpful to consider some relevant key aspects from the other documents at this point.

2.2.1 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 PPS25 planning framework

and there is an aim to enhance their role and make stronger links between surface water drainage and strategic planning.

2.2.2 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 PPS25;
- 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 PPS25. 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 PPS25 in December 2006 (and subsequent revisions). This work, together with the Practice Guide Companion to PPS25 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

2.2.3 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 has 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.

2.2.4 Catchment Flood Management Plans (CFMPs)

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. 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. The CFMP covering the Don catchment is 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.

2.3 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 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 Regional and 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. Recent climate change trends are contained within a UK Climate Impacts Programme document: The Climate of the United Kingdom and Recent Trends published in December 2007 and is available on their website. The next UKCIP report containing further climate change scenarios and is planned for launch in 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. in Annex B of PPS25. These figures should be used in all aspects of flood risk management including the consideration of new developments and changes of land use in flood risk areas.

Yorkshire and Humber Region's Climate Change Action Plan, was published in 2005 with Yorkshire Forward, the Yorkshire and Humber Assembly and the Government Office for Yorkshire and the Humber being key signatories to the plan. It identified a number of actions for named partners such as Yorkshire Forward, the Assembly and the Environment Agency to deliver. These organisations are currently progressing their actions. The Yorkshire and Humber Assembly's thirteenth scrutiny review is considering how Yorkshire Forward is addressing climate change and in February 2008, the Scrutiny Board identified three lines of enquiry for the review: Climate Change Targets and Regional Performance, Balancing Climate Change Action and Economic Growth and Adapting to Climate Change. This action plan and its review are likely to play an increasingly important role in the future management of flood risk as impacted upon by climate change.

In addition, Yorkshire and Humber Region's proposed Single Integrated Regional Strategy will provide opportunities to bring together climate change adaptation through economic development, spatial planning, housing and transport.

2.4 Basic Elements of Flood Risk Assessment

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

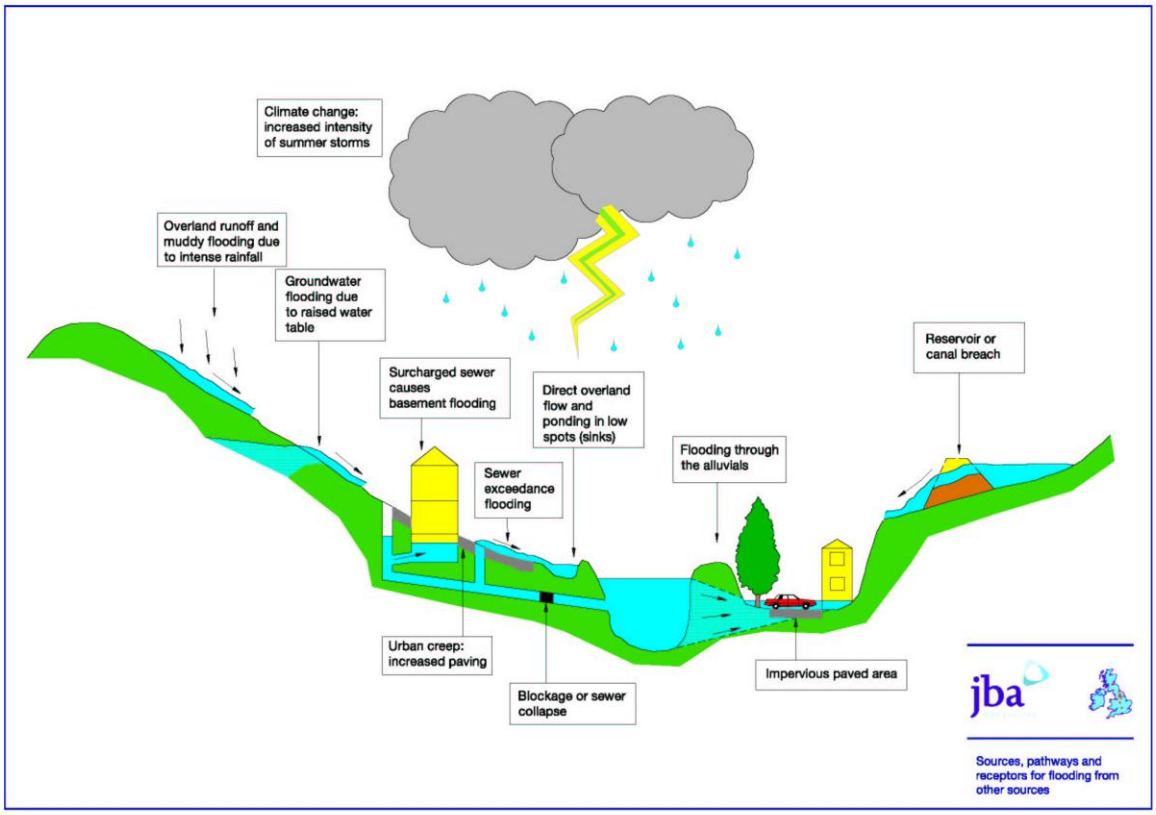
Figure 2-1 below.

With climate change, the frequency, pattern and severity of flooding are 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;
- Surface water flooding occurs when heavy intense rainfall falls on a land surface. Much of this water will not be able to infiltrate into the land surface (or enter local drainage systems) and will move, as rapid overland flow, downslope under gravity to reach the receiving drainage systems or pool in topographic depressions;
- 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 will become larger with a more energised climate.

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. Therefore a clear reminder was provided 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 has recommended that the Environment Agency should proceed in developing a map of these sources and it is believed that this may be available as early as autumn 2008.

In more recent SFRA updates JBA have utilised a screening technique based on the application of a blanket rainfall over a drainage area, and the simulation of its passage through the urban environment. This was developed from research for the Making Space for Water programme and the SFRA maps contained within this report are a result from much of this work.

Increases in flooding impacting on 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.

2.4.1 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.

2.4.2 Flooding Impacts on People

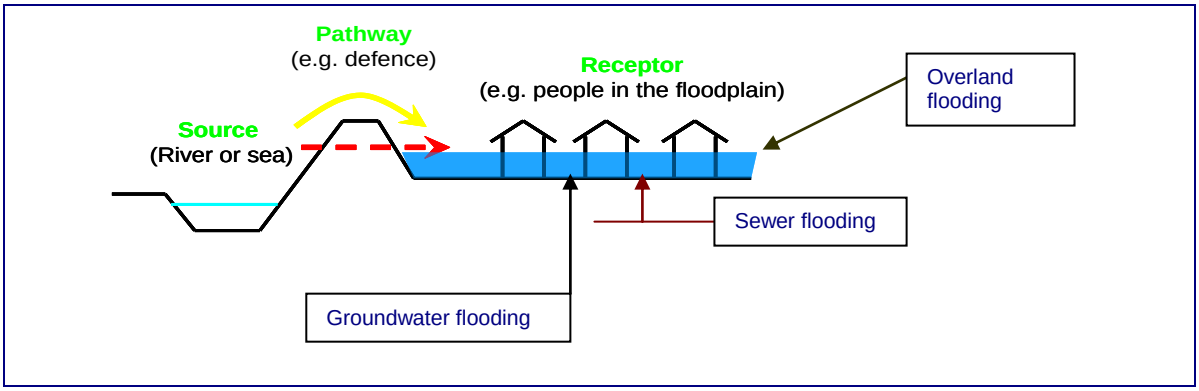
Impacts on people can be severe. In small urban or steep upland catchments which have a very rapid response to rainfall, or with flooding due to infrastructure failure, flood waters can rise very quickly and put life at risk. Even shallow water flowing at 2 metres/second can knock children and many adults 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.

2.4.3 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.

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 can 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.

2.4.4 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. Considered over the lifetime of development, such an apparently low-frequency or rare flood has a significant probability of occurring. For example a 1% flood has a 22% (1 in 5) chance of occurring at least once in a 25-year period (the period of a typical residential mortgage) and a 53% (1 in 2) chance of occurring in a 75-year period (a typical human lifetime).

2.4.5 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 expresses 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 D2 of PPS25 and Appendix A: -of this report and a key objective of the spatial planning process are to avoid flood risk to an inappropriate land use.

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 floodplain should be taken very carefully.

Further consideration of flood risk is contained within Section 4 of this report.

2.5 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.

The Don CFMP is planned for publication in late Summer 2010. This plan will be a major element in delivering an integrated approach to flood risk. The CFMP will 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 alternative management measures and 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, 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.

2.5.1 River Don Catchment Flood Management Plan

One CFMP covers the Barnsley MBC area – The Don CFMP. This CFMP is 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 CFMP 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 CFMP is due for final publication in late Summer 2010 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 2008 and is 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 draft Don CFMP contains two policy units within the Barnsley MBC area, namely Barnsley and Mexborough and the Upper Don. Table 2-1 lists the proposed actions planned for these policy units.

Table 2-1: Don and Rother CFMP – Proposed Policy Unit Actions

Barnsley and Mexborough	Upper Don
Develop a 'River Rother and Dearne Regulator Assessment' to identify the long term approach to managing flood risk.	Work in partnership to develop a Sheffield strategic flood risk management strategy.
Produce a System Asset Management Plan to determine the most sustainable approach to managing assets.	Identify the preferred approach to reducing all sources of flood risk including the potential for upstream and small scale flood storage and the utilisation of reservoirs.
Work in partnership to implement the Dearne Valley Green Heart Project.	Produce and implement a system asset management plan to determine the most sustainable approach to managing assets.
As part of future works, ensure that the potential for habitat creation and environmental improvement is fully investigated and fed into the development of the Yorkshire and North East Habitat Creation Plan.	Further define the risk of flooding on critical infrastructure including gas and electricity installations, the transport network and waste disposal sites.
Produce a Surface Water Management Plan for the sub area.	Identify the potential for a multi objective project, through the development of a Sustainable Land Management Specialist, to identify and implement sustainable land management principles. This project should focus on the need to reduce runoff and soil erosion in turn reducing the risk of flooding.
Produce a register of culverts and outfalls. This should record the location, capacity and condition of assets.	
Further define the risk of flooding, including the implications of climate change, on critical infrastructure within the sub area. Infrastructure to investigate includes gas and electricity installations and the transport network.	

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Within the Upper Don Policy Unit, using Policy Option 6 (areas of low to moderate flood risk where the Environment Agency will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits), the overall Environment Agency vision for the sub area is that the condition and function of the upland environment will be improved to reduce runoff rates and the high frequency of local flood events. As climate change develops, these upland changes will help to mitigate the effects both within this sub area and in Sheffield. In following this policy the Environment Agency will contribute to wider environmental benefits by working with partner organisations to maximise the range of benefits that can be achieved. The area and its character will become a safer location through greater appreciation of flood risk and the application of sustainable development and regeneration.

Within the Barnsley and Mexborough Policy Unit, using Policy Option 6, the overall Environment Agency vision is that they develop and implement an approach to working in partnership to reduce the risk of flooding from all sources. To ensure flood risk management is sustainable the Environment Agency need to further understand the role of flood risk management assets through the implementation of the River Rother and Dearne regulator assessment. Of particular importance to this vision is the long term approach to managing this regulated system and the potential removal of our river regulators. The area and its character will become a safer location through more effective management of the strategic river system and the enhancement of the river corridor.

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3 INTEGTRATED FLOOD RISK WITH LOCAL AUTHORITY PLANNING

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 PPS25: Development and Flood Risk and the accompanying Practice Guide, 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.

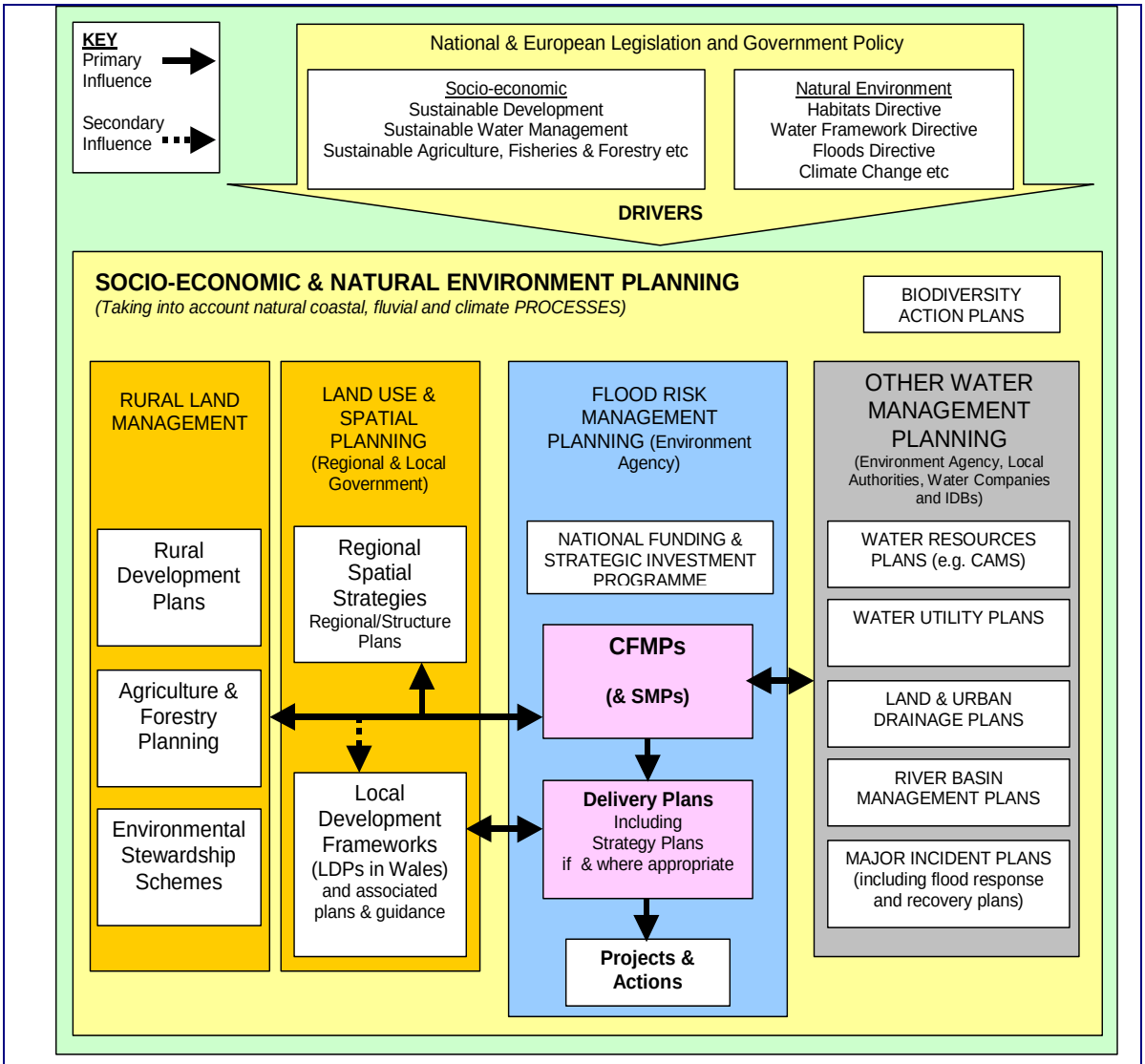
3.1 Introduction

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. Flood risk assessment is required at all levels of the planning process and for all major developments in flood risk areas; these play an increasingly important role in assisting effective delivery of key planning objectives.

