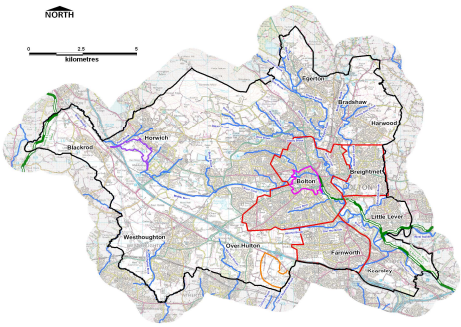
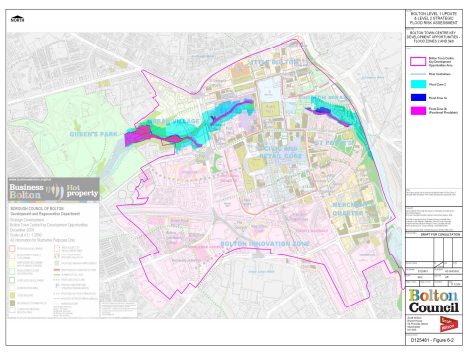
Bolton Metropolitan Borough Council

Bolton Level 1 Update and Bolton Town Centre Level 2 Strategic Flood Risk Assessment

March 2010





Prepared for: Bolton Metropolitan Borough Council

Bolton Council

Revision Schedule

Bolton Level 1 Update and Bolton Town Centre level 2 Strategic Flood Risk Assessment
November 2009

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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Abbreviations

ACRONYM	DEFINITION
AEP	Annual Exceedence Probability
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
ASTSWF	Areas Susceptible To Surface Water Flooding
BW	British Waterways
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
DEM	Digital Elevation Model
DPD	Development Plan Documents
EA	Environment Agency
EP	English Partnerships
FRA	Flood Risk Assessment
GIS	Geographical Information Systems
IDB	Internal Drainage Board
LDDs	Local Development Documents
LDF	Local Development Framework
LDS	Local Development Scheme
LiDAR	Light Detection and Ranging
LPA	Local Planning Authority
NFCDD	National Flood and Coastal Defence Database
ODPM	Office of the Deputy Prime Minister
PCPA	Planning and Compulsory Purchase Act 2004
PPG25	Planning Policy Guidance Note 25: Development and Flood Risk
PPS25	Planning Policy Statement 25: Development and Flood Risk
RFRA	Regional Flood Risk Assessment
RPG	Regional Planning Guidance
RSS	Regional Spatial Strategy
SW	Scott Wilson
SAR	Synthetic Aperture Radar
SA	Sustainability Assessment
SFRA	Strategic Flood Risk Assessment
SPG	Supplementary Planning Guidance
SSSI	Site of Special Scientific Interest
BMBC	Bolton Metropolitan Borough Council
SuDS	Sustainable Drainage Systems
TMBC	Tameside Metropolitan Borough Council
UU	United Utilities

Glossary

TERM	DEFINITION
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Aquitard	Geological formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Climate Change	Both natural and human actions causing long term variations in global temperature and weather patterns.
Culvert	A channel or pipe that carries water below the level of the ground.
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone 1	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or tidal flooding in any year (<0.1%).
Flood Zone 2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of tidal flooding (0.5% – 0.1%) in any year.
Flood Zone 3a	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone 3b	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).
Fluvial Flooding	Flooding by a river or a watercourse.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Internal Drainage Board	Independent bodies with responsibility of ordinary watercourses within a specified district.
Inundation	Flooding.
Local Development Framework	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map.
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Main River	All watercourses shown as such on the statutory main river maps held by the Environment Agency and the Department of Environment, Food and Rural Affairs, and can include any structure or appliance for controlling or regulating flow of water into, in or out of the channel. The Environment Agency has permissive

TERM	DEFINITION
	powers to carry out works of maintenance and improvement on these rivers.
Mitigation Measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Risk	The combination of probability and consequence of an event occurring.
Sequential Testing	A risk based approach in to assessing flood risk, which gives priority in ascending order of flood risk, i.e. lowest risk first.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Stakeholder	A person or organisation that has an interest in, or affected by the decisions made within a site.
Sustainability Appraisal	A process used to identify if policies, strategies or plans promote sustainable development and further used for improving policies. It is a requirement for Regional Spatial Strategies under the *Planning and Compulsory Purchase Act 2004.*
Sustainable Drainage System (SuDS)	Drainage methods designed to mimic the natural system. Where practicable should be used in preference to traditional piped drainage systems.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year Design Standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

1 Introduction

1.1 Policy Context and Background

1.1.1 The Planning and Compulsory Purchase Act 2004 (PCPA) (HMSO, 2004) requires Local Planning Authorities (LPAs) to produce Local Development Frameworks (LDFs) to replace the system of Local, Structure and Unitary Development Plans. LDFs are a portfolio of Local Development Documents (LDDs) that collectively deliver the spatial planning strategy for the Local Authority area. The PCPA requires LDDs to undergo a Sustainability Appraisal (SA), which assists Local Planning Authorities (LPAs) in ensuring their policies fulfil the principles of sustainability.

1.1.2 The North West Regional Spatial Strategy (RSS) was adopted in September 2008 and is now an adopted part of the development plan for all North West authorities. The RSS sets the scale and spatial focus of development within the Region until 2021.

1.1.3 Bolton is preparing its Local Development Framework (LDF) and has established a Core Strategy preferred option, which sets out the main areas where development is proposed. These are Bolton Town Centre, the Renewal Areas of Inner Bolton, Farnworth and Breightmet, and the two strategic sites of Cutacre and Horwich Loco Works.

1.1.4 Planning Policy Statement 25: Development and Flood Risk (PPS25, 2006)1 emphasises the active role that LPAs should have in ensuring that flood risk is considered in strategic land use planning. PPS25 encourages LPAs to undertake a Strategic Flood Risk Assessment (SFRA) as one of the documents to be used as the evidence base for strategic land use planning decisions as part of the LDF. SFRAs are also a component of the SA process and should be used in the review of LDDs or in their production.

1.1.5 The PPS25: Development and Flood Risk Practice Guide 2 recommends that SFRAs are completed in two consecutive stages:

- Level 1 SFRA,
- Level 2 SFRA.

1.1.6 Scott Wilson completed a Sub-Regional Strategic Flood Risk Assessment (SFRA) for Greater Manchester on behalf of the Association of Greater Manchester Authorities (AGMA). The Sub-Regional SFRA investigated and documented flood risk across all 10 AGMA districts primarily based on existing information obtained from key stakeholders. The current and future risks of flooding from all sources were highlighted in the Sub-Regional SFRA. The Sub-Regional SFRA also delivered District narratives specifically for each Local Authority.

1.1.7 The Sub-Regional SFRA highlighted a number of 'critical gaps' in the flood risk data available to the sub-region, especially with regard to flood risk from non-fluvial sources.

[1] Planning Policy Statement 25: Development and Flood Risk, Department for Communities and Local Government, December 2006
[2] PPS25: Development and Flood Risk Practice Guide, Department for Communities and Local Government, June 2008.

1.1.8 It also made recommendations for detailed Level 2 SFRA to be undertaken in some areas to enable application of the Sequential Test and, where required, the Exception Test.

1.1.9 The Hybrid Approach was recommended in the AGMA Sub-Regional SFRA as a means of providing detailed flood risk data in instances where local authorities are aware of areas within their districts that are likely to come forward for development within their LDF prior to undertaking the PPS25 sequential test. Flood risk to these areas may have already been fully or partially defined within the sub-regional SFRA. There may also be instances where the sub-regional SFRA has identified 'gaps' in the flood risk data for potential development areas.

1.1.10 Bolton Metropolitan Borough Council (Bolton MBC) commissioned a Hybrid SFRA study to fill the Level 1 data gaps in the district and to undertake a Level 2 SFRA for Bolton Town Centre. This report documents the methodology and findings of the SFRA for Bolton MBC.

1.2 Study Area

1.2.1 The Level 1 update covers the entire district taking into consideration the hydrological links between Bolton and neighbouring districts. In particular the Level 1 SFRA should highlight risks in the key development areas Bolton Town Centre, the Renewal Areas of Inner Bolton, Farnworth and Breightmet, and the two strategic sites of Cutacre and Horwich Loco Works.

1.2.2 The Level 2 SFRA focuses on the fluvial flood risk for Bolton Town Centre Development Area (Figure 1-1). Details of the hydraulic modelling work are given in Section 6.

1.2.3 A detailed FRA for the two strategic sites of Cutacre and Horwich Loco Works has been conducted in parallel with the SFRA; therefore a Level 2 SFRA is not required for these areas.

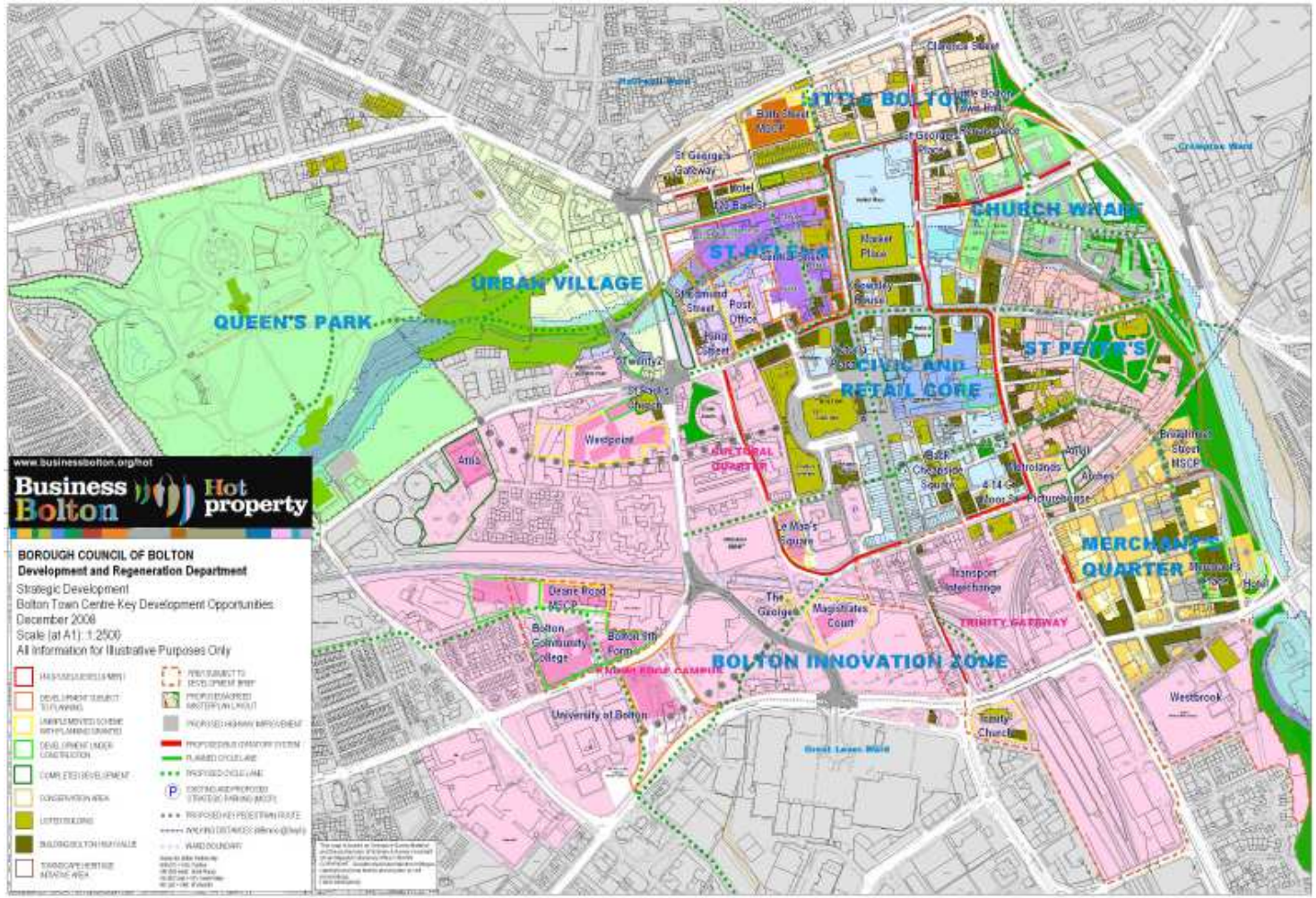


Figure 1-1: Bolton Town Centre planned development and Level 2 SFRA Area

1.3 Aims and Objectives of the Level 1 SFRA Update and Level 2 SFRA

1.3.1 The aim of the Level 1 SFRA update and Level 2 SFRA is to provide Bolton MBC with adequate flood risk information to inform the sequential approach across the district (as defined in PPS25) and detailed information for the application of the PPS25 Exception Test to key development areas.

1.3.2 The following objectives were defined in the study brief:

(a) A schedule of the current condition of flood defence infrastructure, both formal and informal, cross-referenced to specified policies in the Environment Agency River Irwell CFMP with regard to its maintenance and upgrade. Supporting material for the schedule to be provided by the consultant will include walk-over survey records, as-build records where available, a directory of photos, and location plans;

(b) An appraisal of the probability, return period and consequences of overtopping or failure of flood risk management infrastructure, including appropriate allowance for climate change. This should include determining the standard of protection of existing flood defences, the rate and onset of flooding, velocities, creation of hazard maps and emergency planning considerations;

(c) Definition and mapping of the functional floodplain in locations where this is required[3];

(d) Maps showing the distribution of flood risk across all flood zones from all sources of flooding taking climate change into account, using the latest Climate change data sources (UKCP09);

(e) Guidance on strategic flood risk assessment and management issues to be considered in policy development;

(f) Guidance on the preparation of FRAs for sites of varying risk across the flood zones. Consultants should provide spatial recommendations that go beyond the general guidance in PPS25 to inform the preparation of FRAs, including:

- Recommended development approach and potential end use;
- Proposed development control and technical issues to be resolved to permit development;
- Mitigation options required to permit development;
- Supplementary design guidance including minimum floor levels, access and egress, site layout recommendations in relation to vulnerability, building materials and flood resilient construction;
- Residual risk management;
- Advice on the use of sustainable drainage techniques (SuDS);

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

- Overall site-by-site summary guidance suitable for issuing to potential developers.

(g) Identification of the location of critical drainage areas and identification of the need for Surface Water Management Plans;

(h) Identification of any linkages to other relevant studies, such as the Greater Manchester Water Cycle Study and the Greater Manchester Green Infrastructure Study, and any other relevant studies such as the Irwell CFMP;

(i) Guidance on the application of the Exception Test, which will assist planners in taking a sustainable and safe approach when allocating development;

(j) Identification of surface water and drainage flood risk issues (e.g. potential ponded areas and overland flood routes where sewer system capacity is exceeded);

(k) Implications of how canals and reservoirs interact with local rivers and watercourse and the resultant risk that follows from these connections, as well as any overflow weirs, sluice gates and low points and areas where the canal is raised; and

(l) Mitigation options, and potential delivery mechanisms should be presented as part of the Level 2 SFRA.

2 Sequential Approach to Site Allocation

2.1 The Sequential Test

2.1.1 The Sequential Test is a simple decision making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. New development should be directed to sites with the lowest probability of flooding and the flood vulnerability of the intended use should be matched to the flood risk of the site, e.g. higher vulnerability uses should be located on parts of the site at lowest probability of flooding. The Sequential Test is the first stage of the site allocation process.

2.2 Development Vulnerability

2.2.1 In order to determine the suitability of land for development in flood risk areas, the development vulnerability must first be established. Flood Risk Vulnerability Classifications, as set out in Appendix D, Table D2 of PPS25 are shown in Table 2-1

Table 2-1: Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes), which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
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. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).

Water-Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 2-2: Flood Risk Vulnerability and Flood Zone 'Compatibility' replicates Table D.3 from Annex D of PPS25 (and illustrates a matrix of 'Flood Risk Vulnerability' of a proposed development against 'Flood Zone Compatibility)'.

Table 2-2: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3a	Exception Test required	✓	×	Exception Test required	✓
	3b	Exception Test required	✓	×	×	×

✓ Development is appropriate × Development should not be permitted

2.3 Flood Zone Definition

Flood Zone 1

2.3.1 Flood Zone 1 comprises land assessed as having a low risk of flooding with an Annual Exceedence Probability (AEP) less than 0.1% (1 in 1000 annual probability of river or tidal flooding in any year). All uses of land for development are considered appropriate in this zone.

Flood Zone 2

2.3.2 Flood Zone 2 comprises land assessed as having an AEP between 1% and 0.1% (a 1 in 100 and 1 in 1000 annual probability) of river flooding or between 0.5% and 0.1%a (1 in 200 and 1 in 1000 annual probability) of tidal flooding in any year.

2.3.3 As defined in Table 2-2, 'Water-Compatible', 'Less Vulnerable', 'More Vulnerable' and 'Essential Infrastructure' land uses are considered appropriate in this Flood Zone. Subject to

the application of the Sequential Test, 'Highly Vulnerable' uses are only appropriate in this zone if the Exception Test is also passed. All development proposals in this zone should be accompanied by a detailed site specific FRA.

Flood Zone 3a

2.3.4 Flood Zone 3a comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1% AEP) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5% AEP) in any year (high probability).

2.3.5 As defined in Table 2-2, 'Water-Compatible' and 'Less Vulnerable' land uses are appropriate in this zone. 'Highly Vulnerable' land uses should not be permitted in this zone. 'More Vulnerable' and 'Essential Infrastructure' uses 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 users in times of flood. All development proposals in this zone should be accompanied by a detailed site specific FRA.

Flood Zone 3b – Functional Floodplain

2.3.6 Flood Zone 3b comprises land where water has to flow or be stored in times of flood with a 1 in 20 (5%) or greater annual probability of river flooding in any year or is designed to flood in an extreme flood (1% AEP), or at another probability to be agreed between the LPA and the Environment Agency (EA).

2.3.7 As defined in Table 2-2, only the 'Water-Compatible' and 'essential Infrastructure' land uses should be permitted in this zone. Any permitted development within Flood Zone 3b 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,
- Not increase flood risk elsewhere.

2.3.8 'Essential Infrastructure' in this zone should also pass the Exception Test. All development proposals in this zone should be accompanied by a detailed site specific FRA.

2.4 The Exception Test

2.4.1 The rationale of the Exception Test is that development is only permissible in areas at higher risk of flooding where it can be demonstrated that there are no reasonably available sites in areas of lower risk and that the benefits outweigh the risks from flooding. As such, the development must pass the Exception Test (applied by the LPA using evidence supplied by either the Level 2 SFRA or a site specific FRA). The Exception Test is a vehicle for managing flood risk while still allowing necessary development to occur.

2.4.2 Where there are no available sites in Flood Zone 1, decision makers should consider reasonably available sites in Flood Zone 2 taking into account the flood risk vulnerability of land uses and applying the Exception Test if required (e.g. Highly Vulnerable development in

flood zone 2). Only where there are no reasonably available sites in Flood Zone 1 or Flood Zone 2 should decision makers consider sites in Flood Zone 3, taking into account flood risk vulnerability and applying the Exception Test if required (e.g More Vulnerable development in flood zone 3a).

2.4.3 'More Vulnerable' land uses within Flood Zone 3a and 'highly vulnerable' land uses within Flood Zone 2 should only be permitted if an Exception Test has been passed.

2.4.4 PPS25 states that for the Exception Test to be passed, three main criteria must be satisfied in order for the development to be considered acceptable:

- Part i - "It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by an SFRA where one has been prepared. If the DPD has reached the 'submission' stage – the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal";
- Part ii – "The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land"; and
- Part iii – "A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible will reduce the flood risk overall".

2.4.5 For successful application it is important that the arguments presented for justification through the Exception Test are in line with policies set out in Local Plans and the LDF, supported by reference to other national planning and sustainability policies, such as development of Greenfield sites.

2.4.6 This Level 2 SFRA aims to provide information to enable satisfaction of Part iii of the Exception Test. Bolton MBC will need to provide evidence that Part i and Part ii of the Exception Test can be satisfied.

3 Planning Context

3.1.1 Bolton Council is currently in the process of preparing their Local Development Framework (LDF), which will comprise a series of development plan documents and supplementary planning documents. The SFRA will inform this process and in particular, preparation of the Core Strategy.

3.1.2 The Core Strategy will plan for an average of 694 additional dwellings per annum between 2008 and 2026, an overall total of 12,192 dwellings. This is a 20% increase on the minimum level specified in the North West Regional Spatial Strategy (which requires 578 per annum). The higher target reflects the evidence from the housing market assessment, and the Sustainable Community Strategy aspiration to provide housing that meet Bolton's needs. This number also reflects that Bolton is part of the wider AGMA Growth Point.

3.1.3 The Bolton Strategic Housing Land Availability Assessment (SHLAA) 2008 identifies housing land availability in Bolton. The SHLAA indicates that the number of dwellings from outstanding planning permissions and the small site allowance in the Borough is insufficient to meet housing targets under the Growth Point scenario.

3.1.4 The North West of England Plan (September 2008) also sets out the provision of employment land required in the region between 2005 and 2021. The identified need in Greater Manchester is 1904 hectares, which represents a 536 hectare shortfall on the supply of land that was available in 2005 (1368).

3.1.5 The Bolton Employment Land Study (2008) identified ten sites with potential for redevelopment around Bolton Town Centre. They vary in size but include two large sites, Merchant's Quarter and Trinity Gateway. The Study assessed the potential sites; nine of the ten town centre sites score 80% of available points in both the availability and deliverability category and the planning policy and sustainability category, although there are a few Environmental Constraints as shown in Figure 3-2, Appendix 1. The Town Centre development is discussed in more detail in Section 6.

3.1.6 The Core Strategy is the key document in the Council's LDF. The Core Strategy Preferred Options report sets out the Council's vision and spatial strategy for future development and investment up to 2026. The Council are currently drafting their publication version of the Core Strategy, based on this preferred option.

3.1.7 The Council's preferred spatial option is for concentrated urban development, with an element of peripheral development consisting of Green Belt land at Cutacre to allow for enough land to achieve Bolton's economic ambitions. Within the urban area, there will be a concentration of a wide range of different types of development in Bolton town centre, and to a lesser extent in the smaller town centres of Farnworth, Westhoughton and Horwich (Figure 3-1, Appendix 1). There will be a concentration of housing and community infrastructure in the renewal areas of Inner Bolton, Farnworth and Breightmet. There will be a concentration of investment for manufacturing, distribution and office employment along the M61 corridor with strategic investment sites at the Horwich Loco Works (including office and housing

development) and Cutacre (focussing on manufacturing and distribution). In the remaining parts of the Borough; (Westhoughton, Horwich and Blackrod, West Bolton, North Bolton, and Little Lever and Kearsley); there will be more limited development where the local character of the area and the supporting infrastructure allows it.

4 SFRA Approach

4.1 General Approach

4.1.1 The SFRA builds on the AGMA Sub-Regional SFRA and Level 1 SFRA for Bolton taking into consideration the FRA Hierarchy recommended in PPS 25. The starting point for the Level 1 update is the Sub-Regional SFRA which was completed by Scott Wilson in 2008.

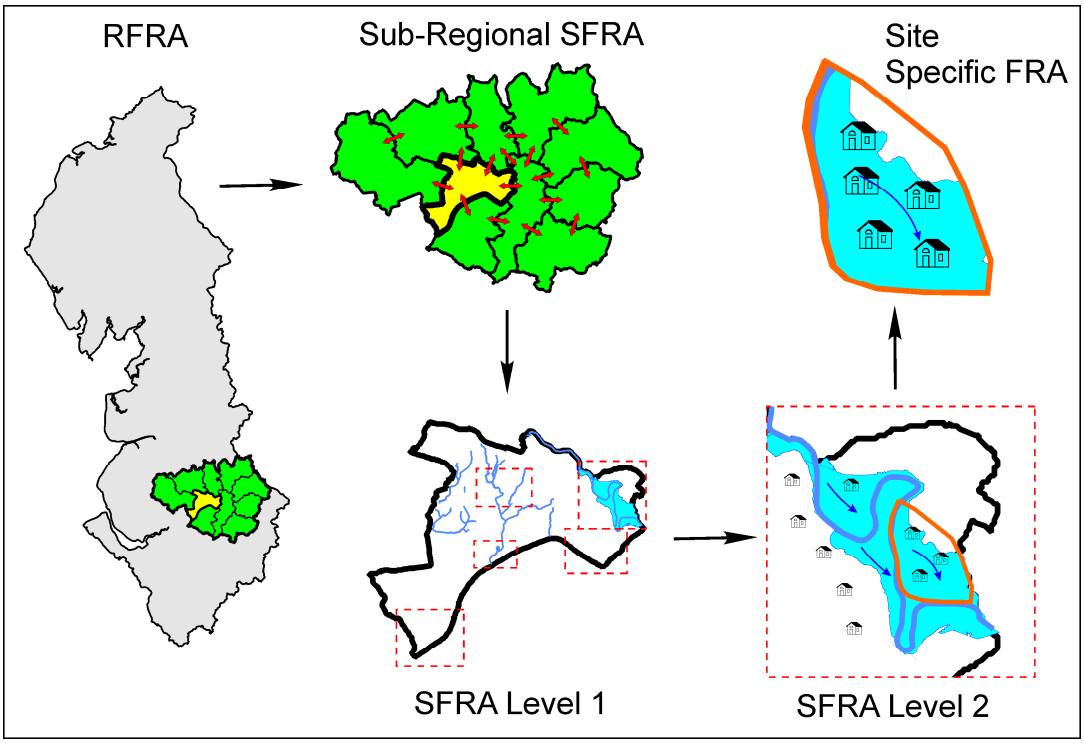


Figure 4-1: Hierarchical Approach to Flood Risk

4.2 Level 1 Update

4.2.1 The first part of the SFRA involves an assessment of flood risk from other non-fluvial sources of flooding within the district boundary, in accordance with PPS 25 and identified in the Sub-Regional SFRA as critical data gaps. The other sources of flooding considered in the SFRA that are relevant to Bolton are:

- Flooding from the Land Pluvial (overland flow) flood risk;
- Flooding from sewers;
- Flooding from Groundwater;
- Flooding from reservoirs and Canals.

4.2.2 Since the AGMA Sub-Regional SFRA was completed the Environment Agency has updated their hydraulic models within Bolton MBC and revised their flood zone maps. The most recent flood zone maps have therefore been used to update the fluvial flood risk data within the district as part of the Level 1 Update.

4.2.3 The general methodology for identifying Level 2 sites would normally involve overlaying district-wide flood risk data with development data across the district, based on development aspirations published in the Core Strategy. Areas where a significant amount of development is planned to be directed to will then require a Level 2 SFRA to inform the Sequential Test and Exception Test, if flood risk issues have been identified in those areas. The only areas where significant development is planned to be directed to are Bolton Town Centre, the Horwich Loco Works and Cutacre sites. Bolton Town Centre is the only area identified in the District where a level 2 SFRA is required. Separate FRAs will be submitted for Horwich Loco Works and Cutacre sites by the developer.

4.2.4 In order to complete the level 1 SFRA update and Level 2 SFRA flood risk data were requested from various sources, including Bolton MBC, Environment Agency, United Utilities and British Waterways. The flood risk data were used to fill in critical data gaps on a district-wide scale and for the Town centre level 2 SFRA.

4.2.5 Data availability was a key issue for the SFRA which has limited the assessment of flood risk from other sources in particular. The extent of the Level 1 Update was tailored to suit the data availability for each source of flooding.

4.2.6 Following the district-wide assessment of flood risk from other sources the level 2 SFRA focuses on providing a detailed assessment of flood risk within the Town Centre boundary to inform the Sequential and Exception Tests. Flood zones and flood depth hazard maps were derived for the Town Centre using a hydraulic model of the River Croal. Details of the hydraulic modelling and mapping work are given in Section 6 of this report.

4.3 Level 2 SFRA Requirements

4.3.1 In general each Level 2 SFRA will differ slightly from others as it seeks to address the particular flood risk issues that are specific to the area in question. The general requirements for a Level 2 SFRA have been set out in the AGMA Sub-Regional SFRA to enable AGMA Councils to determine a consistent scope for a Level 2 assessment in line with the principles of the Hybrid Approach.

4.3.2 As part of the AGMA Sub-Regional SFRA flow charts have been produced (Chart 4-1, Chart 4-2 and Chart 4-3) which highlight the issues the Level 2 SFRA should address and the level of detail and items of work required.

4.3.3 These charts are not designed to be an exhaustive and detailed brief of services, not least because every Level 2 SFRA and more detailed study will have different requirements depending on the flood risk issues (or combination of issues), location and the potential development options of the site or area of interest as well as data availability. As a result, some flexibility in the specification and provision of services for Level 2 SFRAs and more detailed studies is required in each Level 2 SFRA study.

4.3.4 The charts are based on the four main flood sources relevant to the study area (as defined by the Level 1 SFRA). These include fluvial, sewer and drainage, pluvial and surface water, and artificial sources (including reservoirs and canals).

Chart 4-1: Specifying where a Level 2 SFRA or more detailed studies are required.

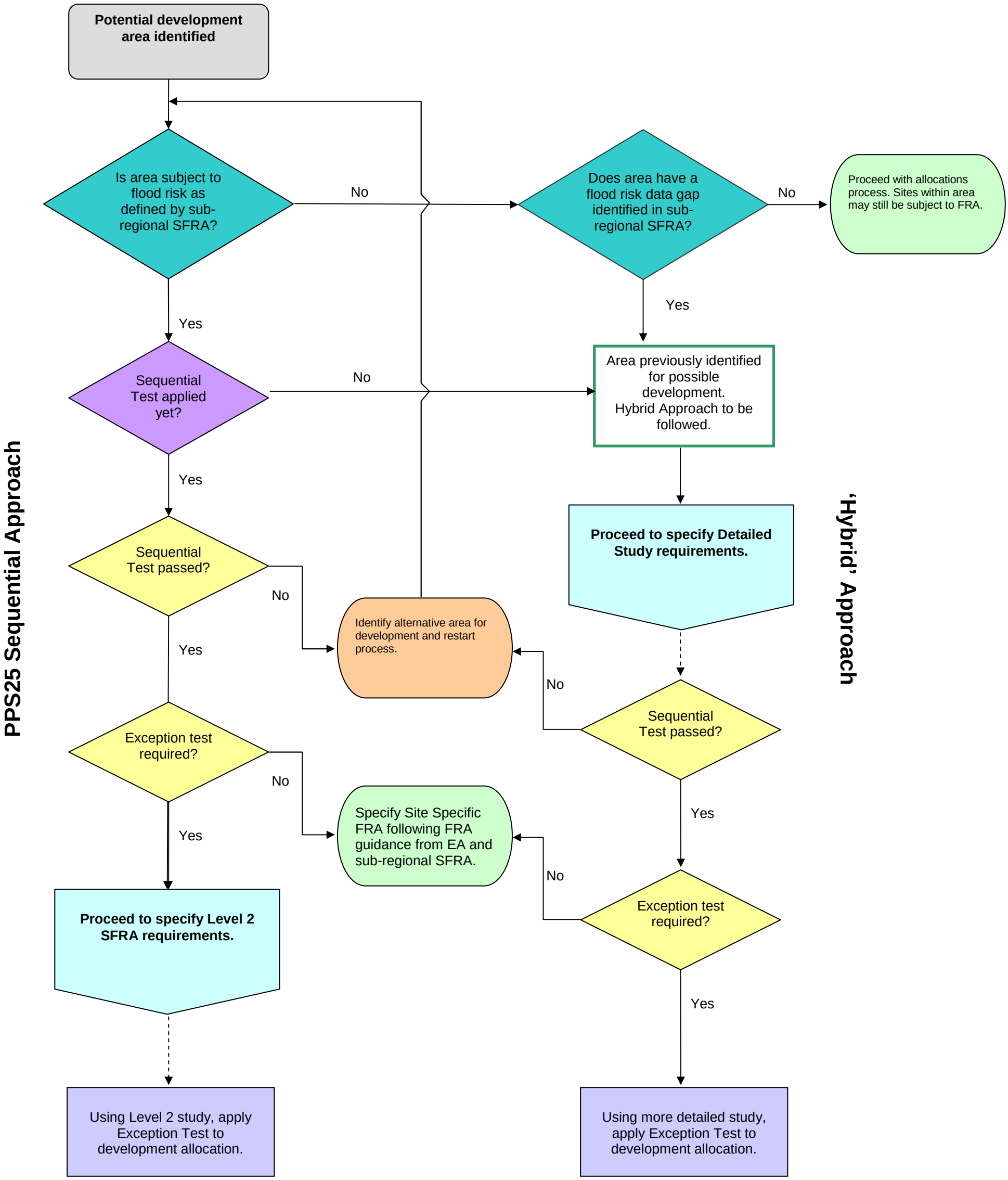


Chart 4-2: Specifying the requirements of a Level 2 SFRA or more detailed study for fluvial and pluvial sources of flooding.