3.2 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. This planning framework is shown below in Figure 3-1.

Figure 3-1: Flood Risk in an Integrated Planning Framework



(Source: Environment Agency (2004) Catchment Flood Management Plans Volume 1 – Policy Guidance)

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 acts as an evidence base for Barnsley MBC and is not a policy document.

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 later in 4 and 8 of this report.

3.3 National Planning Policy

3.3.1 Development and Flood Risk

The introduction of PPG 25 in July 2001 reinforced the responsibility that Local Planning Authorities (LPAs) have to ensure that flood risk is understood and managed effectively using a risk based approach as an integral part of the planning process. PPG 25 represented a marked shift from the reactive resolution of flooding problems as a result of development (i.e. flood defence) to the effective management of flood risk within the planning system.

Notwithstanding this, it is widely recognised that 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 and this balance is further discussed in Section 0 later.

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.

3.3.2 Planning Policy Statement 25: Development and Flood Risk

Whilst it is generally agreed that PPG 25 has worked well, and highlighted the importance of flood risk in the development process, it has been recognised that there is a need to focus on core policies that are clearer and easier to understand.

In December 2006 Planning Policy Statement 25 (PPS25) was published, superseding PPG 25. The new PPS25 (latest version March 2010) is accompanied by a PPS25 Practice Guide, published in December 2009.

The Government, through PPS25, provides clarity on what is required at a regional and local level to ensure that appropriate and timely decisions are made to deliver sustainable planning for development. The key planning objectives are as follows:

Regional planning bodies (RPBs) and local planning authorities (LPAs) should prepare and implement planning strategies that help to deliver sustainable development by:

- Identifying land at risk and the degree of risk of flooding from river, sea and other sources in their areas;
- Preparing Regional or Strategic Flood Risk Assessments (RFRAs / SFRAs) as appropriate, as a freestanding assessment that contributes to the Sustainability Appraisal of their plans;
- Framing policies for the location of development which avoid flood risk to people and property where possible, and manage any residual risk, taking account of the impacts of climate change;
- Only permitting development in areas of flood risk when there are no suitable alternative sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding;
- Safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water, and flood defences;
- Reducing flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SuDS);
- Using opportunities offered by new development to reduce the cause and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SuDS; re-creating functional floodplain; and setting back defences;
- Working effectively with the Environment Agency, other operating authorities and other

stakeholders to ensure that best use is made of their expertise and information so that plans are effective and decisions on planning applications can be delivered expeditiously; and

- Ensuring spatial planning supports flood risk management policies and plans, River Basin Management Plans and emergency planning.

The Sequential Test remains a key part of PPS25, which steers new development to areas at the lowest risk of flooding. This Test is intended to provide a rigorous understanding of flood risk within their area, delineating the extent and nature of flooding in accordance with the flood risk zones set out within PPS25. This must consider the planning context and provide the framework for robust and sustainable flood risk management solutions within those areas where a balance is required between susceptibility to flooding and wider spatial planning pressures.

In addition, PPS25 introduces the Exception Test. It states that if, following application of the Sequential Test in Annex D, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied as detailed in paras. D9–D14. The Test provides a method of managing flood risk while still allowing necessary development to occur.

When the use of the Exception Test is required, decision makers should apply it at the earliest stage in the preparation of all LDDs. All three elements of the Exception Test need to be passed before development is permitted. The Sequential and Exception Tests are discussed further in Section 4 of this report.

PPS25 clarifies that the potential impacts of climate change should be addressed in Flood Risk Assessments, and includes advice on current sources of information on climate change including PPS Planning and Climate Change which is a supplementary document to PPS 1, to ensure that plans and planning decisions are fully informed about climate change.

PPS25 introduces the proposal for the Town and Country Planning (Flooding) (England) Direction 2007 which came into force on 1 January 2007. This document makes the Environment Agency a Statutory Consultee on all applications for development in flood risk areas (except minor development), including those in areas with critical drainage problems and for any development on land exceeding 1 hectare outside flood risk areas. The Direction also introduces the requirement for LPAs to notify the Secretary of State where they are minded to approve a planning application contrary to a sustained objection by the Environment Agency. PPS25 also includes provision to extend the criteria used to determine when the Environment Agency should be consulted on a planning application.

The Practice Guide Companion to PPS25 was published by the Department for Communities and Local Government (CLG) in June 2008 (current version is dated 2009). It provides advice on the practical implementation of PPS25 policy and reflects extensive discussion with local authorities, the Environment Agency and other key stakeholders and practitioners.

Local Authority planners and developers are advised to refer to and use PPS25 and the practice guide in conjunction with the further advice contained within this report.

Catchment boundaries often encompass many more than one planning district, therefore, it is imperative that the planning process ensures that policies adopted within the current planning timeframe are consistent with the longer term vision for the wider catchment as contained in the CFMP (discussed in Section 2.2 of this report), and take adequate account of the impacts that the decisions made may have upon adjoining districts.

3.3.3 Other Planning Policy Statements

PPS1 published in February 2005, sets out the overarching planning policies for the delivery of sustainable development across the planning system and sets the tone for other planning policy statements. PPS1 explicitly states that development plan policies should take account of flooding, including flood risk. It proposes that new development in areas at risk from flooding should be avoided. Planning authorities are also advised to ensure that developments are “sustainable, durable and adaptable” including taking into account natural hazards such as flooding.

PPS1 also places an emphasis on ‘spatial planning’ in contrast to the more rigid ‘land use planning’ approach which it supersedes. Planning authorities will still produce site specific allocations and a proposals map as LDDs, but their Core Strategy will be more strategic and visionary in content and will take into account the desirability of achieving integrated and mixed use development and will consider a broader range of community needs than in the past. With regard to flood risk, it will be

important for the Core Strategies and accompanying Supplementary Planning Documents to recognise the contribution that non-structural measures can make to flood management.

Planning Policy Statement: Planning and Climate Change, a supplement to PPS1, published in December 2007, sets out how the Government expects the planning system to address climate change. It explains that there is a compelling scientific consensus that human activity is changing the world's climate. The evidence that climate change is happening, and that man-made emissions are its main cause, is strong. The Intergovernmental Panel on Climate Change highlights that we are already experiencing the effects of climate change and if these changes deepen and intensify, as they are predicted to do without the right responses locally and globally, we will see even more extreme impacts.

One of the predicted impacts of climate change is more intense periods of rainfall and consequent flooding. The PPS1 supplement requires Regional Spatial Strategies and Local Development Frameworks to shape sustainable communities that are resilient to such effects. A key objective of the planning system being to secure new development and shape places that minimise vulnerability and provide resilience to climate change in ways that are consistent with social cohesion and inclusion. Accordingly new development should be planned to minimise future vulnerability in a changing climate. The SFRA incorporating Sequential and Exception Test information is essential in meeting the objectives of the PPS 1 supplement Planning and Climate Change.

Whilst not directly relevant to the development of an SFRA, it is important to recognise that the exercise takes place within the context of other planning policy guidance and statements, some of which also require sequential testing of site allocations and development proposals. PPS 3 (Housing), emerging PPS4 (Planning for Sustainable Economic Development) and PPS 6 (Planning for Town Centres) are intrinsic within the planning process and, therefore, an understanding of the constraints faced as a result of this additional policy guidance is required.

For example, whilst the PPG3 Sequential Test recognises flood risk as a material consideration, its main emphasis is to seek the re-use of previously developed sites and empty or under-used buildings for housing. PPS25 attempts to reconcile the emphasis which Government places on development of previously developed (brownfield) land for housing with the reality that a significant proportion of this land is located alongside rivers and vulnerable to flooding. Paragraph D14 of PPS25 states:

"Criterion b) of para. D9 (The Exception Test) reflects the Government's commitment to make the most efficient and effective use of land in line with the principles of sustainable development. Reflecting this, Planning Policy Statement 3 (PPS 3): Housing sets out the Government's objectives for a flexible, responsive supply of land for housing which gives priority to the use of previously-developed land for development. However, flood risk should be taken into account in determining the suitability of the land for development."

It also recommends in Paragraph 52 that local authorities should consider combining the Sequential Test for flood risk assessment with reviews of housing land allocations under PPS 3. There is some cause for concern as to whether challenging housing targets can be met when both these potentially conflicting Sequential Tests have been satisfied. One possible solution has been put forward by the Association of British Insurers:

"…when developing on higher-elevation greenfield sites… leaving an equivalent area of low lying brownfield land for flood storage could be the most effective way to minimise flood risk".

This solution will require developers and urban designers to seek innovative design solutions to accommodate the necessary levels of development, whilst ensuring practical and manageable solutions are designed to address the issue of flood risk. Notwithstanding the above, PPS3 (November 2006) removes the requirement for sequential testing of housing sites and instead places emphasis on providing housing within sustainable locations and the effective use of brownfield sites. PPS3 identifies that in preparing Development Plan Documents relating to housing, Local Planning Authorities should assess their potential and suitability for development against the physical and environmental constraints on development of land, including, for example, the level of contamination, severity of flood risk; taking into account that such risks may increase as a result of climate change.

In determining which sites to include as housing allocations, regard should also be made to the sustainability appraisal of the site allocation. It is considered likely that all Local Authorities will include within their sustainability appraisal framework an element regarding potential impacts on flood risk. This along with an SFRA document should help to inform the identification of

appropriate sites which are either not at risk of flooding or are considered sustainable and can incorporate adequate mitigation measures.

3.4 Regional Planning Policy

3.4.1 Regional Spatial Strategy

The Government published The Yorkshire and Humber Plan - The Plan (The Regional Spatial Strategy) in May 2008. The Plan sets out the broad development strategy for the Region. It covers topics such as housing, economic development, transport, the environment and regeneration. Flood risk is referred to in the Core Area policies as well as many of the Sub Area and Thematic or Specific Topic Based Area Policies. For example:

Policy ENV1: Development and flood risk, states:

- *The Region will manage flood risk pro-actively by reducing the causes of flooding to existing and future development, especially in tidal areas, and avoid development in high flood risk areas where possible.*
- *Allocation of areas for development will follow a sequential approach and will be in the lowest risk sites appropriate for the development (identified by Strategic Flood Risk Assessments).*
- *Flood management will be required to:*
    1. *Facilitate development in the cities of Leeds, Bradford, Sheffield, Hull and York, coastal towns including Bridlington, Grimsby, Scarborough, and Whitby, inland urban areas including Doncaster, Goole, Halifax, Scunthorpe, Selby and Wakefield where there is little development land available outside high flood risk zones, and land on the south bank of the Humber, provided the sequential approach has been used to inform decisions regarding flood risk`.*
    2. *Protect parts of the strategic transport network, especially the Selby-Hull, Doncaster-York, and Doncaster- Immingham transport corridors.*
    3. *Provide flood storage, habitat creation and managed realignment in areas around the Humber, and other river corridors as required.*
    4. *Provide positive land management for flood alleviation, particularly in the upland areas of the Yorkshire Dales, the North York Moors, the Howardian Hills and the Pennines*.

Policy YH1: Overall approach and key special priorities states:

- *Avoid increasing flood risk, and manage land and river catchments for flood mitigation, renewable energy generation, biodiversity enhancement and increase tree cover.*

Policy YH2: Climate change and resource use states:

Plan for the successful adaptation to the predicted impacts of climate change by:

- *Minimise threats from and impacts of coastal erosion, increased flood risk, increased storminess, habitat disturbance, increased pressure on water resources, supply and drainage systems.*

Policy YH8: Green infrastructure states:

- *Identify the functional role of green infrastructure in supporting the provision of renewable energy, urban micro climate control, and flood risk management*

3.4.2 Single Integrated Regional Strategy for Yorkshire and Humber

The Government's Sub-National Review of Economic Development and Regeneration (SNR) was published in summer 2007, and it identified a number of changes and new responsibilities for the Regional Development Agencies (RDAs), namely planning, transport and housing. RDAs will be responsible for developing the Single integrated Regional Strategy, and this document will bring together the climate change and other sustainable development elements of the current individual regional strategies for economic development, spatial planning, housing and transport.

It is clear that the SNR will fundamentally change the role and responsibilities of Yorkshire Forward and provide an opportunity to integrate housing and planning with economic development, and to achieve climate change mitigation and adaptation through spatial planning and other measures. Innovative ways will be needed to influence the type of buildings and developments that are

granted planning permission, where the developments occur in the region, and how buildings and other infrastructure are constructed.

3.5 Local Planning Policy

3.5.1 Local Development Frameworks

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

The government set a target for LDFs to begin to replace existing plans by March 2007. It has not been possible within this timescale to replace all current plans in their entirety however; the legislation allows for existing plans to be "saved" in whole or part and incorporated into the LDF. The saved plans will be replaced later by additions to the LDF which will bring it up to date.

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

3.5.2 Barnsley Metropolitan Borough Council

The Barnsley Unitary Development Plan (UDP), originally prepared under the provisions of the Local Government Act 1985 and the Town and Country Planning Act 1990, and adopted in 2000 is currently in the process of being replaced by the Barnsley 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. LDDs can either deal with different issues or different geographical areas, but when taken together they will set out the Council's policies for how it will assess development proposals and direct future growth.

Barnsley Local Development Framework, Core Strategy, Publication (February 2010)

Policy CSP4 - Flood Risk

The extent and impact of flooding will be reduced by:

- not permitting new development where it would be at an unacceptable risk of flooding or would will give rise to flooding elsewhere
- requiring applicants proposing development in Flood Zones 2 and 3 to provide evidence of the sequential test
- requiring site-specific Flood Risk Assessments (FRAs) for development proposals over 1 hectare in Flood Zone 1 and all development proposals in Flood Zones 2 and 3
- requiring proposals over 1000 m^2 floor space or 0.4 hectares in Flood Zone 1 to demonstrate how the proposal will make a positive contribution to reducing or managing flood risk
- requiring all development proposals on Brownfield sites to reduce surface water run-off by at least 30% and development on Greenfield sites to maintain existing run-off rates
- requiring development proposals to use Sustainable Drainage Systems (SuDS) in accordance with policy CSP3
- not culverting or building over watercourses and encouraging the removal of existing culverts wherever practicable
- using flood resilient design in areas of high flood risk.