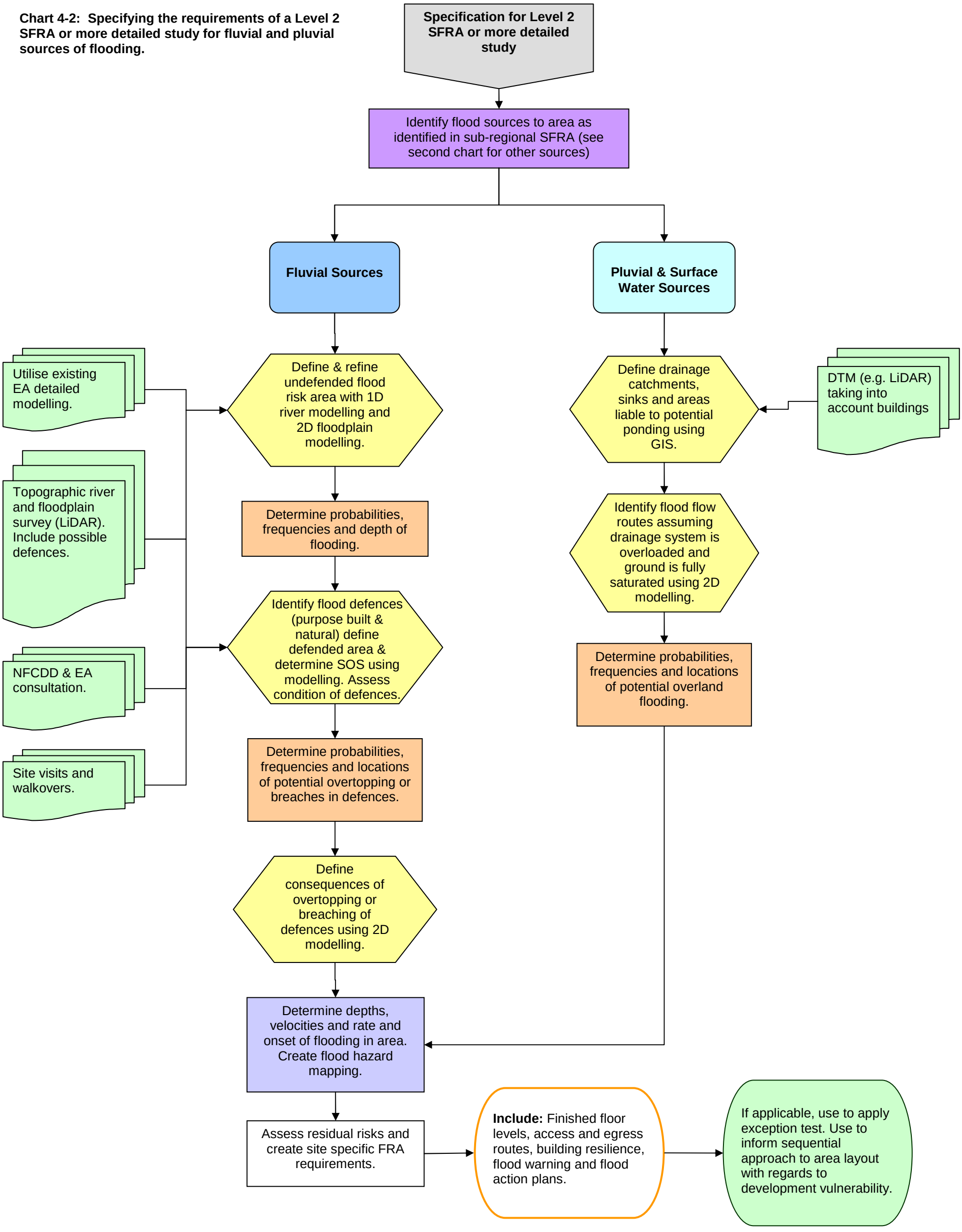
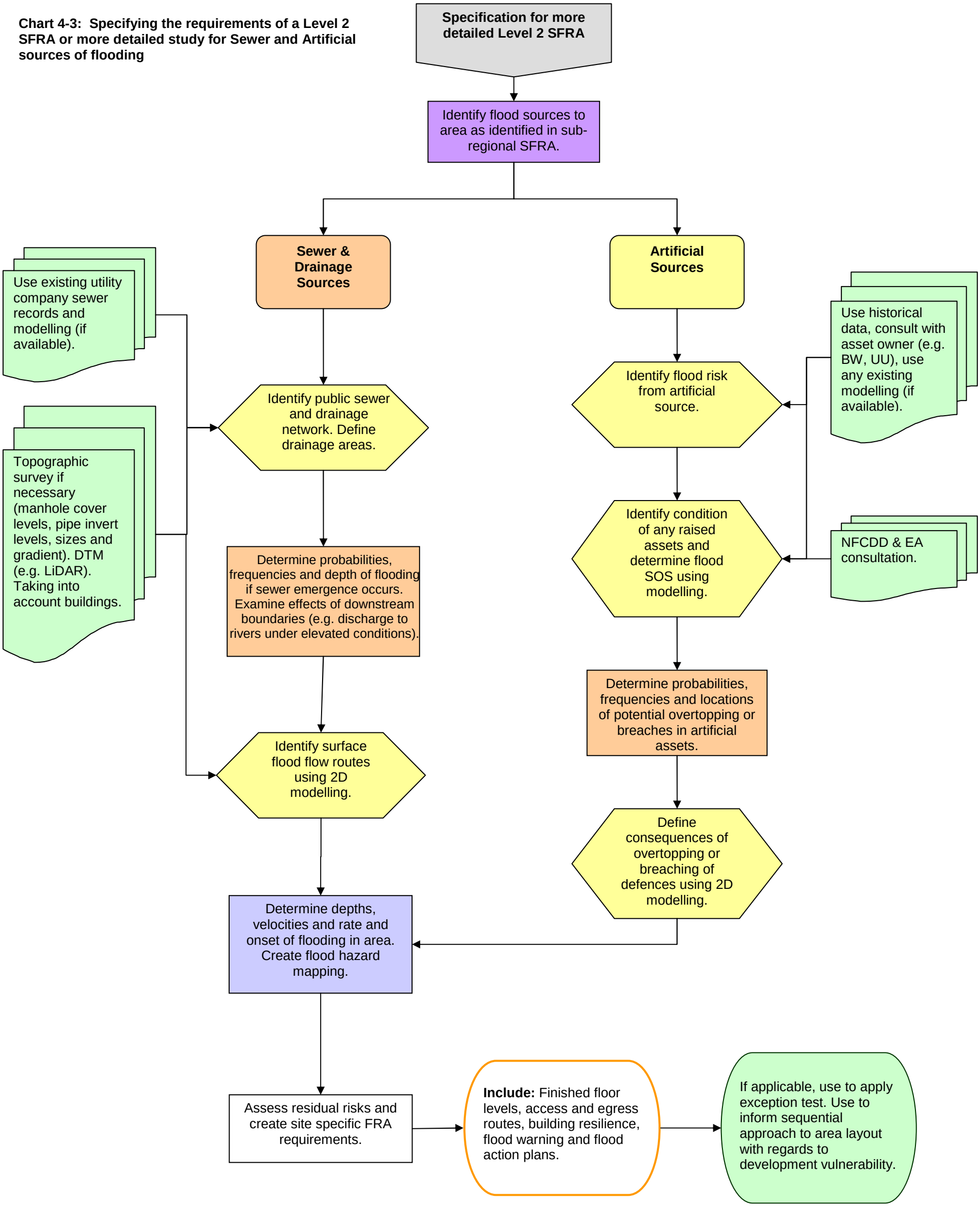


Chart 4-3: Specifying the requirements of a Level 2 SFRA or more detailed study for Sewer and Artificial sources of flooding



4.4 Level 2 SFRA Output

4.4.1 In accordance with the PPS25 Practice Guide and Chart 4-1 the scope of a Level 2 fluvial SFRA should consider the detailed nature of the flood hazard within each flood zone and specifically determine:

- The probability of flooding;
- Depth of flooding;
- Frequency and locations of potential overtopping or breach of defences
- Velocities and onset of flooding
- Flood hazard mapping.

4.4.2 Following discussions with the EA and Bolton MBC and given the mechanism of flooding in Bolton Town Centre it was not considered necessary to undertake two-dimensional modelling for the Town Centre SFRA. The rationale for this decision is explained in Section 6. Therefore the outputs required for the Town Centre Level 2 SFRA are:

- The probability of flooding (flood extent);
- Depth of flooding and;
- Flood hazard mapping.

4.4.3 The depth hazard categories have been mapped using guidance set out in the DEFRA/EA Flood Risk Assessment Guidance for New Development Technical Report[4], which suggests categorising depth hazard as shown in Table 4-1.

Table 4-1: Key to Depth Hazard

Depth of Flooding*	At Risk
0.30m - 0.50m	Some
0.50m - 1.50m	Most
>1.50m	All
*Taken from Table 13.1, FD2320/TR2 Report	

4.4.4 The information on flood probability and depth hazard maps within the Town Centre development area will provide the additional information required for the Exception Test and formulation of appropriate development policies in the Town Centre development area.

4.4.5 Following discussions with Bolton Council and the Environment Agency it was agreed that a Level 2 SFRA for non-fluvial sources of flooding is not required for Bolton. Instead the Level 1 data will be screened to identify areas where further investigation (e.g. Surface Water Management Plans-SWMP) of flood risk from other sources is required.

[4] Flood Risk Assessment Guidance for New Development, Defra/EA Flood and Coastal Defence R&D Programme Technical Report FD2320/TR2, October 2005

5 Level 1 SFRA Update

5.1 Flooding History

5.1.1 There have been few reported incidents of flooding from different sources within the district of Bolton. Figure 5-3 in Appendix 1 shows locations where flooding has been reported in the district. Figure 5-2, Appendix 1 is mainly based on data received from Bolton MBC. The map shows areas where flooding has been reported in the past classified both by occurrence and type (Figure 5-3, Appendix 1). It suggests widespread occurrence of flooding across the District although most incidents are fairly localised. Many of the reported single significant incidents occur in culverted watercourses and might have been caused by blockage of culverts. The Environment Agency has recently commissioned work under the SFRM2 Framework to investigate the risk of flooding from some of these culverted watercourses.

5.1.2 Neither the Irwell CFMP[5] nor the River Irwell Model Review & Update[6] mention historical flooding from fluvial sources. The River Douglas CFMP mentions a recorded flood incident on Pearl Brook in Horwich, which led to localised flooding. The River Douglas CFMP mentions that localised flooding has occurred along the floodplain of the Douglas immediately downstream of the Rivington reservoirs following emergency releases. According to information received from British Waterways a canal breach occurred in the Manchester, Bolton and Bury Canal at Little Lever in 1936.

5.2 Level 1 Update of Fluvial Flooding across Bolton

Fluvial Sources of Flooding within Bolton

5.2.1 The main Rivers within the administrative boundary of Bolton are within the catchment of the River Irwell. The main sources of flooding in the District are the River Croal, River Tonge, Bradshaw Brook and their headwaters and tributaries. A short reach of the River Irwell also passes through Bolton and some watercourses within the district boundary drain into the Douglas catchment. Figure 5-1 shows an overview of watercourses within the District.

5.2.2 The River Croal flows through Bolton Town Centre where significant developments are planned. The upper reach of the Croal is called Middle Brook. Middle Brook starts from near the Reebok Stadium in Horwich, Bolton and follows a south easterly course through Lostock running parallel to the Bolton-Euxton railway line. Beyond Lostock the Brook changes its course and flows in a more predominantly easterly direction towards Bolton Town Centre as River Croal. The Croal flows through several hydraulic structures at Queens Park and Bolton Town Centre before passing through a long culvert – St Peter's Way Culvert in the Church Wharf area. The culvert follows the course of the A666 – St Peter's Way and daylights near the A666 and A579 junction. From here the Croal continues in a south easterly direction meandering along its course towards the confluence with the Irwell at Clammerclough.

[5] River Irwell Catchment Flood Management Plan (December 2006)
[6] River Irwell Model Review & Update (March 2006)

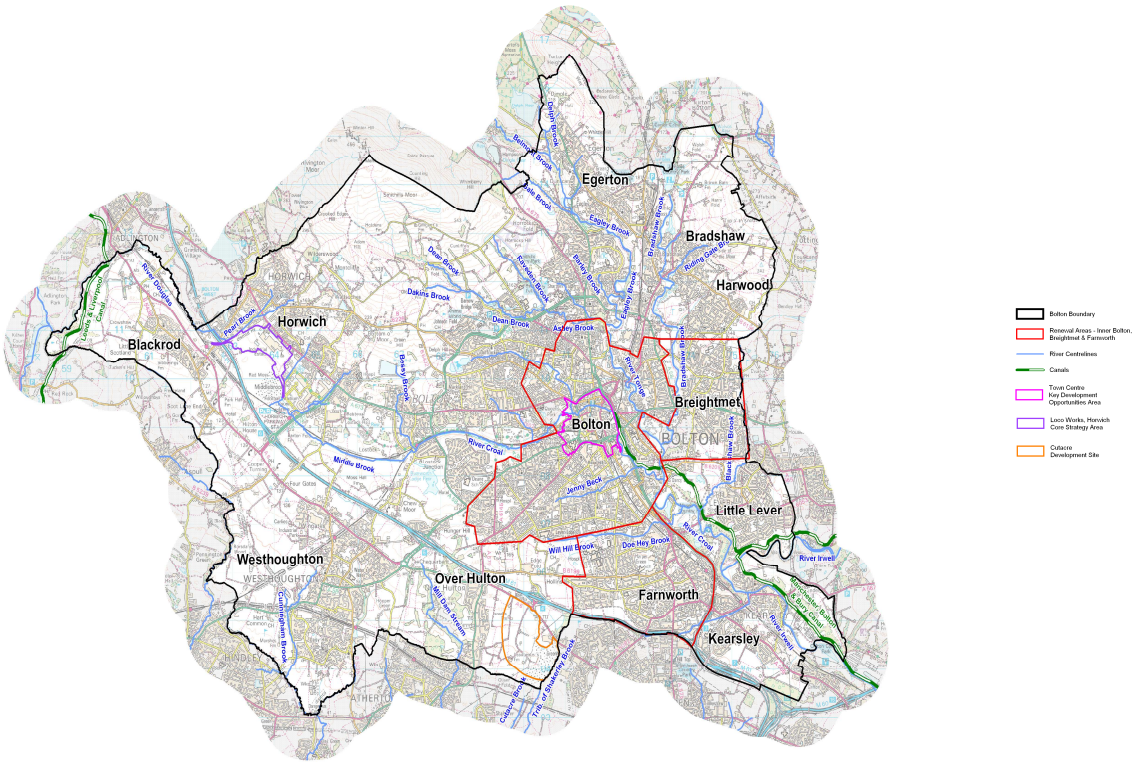


Figure 5-1: Overview of watercourses in Bolton MBC district

5.2.3 Several tributaries flow into the Croal before it discharges into the Irwell. Bessy Brook flows in a southerly direction into the Croal near Lostock Junction in Bolton. Captain's Clough joins the Croal downstream of Queens Park just before Chorley Street. Jenny Beck flows into the Croal near Rose Hill just upstream of the River Tonge confluence. The River Tonge and Bradshaw Brook are major tributaries that flow from the north and discharge into the Croal near Darcy. Doe Hey Brook and Blackshaw Brook also flow into the Croal before it discharges into the Irwell.

5.2.4 Rising from the moors north of Bolton, Ravenden Brook and Dean Brook combine near the A58 and flow in an easterly direction as Astley Brook before combining with Eagley Brook to become the River Tonge. Downstream of Eagley Brook the River Tonge proceeds south and is joined by Bradshaw Brook in Bradford Park on its way into the River Croal in the Burnden area of Bolton. Both the Tonge and Bradshaw Brook flow through the Renewal Areas of Inner Bolton, Farnworth and Breightmet. Other watercourses in the headwaters of the Tonge and Bradshaw Brook include Dakins Brook, Barley Brook, Gale Brook, Belmont Brook, Delph Brook and Riding Gate Brook, a tributary of Bradshaw Brook.

5.2.5 The River Irwell flows from the east from Bury into Bolton near Little Lever and changes its course to continue flowing in a south easterly direction through Kearsley into Salford.

5.2.6 Other watercourses within the River Glaze catchment that flow through the District include Pearl Brook near the Horwich Loco Works development Site in Horwich, Cunningham Brook in Westhoughton, Mill Brook in Over Hulton, Cutacre Brook and a tributary of Shakerley Brook near the Cutacre Development Site.

Method of Assessment

5.2.7 The Environment Agency has completed a flood mapping study in 2007 to update the flood zone maps within the Irwell catchment[7]. The study determined flood outlines for the 5% AEP (1 in 20 year event), 1 % AEP (1 in 100 year event) and 0.1 % AEP (1 in 1000 year event) respectively, for main rivers within the Irwell Catchment, including rivers within the district boundary of Bolton (Rivers Croal, Irwell, Tonge and their tributaries). The most up-to-date flood outlines from the Environment Agency were used to update the fluvial flood risk data from the AGMA Sub-Regional SFRA. Flood outlines for watercourses within the Douglas catchment were also received from the Environment Agency and used to update the AGMA Sub-Regional SFRA flood outlines for these watercourses.

5.2.8 It is important to note that the Level of confidence in the flood zones from the Level 1 update varies depending on whether they have been derived from hydraulic modelling or using generalised flood mapping methods. Figure 5-2, Appendix 1 shows reaches of watercourses within the district for which the Environment Agency holds hydraulic models. Flood zones that are not based on detailed hydraulic modelling data and are likely to be less accurate compared to the modelled reaches. It is important to take this into consideration when undertaking FRAs in future.

Flood Risk Maps

5.2.9 A map showing the updated flood zones within Bolton MBC is shown in Figure 5-1, Appendix 1. Flood zones outside the Bolton Town Centre development have been taken directly from the Environment Agency's updated flood zones. Within the Town Centre development area the Environment Agency flood zones have been replaced with the flood zones from the SFRA, which are based on model runs undertaken as part of this SFRA.

5.2.10 The maps show that the risk of fluvial flooding within the district is generally low. Due to the incised nature of the Croal, Tonge and Bradshaw Brook, flood zone 3b is generally within the river banks. Flood zone 3a and flood zone 2 extend out of bank at some locations but the spread of the flood zones beyond the river banks is generally limited by the narrow valleys. The extent of flooding is more obvious along the lower reach of the River Tonge towards the confluence with the Croal, along the River Croal immediately downstream of the confluence and at Kearsley along the Irwell.

5.2.11 The area at greatest risk of fluvial flooding is in Kearsley downstream of the confluence of the Croal and the Irwell (Figure 5-1 Appendix 1). The source of flooding to the area is from the combined flows of the Irwell and Croal and their tributaries. No significant developments are planned in this area.

[7] River Irwell Model Review and Update (2007)

5.2.12 A small area in the Church Wharf area in Bolton Town Centre is shown to be within flood zone 3a (Figure 5-1 Appendix 1). The risk of flooding to this site is from the River Croal as discussed in more detail in Section 6.

5.2.13 Elsewhere within the district flood zone 3a and flood zone 2 mainly lies within the Green Belt where planned development is very limited. The risk to properties in these areas is therefore low.

5.2.14 It should be noted that the flood zone map shown in Figure 5-1, Appendix 1 does not include ordinary watercourses within the district. These should be taken into consideration in future FRAs for sites located close to such watercourses. The Horwich Loco Works site and the Cutacre site both have unmapped watercourses flowing through them, which should be considered at an appropriate level in the FRAs for these sites.

5.3 Pluvial Flood Risk (flooding from overland flow)

Source of Flooding

5.3.1 Overland flow is caused by water flowing over the ground surface that has not entered a natural drainage channel or artificial drainage system[8]. Overland flow often occurs typically when the soil is saturated and natural drainage channels or artificial drainage systems do not have the capacity to absorb the additional flow. Overland flow can cause localised flooding in natural valley bottoms as normally dry areas become covered in flowing water and in natural low spots where the water may pond. Flooding from this source can occur anywhere within a catchment, but is most likely to occur in relatively low-lying areas, or where the pathway for runoff is restricted by terrain or man-made obstructions.

Method of Assessment

5.3.2 There is no record of broad scale pluvial flooding in Bolton. The map received from Bolton MBC showing sites that have had land drainage problems and sites where some form of flooding has occurred in the past (Figure 5-3, Appendix 1) shows a wide distribution of occurrence of flooding in the past across the District, although it is likely that these incidents are fairly localised.

5.3.3 Apart from the anecdotal flood map the only other source of data on pluvial flood risk is the Environment Agency's map showing Areas Susceptible to Surface Water Flooding (ASTSWF). The ASTSWF maps were produced for the whole of the UK. The latest versions of the EA maps for Bolton MBC were requested and provided for the study as a GIS layer, which could be overlaid with maps and other spatial data types. The ASTSWF maps provides three bandings from 'less' to 'more' susceptible to surface water flooding. The 'more' band will normally be useful to help identify areas which have a natural vulnerability to flood first, flood deepest, and/or flood for relatively frequent, less extreme events (when compared to the other bands). All bands combined are also useful for screening wider areas that are susceptible to surface water flooding.

[8] CIRIA Report C624 Development and flood risk – guidance for the construction industry

5.3.4 The map was produced following a simple method that uses rainfall data for a 6.5 hour storm with a 0.5% average probability of being exceeded each year (1 in 200 year).

5.3.5 The ASTSWF maps were used to highlight pluvial flood areas within the district. An assessment of the topography based on LiDAR data was also undertaken to investigate the general drainage pattern within the district and to identify low-lying areas where ponding of surface water is likely to occur.

Results

5.3.6 The ASTSWF maps should be interpreted with caution as they are based on broad scale modelling. The Environment Agency recommends that Local Planning Authorities should use local data to assess the bands and then decide which bands are most appropriate for their purposes, noting that surface water flooding can occur outside of the bands[9]. Because of the way the ASTSWF maps have been produced and the fact that they are indicative, the maps are not appropriate to act as the sole source of evidence for any specific planning decision at any scale without further supporting studies or evidence. Their use in planning will normally be to highlight areas where more detailed study of surface water flooding may be appropriate as part of a strategic flood risk assessments (SFRA) in England.

5.3.7 The ASTSWF map for Bolton provides a general overview of pluvial flood risk areas within the district and the distribution of flood prone areas is supported by topographical data based on LiDAR (Figure 5-5, Appendix 1). Figure 5-4 in Appendix 1 shows the distribution of areas susceptible to surface water flooding within Bolton. It shows a wide distribution of areas susceptible to surface water flooding within the district. As shown in Figure 5-4, Appendix 1, areas susceptible to pluvial flooding include Horwich, Bolton Town Centre, the Renewal Areas of Inner Bolton, Farnworth and Breightmet, Little Lever, Kearsley and to a lesser extent Westhoughton and Over Hulton and the cutacre site. Generally, the low lying areas along the river valleys and along the course of culverted watercourses as well as natural low spots appear to be most susceptible.

5.4 Sewer and Drainage Flood Risk

Source of Flooding

5.4.1 Much of the sewer network within Bolton and other parts of Greater Manchester dates back to Victorian times, some of which is of unknown capacity and condition. More recent sewers within the district are likely to have been designed to the guidelines in “Sewers for Adoption” (WRC, 2006). These sewers tend to have a design standard of up to the 3.3% AEP (1 in 30 year storm event, which equates approximately to a 1 in 5 year flood flow), although in many cases, it is thought that the design standard is lower, especially in privately owned systems.

5.4.2 During heavy rainfall, flooding from artificial drainage systems may occur if:

- the rainfall event exceeds the capacity of the drainage system;
- the system becomes blocked by debris or sediment;

[9] Areas Susceptible to Surface Water Flooding - Guidance for Local Planning Authorities in ENGLAND for land use planning and other purposes (not emergency planning) v1 July 2009

- The system surcharges due to high water levels in rivers.

5.4.3 Sewer flooding has the potential to occur anywhere within the sub-region especially in areas with a high urban density.

Method of Assessment

5.4.4 United Utilities (UU) provide potable water distribution and wastewater services for Bolton. UU have provided an updated register of flood events that have affected properties (internal) and outside areas such as roads (external) to a five-digit postcode area Figure 5-6 A, Appendix 1 for the SFRA. The register, known as the DG5 register, contains commercially sensitive information that is also covered by the Data Protection Act (1998).

5.4.5 United Utilities has also provided data showing drainage areas within the district and the drainage network for Bolton. Although this information does not show which areas are at risk of flooding from the sewer network, it gives an overview of which areas are connected and drain to the respective Waste Water Treatment Works (WwtW) within the district. Due to the sensitivity of the sewer network data, United Utilities were unable to provide model results data from their sewer network. The DG5 data is therefore the only data available on flooding from the public sewer network.

5.4.6 The map received from BMBC showing recorded flooding incidents from various sources within the district as a GIS layer also provided some information on flooding from parts of the drainage system.

Results

5.4.7 Due to lack of model data showing which parts of the sewer network have insufficient capacity and areas at risk of flooding from sewers, a detailed analysis of the scale and consequences of sewer flooding has not been possible at this stage of the SFRA. The DG5 data and historical records of flooding are the only data sources that were available for the SFRA. These historical data are purely a record of instances of flooding and do not provide an indication as to the current or future flood risk posed by the sewer and drainage network. It is even possible that the cause of the flooding recorded during these events have already been addressed. For completeness, a map showing the DG5 data is presented in Figure 5-6 (A), Appendix 1. Recorded incidents of flooding from the drainage system provided by Bolton MBC are shown in Figure 5-3, Appendix 1.

5.4.8 The historical data suggest that the risk of flooding from sewers and the drainage system is low. However, it should be noted that the events recorded are for a high AEP and therefore the risk of flooding from more significant events (with a low AEP) is unknown at this stage. The latter can only be quantified by a more detailed hydraulic assessment of the sewer network and topographic data.

5.5 Critical Drainage Areas

5.5.1 One of the requirements of the SFRA is the identification of the location of critical drainage areas and identification of the need for Surface Water Management Plans (SWMP) to inform

development policies. This requirement is also highlighted in paragraph 3.57 of the PPS25 Practise Guide as a required output from a Level 2 SFRA.

5.5.2 The question of Critical Drainage Areas (CDAs) has been raised and discussed on several occasions with Local Authorities, the Environment Agency, United Utilities and representatives from other AGMA councils at different stages of the SFRA. It became clear during these discussions that although CDAs have been mentioned in the Surface Water Management Plan (SWMP) Technical Guidance (Defra 2009), and in PPS25, there is no clear definition of what actually constitutes a CDA.

5.5.3 For the purpose of this SFRA a CDA is considered to be an area contributing surface water runoff, either as direct overland flow or from the existing sewer network, which causes flooding at locations within that area. The risk of flooding is thereby confirmed, either by historical evidence, or through numerical modelling or other detailed form of analysis. A CDA therefore has areas within it where surface water flood risk exists (flood-prone areas within a CDA) and areas where properties, although not directly at risk, contribute to that flood risk (upstream areas in a CDA directly affecting flood-prone areas).

5.5.4 It was agreed with the Steering Group that a screening approach to identify CDAs rather than a detailed assessment would suffice for the SFRA. A simplified methodology to identify CDAs was proposed based on the following considerations:

- historical data on surface water flooding, where available;
- Environment Agency maps showing areas susceptible to surface water flooding;
- topographical data (LiDAR and FEH catchment boundaries);
- United Utilities Drainage Area maps.

5.5.5 The methodology was applied in Bolton. However, due to the uncertainty of the ASTSWF data and lack of sufficient historical flooding data and sewer model data, it was concluded that a more precautionary approach should be taken to avoid misinterpretation of current and future surface water flood risk. It was agreed that it would be better to focus on identifying policies for CDAs rather than defining CDAs on a map based on insufficient information.

5.5.6 Management policies based on the precautionary principle have been discussed and agreed with Bolton MBC and the Environment Agency based on the above definition of a CDA. The policies and their application should be reviewed as more data on surface water flood risk becomes available to enable CDAs to be defined based on more accurate data. United Utilities are currently considering sharing their sewer model data in future SWMPs and it is anticipated that such data will greatly improve the definition of CDAs across the district.

5.5.7 The CDA work has highlighted cross boundary issues that need to be taken into consideration in future SWMPs. A review of the LiDAR and catchment boundary data shows that part of the district drains directly into the River Douglas catchment in Wigan (Figure 5-5, Appendix 1). Figure 5-6B, Appendix 1 also shows that part of Bury, Wigan and Salford drain into Bolton via UU's drainage system.

5.6 Flood Risk from Man-Made/Artificial Sources – Canals

Source of Flooding

5.6.1 The risk of flooding from canals is generally low because of their regulated nature. The main source of flooding from canals results from a breach of raised canal embankments or collapse of a canal reach above culverted sections of a watercourse. Generally the canals have a freeboard of approximately 300mm between the normal water level and canal bank and water levels are controlled by overflow structures/ sluices.

5.6.2 Sections of the Leeds and Liverpool Canal and the disused Manchester, Bolton and Bury Canal run through Bolton. Although there is little evidence of flooding from canals in Bolton, a canal breach occurred in the Manchester, Bolton and Bury Canal at Little Lever in 1936. Following the 1936 breach event the disused Canal was split into three isolated sections.

5.6.3 The Level 1 SFRA identified suspected canal feeds from the River Croal system, which may indicate a direct link to the canal. The suspected canal feeds have been included on Figure 5-7, Appendix 1, however they are not considered to pose a flood risk within the borough.

Method of Assessment

5.6.4 Raised canal embankments have been identified using a Digital Terrain Model (DTM) based on LiDAR data in conjunction with Ordnance Survey Maps. The raised canal embankments thus identified have been highlighted as locations where the canal is more vulnerable to a potential breach. The canal reaches, together with adjacent areas potentially at risk are shown on Figure 5-7.

5.6.5 The flood risk posed by a potential breach in the canal embankment may be direct or indirect. A direct flood risk is where development is directly affected by the flood waters, where as, an indirect flood risk results from flood waters flowing to a nearby watercourse. By considering the likely flow route during a breach an indicative assessment of flow pathways and risk is provided based on a review of the DTM and Ordnance Survey Maps. The results are summarised in (Table 5-1) and Figure 5-7 in Appendix 1. It is important to note that no canal breach modelling has been undertaken to inform this study.

Results

5.6.6 Figure 5-7 identifies three potentially vulnerable breach locations along the disused Manchester, Bolton and Bury Canal. No raise canal embankments have been identified along the Leeds, Liverpool Canal, which passes through a small section of the borough to the east of Blackrod.

5.6.7 Further details of the potentially vulnerable breach locations along the disused Manchester, Bolton and Bury Canal and the nature of flood risk posed in the event of a breach are provided in Table5-1.

Table 5-1: Potential breach vulnerability locations along the Manchester, Bolton and Bury Canal

Figure 5-5 Inset No.	Location of Raised Canal Embankment (NGR)	Direct/indirect flood risk	Predominant Flood Route	Potentially Effected Watercourse
1	Southwest of Little Lever (SD746070)	Indirect	South	River Croal
2	Southeast of Little Lever (SD761067)	Indirect	West	River Irwell
3	North of Prestolee (SD759057)	Direct & Indirect	South	River Irwell

5.6.8 Figure 5-7, Inset 1 identifies that the canal's southern embankment is raised to the southwest of Little Lever. In the event of a breach the likely flow route would transfer flood waters to the River Croal, which may pose an indirect flood risk to development downstream.

5.6.9 Figure 5-7, Inset 2 identifies that the canal's southern embankment is raised to the southeast of Little Lever. In the event of a breach the likely flow route would transfer flood waters to the River Irwell, which may pose an indirect flood risk to development downstream.

5.6.10 Figure 5-7, Inset 3 identifies that the canal's southern embankment is raised to the north of Prestolee. In the event of a breach flood waters could directly effect existing development within the Prestolee area, or indirectly effect development downstream by flowing into the River Irwell.

5.6.11 The key development areas identified by Bolton Borough Council would not be directly or indirectly affected by a breach in the raised canal embankment at the locations identified in Figure 5-7. However, where development is proposed in the vicinity or directly downstream of these potential breach vulnerability locations a site specific FRA should investigate further the flood risk posed by to the development by this disused canal.

5.7 Flood Risk from Man-Made/Artificial Sources – Reservoirs

Source of Flooding

5.7.1 The risk of flooding from reservoirs is mainly due to dam/reservoir wall failure and emergency releases into the catchment.

5.7.2 There are several reservoirs under the Reservoirs Act 1975 (volume greater than 25,000 m^3) within the Bolton MBC administrative area that may constitute flood risk to Bolton either by flooding properties directly or by discharging additional flows into rivers thereby increasing the risk of flooding.

5.7.3 There is little historical evidence of reservoir flooding in Bolton; however it is reported in the River Douglas CFMP that localised flooding has occurred in the Douglas immediately downstream of the Rivington reservoirs following emergency releases. Such incidents have been kept to a minimum and only occur following consultation between key management authorities.

Method of Assessment

5.7.4 The Environment Agency is currently producing Reservoir Inundation Maps (RIM) to quantify the risk of flooding from reservoirs throughout the United Kingdom. When completed RIM will provide detailed flood extent and hazard data. However, it is understood that RIM outputs will not be available to inform the planning process due to security reasons. Therefore for the purpose of the SFRA a qualitative assessment has been undertaken to identify the potential flood risk from reservoirs within the district following a breach.

5.7.5 In the event of a breach or overtopping of the reservoir control structure or embankment the predominant flow route has been identified based on an assessment of local topography and the DTM (based on LiDAR data). It is important to note that no detailed modelling of the flood route or flood depths has been undertaken as part of this study. Flooding from a reservoir breach is a complex process. The assessment method applied in the SFRA is a simplification with the sole purpose of signposting obvious residual risk areas and does not provide a definitive indication of flow routes or risk.

Results

5.7.6 Figure 5-8, Appendix 1 identifies ten reservoirs where a breach in the control structure or embankments could pose a flood risk within Bolton MBC district boundary. The general flow route anticipated in the event of a breach is also identified on Figure 5-8, Appendix 1, which can be used to highlight potential breach vulnerability areas. Further details of these reservoirs and an indication of the predominant flow route are provided in Table 5-2.