It is predicted that the incidence of flooding will increase as a consequence of climate change. In Barnsley, the rivers Dearne and Dove and the low lying areas in the East of the Borough are particularly at risk from flooding. However, recent flood events caused by surface water and sewer flooding have demonstrated that areas which have not suffered from flooding in the past can still be at risk. It is therefore important that all new development is located and designed to reduce the risk of flooding to the development itself and settlements downstream.

The Environment Agency produces Flood Zone maps which show the areas most at risk of river flooding. On these maps the area of highest flood risk is known as Flood Zone 3 (1 in 100 year probability of flooding) and the area of medium flood risk as Flood Zone 2 (1 in 1000 year probability of flooding). All land outside the high and medium flood zones is classified as Flood Zone 1 (less than 1 in 1000 year probability of flood). These maps will be incorporated into the proposals maps that will accompany the Development Sites DPD but, as they are regularly updated we advise people to check the Environment Agency's website for the most up to date flood maps.

In accordance with national policy to discourage development in areas at risk of flooding the Council will adopt the sequential approach to new development. This means there will be a general presumption against development within areas of high or medium flood risk (Flood Zones 3 and 2), unless there are no reasonably available sites in areas of lower flood risk (Flood Zone 1) and the benefits of the development outweigh the risks from flooding.

The Functional Floodplain, Flood Zone 3b, comprises land where water is stored in times of flood. This is sometimes known as Washlands and forms a vital part of flood control. Development will not be allowed in Flood Zone 3b unless it can be show that there would be no harmful effect on the ability of this land to store floodwater.

The Council has carried out a Level 1 Strategic Flood Risk Assessment (SFRA). The SFRA indicates that the majority of areas where growth will be located are within Flood Zone 1 and therefore we do not expect a Level 2 SFRA to be required. Site-specific FRAs will be required for development proposals which fall within Flood Zone 2 and 3.

Prospective developers required to submit a site-specific Flood Risk Assessments (FRAs) must demonstrate the following, in accordance with PPS25: Para 22, Annex E

- whether the development is likely to be affected by flooding (from all sources: rivers, land, groundwater, sewers, reservoirs, canals and other artificial sources) now or in the future, taking climate change into account
- the development is safe and where possible reduces flood risk
- whether it will increase flood risk elsewhere; and
- measures to mitigate the effects and risks of flooding, and
- incorporate an assessment of surface water and drainage.

There is growing importance attached to the need to address surface water flooding issues. Developers will need to take into account the SFRA and give particular consideration to the surface water flood maps. Development which would increase the risk of flooding by increasing the rate or volume of surface water must be the subject of measures that will reduce the risk of flooding. In cases where development would increase the risk of flooding by increasing surface water, developers will have to take action to reduce flooding so the development can go ahead, for example, by creating balancing ponds and other facilities for holding water. We will consider the need to produce Surface Water Management Plans in partnership with stakeholders to reduce the threat of surface water flooding.

Balanced and Sustainable Approach

The Yorkshire and Humber Plan – Spatial Vision, presents a Regional Sustainable Development Framework (RSDF) in which the Regional Economic, Spatial, Housing and Cultural Strategies inextricably link and guide the development of local strategies and programmes such as LDFs, Sub-Regional Investment Plans and LSP/Community Plans. The Regional Development Agency and the Regional Housing Board have prepared their strategies based on the RSDF.

The Region is experiencing a growth in the number of households, greater than seen in the previous 10-15 years and there is a need to provide sufficient homes to house the additional households expected to form across the Region. There is also a need to manage the release of housing land to support housing market re-structuring in low demand areas and increase the provision of affordable housing, particularly in areas of high need. With regard to economic development, sites are needed to ensure that a package and new homes and jobs are provided.

This need for growth and economic development presents both opportunities and challenges for flood risk management. The Regional target for the proportion of housing development taking place on previously used land is 65% and inevitably many of these areas are subject to flood risk. 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, PPS25 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 PPS25 is provided in Section 4 of this report.

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4 RISK BASED SEQUENTIAL APPROACH TO SFRA'S

This section contains information and guidance on: the risk based approach, levels of flood risk assessment, delineation of flood risk zones, flood risk vulnerability classifications, principles of the sequential and exception tests, management decisions and actions and flood risk indicators and balance sheet.

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.

4.1 Introduction

The SFRA is a planning tool that is used to inform the spatial planning and development management process. It helps to ensure new development is appropriate where this takes place in areas at risk of flooding, and that developments are sustainable. Due to the need for growth, re-generation and inward investment, suitable development land has to be identified and it's land use changed where necessary, in order to meet this demand.

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 recently 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 very important to try and avoid developing in flood risk areas in the first instance. Where this is not possible then the vulnerability of the proposed land use to flooding should be considered and measures taken 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 PPS25. This approach is explored further and explained below.

4.2 Summary of the Risk Based Sequential Approach

The sequential approach to flood risk is all embracing and should be adopted at the earliest opportunity, and at all levels of the planning process. Flooding from all sources should be considered and it is helpful to break flood risk down into the basic components of source, pathway and receptor as described earlier in Section 2.4.

The risk based sequential approach requires;

- Strategic avoidance of adding to the sources;
- Managing flood pathways to reduce the likelihood of flooding; and
- Reducing the adverse consequences of flooding to receptors by avoiding inappropriate development.

Key elements of this approach are:

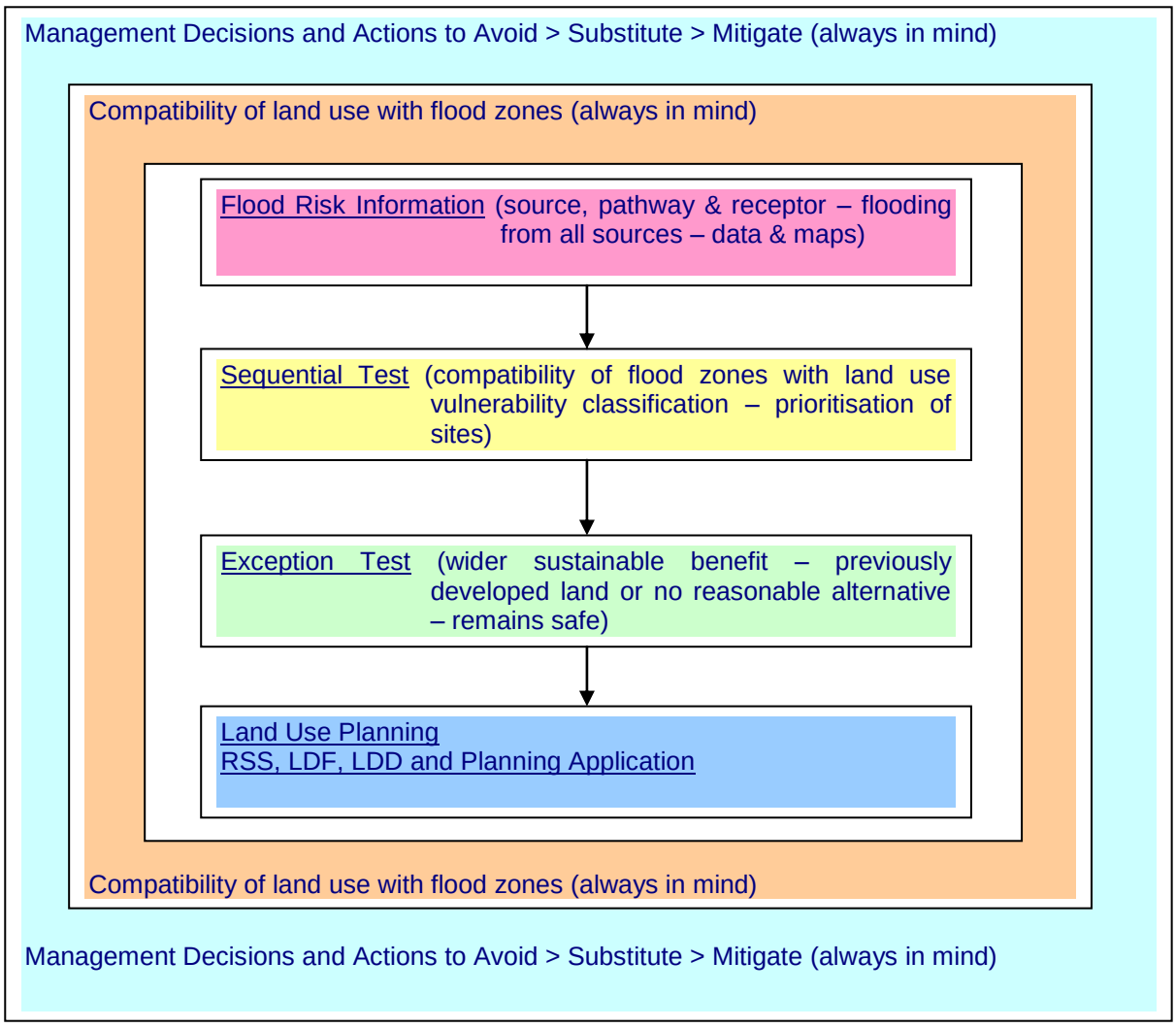
- Management actions taken at all levels of the planning process for all land uses in all

locations;

- Identification of designated flood zones;
- Vulnerability classifications for certain land uses;
- Appropriate flood risk assessment at regional, strategic and site levels;
- Sequential consideration of first avoiding, then substituting and then mitigating flood risk. This applies throughout the whole risk based approach, at all levels and stages of planning and for all land uses and sizes of development;
- Sequential Test to seek compatibility between proposed land use and it's vulnerability to flooding; and
- Exception Test where necessary, to ensure sustainability;

To be able to deliver the sequential approach, many flood risk factors need to be brought together in an appropriate FRA as detailed later in this Section. Figure 4-1 below shows the key elements of the approach.

Figure 4-1: Overview of Risk Based Sequential Approach



Working through Figure 4-1 above it can be seen that management actions to avoid, substitute and/or mitigate flood risk along with the need to do all that is possible to ensure compatibility of land use with PPS25 flood zones, embrace the approach. It is usually the case that opportunities to enable some avoidance, substitution and mitigation of flood risk can be created at many, if not all stages of the process and these opportunities should be taken. Once an appropriate SFRA has been completed this allows the important stages of the Sequential Test, and where necessary the Exception Test to be carried out. The Sequential Test is used to prioritise sites in order of probability to flooding and their acceptability in terms of development and the Exception Test ensures the development is sustainable and remains safe. Appropriate policies, allocations and conditions etc. can then be used in the planning process to secure appropriate and sustainable development. More information on all these key elements now follows.

4.3 Levels of Flood Risk Assessment

Within the hierarchy of regional, strategic and site-specific flood-risk assessments, a 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. As stated in PPS25 the three principle 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 PPS25 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 RSSs and LDF/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 RSSs and 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 allocation and the Environment Agency Flood Zones;
- Inform the strategic environmental assessment of RSSs and 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.

4.4 Delineation of Flood Zones

4.4.1 Environment Agency Flood Maps

These 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.

PPS25 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 of PPS25, are used to determine the need for Sequential Tests and more detailed flood risk assessments.

4.4.2 Delineation of Low Risk Zone 1

PPS25 considers areas within Flood Zone 1 to be at low risk to flooding. The annual probability of flooding within this zone is less than 0.1% or can be easily defined as areas within the District/Borough Council area located outside either Flood Zone 2 or 3.

Generally there is no constraint to development, in terms of flood risk, within Flood Zone 1 although, to stay in line with Environment Agency Standing Advice, any development over 1 ha should be accompanied by a site-specific Flood Risk Assessment. Localised drainage arrangements should be discussed and consideration of drainage needs to ensure that development will be safe and there will be no increase in flood risk elsewhere.

4.4.3 Delineation of Medium Risk Zone 2

PPS25 considers areas within Flood Zone 2 to be at medium risk of flooding (Map 4). The annual probability of fluvial flooding within this zone is between 0.1% and 1% (or between 0.1% and 0.5% for tidal flooding). In general, Flood Zone 2 is considered suitable for most development except highly vulnerable land uses where the Exception Test is required, such as police stations, fire stations and ambulance stations.

However a risk-based assessment of allocations within Zone 2 must be undertaken. Although more vulnerable land uses such as hospitals, residential institutions and residential development are permitted in Flood Zone 2, it will be extremely important that detailed Flood Risk Assessments are carried out. These will need to clearly quantify actual flood risk, show that there is safe access and egress and show that any residual risk can be safely managed, especially when development is in the form of hospitals. Consideration of local drainage issues will also be required.

4.4.4 Delineation of High Risk Zone 3

PPS25 considers areas within Flood Zone 3 to be at high risk of flooding (Map 3). PPS25 defines High Risk Flood Zone 3 as two sub-zones 3a and 3b, which correspond to high probability flooding and the functional floodplain.

- Flood Zone 3a: High Probability

In accordance with Table D.1 of PPS25 *"This zone comprises land assessed as having between a 1% and 0.1% annual probability of flooding or between a 0.5% and 0.1% annual probability of sea flooding in any year."*

- Flood Zone 3b: The Functional Floodplain

In accordance with Table D.1 of PPS25 *"This zone comprises land where water has to flow or be stored in times of flood"*

4.4.5 Delineation of the Functional Floodplain

PPS25 considers the functional floodplain as areas compromising land within Flood Zone 3 where water has to flow or be stored in times of flooding, and SFRAs are tasked with the responsibility of identifying this Flood Zone 3b (FZ3b).

PPS25 suggests that land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions between the LPA and the Environment Agency to identify the functional floodplain. Only water-compatible uses and essential infrastructure should be permitted within FZ3b.

SFRAs also have the ability to identify where it might be appropriate to extend the 5% (or higher) flood outline to areas within Flood Zone 2 and 3 to restore or expand the functional floodplain. The ability to identify and safeguard large enough areas against redevelopment and development in both urban and rural areas, means that existing open space can potentially be used for flood storage, effectively reducing flood risk downstream. This process assists Flood Zone 3 policy aims, identified in table D.1 in PPS25, 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% annual probability flood event is very similar to that used in a 1% 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 the Don and Dearne valleys.

The presence of designated washlands or flood storage areas are included within the defined Functional Floodplain. Whilst it is generally accepted that undeveloped land that floods between a 5% event and a 1% event can be considered as naturally flooded areas, it is the approach of retaining the flood management capabilities of such areas in a proactive manner which is crucial to the concept of this SFRA and for current and future sustainability.

In keeping with the recommendations of PPS25 areas already benefiting from defences or those which have already been developed have not been considered as Functional Floodplain. Major transport infrastructure e.g. motorways and railways have also been excluded from Functional Floodplain areas, as well as the removal of 'dry islands' in conjunction with the 'size standards used' within the Environment Agency SFRM Specification for Flood Risk Mapping. It has been acknowledged that there are some inaccuracies on minor watercourses, in particular non-main rivers due to scale and misalignment. 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. However, whilst these areas are not necessarily defined as Functional Floodplain within this SFRA, unmapped low lying undeveloped land upstream of major communities should be given priority as potential naturally flood areas through planning decisions thereby allowing for the potential for a reduction of flood risk to that community during large fluvial events.