Table 5-2: Reservoir and potential breach vulnerability areas inside study area boundary

Figure 5-6 Inset No.	Reservoir Name	Category	Capacity m^3	Predominant Flow Direction
1	Jumbles	Impounding	2,050,000	Bradshaw Brook River Valley
2	Bradshaw Service	Non-Impounding	450,000	Bradshaw Brook River Valley
3	Mortfield Lodge	Impounding	78,000	East towards Bolton Town Centre
4	Doffcocker Lodge	Impounding	123,000	East towards Bolton Town Centre
5	Bolton (Lower)	Non-Impounding	32,000	River Croal River Valley
6	Doe Hey (Higher & Lower)	Impounding	527,000	Doe Hey Brook River Valley
7	Rumworth	Impounding	432,000	River Croal River Valley
8	Higher Rid	Impounding	561,000	Bessy Brook River Valley
9	Rivington (Lower)	Impounding	6,785,000	River Douglas River Valley
10	Park	Impounding	122,000	West

5.7.7 Figure 5-8, Appendix 1 indicates that in general the reservoirs are located in the upper catchments of the study areas watercourses. In the event of a breach the predominant flood routes from the majority of the reservoirs would follow the general direction of the river valleys. This would increase river flows and therefore potentially pose a significant flood risk to areas located downstream. Figure 5-8, Appendix 1 also indicates that in some cases, for example Doffcocker Lodge, flood water resulting from a breach in one reservoir could overwhelm a downstream reservoir.

5.7.8 In addition to the flood risk posed by reservoirs located within Bolton there are a number of reservoirs located to the north beyond the study area boundary. These reservoirs are located in the headwaters of many of the watercourses which flow through Bolton and therefore may pose a flood risk in the event of a breach event.

5.7.9 Figure 5-8, Appendix 1 highlights the predominant flow direction, in the event of a breach, from reservoirs located to the north of Bolton. Table 5-3 lists the reservoirs outside of the Bolton study area, which may pose a flood risk and indicates the predominant direction of flow, which can be used to highlight vulnerable areas.

Table 5-3: Reservoir located outside the study area which may present a potential flood risk

Reservoir Name	Predominant Flow Direction
Belmont	Belmont Brook River Valley
Delph	Delph Brook River Valley
Dingle	Gale Brook River Valley
Springs	Gale Brook River Valley
Turton and Entwistle	Bradshaw Brook River Valley
Wayoh	Bradshaw Brook River Valley
Anglezarke	Rivington (Upper)
Rivington (Upper)	Rivington (Lower)

5.7.10 The information shown in Figure 5-8, Appendix 1 Table 5-2 and Table 5-3 provides an overview of reservoirs and provides an indication of potential breach vulnerability areas, thus highlighting the flood risk posed by reservoirs within and outside the study area.

5.7.11 Where development is proposed in close proximity to areas vulnerable to flooding from reservoir breach a site specific FRA should assess the flood risk from these sources. It should be noted that the risk of flooding from reservoirs is extremely low. Reservoirs are inspected regularly by specially qualified Engineers and are normally safe.

5.8 Groundwater Flood Risk

Source of Flooding

5.8.1 Groundwater flooding tends to occur after much longer periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

5.8.2 The main causes of groundwater flooding are:

- Natural groundwater rising due to exceptionally wet periods leading to rapid recharge.
- Groundwater rebound due to cessation of abstraction and mine dewatering
- Existence of confined aquifers and springs.

Method of Assessment

5.8.3 The Environment Agency was contacted to determine availability of groundwater flooding data since the Sub-Regional SFRA has been completed. The data requested include Groundwater Emergence Zone maps, historical evidence of groundwater flooding, groundwater vulnerability maps and groundwater levels data. The Environment Agency does not have the groundwater data that was requested for the SFRA. The Irwell and Douglas CFMPs and the British Geological Survey Technical Report WD/97/34 were reviewed to obtain information on the hydrogeology of the area and references made to groundwater

flooding. The assessment was therefore based on review of the groundwater vulnerability map, the Irwell and Douglas CFMPs and the British Geological Survey Technical Report WD/97/34.

Results

5.8.4 There are no documented records of groundwater flooding within Bolton MBC district. Information on groundwater flood risk could not be obtained from either the Environment Agency or Bolton MBC. The Environment Agency's groundwater vulnerability maps show that much of the district is classed as minor aquifer.

5.8.5 Table 5-4 shows the hydro geological units within Bolton MBC.

Table 5-4: Key Hydro geological Units in Bolton MBC District

System and Lithostratigraphical Division		Aquifer Unit
Quaternary	Alluvium	Variable, but probably an aquitard
	Peat	Variable, but probably an aquitard
	River terrace deposits	Variable, but probably an aquifer
	Glacial Sands and gravels	Variable, but probably an aquifer
	Till	Variable, but probably an aquitard
Carboniferous	Coal Measures	Multilayered with aquitard and aquifer units

5.8.6 Sandstone horizons within the Coal Measures may act as minor aquifers (aquifers allow groundwater movement). Where these are present at outcrop, there is some potential for groundwater flooding. However, much of the study area is covered by a blanket of Till, which is expected to behave as an aquitard (aquitards prevent groundwater movement).

5.8.7 Other areas where there is potential for groundwater flooding are those underlain by sand and gravel or river terrace Drift deposits. These are expected to behave as aquifers, although the nature of the deposits is likely to vary on a local scale. It is possible that these Drift deposits will contain perched groundwater tables, and may be in hydraulic continuity with surface water courses.

5.8.8 In summary, the risk of flooding from groundwater is considered to be low.

6 Bolton Town Centre Level 2 SFRA

6.1 Bolton Town Centre Development Plans

6.1.1 The Council's preferred spatial option has identified a concentration of a wide range of different types of development in Bolton Town Centre and the smaller town centres of Farnworth, Westhoughton and Horwich. The town centre in particular and, to a lesser extent, the inner renewal areas of Inner Bolton, Farnworth and Breightmet will be home to major development. The specific areas for proposed development in the Town Centre Level 2 SFRA area, a description of the development proposed and their vulnerability to flooding are set out in Appendix 2 (Bolton level 2 SFRA – Planning Policy Summary Table). A map of the Town Centre planned developments is shown in Figure 1-1 and Figure 6-2 in Appendix 1 (with flood zones).

6.1.2 Some of the key areas of development planned within Bolton Town Centre and their vulnerability are set out below:

Table 6-1: Examples of key developments and appropriate flood zones

Description of Development	Vulnerability Classification	Appropriate Flood Zones	
Trinity Transport Interchange	Essential Infrastructure	1 and 2. Exception Test required for zone 3a	
Bolton Urban Business Quarter Breightmet Street	Less Vulnerable	1,2 and 3a	
	Less Vulnerable	1,2 and 3a	
The Church Wharf mixed use scheme	Mixture of more and less vulnerable	More vulnerable: 1 and 2. Exception Test required for zone 3a	Less vulnerable: 1,2 and 3a
Central Street mixed use scheme	Mixture of more and less vulnerable	More vulnerable: 1 and 2. Exception Test required for zone 3a	Less vulnerable: 1,2 and 3a
Westbrook Gateway mixed use development	Mixture of more and less vulnerable	More vulnerable: 1 and 2. Exception Test required for zone 3a	Less vulnerable: 1,2 and 3a
Clarence Street mixed use development	Mixture of more and less vulnerable	More vulnerable: 1 and 2. Exception Test required for zone 3a	Less vulnerable: 1,2 and 3a
Bolton Community College and Bolton Sixth Form College's Central Campus, Engineering & Construction School and associated facilities at Deane Road	Mixture of more and less vulnerable and water-compatible development	More vulnerable: 1 and 2. Exception Test required for zone 3a	Less vulnerable: 1,2 and 3a
		Water compatible appropriate in all zones	
Residential development in Farnworth	Mixture of more vulnerable and water-compatible development	More vulnerable: 1 and 2. Exception Test required for zone 3a	Water compatible: All flood zones

Description of Development	Vulnerability Classification	Appropriate Flood Zones	
Residential development in Breightmet	Mixture of more vulnerable and water-compatible development	More vulnerable: 1 and 2. Exception Test required for zone 3a	Water compatible: All flood zones

6.2 Town Centre Level 2 Fluvial Flood Risk Assessment

6.2.1 Given the detailed planned developments for Bolton Town centre, a level 2 SFRA has been undertaken to provide sufficient detail on fluvial flood risk to inform the Sequential Test and the Exception Test and for the development of appropriate planning policies within the Town Centre development area. Hydraulic modelling was undertaken as part of the Level 2 SFRA to determine flood zones within the Town Centre and produce flood envelopes and flood depth hazard maps for the Exception Test. Flood defences within the Town Centre development area were inspected to determine their conditions and standard of protection (SoP), where applicable. An assessment of the impact of the Town Centre development without and with mitigation measures assuming a flood protection scenario to defend the entire Town Centre to a SoP of 1% AEP (1 in 100 year event) was also undertaken as part of the Town Centre Level 2 SFRA.

Sources of Fluvial Flooding to Bolton Town Centre

6.2.2 The main source of fluvial flooding to Bolton Town Centre is the River Croal. The Croal flows into the Town Centre from the west passing through Queen's Park just before the boundary of the Town Centre Development Area. It passes through a series of weirs in the park upstream of the planned Urban Village Development. In addition to the River Croal, a culverted tributary called Captain's Clough discharges into the Croal from the north, just upstream of Chorley Street Bridge. Captain's Clough passes through the planned Urban Village Development (Figure 6.1, Appendix 1).

Hydraulic Modelling

6.2.3 Two ISIS hydraulic models of the River Croal were obtained from the Environment Agency for the level 2 SFRA. Both ISIS models come from the same source and were updated with additional data. The original model was first constructed by HR Wallingford in 1997 and was based on Environment Agency topographic surveying undertaken at that time. It includes the River Croal, River Irwell, Astley Brook, River Tonge and inflows from tributaries. The model was updated in 2007 as part of the Environment Agency Strategic Flood Risk Mapping programme. The Environment Agency provided the updated ISIS model of the River Croal to Scott Wilson for the purpose of the Bolton Level 2 SFRA (as of June 2009).

6.2.4 A second ISIS model of the River Croal, which was used for an FRA in Church Wharf in Bolton Town Centre, was also obtained from the Environment Agency in September 2009. The Church Wharf FRA model covers the entire River Croal but also contains more cross sections (from updated channel and floodplain survey) in the Church Wharf area and some

of the hydraulic structures have been updated in the model. Following a review of the hydraulic models and hydrology reports and discussions with the Environment Agency it was concluded that the Church Wharf hydraulic model was the most appropriate for the SFRA.

6.2.5 The River Irwell Model Review and Update hydrology report was reviewed to identify the methods used to derive the model hydrological inputs. The hydrology report recommended the Flood Estimation Handbook (FEH) statistical method as the preferred approach to derive peak flow estimates at all points within River Irwell for a range of flow estimates (1 in 2, 5, 10, 25, 50, 75, 100, 200 year events) for the strategic flood risk mapping. The hydrological inputs, which were based on FEH CD-ROM v1 were checked against FEH CD-ROM v2 peak flows and found to be comparable. It was therefore recommended that the hydrological inputs for the 1% AEP (1 in 100 year event) were appropriate for the SFRA.

6.2.6 The River Irwell Model Review and Update hydrology report did not include the 0.1% AEP (1 in 1000 year event). However, the Church Wharf model obtained from the Environment Agency contained inflows for the 0.1% AEP event. It is noted that the hydrological inputs for the 0.1% AEP event and the flows in the model for this event were found to be higher than expected. This was brought to the attention of the Environment Agency. A full hydrological analysis was beyond the scope of the SFRA therefore to map Flood Zone 2 in the SFRA, the hydrological inputs from the Church Wharf FRA model for the 0.1% AEP were used in the baseline, pre-development SFRA model.

6.2.7 As the SFRA is concentrating on Bolton Town Centre, the model was trimmed to reduce run times and results processing (trimming to exclude upper reaches of Middle Brook, Astley Brook and River Tonge). However, tests were carried out to ensure that the trimmed model produced identical results to the full model. Following other minor corrections and amendments to the model (for example, pipe crossings and trash screens) runs were undertaken to determine flood zones 1, 2, 3a and 3b. Flood depth and flood hazard maps were also derived using outputs from the model. Details of the hydraulic modelling work are documented in a separate hydraulic model report.

6.2.8 After visiting the Town Centre and reviewing the LiDAR data and the ISIS model it was concluded that a two dimensional floodplain model was inappropriate for the Town Centre level 2 SFRA. This conclusion was reached on the basis that the Croal follows a narrow valley in the Town Centre and the spread of the flood outlines is relatively constrained on both sides of the channel. Furthermore, there are virtually no continuous flood defences or infrastructure that provides a significant protection to the Town Centre for the 1% AEP flood event. A breach analysis is therefore not required as the land behind the defences will flood before the defences are overtopped.

Baseline Model Update

6.2.9 Following a review of the model and site visits to Bolton Town Centre it was concluded that some modifications are required in the baseline model to reflect current hydraulic conditions and the presence of hydraulic structures that are not in the existing model.

6.2.10 The following modifications were made to the hydraulic model:

- There is a large sewer pipe that crosses the River Croal near the Bolton Lads and Girls Club, upstream of Chorley Street Bridge (Plate 6.1), which represents a significant constriction to flows. A structure was introduced in the model to represent this feature;

Plate 6-1: Trunk Sewer upstream or Chorley Street Bridge

- The existing model shows an open channel section of the River Croal between Bridge Street and Crown Street. However, it was confirmed during our site visit with staff from Bolton Council that this reach is already culverted. Due to lack of data this section was culverted assuming the same culvert dimension as the Knowsley Street Culvert.

- A simple representation of Captain's Clough was included in the existing hydraulic model. Culvert dimensions and levels obtained from Bolton MBC were used to represent Captain's Clough and flows were applied upstream of the culvert.

- A coarse trash screen built by the Environment Agency at Church Wharf was included in the model. A similar trash screen between Chorley Road and Marsden Road could not be included in the model due to lack of information on the modified channel and the screen.

Plate 6-2: Coarse Trash Screen at Church Wharf

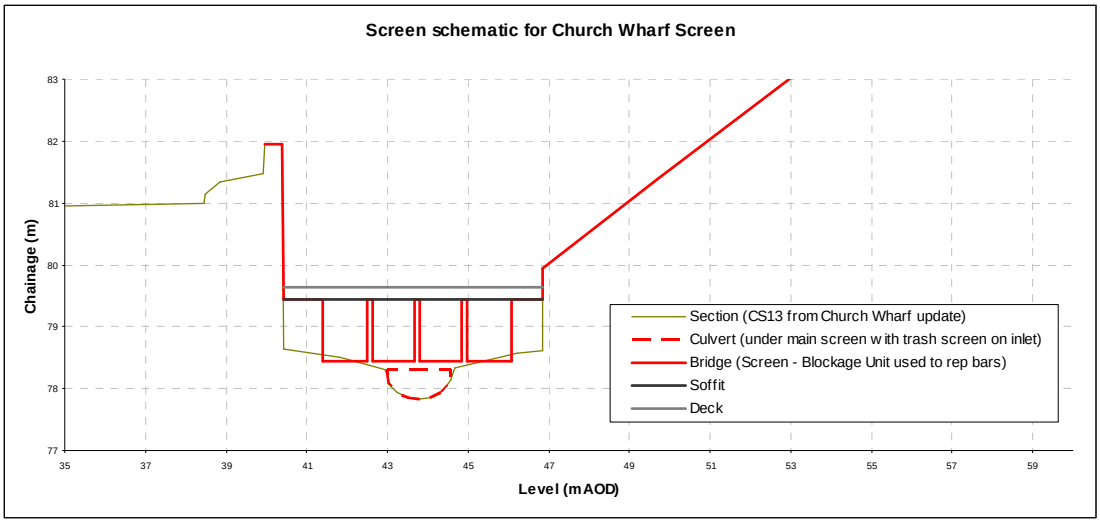


Figure 6-1: Representation of trash screen in hydraulic model

Post Development Model Scenarios

6.2.11 In addition to the baseline model a **Post-Development scenario (without mitigation)** and **Post-Development with Mitigation scenario** were investigated to determine the impact of the town centre development on the flood risk regime.

6.2.12 In the **Post-Development scenario** the following changes were made to the model:

- The open channel section between Central street and Knowsley street was culverted to connect the Retail Centre complex on both banks of the river (Figure 6-2);

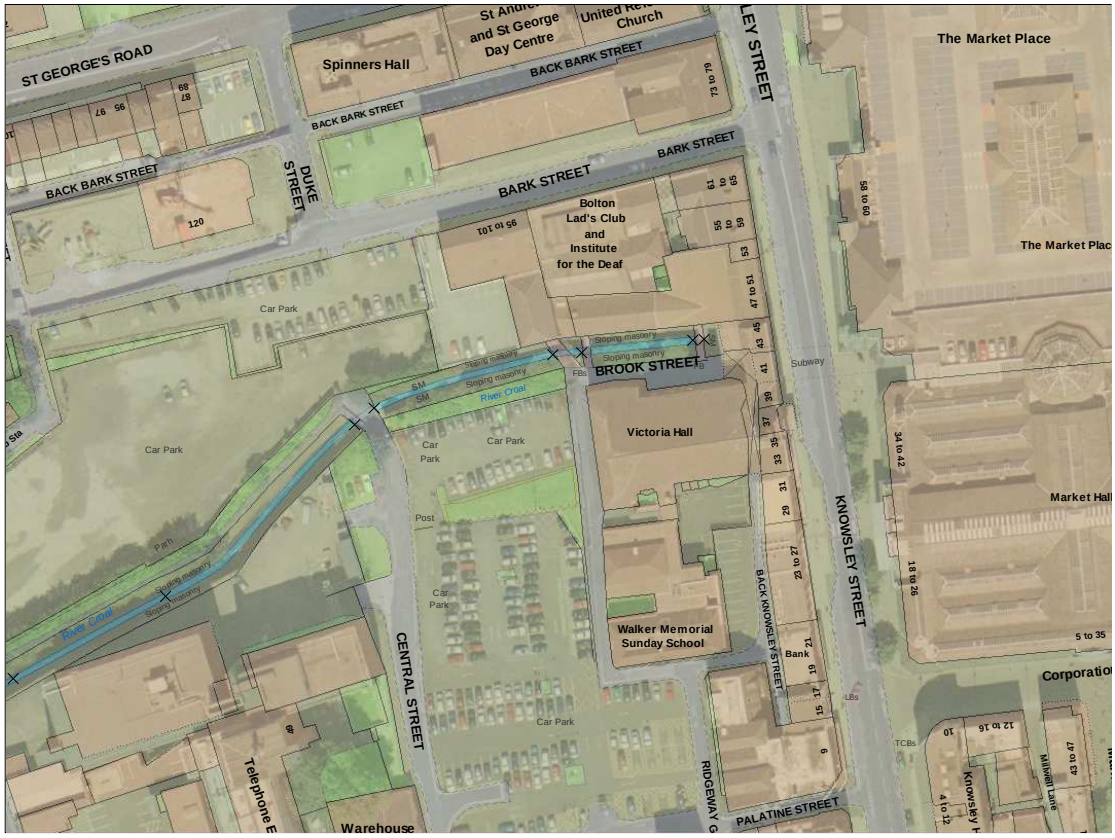


Figure 6-2: Map showing reach between Central Street and Knowsley Street planned to be culverted as part of the Town Centre Development

- The open channel section between Crown Street and Manor Street/Bank Street Bridge was culverted to connect the Leisure Centre complex planned in Church Wharf (Figure 6-3). It is assumed that the culvert will be an extension of the Crown Street Culvert to manor street bridge;

Figure 6-3: Map showing reach between Crown Street and Manor Street/Bank Street planned to be culverted as part of the Town Centre Development

- The proposed development at Church Wharf was also incorporated in the model.

6.2.13 In the **Post-Development with mitigation** scenario a defence was represented in the model for both bank (if necessary) of the River Croal through the town centre to assess the impacts of defending to the 1% AEP event.

Flood Defences and SoP

6.2.14 An inspection/survey of flood defences was completed as part of the Town Centre level 2 SFRA work to determine where flood defences exist, the condition and type of existing defences. A walkover survey was undertaken along the entire reach of the River Croal within the Town centre development area. Prior to the walkover, the NFCDD database was reviewed to highlight areas where the inspection needs to focus.

6.2.15 The walkover survey confirmed the NFCDD data showing very limited existence of flood defences within the Town Centre development area. Flood defences found in the study area were mainly informal defences comprising stone/brick masonry walls and in most cases they exist only for a short reach of the river (Figure 6.8, Appendix 1). A summary of the findings of

the flood defence inspection is given below. A detailed report of the defences can be found in the Flood Defence Inspection Report in Appendix 3.

6.2.16 In summary, the channel within the Town Centre Development Area is mostly stone pitched and lined with masonry up to channel bank level. There are two short reaches of informal defences on the left bank of the channel; downstream of Bank Street/Manor Street and between Central Street and King Street, but neither are tied to high ground downstream and therefore the land behind can be flooded before they are overtopped.

6.2.17 As there are currently hardly any raised flood defences in the Town Centre development area that protect properties adjacent to the channel it is not necessary to further investigate the standard of protection. However, as discussed below, the banks of the channels have been raised above the 1% AEP water level in the model in order to investigate the impact of defending the town centre to the 1 in 100 year SoP.

Water Levels

6.2.18 Figure 6-4 shows a long section from the Town Centre model with river bed levels and water levels for the 5% AEP (functional flood plain), 1% AEP, 1% AEP plus Climate Change and the 0.1% AEP events in the baseline model. The 5% AEP event is contained within the banks of the channel throughout the Town Centre and the 1% AEP event is also mostly in bank. The most striking feature of the water levels long sections is the effect of hydraulic structure (weirs, culverts and bridges) in the channel which results in the stepped shape of the long sections. The largest head loss occurs at the derelict weir in Queen's Park, but there are losses across all structures, including the coarse trash screen in the Church Wharf. The trash screen causes a significant head loss (of more than 1m) and increase in water levels in the Church Wharf area between the screen and the downstream end of the Bank Street/Manor Street culvert.

6.2.19 St Peter's Way Culvert is a key hydraulic control point for the Town Centre. When it blocks or surcharges water levels within the entire Town Centre could increase. The culvert partly surcharges for the 1% AEP plus Climate Change event. Climate Change is estimated to cause an increase of up to 0.7m within the Church Wharf Development Area. For the 0.1% AEP event there is a significant increase in water levels as the St Peter's Way culvert surcharges completely drowning the trash screen and causing river banks to be overtopped in most places. However, as mentioned earlier the flows for this event appear to be overestimated, therefore the results from this model run should be treated with caution and will need to be reviewed in future site specific FRAs.

6.2.20 The right bank levels of the Croal within the Town Centre are generally higher than the left bank levels and therefore the land to the north of the river is more likely to flood during extreme flood events.

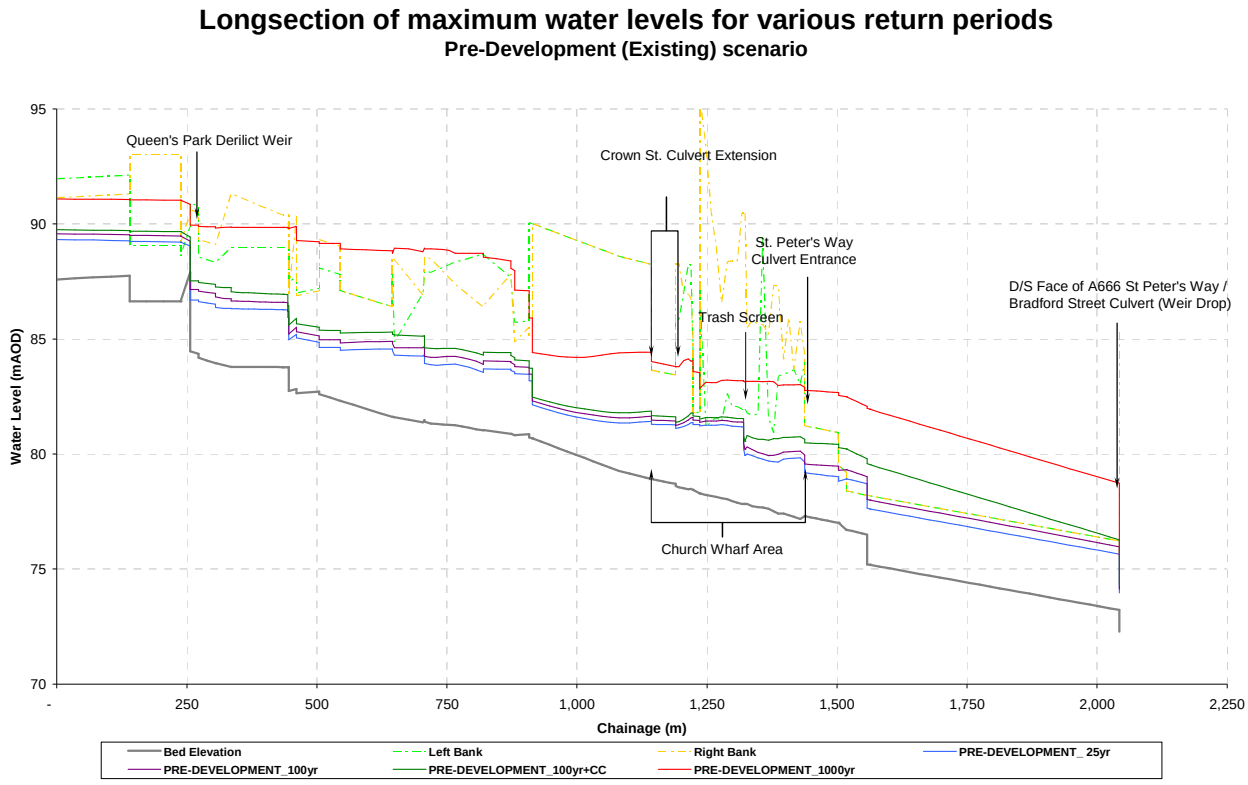


Figure 6-4: Long Section showing water levels in Bolton Town Centre

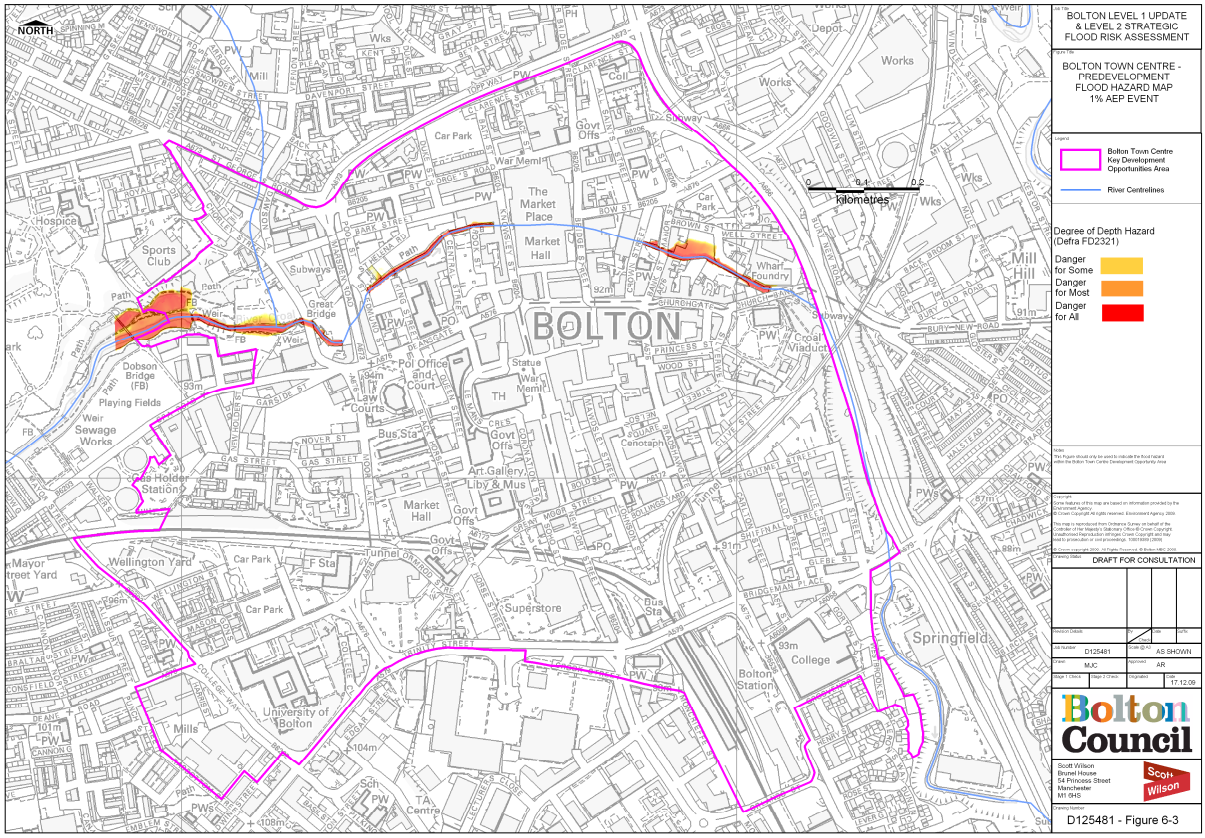
Flood Depths and Depth Hazard Mapping

6.2.21 In order to apply the Exception Test for developments within the Town Centre flood hazard map are required. The hazard maps provide information on flood depths and associated hazards in addition to flood zones. Flood depths hazard maps have been derived using model results for the various scenarios and LiDAR data. The flood depth maps produced from the model results for the 1% AEP, 1% AEP plus Climate Change and the 0.1% AEP are presented below and in Appendix 1 (Figure 6-3, 6-4 and 6-5 respectively).

6.2.22 Depth hazard categories were mapped using guidance set out in the DEFRA/EA Flood Risk Assessment Guidance for New Development Technical Report[10]. The depth hazard maps show areas forecasted as danger for all near the channel.

6.2.23 Figure 6-5 (also presented as Figure 6-4 in Appendix 1) shows the flood hazard map for the 1% AEP event. The extent of the flood outline for this event is very limited. The map shows no flooding between Chorley Street and Bank Street/Manor Street in the Church Wharf area. A limited amount of flooding occurs within the car park in the Church Wharf area and in Queens Park with flood depths between 0.3m and 1.5m (risk for some, risk for most).

[10] Flood Risk Assessment Guidance for New Development, Defra/EA Flood and Coastal Defence R&D Programme Technical Report FD2320/TR2, October 2005

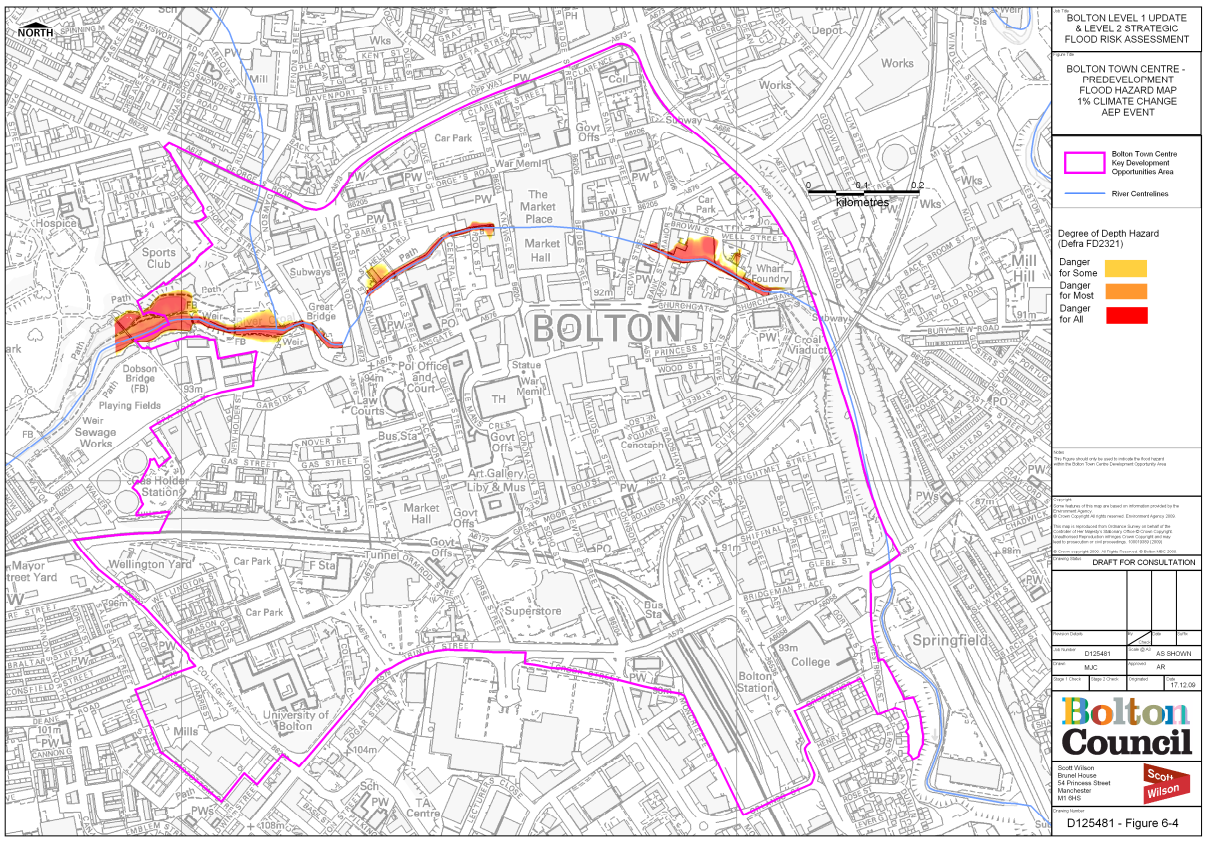


Depth Hazard Key

0.30m - 0.50m
0.50m - 1.50m
>1.50m

Figure 6-5: Bolton Town Centre Depth Hazard map for the 1% AEP event

6.2.24 Figure 6-6 (also presented as Figure 6-5 in Appendix 1) shows the depth hazard map for the 1% AEP plus Climate Change. The areas at risk are similar to those for the 1% AEP. Although there is an increase in flows and water levels due to Climate Change, this does not give rise to significant increase in flood outline due to the constrained nature of the valley. The flood outline for the 1% AEP with Climate Change, however, extends to Brown Street in the Church Wharf Development Area with flood depths between 0.3m and 1.5m (risk for some, risk for most).