Conversely, there should be recognition that due to scale and mapping difficulties there may be a critical Functional Floodplain of a 5% frequency, in close proximity to small watercourses that cannot be mapped. Therefore, it is important this is assessed in more detail at a site-specific FRA level.

The SFRA should be fully integrated with CFMPs and other Strategies that show, at catchment scale, the need to protect the floodplain and avoid inappropriate development in high flood risk areas. Future updates to the Environment Agency Flood Map may require revisions to the FZ3b designations to be incorporated during subsequent SFRA updates.

The Barnsley SFRA 3b Functional Floodplain has been derived from the following data sources:

1. The "Washland" boundary from the former UDP maps.
2. Flood Storage Areas, this is a layer of asset data provided by the Environment Agency.
3. Flood Zone 3, and Flood Zone 2 (this includes extent of historical flooding) boundaries.

The 3b outline has been modified upon agreement between the local planning authority and the Environment Agency.

The following decisive factors have been used:

1. To not include developed land, (including Waste Water Treatment Works).
2. To include land where other localised flooding is known to have occurred.

3. To take account of outlines of latest 2010 model for the Upper Dearne.
4. To include areas to preserve for future flood storage.

Note: Waste Water Treatment Works have been excluded from the 3b Functional Floodplain to allow for future upgrading. If such works become redundant then the Local planning Authority reserves the right to include them within the 3b Functional Floodplain.

Further information on flood risk zones is contained in Appendix A: - of this report.

4.5 Application of the Sequential Test

The SFRA provides a framework to undertake both the Sequential and Exception Tests as part of the sequential approach. The PPS25 Sequential Test "sieving" process focuses on considering flood risk and, if required, its mitigation through each tier. The process can involve creating long lists of 'reasonably available land' and then comparing all of these sites to flood maps in the SFRA, and explaining in detail why certain areas in the Borough can or cannot be appropriately developed. Under PPS25, following application of the sequential test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied.

The principle of the Sequential Test sieving process embracing the Sequential and Exception Tests is shown in Figure 4-2 below.

Figure 4-2: Sequential Test Sieving Process

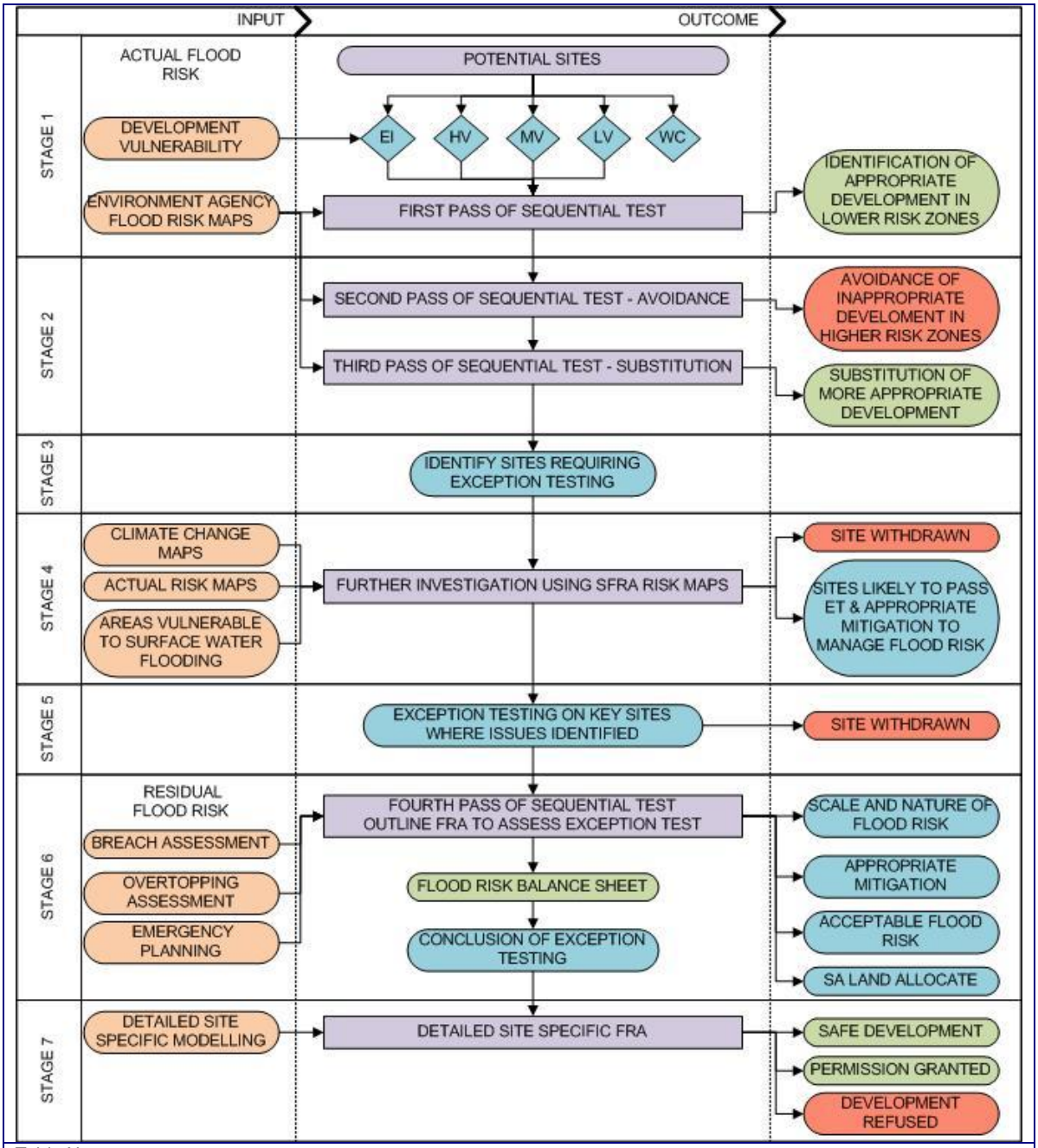


Table Notes:
See Section 4.9 for information on Flood Risk Balance Sheets.
EI = Essential Infrastructure, HV = Highly Vulnerable, MV = More Vulnerable, LV = Less Vulnerable, WC = Water Compatible.

The Sequential Test sieving process comprises seven key stages, designed to "sieve out" the development allocations at an early stage that may be considered inappropriate in accordance with PPS25 and where the Exception Test is required are unlikely to meet the flood risk management requirements. A key element of the sieving process is to minimise the number of development proposals needing to be subjected to the Exception Test and then to estimate the likely outcome of those that do. This is to do all that is possible at the SFRA stage to ensure cost effective use of time and resources and to avoid inappropriate development in flood risk areas in accordance with PPS25. As previously mentioned in Figure 4-1, this is achieved using a hierarchical approach to risk management, by first avoiding the risk wherever possible, then if this cannot be done,

substituting it for a less vulnerable land use and then finally incorporate mitigation measures to reduce flood risk to people and property both on the site and elsewhere.

Having completed the Sequential Test the Exception Test aims to provide a method of managing flood risk whilst still allowing necessary development to occur in the interests of sustainable development.

4.6 Flood Risk Vulnerability Classification

Flood risk vulnerability classifications are provided in Table D.2 of PPS25 and Appendix A: - of this report. These provide recognition that not all land uses have the same vulnerability to flooding. Some land uses, such as residential developments, are more vulnerable to the potential loss of life and damage to personal property and possessions than, say, shops and offices. Five flood risk vulnerability classifications are contained in PPS25 and these are:

- Essential infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable
- Water compatible development.

4.6.1 Flood Zone 1 – Low Probability

From a flood risk perspective all land uses are acceptable within Flood Zone 1. Flood risk is not considered to be a significant constraint to development and all land uses listed below are appropriate in this zone:

- Essential infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable
- Water compatible development.

A detailed Flood Risk Assessment will not usually be required for development in this zone unless there are, for example, historical records of localised flooding or site specific considerations that necessitate further investigation.

However, due to their potential impact on the local flood risk, a Flood Risk Assessment will be required for all developments greater than 1ha in size. This will include further consideration of surface water drainage and on-site mitigation measures that may be required, particularly where the capacity of the surface water sewer or receiving watercourse is limited. This assessment will be undertaken by the developer of the site and should be appropriate to the scale, nature and location of the development. The Environment Agency will be able to advise potential developers as to their specific requirements on a site by site basis.

4.6.2 Flood Zone 2 – Medium Probability

Subject to the application of the Sequential Flood Risk Test, PPS25 specifies suitable types of development in Flood Zone 2 as:

- Essential infrastructure
- More vulnerable
- Less vulnerable
- Water compatible development.

Highly vulnerable uses should only be permitted in this zone if the Exception Test is passed. The SFRA is unable to assess whether the site will pass parts a. and b. of the Exception Test. However, the council must be able to demonstrate the need for development through the spatial planning process.

A Flood Risk Assessment will be required for all development in this zone. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk

following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals will also need to demonstrate that access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level. A further level of analysis may be required where development is planned behind or adjacent to existing defences in order to test the sustainability and robustness of the mitigation measures. In keeping with Flood Zone 1 other flood risk constraints, such as incidents of localised flooding and other site specific considerations will need to be addressed. Again, detailed FRAs will be undertaken by the developer of the site and the Environment Agency will be able to advise potential developers as to their specific requirements on a site by site basis. The Flood Risk Assessment will need to address part c. of the Exception Test and should only be commenced when the planning justification is clearly established.

4.6.3 Flood Zone 3 – High Probability

A Sequential Test is used to prioritise sites in order of vulnerability to flood risk and their acceptability for development. Developers should primarily focus on lower Flood Zones in preference to Flood Zone 3. Any proposals for development within Flood Zone 3 will require developers to undertake a detailed Flood Risk Assessment. It should be noted that constraints to development are likely to be significant and developers should seek advice from the Councils and the Environment Agency as to the specific requirements for assessment.

Flood Zone 3 is subdivided into Zones 3a and 3b. Flood Zone 3b is the portion of floodplain that provides natural and/or managed flood attenuation/storage. It can be all or part of the flow area and owing to the frequency of inundation, Zone 3b areas are considered to be Functional Floodplain. Urban areas are generally considered to be Zone 3a, so for the purpose of this SFRA, brownfield sites will be assumed Zone 3a.

Zone 3a is potentially suitable for water compatible and less vulnerable land uses. The more vulnerable and essential infrastructure uses should only be permitted in this zone if the Exception Test is passed, which will take into account the presence. Highly vulnerable development should not be permitted in this zone.

In Zone 3b, only essential infrastructure (subject to exception testing) and water-compatible uses may be permitted.

Where sites are partially located within Flood Zone 3b, it is recommended that Councils should avoid development by specifying water compatible uses or Public Open Space for these areas.

Land use vulnerability classifications and flood zones are carried forward into Table D.3 for application of the Exception Test.

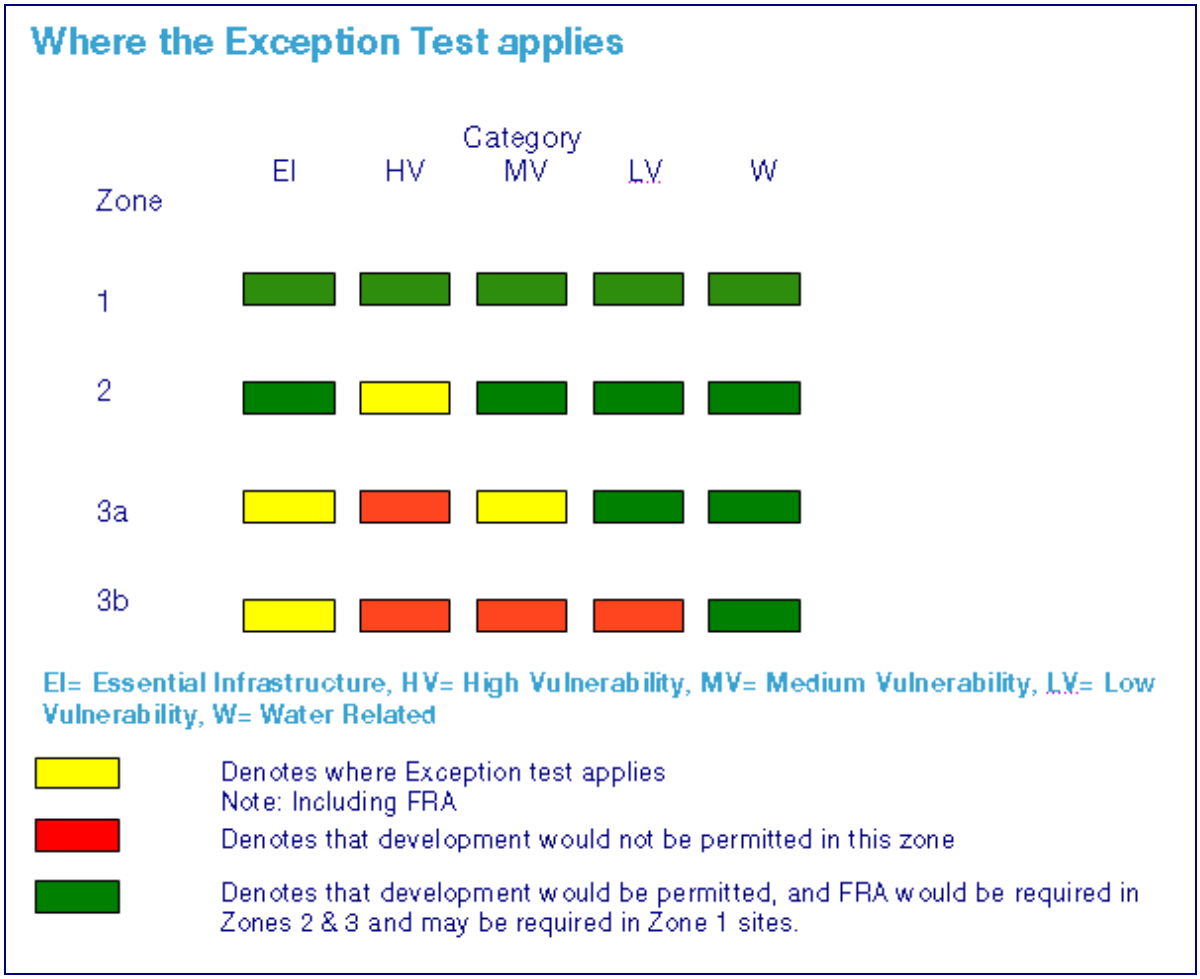
4.7 Application of the Exception Test

Where new development is exceptionally necessary within areas at risk of flooding, 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 19 of PPS25, which states:

"The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons, taking into account the need to avoid social or economical blight and the need for essential civil infrastructure to remain operational during floods…"

PPS25 explains where and for what type of development the Exception Test needs to be applied. In some situations, for certain types of development, it is not appropriate to use the Exception Test to justify development. For example, highly vulnerable development cannot be justified within the high risk zone through the use of the Exception Test. Figure 4-3 below shows flood risk vulnerability and flood zone compatibility and indicates situations where it is necessary and appropriate to apply the Exception Test.

Figure 4-3: Where the Exception Test Applies



There are three stringent conditions, all of which must be fulfilled before the Exception Test can be passed. These conditions (see paragraph D9 of PPS25) are as follows:

- 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. If the LDD has reached the 'submission' stage (see Figure 4.1 of PPS 12: Local Development Frameworks) the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal (SA);
- The development must be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and
- A site-specific Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The SFRA provides sufficient information to complete the Sequential Test in terms of flood risk. However it can only provide information on where it will be necessary to complete the Exception Test and areas where part c) of the Exception Test is most likely to be met. It will not provide sufficient information to complete the Exception Test. To pass part c) more detailed assessment of risk will still be required. Only on completion of the Sequential Test should the Exception Test be used to justify allocations or developments in high risk areas. Whilst the SFRA has been undertaken in conjunction with the Environment Agency, it is likely they will object to some of the sites, and may maintain objections to these on site specific flood risk grounds unless sufficient information can be provided to show the risks can be safely mitigated in the design. This is a matter of detail that cannot be addressed in a SFRA however; elements that will need to be considered in the delivery of the Exception Test include:

- Will the development be safe? Can all the risks be designed out and can the residual risks to people and property be managed by an emergency plan or by limiting the type of land use?
- Will the site be deliverable? This involves a review of economic and design aspects, together with an understanding of how complicated the assessment will need to be and how "exceptional" the development would need to be.
- How well does the development fit with the current mix of land uses and future provision of flood management measures? Can development within the policy area reduce flood risk to other areas; will it require further more expensive provision of flood defence infrastructure?

4.8 Management Decisions and Actions

Throughout the risk based sequential approach, management actions to avoid, substitute and mitigate flood risk should always be kept in mind and opportunities taken to minimise flood risk at every stage of the planning process. The principle aim of these actions is to ensure that risks to receptors are reduced to acceptable levels and the risks of flooding to people, their property and the environment.

As previously discussed the hierarchy of management decisions and actions include:

- **Avoidance** by locating new development outside areas at risk of flooding;
- **Substitution** by changing from a more to a less vulnerable land use; and
- **Mitigation** by instituting measures such as flood-protection schemes to protect property against flooding.

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. For these situations, mitigation is needed to reduce flood risks to an acceptable level. This can comprise community protection through the use of 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.

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. In this context the assumptions shown in the following table have been made. 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.

Suggested screening criteria for mitigation measures are shown in Table 4-1 below. This table refers to indicative depths of flooding before mitigation measures are put in place and should not be mistaken for acceptable levels of flooding after mitigation. These depths do NOT represent acceptable flooding.

Table 4-1: Suggested Screening Criteria for Mitigation Measures

Depth of Inundation*	Comments
0 to 1.0 m	Sustainable mitigation and flood risk management may be feasible for both housing and employment purposes. There is a greater likelihood that the Exception Test can be passed.
1.0 to 1.5 m	Mitigation is likely to be costly and may not be economically justifiable for low value land uses. Housing allocations are considered appropriate, provided flood risk can be managed or mitigated (e.g. by using lower levels for car parks or public areas). 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. The likelihood of passing the Exception Test is lower.
Above 1.5 m	Flood risk mitigation measures are unlikely to be economically justifiable and both housing and employment allocations should be reconsidered in favour of alternative lower risk sites. Development is unlikely to be sustainable and the likelihood of passing the Exception Test is low.

*Notes: * Based on predicted depth of inundation for the 1% (Fluvial) event + 20% additional flow for Climate Change as per PPS25. Environment Agency flood zone data.*

In addition other screening factors may be used including:

- 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.

Whilst flooding mitigation measures can be implemented in most sites, 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.*

As part of the hierarchy of management decisions and actions to help provide a degree of confidence that individual development allocations may or may not pass the Exception Test, a small suite of flood risk indicators can be used to balance and weigh various sites and uses. This process is described below.

4.9 Flood Risk Indicators and Balance Sheet

The SFRA is precautionary, applying a longer term holistic approach to ensuring development does not compromise future flood management measures and vice versa. The Exception Test is not black and white, and needs to assess the acceptability of the residual risks. Where the residual risks are significant it is unlikely that further investment would exceptionally be justified, particularly if it introduces significantly more people into the flood risk area.

To provide this longer term view to spatial planning in flood risk areas a number of indicators have been developed to allow a comparison of the appropriate land uses in each policy area and how they would fare within the PPS25 Exception Test. . Whilst these indicators focus on flood risk issues, alternative sustainability measures could be added to the list to encapsulate all relevant issues into the assessment and help the LPA to assess whether developments have passed Part 'a' of the Exceptions Test. Further indicators could be found in the relevant LPA Sustainability Appraisal. The main flood risk indicators suggested within this SFRA are as follows:

- **Development is within existing flood risk area** – existing flood warning and evacuation in place. Importantly how easily will the area recover following a flood event? New development may lose local services for 12 months if an event occurs.
- **Residual risk measures are easily applied and within a norm** – Low depths of flooding can be easily designed out by modest alteration of ground or floor levels. 1st floor accommodation has implications for the urban design and place setting of the development.
- **Egress and access. Impact on emergency planning provision and whether development would be safe** – This is a key issue and prime test in the PPS25 Exception Test. Access routes need to be natural and accessible in a flood to the emergency services
- **Change in the number of people at risk as result of development** – Introduction of more people will put a greater strain on the emergency services in an event. Whilst they may be accommodated at high elevation they will require support very quickly even after the inundation has stopped.
- **Change in number of properties at risk in 1% and 0.1% event before and after. Assumes mitigation measures put in place** – From an economic viewpoint development can replace existing property with lower vulnerability land uses and also development that is designed to be flood resistant or resilient. A reduction in economic risk can be achieved.
- **Scale and nature of flood risks** – The SFRA risk maps indicate likely depths and flow routes. From running the surface water flooding assessment the scale and extent of the surface water flood risks can be considered.
- **Impact of mitigation measure on other areas downstream and adjacent** – How wide ranging does the impact assessment need to be to take account of the effects of significant land raising or alteration or blockage of flow routes.

LPAs should use these indicators to qualitatively assess each key type of vulnerable land use proposed in each of the policy areas being considered by the SFRA. Each of the indicators should be scored according to the system outlined in Table 4-2 below to produce a flood-risk balance sheet. The results should be assessed to produce one of five possible outcomes on the acceptability of a particular type of development within a policy area. The five potential outcomes are:

- Counter to strategic approach, flood risk unacceptable. It would be difficult to meet the criteria of the Exception Test. Development not recommended;
- Sequentially not preferred but a limited range of land uses might be possible;
- Sequentially not preferred but a wider range of land uses could be brought forward after careful consideration and subject to an appropriate site-specific FRA;
- Acceptable with some detailed consideration of flood-risk issues to be resolved by an appropriate site-specific FRA; and
- Acceptable subject to a satisfactory appropriate site-specific FRA.

This simple assessment through the flood-risk balance sheet allows an initial sequential approach to be adopted against flood-risk criteria to deliver a hierarchy of recommended land uses and development allocations that meet the criteria of the Exception Test, where appropriate. The balance sheet could be used as means of comparing the relative flood risk of two sites in Flood Zone3, in order to determine which is sequentially preferable when undertaking the Sequential Test. This will help support appropriate policies within LDFs & LDDs and provide the evidence for the LPA in reviewing any subsequent planning applications that attempt to use the Exception Test to support alternative land uses in these areas. The application of this approach to windfall sites could be more problematic. An example of a completed flood risk balance sheet is contained in Appendix B: - of this report.

It should be noted that a detailed flood risk assessment will still always be required.

Table 4-2: Scoring of Indicators in Reviewing Indicative Acceptability of Proposed Development

Flood-risk indicator	Ultra-positive ++	Positive +	Neutral =	Negative -	Ultra-negative --
Development is within existing flood-risk area		No risk		Risk area within resilient communities	Vulnerable community, which would struggle to recover
Residual risk measures	None required	Measures could reduce risk to existing development		Standard, no major alteration to layout and form	Flood resistance is dominant in design
Egress and access/emergency planning impact		No special provisions, risks acceptable		Needs to be managed, should be acceptable subject to FRA	Special provision, natural response will not be obvious. Risks may not be acceptable
Change in number of people at risk	Significant reduction	Reduction	No change	Increase	Significant increase
Change in number of properties at risk	Significant reduction	Reduction	No change	Increase	Significant increase
Scale and nature of flood risks	Benign and understood				Difficult to warn, unpredictable, may result in operational failure of defences, from multiple sources
Impact of mitigation elsewhere	Significant reduction in overall flood risk	Reduction	Neutral impact	Increase in flood risk elsewhere	Significant increase in flood risk elsewhere

4.10 Influencing Land Use Planning

Flood risk is a material consideration in land use planning decision making and can greatly impact on the sustainability of various land uses in all locations. Having completed an appropriate flood risk assessment for a development proposal under consideration, and applied the Sequential Test and Exception Test where necessary, the resultant assessment of appropriateness and 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 RSS, LDFs and LDDs will be influenced and shaped by the sequential approach informed by the RFRA and Local Authority SFRAs. In turn, individual planning applications will be influenced by the site-specific FRA having regard to the LDF and LDD, and either granted with flood

risk conditions or rejected by the LPA. Planners and developers should take full account of the sequential approach taken, including the results of the sequential and exception tests to assist their decision making.

5 OVERVIEW OF FLOOD RISKS

This section contains information and guidance on: the Dearne and Upper Don 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;
- Actual flood risk maps provide a valuable starting point in considering flood risk as a material consideration in land use planning decisions and;
- 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.

5.1 Introduction

As discussed in Section 2 of this report flooding can occur from many different sources and PPS25 requires all of these flood risks to be considered at all stages of the planning process. The Dearne and Upper Don catchments all have their own unique characteristics and flooding issues that need to be considered as part of the land use planning process. It will be helpful to planners and developers to have an overview of these factors prior to undertaking the Sequential and Exception Tests as part of the risk based sequential approach and then allocating proposed development sites in these catchments. The principal catchment characteristics and flooding issues from different sources are discussed below.

The Barnsley MBC area includes catchment areas of the River Dearne and the Upper Don. This is shown in Map 1. The Barnsley MBC area includes reaches of the following main rivers:

- Upper Don (part length)
- River Dearne (part length)
- River Dove (part length from River Dearne to Barnsley Road, Aldham)
- Knoll Beck and tributary (part length form River Dearne to Wentworth Road, Jump)
- Sough Dyke (part length from River Dearne to Springfield Street, Barnsley)
- Measborough Dyke (part length from Sough Syke to Doncaster Road, Measborough)
- Cawthorne Dyke (part length from River Dearne to Barnsley Road, Darton)
- Cubley Brook (Penistone)

5.2 Catchment Characteristics

The River Dearne rises in Flockton Moor, Emley Moor and Denby Dale area. The Upper Don rises on Thurlstone Moors near the Snailsden, Winscar and Windleden reservoir complex.

The Upper Don and Dearne typically experience fairly natural flood response. However, the Bolton regulator does provide in-stream attenuation. There are also a number of designated washlands in the Dearne (Map 6)

The Rivers Dearne and Upper Don with the Barnsley MBC area have a history of flooding, as shown in Table 5-1.

Table 5-1 Major Flood Events in Dearne and Upper Don Catchments

Date	River/ Area Affected
2007	Major Flooding in Dearne Valley
2000	Major Flooding in Dearne Valley
1947	Major Flooding in Dearne Valley
1909	Flooding Dearne valley at Bolton-on-Dearne
1886	Major flooding in Dearne Valley
1883	Flooding in Barnsley, R.Dearne
1875	Flooding in Dearne Valley
1861	Bursting of Barnsley Canal near Royston
1846	Major flooding in Barnsley, R.Dearne
1832	Major flooding in Barnsley, R.Dearne
1807	Flooding in Dearne Valley

The extents of four historical flood events (March 1947, January 1982, November 2000, June 2007) within the Barnsley MBC area are given in Map 2. The flooding in these years was not restricted just to existing floodplain areas, as localised flooding also took place (especially in urban areas).

There are about 10 flood warning areas within the Barnsley MBC area on the Rivers Dearne and Upper Don.

5.3 Defended Area – Dearne Catchment

The River Dearne and Dove main rivers between Barnsley and Bolton-on-Dearne are defended up to a 30 year standard of protection (Map 5), as is Knoll Beck from Hoyland to its confluence with the Dearne. The part of the Upper Don catchment that is within the Barnsley MBC boundary does not contain any defences

5.4 Localised Watercourse Flooding

Ordinary watercourses are those rivers and streams that are not designated as 'Main River'. The maintenance of ordinary watercourses fall on the riparian owners of the land through which it flows, with the management falling on the Local Authority who act as "operating authority" using their powers under the Land Drainage Act 1991.

A number of the ordinary watercourses within Barnsley MBC 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 some of the remaining COWs and took over responsibility for their maintenance and management. All the previous COWs are now defined as 'Main Rivers'. Barnsley MBC is now only an overseer, requiring the riparian owners to carry the necessary maintenance.

For the purposes of the SFRA, flooding issues in respect of previously designated COWs have been considered to be a good summary of the current non-main river flooding issues, although when FRAs are undertaken, full consultation with the Environment Agency and relevant Local Authorities should take place.

The fluvial flood extent and depth maps discussed in Section 5 of this report and attached for key local authority areas; identify the potential scale of flood inundation and should be used to guide the sequential approach and detailed FRAs.

5.5 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 Urban 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, the Environment Agency and the Dearne and Dove Internal Drainage Board 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. Surface water management plans could be particularly necessary in those catchments draining to pumping stations where the current standard of protection are not necessarily as high as in other parts of the Barnsley MBC area.

The areas naturally vulnerable to surface water flooding maps (discussed in more detail in Section 6 of this report) provide an indication of the surface water flood extent and variation in flood depths due to an extreme rainfall event (e.g. 100 year return period).

The topography of the Barnsley MBC 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. Some modelling of the possible surface water flooding within the urban areas as a result of the 100 year rainfall event has been undertaken in order to provide an indication of areas where surface water (derived from rainfall only) will naturally flow towards and possibly pond. These areas have been mapped in Map C. Areas where surface ponding may generate flood depths in excess of 0.5m (which could also be further exacerbated by flooding from local watercourses) are distributed across the Barnsley MBC urban areas with particular concentrations in:

- The railway area just east of Market Hall in Barnsley town centre
- South western parts of Thurnscoe
- North western parts of Bolton-on-Dearne
- Eastern parts of Penistone

The Barnsley MBC Drainage Engineer has also identified that the rear of Grange View (Royston), Burton Grange (Lundwood) and Broomhill (Wombwell) are all areas with persistent surface water flooding problems.