Depth Hazard Key

0.30m - 0.50m
0.50m - 1.50m
>1.50m

Figure 6-6 : Bolton Town Centre Depth hazard map for the 1%AEP event plus Climate Change

6.2.17 Figure 6-7 (also presented as Figure 6-1 in Appendix 1) shows the Town Centre Development Area with flood zones derived from the modelling work.

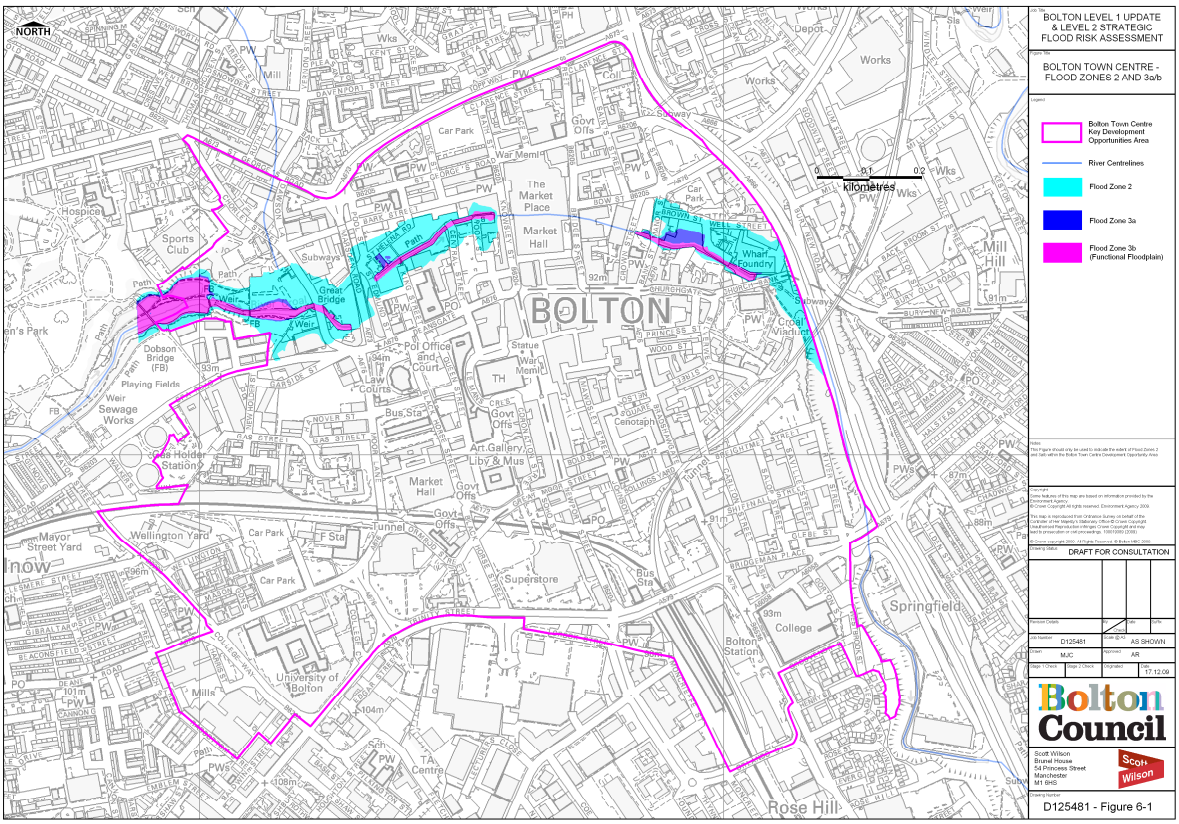


Figure 6-7: Flood Zone within Bolton Town Centre

6.2.25 Most of Bolton Town Centre lies within flood zone 1 and flood zone 2. Flood zone 3b is entirely within the channel and flood zone 3a is limited to a small area in the Church Wharf area near the trash screen and in Queen's Park. The following areas are in flood zone 2:

- Most of the area bounded by Manor Street, Brown Street/Well Street, the A666 and the River Croal in the Church Wharf development area lies within flood zone 2;
- In the Central Street/St Edmund Street Development Area, most of the area bounded by Bark Street, Marsden Road, Knowsley Street and the left bank of the Croal lies within flood zone 2. Similarly part of the land on the right bank from Knowsley Street to Marsden Road lies within flood zone 2.
- A significant area on both sides of the river lies within flood zone 2 in the reach between Marsden Road and Queens Park.

Impact of Planned Town Centre Developments

6.2.26 Figure 6-8 shows a long section from the Town Centre model for the Pre-Development and Post-Development model scenarios. The comparison shows that the impact of the Town Centre planned developments is most significant in the reach between the coarse trash screen at Church Wharf and Knowsley Street. The entire channel reach between Central Street and Manor Street/Bank Street will be culverted and the model results suggest that the

culvert does not surcharge for the 1%AEP plus Climate Change. The developments alone, without raising the left bank levels does not increase the risk in the open channel reach in the Church Wharf area. However, defending developments on the left bank of the Croal in the open channel reach in the Church Wharf area causes an increase in water levels in the area by up to 1m. As shown in Figure 6-9, this increase in water levels in the defended scenario does not have any negative effect on flows downstream of the Town Centre Development Area.

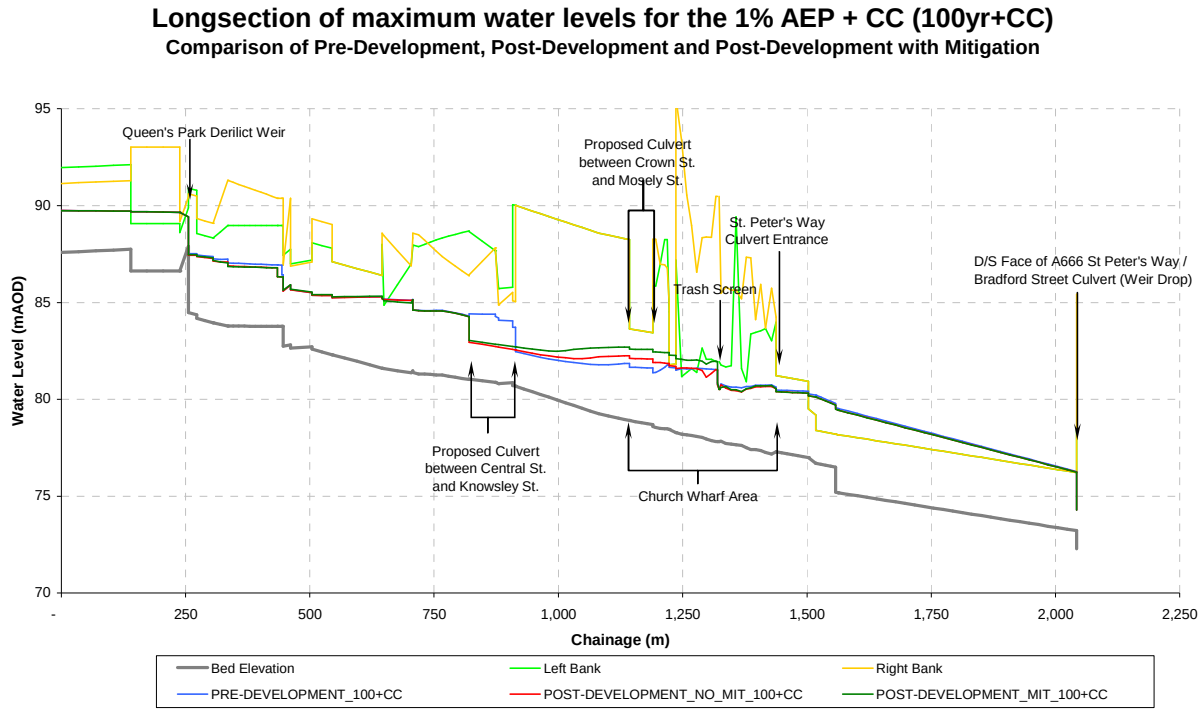


Figure 6-8: Flood Zone within Bolton Town Centre

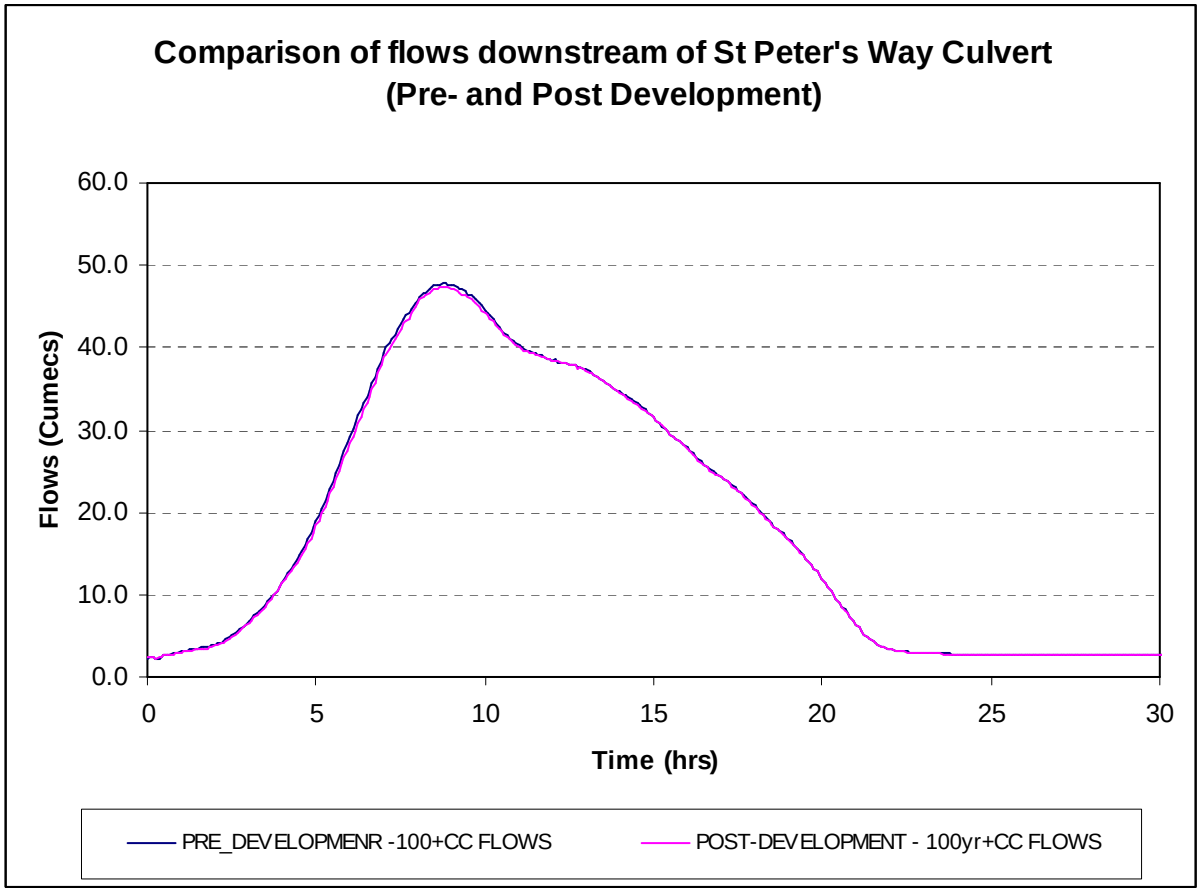


Figure 6-9: Comparison of flows (1%AEP + CC) downstream of St Peter's Way Culvert

6.3 Risk of Flooding from Other Sources

6.3.1 Historical evidence gathered as part of the SFRA suggests that there have been incidents of flooding from the sewer system within the Church Wharf Development area. A sewer storage tank and overflow has been built by United Utilities at the bottom of the valley in the Church Wharf area to attenuate combined sewer flows collecting at this location. No other incidents of flooding have been reported within Bolton Town Centre.

6.3.2 There is risk of flooding from Captain's Clough which arises from the culvert surcharging, but the risk is generally low. It should be noted that Captain's Clough was incorporated in the ISIS model only to test its capacity and interaction with the Croal as there was insufficient data during the course of preparing the SFRA. The information on risk of flooding from Captain's Clough should be updated when the modelling work commissioned by the Environment Agency is completed.

6.3.3 The ASTSWF maps show areas susceptible to surface water flooding in the Bolton Town Centre development area, but the overall risk is low. The main areas highlighted to be potentially susceptibly to surface water flooding are at the bottom of the valley in Church Wharf, the reach between Knowsley Street and Queens Park and along the route of

Captain's Clough culvert. Parts of the southern boundary of the Merchant's Quarter development are also shown to be at risk of pluvial flooding according to the EA maps.

6.3.4 The risk of flooding from Groundwater and Canals to Bolton Town Centre is very low. There is, however, a residual risk of flooding from the reservoirs upstream of Captain's Clough.

7 SFRA Policies and Flood Risk Management

7.1.1 The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is exceptionally necessary in high risk areas, development policies should aim to make it safe without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

7.1.2 To achieve this aim Local Authorities must be able to use the SFRA to appraise risk and develop policies to manage risk and reduce risk through planning and other means.

7.2 District Wide SFRA Policies

7.2.1 To ensure a holistic approach to flood risk management and make sure that flooding is taken into account at all stages of the planning process, the findings of the SFRA should be incorporated into the emerging LDF for Bolton MBC. In accordance with PPS25, a specific policy on flood risk should be included in the final Core Strategy to ensure that:

- Development is located in the lowest flood risk areas;
- New development is flood-proofed to a satisfactory degree and does not increase flood risk elsewhere where avoidance of risk through the sequential approach is not possible;
- Surface water is managed effectively on site; and
- Any development in Flood Zone 2 or Flood Zone 3 is safe.

7.2.2 At the district level the Level 1 Update data should be used by Bolton MBC to appraise risk to and from developments. With the help of the flood zones appropriate policies can be formulated for each flood zone taking into consideration the vulnerability classification for each development.

7.2.3 In flood zone 1 the policy objective should be to reduce surface water runoff from the site through appropriate application of sustainable drainage techniques (i.e. SuDS) and to reduce the overall risk from other sources.

7.2.4 In flood zone 2 and 3 the policy objectives should be:

- 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 (i.e. SuDS);
- To create space for flooding to occur by restoring functional floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.
- To reduce the overall risk of flooding from other sources.

7.2.5 Application of the Sequential Test should ensure that more vulnerable land uses are not permitted in areas at high risk of flooding. Where there are valid over-riding reasons for a

vulnerable land-use in a higher flood risk area, the LPA and/or developer needs to demonstrate that all three elements of the Exception Test are passed.

7.2.6 In order to ensure that developments satisfy the Exception Test the following should be considered:

- Sequentially allocate development to consider relocating existing development to land in zones with a lower probability of flooding;
- If development is to be constructed with less vulnerable uses on ground level, agreements need to be in place to prevent future alteration of these areas to more vulnerable uses without further assessment of flood risk;
- Multi storey residential development may be acceptable in high flood risk areas as they offer an opportunity to retreat to higher levels; and
- For 'vulnerable' developments proposed within Flood Zone 2 and Flood Zone 3 opportunities should be seek to:
  - Reduce flooding by considering the layout and the form of the development and the appropriate application of sustainable drainage techniques;
  - Create space for flooding to occur by restoring functional floodplains and flood flow pathways and by identifying, allocating and safeguarding open space for storage; and
  - Ensure developers incorporate flood resilience measures into the design of developments, including such measures as:
    - Replacing timber floors with concrete floors covered with tiles,
    - Replacing chipboard/MDF kitchen / bathroom units with plastic equivalents,
    - Replacing gypsum plaster with more water-resistant material, such as lime plaster or cement render,
    - Moving service meters, boilers and electrical points above flood levels,
    - Install one-way valves into drainage pipes to prevent sewage backing up into the house.

Surface Water Management Strategy

7.2.7 A site-specific FRA is required by PPS25 for all development proposals greater than 1 ha, or 0.5ha in CDAs, to determine the impacts the development would have upon surface water runoff, regardless of the Flood Zone the development is located within. The use of Sustainable Drainage Systems (SuDS) should be encouraged for all developments as part of any surface water management strategy. SuDS options should be investigated as part of a surface water management plan (SWMP).