5.6 Groundwater Flooding

Groundwater flooding is caused by the emergence of water originating from underground. The water may emerge from either 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. Likely candidates for groundwater flooding in the Barnsley MBC area are: Kingstone area of Barnsley; Kingwell area of Worsbrough; Millhouses area of Hoyland; and Upperwood area of Darfield.

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.

Staff at the Coal Authority were consulted with respect to the possibility of flooding caused by the re-emergence of minewaters from the formerly very important South Yorkshire mining region following the cessation of minewater pumping. These discussions indicated that The Coal Authority have a comprehensive network of groundwater monitoring boreholes across South Yorkshire and, by working in partnership with the Environment Agency and other local coal mining interests are developing a strategic forward plan to manage minewater levels to minimise the risk of re-emerging minewaters causing both flooding and/or initiating water quality problems in the major Sherwood Sandstone water resource aquifer. Maps provided by the Coal Authority that identify areas where minewaters could re-emerge indicate that 6 proposed development sites/areas could be affected, namely: HS35, HS8, SAF30, SAF38, SAF36 and SAF13.

5.7 Reservoir Flooding

According to the Environment Agency's Register of Reservoirs, there are 19 operational 'large raised reservoirs' located within the boundaries of the Barnsley MBC boundary ranging in capacity between about 35,250m^3 and 8,296,000m^3.. 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 so would therefore provide little potential attenuation for flooding. Service reservoirs are not included in this register.

Reservoirs can also act as a major source of floor risk, as experienced recently during the 2007 summer floods in England and Wales, where 18 reservoirs were affected. Reservoir flooding is therefore an important source of flood risk which has been noted within Pitt Review and acknowledged by Hilary Benn, the Secretary of State for Environment, Food and Rural Affairs, who has pledged £1 million to improve reservoir safety specifically for inundation mapping.

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 and it is now suggested that a better risk-based approach to reservoir safety is needed, focusing on those reservoirs that pose the greatest risk to the public, even if they're not currently covered by the regulations.

Table 5-2: 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, and
- A communications plan with external organisations, mainly the emergency services.

5.8 Sewer Flooding

Yorkshire Water have provided data on internal and external flooding from their databases. In the Yorkshire Water managed and maintained system the incidence of external sewer flooding are not widespread or particular frequent. Those areas that appear to be more prone to external sewer flooding are parts of Stairfoot, Lunwood, Elsecar, Goldthorpe, Darton, Higham, Silkstone Common, Smithies and Darfield.

It is widely acknowledged by many climate change studies and PPS25 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 will also increase.

5.9 Internal Drainage Boards

Barnsley MBC contains the Dearne and Dove Internal Drainage District (IDD), which has the statutory responsibility to maintain effective land drainage primarily on agricultural land, but also in some built-up areas (Map B). The Dearne and Dove IDD, within the Barnsley MBC area, contains both pumped and gravity drained watercourses. These IDD watercourses typically only have up to about a 30 year standard of protection (taking into account freeboard) and therefore do not currently have the appropriate standard of protection for new development.

Any development within IDB areas will require restriction of surface water discharge rate based on greenfield runoff or the relevant pumping station capacity. The latter is usually based on less than greenfield runoff. Land drainage pumping capacity normally assumes that there is significant storage volume available in the open watercourses and the surrounding soil. As some of this volume is lost during development, the IDBs normally restrict development runoff to the pumping station capacity. Developers need to make early contact with the relevant IDB at an early stage to obtain the Board's requirements on discharge rates and possible storage requirements.

5.10 Effects of Future Land Management on Future Flood Risk

Barnsley MBC area includes significant amounts of rural, particularly agricultural, land. The designated Green Belt is unlikely to be developed to any significant level. However, changes in land management practices can have either a negative or positive impact on flood risk. However, the quantification of this effect at a catchment scale is still the subject of research. Improved

agricultural drainage, prevalent within the IDB areas, and agricultural intensification tend to increase peak flows and results in a faster response of river levels to rainfall inputs.

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

The long term sustainable policies and action plans that will be forthcoming from the Don CFMP would also 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.

5.11 Condition of Flood Defences

The condition of existing flood defences is an important consideration for local authority planners when allocating new development. PPS25 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 5-3 below.

Table 5-3: 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.

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future, is an issue than needs 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.

5.12 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 Dearne valley 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.

The consequences of flooding behind defences can be 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.

The typical defence standard for defended areas in the Dearne valley is a 1 in 30 year flood event. However, there is always the possibility of a larger event occurring and overtopping the defence, which must be investigated, especially if you consider potential climate change effects.

Whilst Environment Agency Flood Maps provide a sufficient starting point in investigating flood risk in the Dearne valley, they do not provide the level of detail needed to assess the residual risk, especially those which lie behind existing flood defences. It is essential that Barnsley MBC and South Yorkshire county engineers are consulted with respect to any proposed development near an area deemed to be defended in any way to ensure that detailed local knowledge on these defences and their condition is fully considered.

This SFRA has provided sufficient data and information to enable Barnsley MBC to apply to Sequential Test and goes some way in investigating residual risk in providing a suite of SFRA Flood Risk Maps (discussed in the next section).

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6 SFRA MAPS

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

Key messages:

- SFRA maps provide a valuable source of broad scale current and future flood risk information, to assist with the sequential approach sieving process.
- These maps supplement the Environment Agency's Flood Maps.
- The suite of maps should be viewed collectively and not as individual maps in isolation.
- These maps are appropriate for early and strategic consideration of development allocations and related broad scale management decisions.

6.1 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 Maps are very useful in this respect in showing indicative land use planning zones as required by PPS25, they are a starting point in the consideration of flood risk in a particular area.

Environment Agency 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 D3 of PPS25.

However, consideration of actual flood risk factors is also needed to gain a greater understanding of the varying degrees of flood risk at a borough level. These include:

- Presence of defences
- Functional floodplain
- Speed of flood flow
- Variations in depth of flood water
- Flooding from other sources
- The impact of climate change on flood extents and depths
- Ability for emergency evacuation in extreme events

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 allocations put forward in the LDD, can comply with the Sequential and Exception Tests in PPS25 and importantly the developments will be safe for occupants and users.

This broad assessment is assisted greatly by the use of SFRA Flood Risk Maps providing information on flood risk factors needing to be taken into account. A description of the Environment Agency Flood Zone Maps, together with these supporting SFRA Flood Risk Maps, and how they may be interpreted are given below.

6.2 Environment Agency Flood Zone Maps

The Environment Agency Flood Zone Maps have been provided on 2 maps at a borough level. Version 3.17 of the Environment Agency Flood Zones, provided in March 2010, have been used as the latest Flood Zones in this area.

This map illustrates:

- Flood Zone 3a (Map 3)
- Flood Zone 3b (Functional Floodplain) (Map 6)
- Flood Zone 2 (Map 4)

These key maps should be used for the facilitating the undertaking of the Sequential Test by planners and developers according to PPS25, as discussed previously in Section 4 and illustrated within stage 1 of the Sequential Test sieving process.

The SFRA Risk Maps discussed below should be used to support the Environment Agency Flood Zone Maps in Sequential Testing as a second or third pass of the sieving process.

6.3 SFRA Maps: Interpretation and Use

Three sets of maps have been produced in support of the Environment Agency's latest Flood Zone Maps.

These maps 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 map should be considered in isolation without reference to the others.

All of the maps need to be interpreted consistently for various proposed development locations in order to complete the second or third pass of the sequential approach sieving process after the Environment Agency Flood Zone Map has been used to carry out the first sweep or sequential testing. They can also be used "outside" of the sieving process to gain an understanding of various flood risk factors appertaining to non development locations and more general areas of interest.

The detail provided in the SFRA Maps will also facilitate the application of the Exceptions Test where applicable.

All the SFRA maps show flood extents and flood water depths, which are colour coded to represent various depth ranges.

The maps are:

- Fluvial Flood Extent and Depth Maps (Map D and Map E)
- Areas Naturally Vulnerable to Surface Water Flooding Maps (Map C)
- Climate Change Maps (Map H)

6.4 Fluvial Flood Extent and Depth Maps

The fluvial flood extent and depth maps show the potential scale of flood inundation during overtopping of different standards of flood defence during a range of flood events (They do not include the impact of a breach or failure of defences).

With specific regard to this SFRA, the typical range of defence standards found in the Barnsley MBC area is to protect up to a 1 in 30 year flood event.

Two sets of maps cover the Barnsley MBC area for the following scenarios:

- S2Q100 - 1% (1:100y) flood event assuming no flood defences exist (Map D);
- S2Q1000 - 0.1% (1:1000y) flood event assuming no flood defences (Map E);

The variation and graduation of colours from dark blue to orange clearly shows the flood water depth at any particular point across the flooded area. In comparing all the maps in respect of a particular development allocation the variation in colour and hence the depth of flood water at that site/area can be determined and possible avoidance, substituting (for a lower vulnerability use) and mitigation measures can start to be considered.

6.5 Areas Naturally Vulnerable to Surface Water Flooding Maps

The areas naturally vulnerable to surface water flooding maps (Map C) provide an indication of surface water flood extent and variation in depths for particular geographical areas of interest, resulting from a 1% (1 in 100 year) rainfall event; and assuming a 10% (1 in 10 year) rainfall event theoretically being 'lost' due to the sewer capacity. The modelling technique includes the presence of flood defences and how water may pond behind these defences. This modelling should only be regarded as indicative because we are not modelling the sewer drainage processes accurately.

There is a set of four maps covering the Barnsley MBC area and the extent and variation in depth of potential flooding due to surface water is shown in a yellow to red scale where the darker the red in colour, the deeper the flood water. These maps are extremely helpful in supplementing the Fluvial Flood Extent and Depth Maps as they indicate where localised surface water flooding could cause problems in specific areas, even if the Main Rivers are not overflowing. This is often due to high intensity, short duration rainfall events, which exceed the capacity of the sewer systems. As a result, surface water is unable to drain away safely and flooding results.

The maps typically show shallower (light yellow) flooded areas on tributaries and feeder streams to Main Rivers, where steeper sloping valleys exist and on the edge of the natural floodplain of Main Rivers, again where land levels tend to rise more steeply. The deeper (darker red) flooded areas are predominantly in valley bottoms and in the Main River floodplain. From the maps it can be seen that 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.

These maps are extremely helpful in supporting the Environment Agency Flood Zone Maps during the Sequential Test as indicated above to assess the relative degree of flood risk and where surface water flooding is sufficiently hazardous to jeopardise the principle of development. In particular, they show where vulnerable areas are and if development allocations are proposed in these vulnerable areas then appropriate avoidance, substitution and mitigation measures are needed. Many of the specific ways in which these maps are helpful to the consideration of flood risk are the same as stated above for the fluvial flood risk maps but acknowledging the risk is from a different source. However, the same areas of land coloured by both sets of maps indicate a combined flood risk from fluvial and surface water sources.

6.6 Climate Change Maps

Climate change maps (Map H) show fluvial flood extent and depths from Main Rivers and extent and depths variations, for a undefended floodplain with a 1% (1:100y) fluvial flood flow plus a 20% increase in volume of flood flows. This allows for the effects of climate change over the next 100 years.

PPS25 requires the consideration of the sensitivity to new developments of climate change to be considered as part of an appropriate FRA and these maps 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, or substituted, 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 PPS25.

The sequential approach requires early consideration of the effects climate change on flood risk and these maps help greatly in this respect.

6.7 Conclusion and Further use of SFRA Maps

Examples of conclusions and further uses of these maps (for the River Don catchment and its tributaries) include:

- Identifying general extents and depths of Main River flooding;

- Comparing flood extents generally and for specific areas, with those shown on the Environment Agency Flood Zone Maps;
- Comparing flood extent and depth relating to existing and future land uses;
- Identifying where flooding problems are likely currently, and in the future in terms of:
    - residential areas;
    - business parks and industrial areas;
    - schools, hospitals and civic buildings;
    - transport activities including road and rail disruption;
    - utility infrastructure such as water and sewage treatment works, pumping stations, power stations and electricity supply sub stations etc;
- Assisting a sequential approach to locating new development in lower flood risk areas, having first carried out the sequential test using the Environment Agency's Flood Zone Maps;
- Identifying the scope for maximising a sequential approach to the development allocation including layout and design.
- Identify areas of floodplain where preparations for emergencies are needed including emergency plans, flood warnings and evacuation etc;
- Assist emergency services activities on the ground to help avoid deep and potentially fast flowing water;
- Identify the location of open space areas that currently flood and provide flood storage without causing too much disruption to existing land uses and people and property; and
- Identify where these flood storage areas might be better utilised in future and locations for potential new flood storage areas and washlands where development should be avoided.

The maps are extremely useful in answering specific questions about specific development allocations, prior to the decision for the proposal to be subjected to the Exception Test in PPS25. In particular, they are helpful by:

- Providing an early indication prior to detailed hydrological and hydraulic modelling, of the likelihood of the site and it's occupants remaining safe in a 1% and a 0.1% flood event and the proposal being able to pass condition c) of the exception test in PPS25;
- Showing where narrow or wide floodplains exist and the potential difficulties for emergency evacuation in an extreme event by land vehicles as opposed to boat use or aircraft;
- Indicating current and future extents and depth of flooding in the proposed development area for the defended scenario;
- Targeting valuable time and resources towards those development allocations that are likely to succeeded as opposed to those which are likely not to pass the Exception Test and not gain planning approval due to flood risk constraints;
- Giving an early indication of the feasibility of providing appropriate mitigation measures. As flood water depths increase, effective and viable mitigation measures can become less likely and more costly;
- Knowing the likely design, engineering and building requirements early on in the consideration of the suitability of the site for the proposed development to assist financial estimates and consideration of the overall viability of development project at that site;
- Early appreciation and commitment to likely expenditure to make the site safe as required in PPS25; and
- Early identification of flood storage and/or floodplain restoration as part of the overall development proposal.

7 BARNSLEY SITE CATEGORISATION

7.1 Introduction

A Level 1 SFRA should enable the Council to carry out the Sequential Test as outlined in Annex D of PPS25. This section provides the Council with Flood Zone classifications for all present development locations they have identified for an SFRA. This will assist the Council in developing their LDF and prioritising their allocations.

Using the datasets supplied by various parties it has been possible to undertake an initial categorisation of the proposed development sites/areas based on GIS datasets. This assessment has been undertaken for development sites/areas proposed for housing, employment, minerals or strategic waste.

Tables A1-A5 have been split into those sites that are wholly in Environment Agency Flood Zone 1 (i.e. low flood risk) and those sites which fall wholly or partly into Flood Zone 2 (medium flood risk) and Flood Zone 3 (high flood risk). Where possible, the development sites/areas that fall wholly or partly into Flood Zone 3 (high flood risk) they have been allocated to flood zone 3a or 3b (functional floodplain – designated washlands and flood storage areas). The description of the column headings in the categorisation tables is given in Table 7-1 below.

The overarching aim of PPS25 is to guide development away from high flood risk. Where the part of the proposed development site/area within Flood Zone 2 and 3 is relatively small, it may be possible to use 'sequential design' within the overall site to relocate more vulnerable development away from the high risk area. However, where a large percentage of the site is within Flood Zone 2 or 3, the Council should look at opportunities to relocate development to lower risk areas.

If relocation is not possible due to other development or sustainability pressures, the Exception Test may be necessary. A further level of analysis may be required where development is planned behind or adjacent to existing defences.

If the Level 1 SFRA indicates that the majority of the proposed development sites are located within Flood Zone 1 then we would not expect that a Level 2 SFRA will be required.

7.2 Flood Zone Analysis

This section details how the analysis of the various GIS datasets was undertaken with respect to the existing Environment Agency Flood Zone maps. The analysis results can be found in Tables A1-A5.

7.2.1 Flood Zone 2, Flood Zone 3

The actual flood zone datasets used to estimate percentages of site/areas within the flood zones are the March 2008 flood zone maps that JBA produced for the Environment Agency. It is known that the actual Flood Zone 3 outline for parts of the wider River Don system may be in error due to i) errors in the original topographic survey data used in the flood modelling, and ii) the original method of projecting the flood level across the floodplain from channels that are actually, in places, elevated water carriers across the floodplain. In this instance the extent of the current flood Zone 3 will be somewhat exaggerated in places.

7.2.2 Flood Zone 3b

Percentage of an area in Flood Zone 3b was estimated based on whether the area falls within a designated washland or flood storage area (as provided by Barnsley MBC and the Environment Agency). The full definition of Flood Zone 3b is section in Section 4.4.5.

Where the percentage of a designated washland or flood storage area in an area exceeded the percentage of Flood Zone 3, the greater percentage was chosen to be Flood Zone 3b.

Various discussions have taken place with the designation of a 'Naturally flooded areas' dataset, which would indicate those floodplain areas, especially those that are undeveloped and undefended, where flooding would occur more naturally. These are also areas where under Defra's Making Space for Water initiative and a PPS25 overall objective more flooding could be encouraged to take place to reduce downstream flood risk and also provide environmental enhancement opportunities. As a result inappropriate developments would be directed away from these areas. In undeveloped and undefended areas this could be the 100 year flood outline, whereas undeveloped land in a defended area this could the 20 year flood outline.

7.2.3 Flood Zone 3a

After estimating the percentage of an area of a site in Flood Zone 3b, the reminder of the area within the Flood Zone 3 outline was assigned Flood Zone 3a. All Areas Benefiting from Defences (ABDs) within Flood Zone 3 would be designated as Flood Zone 3a.

7.3 Modelled Flood Depth Analysis

The modelling work undertaken by JBA Consulting as part of the North East Strategic Catchment Modelling project for the Environment Agency, which uses LiDAR/SAR data and JFLOW or TUFLOW 2d models, has produced more accurate and consistent flood depths grids for a range of design flows and flood defence standard of protections. These data therefore provide more information on flood risk, especially for development behind flood defences, and have been utilised in this SFRA.

The flood depths were banded for the purpose of this SFRA Level 1 as follows: <0.01m, 0.01m–0.5m, 0.5m – 1.0m, 1.0m – 1.5m, >1.5m. As detailed in Table 4-1 it might be possible to mitigate against flood up to about 1m depth, especially for higher value housing and employment developments. Once the flood depth exceeds about 1m then the potential cost of mitigation often becomes unjustifiable, even for high value land uses. One mitigation option is to alter the development footprint to avoid areas of potentially deeper flooding, or alternatively change the development land use within the potentially deeper water area to be water compatible.

7.4 Site Categorisation

Each proposed development site (for housing and employment) was assessed with respect to a number of GIS spatial datasets. The results of this analysis can be found in Appendix Tables A1-A5. A description of all the column headings in the tables is given in Table 7-1.

Table 7-1 Column headings in Level 1 SFRA Development site/area categorisation

Column heading	Description
IDENT	Unique site identifier
BF_GF	Brownfield (BF) or Greenfield (GF)
Size_ha	Size (hectares)
Catchment	Fluvial catchment
Defence	Flood defence asset present (yes/no)
Defence Information	Information on flood defence asset (if present)
SOP	Flood defence standard of protection (in years), if available (from NFCDD)
FZ 2 (%)	Percentage of development site/area in flood zone 2
FZ 3 (%)	Percentage of development site/area in flood zone 3
FZ 3a (%)	Percentage of development site/area in flood zone 3a
FZ 3b (%)	Percentage of development site/area in flood zone 3b (functional floodplain), designated as washlands or flood storage areas (FSAs)
FWA	Flooding warning area information
Washland (%)	Percentage of development site/area in designated washland
Greenbelt (%)	Percentage of development site/area in designated greenbelt
Soils and Geology	Drift (superficial) geology and solid geology within development site/area
IDB boundaries	Identification of site/area within an IDB controlled catchment (if known)
S2Q100%	Percentage of development site/area within the S2Q100 (fluvial) flood outline
S2Q100 max	Max depth (m) of flooding within the S2Q100 (fluvial) flood outline
S2q100 ave	Ave depth (m) of flooding within the S2Q100 (fluvial) flood outline

Column heading	Description
S2q100 min	Min depth (m) of flooding within the S2Q100 (fluvial) flood outline
S2Q1000%	Percentage of development site/area within the undefended 1000 year (S2Q1000) fluvial flood outline
S2Q1000 max	Max depth (m) of flooding within the S2Q1000 (fluvial) flood outline
S2Q1000 ave	Ave depth (m) of flooding within the S2Q1000 (fluvial) flood outline
S2Q1000 min	Min depth (m) of flooding within the S2Q1000 (fluvial) flood outline
S2Q100 + CC%	Percentage of development site/area within the undefended 100 year (S2Q100) fluvial flood outline with climate change (CC) increase
S2Q100 + CC max	Max depth (m) of flooding within the S2Q100 (fluvial) flood outline with CC increase
S2Q100 + CC ave	Ave depth (m) of flooding within the S2Q100 (fluvial) flood outline with CC increase
S2Q100 + CC min	Min depth (m) of flooding within the S2Q100 (fluvial) flood outline with CC increase

In Barnsley 30 housing sites/areas, 11 employment sites/areas and 34 safeguarded sites are wholly located in the Environment Agency Flood Zone 1. 3 housing site/area, 2 employment sites and 4 safeguarded sites are partially or wholly located in the Environment Agency Flood Zone 2 or 3. The restored Barnsley canal would have <1.6km in the Environment Agency Flood Zone 2 and <0.6km in Flood Zone 3.

A more detailed assessment (using a colour coding of risk) of the flood outlines, potential flood depths, flood defences in those development sites/areas in Flood Zone 2, and particularly those in high risk Flood Zone 3, has been undertaken to provide the necessary statement on the feasibility of these developments with respect to flood risk.

7.4.1 Proposed Housing Sites

Table A1 provides an assessment of each proposed housing site/area. HS41 in Flood Zone 3 only had 4% of its land area within both FZ3a and the S2Q100 (undefended 100 year fluvial flood) modelled flood outline with average flood depths less than 0.5m. This only increased very slightly with climate change. A slight change to the design of the proposed development at this site and/or a change to the footprint of the development site boundary would remove this site from Flood Zone 3. HS39 with 15% of its area in FZ3a and 20% in S2Q100, had an average modelled flood depth (S2Q100) of <0.5m, which like HS41 increased only slightly with climate change. A slight change to the design of the proposed development at this site and/or a change to the footprint of the development site boundary would remove this site from Flood Zone 3. HS51 with 15%of its area in FZ2 (0% in FZ3) and 42% in S2Q100 had an average modelled flood depth (S2Q100) of <0.5m. Under climate change then 50% of the site area would fall within the S2Q100 outline, though the average modelled flood depth would still be <0.5m.

7.4.2 Proposed Employment Sites

Table A2 provides an assessment of each proposed employment site/area. For the one site in Flood Zones 2 (18% of the site area) ES21 has <1% of the development area within the S2Q100 (undefended 100 year fluvial flood) modelled flood outline with an average flood depth <0.5m. The flooded area and depth does not increase with climate change.

7.4.3 Proposed UDP Sites

Table A3 provides an assessment of each existing UDP development site/area. All five proposed developments sites (1 employment and 4 housing sites) are wholly within Flood Zone 1. Site WW4/3 has a negligible proportion of its area (<0.5%) within FZ2, which would be wholly taken out of FZ 2 but a very slight boundary change.

7.4.4 Proposed Safeguarded Sites

Table A4 provides an assessment of each proposed safeguarded site/area. Of the 4 safeguarded sites/areas that are partially or wholly located in Flood Zones 2 or 3 there are 2 sites with less than 5% of their land area within Flood Zone 3 and the S2Q100 (undefended 100 year fluvial flood) modelled flood outline. Both SAF36 and SAF38 have about 50% of their land area in Flood Zone 3, which indicates that they have a very high level of flood risk and are only suited to water compatible development. SAF38 has 69% of its land area within the S2Q100 (undefended 100 year fluvial flood) modelled flood outline with average flood depths of 1-1.5m making it a high risk site. SAF36 has 58% of its land area within the S2Q100 (undefended 100 year fluvial flood) modelled flood outline with average flood depths of 0.5-1m making it a moderate risk site.

7.4.5 Proposed Canal Restoration

Table A5 provides an assessment of the proposed Barnsley canal restoration. The canal runs through both rural and urban areas with only 0.58km of its 22km length located within Flood Zone 3 (0.65km within the modelled S2Q100 outline) where the canal passes over the floodplain (in an aqueduct or within an embanked channel. With climate change the length of canal within the S2Q100 outline only increases slightly to 0.70km.

8 GUIDANCE FOR DETAILED FLOOD RISK ASSESSMENTS

This section contains information and guidance on: key FRA reference documents, general principles of flood risk assessment, surface water drainage, Flood Zones 3a and 3b (including defended and undefended areas, public safety and rapid inundation, and the feasibility of flood risk mitigation), Flood Zone 2 and Flood Zone 1, and flood risk issues relating to other known flood risk areas including Internal Drainage Districts.

Key messages:

- Primary sources (PPS25, PPS25 Practice Guide and CIRIA Report 624) should be used for FRAs and be supplemented by information in this SFRA;
- FRAs are required for all development proposals in Flood Zones 2 and 3 and also for developments over 1 ha in Flood Zone 1;
- Surface water drainage assessments are required as an integral part of the FRA;
- Demonstration that technically feasible flood risk mitigation options are available is required;
- Overtopping and breach of flood defences should be considered along with emergency access, egress and evacuation;
- FRAs should demonstrate that the development and it's users and occupiers will remain safe in times of flood; and
- Functional floodplain should be considered as essential green infrastructure and safeguarded wherever possible.

8.1 Introduction

As discussed in Section 3 of this report there are principally three levels of flood risk assessment namely, Regional Flood Risk Appraisals (RFRAs), Strategic Flood Risk Assessments (SFRAs) and Site-specific (known as Detailed) Flood Risk Assessments (FRAs). The FRAs are site or project specific and are the responsibility of those proposing development to undertake. The principle aims of a FRA are to determine the acceptable management of flood risk to the development proposal itself and any impacts elsewhere, and to ensure that the development and its users/occupants remain safe in times of flood. The FRA will determine any effective flood mitigation measures necessary and include these in the development proposal. The FRA needs to demonstrate that the proposed development will not increase flood risk either upstream or downstream of the site and all sources of flood risk, including fluvial, surface water runoff and drainage need to be considered. The FRA will then be submitted to the LPA in support of the developers outline and/or detailed planning application.

Flood Risk Assessments for proposed development should follow the approach recommended by:

- The Environment Agency (see its National Standing Advice to Local Planning Authorities for Planning Applications – Development and Flood Risk in England (March 2007). See www.pipernetworking.com for all guidance on the scoping and undertaking of detailed FRAs.
- CIRIA Report C624 Development and Flood Risk – Guidance for the Construction Industry (2004)
- PPS25 and its Practice Guide.

These documents describe when a FRA is required, what it should contain and are extremely helpful in guiding developers to produce a "fit for purpose" FRA and are commensurate with the

advice given in this SFRA. All proposed development sites require at least an initial assessment of flood risks. A detailed FRA will be required for all developments that fall in the medium and high flood risk zones and other sites where significant flood risk is identified. A brief FRA will be required for sites in Flood Zone 1 which are greater than 1 ha (unless there are significant flooding issues, when a more detailed FRA will be necessary).

The information that follows serves to highlight key aspects of detailed FRAs and should be used in conjunction with the principle sources of information identified above.

8.2 General Principles

Annex E of PPS25 provides information on the general principles of flood risk assessment and states the minimum requirements for all stages of the planning process. These include:

- 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.

Figure 2.4 of the Practice Guide provides information on the scope of FRAs and this should be used as a starting point for all development proposals and then supplemented to reflect any specific peculiarities or issues in respect of the particular development proposal or site under consideration.

Information on levels of flood risk assessment is provided in both the CIRIA C624 Publication and Table 2.3 of the Practice Guide. There are principally 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.

Table 2.4 in the Practice Guide provides a helpful list of typical sources of information to help undertake an appropriate FRA.

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 and the LPA to discuss their proposals in outline and consider the site in respect of the risk based sequential approach contained within the SFRA.

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. Compensation measures will be needed in both defended and undefended floodplains. This concept is included in PPS25 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 and its mitigation measures will be addressed via the Sustainability Appraisal. These 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 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 as discussed in Section 2 of this report 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 PPS25 only the water compatible uses are allowed in this Flood Zone. Essential Infrastructure can be permitted after the Exception Test is passed. According to PPS25, 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 PPS25, 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.

As discussed in Section 4.4.5 of this report, 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

PPS25 states that the water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the sequential process. According to PPS25 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.

According to PPS25, developers and local authorities should implement the following policy aims:

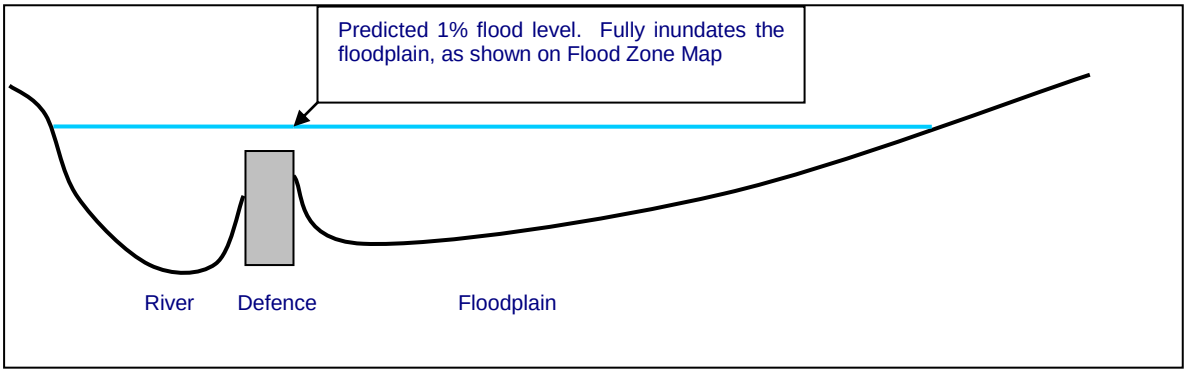
- Reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques;
- Relocate existing development to land in zones with a lower probability of flooding; and
- Create space for flooding to occur by restoring 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 actual risk within Flood Zone 3 is required. Annex G in PPS25 deals with 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.

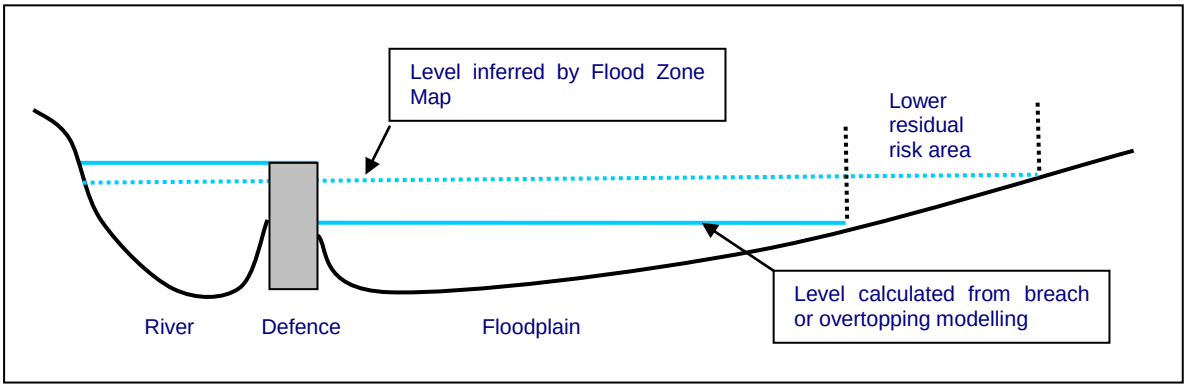
In the context of this discussion, an undefended area of floodplain as shown in Figure 8-1 below is considered to be an area where the water level for the 1% event will be similar to that in the relevant watercourse. These areas may be entirely undefended or if defences are present they are discontinuous or constructed to a low standard. Figure 8-1 illustrates 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 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, as a minimum, 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 PPS25 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. PPS25 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 5 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.

8.6.3 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.

8.6.4 Breach

Where the defences are shown to be at risk of overtopping and/or NFCDD data or additional information indicate that the flood defences are in poor or very poor condition, for the purposes of the SFRA it may be assumed that there is a reasonable likelihood of defence breach (i.e. a major failure of the flood defences) in a major flood event during the lifetime of any new development. A high degree of flood risk mitigation needs therefore to be provided or it may be that due to the high risk, the location is deemed to be unsuitable for development. If mitigation measures are acceptable, then 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.

In locations where the defence is of a high standard, both in terms of stability and height, then the probability of a breach occurring is reduced and hence the risk reduces as well. The overall probability of the consequences associated with a breach occurring extend to the extreme end of the risk continuum. This does allow a more considered approach to residual risk, and some flooding of non-sensitive or vulnerable developments may be considered acceptable.

Where the defences are shown to provide a standard of protection greater than the 1% event (with climate change), NFCDD data indicate that the defences are in good or very good condition, and there is an absence of detailed survey data to suggest otherwise, for the purposes of the SFRA it may be assumed that the likelihood of defence failure in a major flood event is low. With the defences mitigating risk substantially, a lesser degree of site-based flood risk mitigation may be adopted, with the focus on providing safety to the development and its occupants from residual risks. Assuming it can be demonstrated that occupants remain safe, for housing developments it is recommended that minimum floor levels be set to the maximum breach level for a 1% event less 300 mm, or 600 mm above natural surface level, whichever is greater.

A maximum inundation depth of 0.6m may be considered acceptable when combined with the 1% (1 in 100 yr) event and a breach in these well defended areas in employment developments under these circumstances after consideration of uncertainty and climate change has been added to the minimum floor levels. However, occupants and users still need to remain safe. Identification of the rapid inundation zone is essential in these circumstances, before deploying a relaxation of the residual risk accepted within the design. In comparison to residential areas, where societal risks are generally designed out, it is considered appropriate to possibly transfer these residual risks via insurance or resilience in the design of the commercial use, if the users of the site can remain safe.

The effects of land raising within defended areas on potential breach risk also warrants careful consideration in the flood risk assessment. In confined floodplains where breach levels approach those in the main river, land raising is unlikely to have any impact on breach water levels and extents. However, where the floodplain is not confined by natural high ground or secondary defences, or where the passage of breach floodwater is restricted by partial barriers such as road or rail embankments, and consequently breach levels do not approach the main river level, then there is potential for land raising to lead to an increase in flood risk (extent and depth of breach) elsewhere. 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 unlikely 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.

8.6.5 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:

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 of 0-1

A number of flood hazard thresholds have been identified describing a flood hazard as “Dangerous for some”, “Dangerous for most” and “Dangerous for all”. At present the lower threshold for “dangerous for some” of 0.75 is appropriate with a conservative upper threshold of 1.5. The threshold of 2.5 for “Dangerous to all” has been set with a less conservative view and it should be noted that hazard is not purely a function of flood depth. Flood hazard thresholds are shown in Table 8-1 below.

Table 8-1: Flood Hazard Thresholds

Flood Hazard d(v+0.5)+DF	Description	Alternative Name / Hazard Class
0	Safe (dry)	None
0 to 0.75	Caution	Low
0.75 to 1.5	Dangerous for some	Moderate
1.5 to 2.5	Dangerous for most	Significant
Over 2.5	Dangerous for all	Extreme

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. This should be the aim, but in exceptional circumstances a low hazard condition may be acceptable if the flood warning is robust and occupants remain safe. Greater depth and velocity may be permitted where elevated and safe access / egress to safe ground are provided.

8.7 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 in Section 2.2.2 of 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.

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9 CONCLUSIONS

9.1 Overview of SFRA Outcomes

Barnsley MBC 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 LDF's fully addresses the requirements of PPS25, 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.

The Barnsley MBC area is located with the River Dearne and Upper Don catchments. Flood processes and flood risk issues across the borough are inextricably linked by the Rivers Dearne and Upper Don and their tributaries.

This SFRA has taken a 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 PPS25. Firstly, 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 PPS25.

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

- Fluvial Flood Extent and Depth Maps
- Areas Naturally Vulnerable to Surface Water Flooding Maps

These maps, along with the published Environment Agency Flood Zone Maps, supply the detail and understanding of flood risk across the councils, providing the level of detail needed to assess current and future allocations in line with PPS25.

The councils are 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 maps can be used to gain a better understanding of the likelihood of sites passing the test and the level of appropriate mitigation need to make to site safe.

It is highlighted that there are a range of national and regional planning policy which LPAs must consider in the allocation of land for development. PPS25 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 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*. Where the council have identified those sites which are required to provide long term social and economic sustainability this SFRA has introduced a number of indicators along with a flood risk balance sheet. The flood risk balance sheet allows a simple sequential approach assessment to be delivered against flood risk criteria and a hierarchy of recommended land uses and how they would fare within the PPS25 Exceptions Test. This level of assessment would 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 would only be appropriate to consider undertaking a Level 2 SFRA in specific locations where flood risk has been identified as a critical issue but where a development is still required to meet the wider sustainable objectives of Barnsley MBC.

However, the Level 1 SFRA indicates that the majority of the proposed development sites are located within Flood Zone 1 and as a result we would not expect that a Level 2 SFRA will be required.

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 was taken, and in these circumstances there is merit in more detailed assessments within the context of an 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 updated on a regular basis. Barnsley MBC 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.

9.2 Guidance for Development Control

It must be made clear that this SFRA does not preclude the need for detailed site specific flood risk assessments (FRA). Site specific FRAs will be required for all development within Zones 2 and 3, and for all developments within the catchment of an Internal Drainage District (IDD). A FRA will also be required for all operational development greater than 1ha in size in Flood Zone 1.

This SFRA has identified flood risk areas i.e. Flood Zone 1, 2, 3a and 3b using the Environment Agency Flood Zone Maps and provided further SFRA maps. . The primary objective of the FRA should be to demonstrate adherence to policy requirements surrounding flood risk, as defined by the recommendations of the SFRA.

In line with the Environment Agency standing advice for development and flood risk FRAs will also be required for operational development greater than 1ha within Zone 1. The FRA will be required to demonstrate that it will be feasible to balance surface water runoff to the Greenfield runoff rate up to the 1 in 100 years. LPAs may also require a minimum design for drainage systems for example to be able to cope with a 1 in 30 year event. They may also require that this includes the removal of a climate change volume, which will also need to be agreed with the LPA and tackled within the FRA. However, it must be acknowledge that in specific circumstances, attenuation to greenfield runoff rate may not be achievable, which would need to be dealt with through a site specific FRA. Sustainable Drainage Systems (SuDs) have to be investigated and any obstacles to the use of SuDs will need to clearly justified within the FRA.

PPS25 provides some guidance with respect to the preparation of site-based FRA in Annex E. A pragmatic and risk-based approach should be taken to the preparation of a FRA, commensurate to the degree of flood risk posed to (and/or by) development of the site. The detail included within the FRA should follow the Flood Response matrix included in the current standing advice from the Environment Agency (see www.environment-agency.gov.uk), the guidance provided by the CIRIA

Report C624 (Development and flood risk – guidance for the construction industry) and the guidance provided in this SFRA in Section 8.

The Environment Agency standing advice has been produced to enable LPAs in England to make decisions on low risk planning applications where flood risk is an issue without directly consulting the Environment Agency for an individual response. In the instance where development sites lie within a former COW catchment, IDB/IDD areas or other sensitive areas the FRA should be discussed with the relevant body such as the Internal Drainage Board, sewerage undertakers, highways authority and reservoir owners and operators prior to application. The Environment Agency standing advice also identifies those higher risk development situations where case by case consultation with the Agency should continue.

Flood Risk Assessment Notes (FRAN) also provided as part of the Environments Agency's standing advice provides advice on general topics to do with flood risk potential that are not fully included within the SFRA as well as covering topics covered in more detail within the SFRA.

The Environment Agency anticipates that the information provided within the SFRA will feed directly into FRAs. Floor levels/inundation depths suggested by the SFRA should be taken as a starting point. Further investigation as part of the individual FRAs could reveal more accurate data and floor levels should be set around these calculations and modelling and not that provided by the SFRA.

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FIGURES

MAPS

APPENDICES

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

A.1 FLOOD RISK ZONES

Table B - 1: Flood Risk Zones

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. See Annex E (of PPS25) for minimum requirements

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.

Subject to the Sequential Test being applied, the highly vulnerable uses in Table D.2 (of PPS25 and Table B-2 of this report) are only appropriate in this zone if the Exception Test is passed

FRA requirements.

All development proposals in this zone should be accompanied by a FRA,. See Annex E (of PPS25) for minimum requirements

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 D.2 (of PPS25 and Table A-2 of this report) are appropriate in this zone.

The highly vulnerable uses listed in Table D.2 (of PPS25 and Table A-2 of this report) should not be permitted in this zone.

The more vulnerable and essential infrastructure listed in the Table D.2 (of PPS25 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, See Annex E (of PPS25) 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;

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

Local planning authorities should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions to identify the functional floodplain.

Appropriate uses

Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to:

– 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.
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 B - 2: Flood Risk Vulnerability Classification

Classification	Description
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines
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. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
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.21 • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable	• Police, ambulance and fire stations which are ***not*** required to be operational during flooding. • 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 works which do **not** need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water-compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor • sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, **subject to a specific warning and evacuation plan.**
1) This classification is based partly on Defra/Environment Agency research on Flood Risks to People (FD2321/TR2) and also on the need of some uses to keep functioning during flooding. 2) Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity. 3) The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.	

Appendix B: - Example Flood Risk Balance Sheet

B.1 EXAMPLE FLOOD RISK BALANCE SHEET

Policy area	Proposed land use	Flood risk indicators adopted as measure of Acceptability *(-ve indicates flood risk is unacceptable or results in difficulty of delivery of a site)*							
		A	B	C	D	E	F	G	Recommendation
		Development is within existing flood risk area	Residual risk measures are easily applied and within a norm	Egress and access. Impact on emergency planning provision and whether development would be safe	Change in the number of people at risk as result of development	Change in number of properties at risk in 1% and 0.1% event before and after. Assumes mitigation measures put in place	Scale and nature of flood risks.	Impact of mitigation measure on other areas d/s and adjacent	**Counter** to strategic approach, flood risk unacceptable. Exception Test would be difficult to pass. Not recommended **Sequentially not preferred, where limited land uses maybe possible** **Sequentially not preferred** but a range of land uses could be put forward after careful consideration and FRA **Acceptable with some detailed consideration of flood risk issues** **Acceptable** subject to FRA
Example Site 1	Housing	--	-	--	--	+	---	-	Not recommended. Sequentially better sites in AAP. Risks too high and not easily reduced.
Example Site 1	Retail and industry	-	+/ -	-	=	+/++	---	+/-	Careful strategic development could reduce flood risks to existing areas. Significant investment needs careful consideration.
Example Site 2	Housing	--	--	--	--	-	--	=	Not recommended. Sequentially better sites in AAP. Risks too high and not easily reduced.
Example Site 2	Commercial	--	-	--	-	+	--	=	Existing land uses can be regenerated on like for like basis. All as open or undeveloped spaces to be retained for flood storage

Example Site 3	Housing	-	-	--	--	-	-	=	Area is attached to higher ground and egress is obvious. Design could reduce flood risks in adjacent areas
Example Site 3	Commercial	-	-	-	-	+	-	=	Like for like regeneration possible, no increase in density of development
Example Site 4	Housing	-	+	-	-	+	-/+	+	At elevated ground levels, strategically placed to reduce risk to existing houses. Waterfront development to be used to reinforce defence line
Example Site 4	Commercial	-	-	--	+	+	-	=	Appropriate and straightforward flood resilient design. Surface water flooding main risk, and evacuation plan needed.
Example Site 5	Residential	-	-	--	-	+	-	=	Current flat type development appropriate. Need to understand surface water issues in area better, and design emergency plan to reflect shelter in place response
Example Site 5	Commercial	-	-	+	+	+	-	=	Redevelopment could lower scale of flood risk in this area.

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Appendix C: - Barnsley Assessment Tables

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