7.2.8 PPS25 states that a Level 2 SFRA should identify the need (or not) for a SWMP. It is considered that it would be prudent to undertake such a study for Bolton MBC given the widespread distribution of areas susceptible to surface water flooding.

7.2.9 A SWMP is a framework through which key local partners with responsibility for surface water and drainage in their area work together to understand the causes of surface water

flooding and agree the most cost effective way of managing surface water flood risk[11]. SWMPs do not form part of the statutory spatial planning system, but have important links with it.

7.2.10 As discussed in Section 5.5 surface water management policies across the district have been discussed and agreed with Bolton MBC and the Environment Agency based on consideration of CDAs throughout the district. Although CDAs have not been presented in the SFRA it is recommended that surface water management policies are developed taking into account the concept of CDA. When future work on SWMPs enables better definition of CDAs then the policies can be applied more consistently in agreement with United Utilities and the Environment Agency. A district-wide policy to reduce runoff should be encouraged.

7.2.11 The policy for flood prone areas in a CDA should include reducing the risk of surface water flooding as well as reduction of runoff taking Climate Change into consideration. In non-flood prone areas within CDAs the policy should be to reduce runoff taking Climate Change into consideration. In areas outside of CDAs new developments should aim to reduce runoff and achieve sustainable rates.

7.2.12 The target in terms of percentage runoff reduction is not fixed. Whilst PPS25 does not suggest a specific amount or percentage reduction the Code for Sustainable Homes[12] on the other hand encourages up to 100% reduction of additional runoff in areas where the risk of flooding is high. Bolton MBC should therefore agree target rates with the Environment Agency.

7.2.13 The Environment Agency suggests reducing runoff from Brownfield sites across the district by 30% and 50% in CDAs. In the interim, before achieving a better definition of CDA boundaries a target rate of 50% on all Brownfield sites is recommended. To reduce the risk of surface water flooding in CDAs it is suggested to set floor levels to 300mm above road level as agreed at the CDA meeting of 22nd September.

7.3 Town Centre Specific SFRA Policies

7.3.1 Policies for the district will apply to the Town Centre development area. The detailed modelling for the Town Centre makes it possible to use the outlines and flood depth hazard mapping to achieve a better understanding of fluvial flood risk. Figure 7-1 below shows the Town Centre Development Plan with flood zones derived from the study.

[11] Surface Water Management Plan Technical Guidance - Living draft version 1, February 2009
[12] DCLG (2006) Code for Sustainable Homes

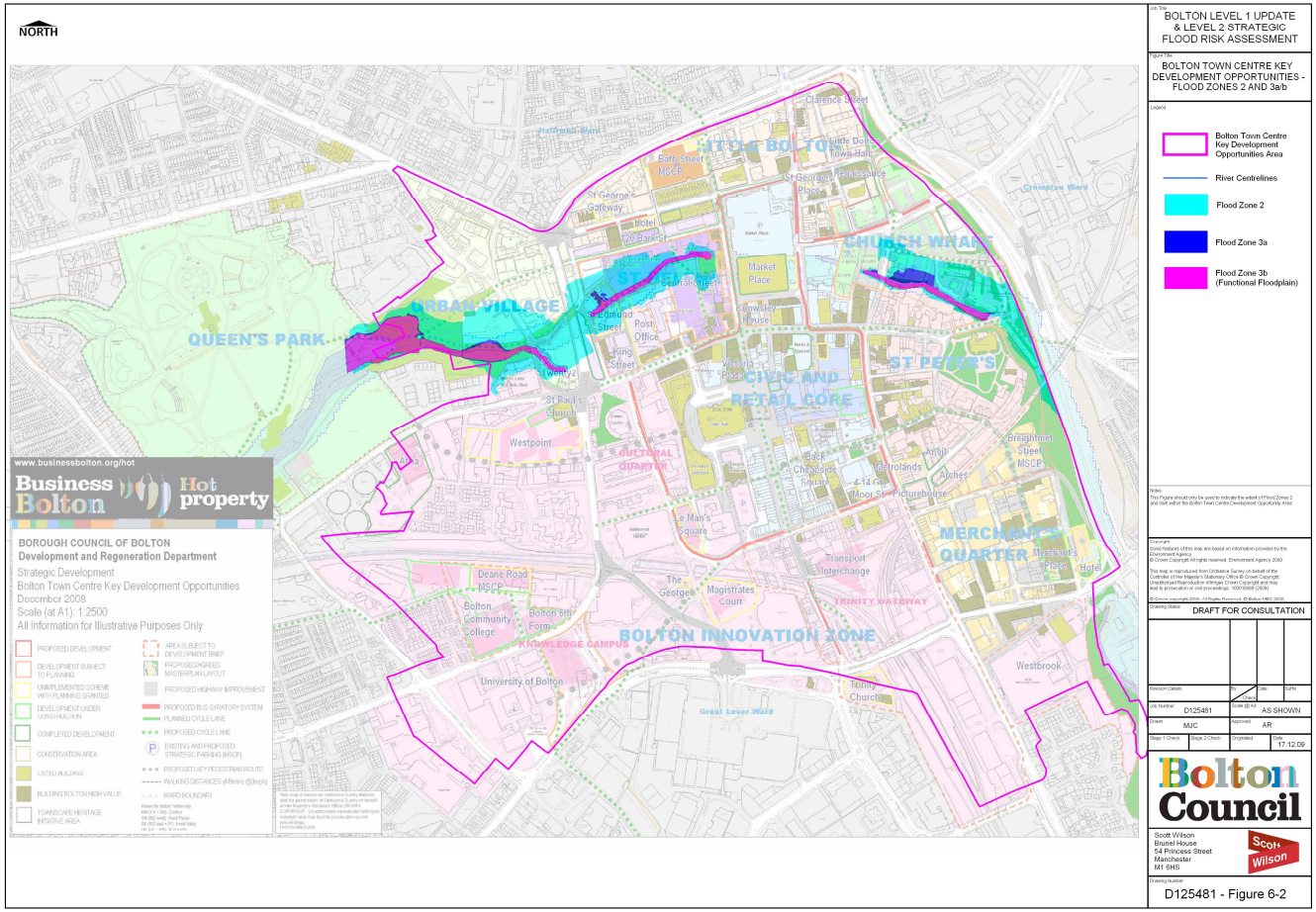


Figure 7-1: Bolton Town Centre Development with Flood Zones

7.3.2 Based on the 1% AEP results the main area within flood zone 3a in the Town Centre development area is the area near the river in the Church Wharf development area. All other areas are either in flood zone 2 or flood zone 1.

7.3.3 The Town Centre development plans are summarised by site in Appendix 2. For each site an analysis of the density and type of development is presented in a Table and the vulnerability of the various types of developments are shown in the Table for ease of application of the Sequential Test. Appendix 2 should be used in conjunction with the flood risk data from the SFRA when applying the Sequential and Exception Test.

7.3.4 Should development be proposed in Flood Zone 2 and 3a, then a site-specific FRA should be undertaken to delineate the boundary of Flood Zone 3a considering an allowance for climate change in order to optimise the layout and use of different parts of the site to reduce the risk of flooding to people and properties. The site-specific FRA should also address issues relating to the management of surface water runoff and flood risk from non-fluvial sources.

7.3.5 Other Town Centre sites fall within flood zone 1 and 2 where development would generally be suitable for allocation provided adequate mitigation measures are implemented to make the site safe and flood proof. A site-specific surface water FRA will be required for any development within Flood Zone 2 and development which exceeds 1 ha within Flood Zone 1. Developments which exceed 0.5ha within a CDA will also require an FRA.

7.4 Flood Risk Management Options

Flood Defences and Impact Assessment

7.4.1 The hydraulic model for the Town Centre was used to assess the impact of developments in the Town Centre. The objective of the impact assessment is to determine the effect of a strategic flood mitigation option of raising the SoP within the Town Centre to 1% AEP to enable development within flood zones currently designated as flood zone 3a and flood zone 2. PPS25 allows development of appropriate vulnerability classification within flood zone 3a and flood zone 2, provided that adequate mitigation measures that do not have a negative impact on third parties elsewhere in the catchment are implemented.

7.4.2 It was assumed that each of the discrete development zones within the Town Centre is fully protected to the 1% AEP event and the height of defences and bank levels in the model were raised above the predicted water levels for the 1% event. This scenario is the post-development with mitigation scenario.

7.4.3 Water levels and flows from this scenario were compared with the “undefended” or pre-development scenario (i.e. the scenario without raised bank levels) to assess the impact of such a mitigation measure. The comparison shows an increase in water level by up to 1m within Church Wharf. Beyond the Town Centre development area the impact is negligible. The difference in peak flows for the two scenarios is similarly negligible beyond the Town Centre as shown in Figure 6-9 in Section 6. This demonstrates that properties within the

Town centre can be defended to the 1% AEP standard, if required, without any impact beyond the Town Centre development area.

7.4.4 Options for increasing the standard of protection include raising the land adjacent to the river or building raised defences or secondary defences behind the river banks (for example footpath or road on an embankment). However, it should be noted that there is a residual risk of breaching associated with raised flood defences.

7.4.5 The most striking opportunity to reduce flood risk to the Church Wharf area would be the removal of the existing coarse trash screen and replacing it with one designed according to Environment Agency Guidance at the entry of St Peter's Way Culvert. This will reduce both the current risk of flooding as well as the impact of the Town Centre Development in a defended scenario.

7.4.6 Implementation of the Town Centre Developments will imply that the entire reach from Central Street to Manor Street/Bank Street Bridge will be culverted. Although the culvert extensions from Central Street to Knowsley Street and Crown Street to Manor Street/Bank Street do not increase the risk of flooding, they reduce access to the culvert for maintenance and clearance purposes. Consideration should therefore be given to introducing a properly designed trash screen at Central Street to reduce the residual risk of culvert blockage. It should be noted that any relocation of screens must consider the need for vehicle access to it at all times

7.4.7 The CFMP identifies storage areas the River Tonge and Bradshaw Brook. Storage in these areas will not have any impact on water levels within Bolton Town Centre. However, during the course of preparing the SFRA Queens Park was identified as an opportunity to provide storage to reduce the risk of flooding to Bolton Town Centre.

7.4.8 Bolton MBC plans to develop and enhance the recreational function of Queens Park. This provides an opportunity for integrating flood management options with the planned development for Queens Park. In particular, flood defences on the left bank of the Croal in the Urban Village development area can be integrated within the planned developments for Queens Park. For example, a footpath could be built on an embankment near the river bank to protect the development from flooding. The feasibility of an embankment will depend on the topography of the land behind and should be carefully considered.

8 Site Specific Flood Risk Assessment Guidance

8.1.1 In accordance with Paragraph E2 of PPS25: "Any organisation or person proposing a development must consider whether that development will not increase flood risk and where practicable endeavour to reduce flood risk. The future users of the development must not be placed in danger from flood hazards and should remain safe throughout the lifetime of the plan or proposed development and land use".

8.1.2 Regardless of the SFRA for Bolton, site-specific Flood Risk Assessments (FRAs) are required for all development in Flood Zone 2 and Flood Zone 3 and for sites greater than 1 ha in Flood Zone 1, in accordance with Table D1 of PPS25.

8.1.3 Future developments should satisfy SFRA policy objectives recommended in Section 7. At all stages of a planning application, developers should consult Bolton Council, and where necessary the EA and United Utilities to ensure the site-specific FRA provides the necessary information to fulfil the requirements for planning applications.

8.1.4 Where the quality and/or quantity of information for any of the flood sources affecting a site is insufficient to enable a robust assessment of the flood risks, further investigation will be required. For example a two dimensional model will be required where details of flooding mechanisms, flow paths and the onset of flooding are required to understand the risk of flooding and to ensure that the proposed development incorporates appropriate mitigation measures.

8.1.5 Developers should also identify residual risk as part of a site specific detailed FRA. Such assessment should be appropriate to the scale and nature of the proposed development and flood risk. Should the potential impact be unacceptable, mitigation should be provided. The depth hazard mapping undertaken for the Bolton Town Centre development area as part of this SFRA should be reviewed and where necessary expanded as part of any site-specific FRA within the Town Centre development area.

8.2 Application of the Sequential Approach

8.2.1 The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas e.g. residential developments should be restricted to areas at low hazard whilst parking, open space or proposed landscaped areas can be placed in areas with a higher probability of flooding.

8.2.2 Structures such as (bus, bike) shelters, park benches and storage facilities located in areas with a high flood risk should be flood resilient and be firmly attached to the ground.

8.3 Building Design

Finished Floor Levels

8.3.1 Where development in flood risk areas is unavoidable, the most common method of mitigating flood risk to people, particularly with 'more vulnerable' (residential) land uses, is to ensure floor levels are raised above the water level derived for the 1% AEP (1 in 100 year event) plus climate change within the immediate vicinity of the site.

8.3.2 The Environment Agency's Standing Advice on FRA and mitigation requirements (finish floor levels, access and egress requirements and acceptable runoff) should be consulted when undertaking an FRA.

8.3.3 In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the EA should be approached to discuss acceptable options for setting the minimum internal ground floor levels provided flood resilience (wet proofing) measures are implemented up to the 1 in 100 year + 20% future climate change flood level plus an allowance to be agreed. There are also circumstances where flood resistance (dry proofing) measures should be considered first. Further guidance is provided in paragraphs 6.29 to 6.35 of the PPS25 Practice Guide.

8.4 Surface Water Management

8.4.1 In designing buildings flood risk management policies require that the developments are 'safe', do not increase flood risk elsewhere and where possible reduce flood risk overall.

8.4.2 For all developments on Brownfield sites in CDAs runoff rates should, as a minimum, be reduced by 50%, taking Climate Change into consideration. Where feasible developments should aim to reduce runoff to Greenfield runoff rates.

8.4.3 All developments on Greenfield land, within and outside of CDAs, should reduce runoff to Greenfield runoff rates, taking Climate Change into consideration.

8.4.4 For developments on Brownfield sites outside of CDAs, runoff rates should be reduced by 30%. Pending further clarification on the CDA boundaries (to be delivered through SWMPs) a target rate of 50% on all Brownfield sites is recommended for the entire district.

8.4.5 PPS25 Practice Guide and EA guidance strongly recommend that suitable surface water mitigation measures are incorporated into any development plans in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should ideally be achieved by incorporating SUDS.

8.4.6 SUDS designs should aim to reduce runoff by integrating storm water controls throughout the site in small, discrete units. Through effective control of runoff at source, the need for large flow attenuation and flow control structures should be minimised if possible.

8.4.7 SUDS can be broadly split into two types: Source control and Site control. Source control methods aim to control runoff at or close to the source e.g. green roofs, rainwater harvesting. Site control is the management of runoff from several areas e.g. the use of ponds.

8.4.8 In order to identify the most suitable drainage solution, both source and site control measures should be assessed as part of any site-specific FRA. SUDS measures that may be suitable for use in the district are discussed in more detail below.

8.4.9 Table 8-1 has been reproduced from the SUDS Manual, CIRIA C679 and outlines typical SUDS options details typical SUDS components.

Table 8-1: Typical SuDS Components

Component Description	Example
Filter Strips	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.
Swales	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow).
Infiltration Basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.
Wet ponds	Wet ponds are basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits.
Extended Detention Basins	Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment.
Constructed Wetlands	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat.
Filter Drains and Perforated Pipes	Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect and convey the water.
Infiltration Devices	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground.
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.

8.4.10 Some specific SUDS features, including balancing ponds must be located outside the 1 in 100 year floodplain.

Green Roofs

8.4.11 Green roofs are a layer of vegetation, placed over a drainage layer that is designed to intercept and retain rainfall leading to a reduction in the volume of runoff. The use of green roofs can reduce the size of downstream SUDS and drainage infrastructure required.

8.4.12 According to the English Nature research report[13] '*Green Roofs: Their existing status and potential for conserving biodiversity in urban areas*', 71% of rain falling on a 100mm turf layer can be retained within the turf layer, greatly reducing storm water runoff. There are two main types of green roof, extensive and intensive.

8.4.13 An extensive green roof is a covering of the whole roof area with low growing, low maintenance plants. They usually comprise of 25 – 125mm thick soil layer in which a variety of hardy, drought tolerant, low level plants are grown. Extensive green roofs are designed to be self sustaining and cost effective and can be used in a wide variety of locations often described as an 'ecological protection layer'.

8.4.14 An intensive green roof is a landscaped area which includes planters or trees and is usually publicly accessible. They may include irrigation and storage for rainwater. They often require more maintenance and impose a greater load on the roof structure than extensive green roofs. Some city parks are in fact intensive green roofs such as the parks within the Canary Wharf Estate, Canada Square and West Ferry Circus and the roof of Cannon Street Station in London.

8.4.15 The Environment Agency's Green roof toolkit document providing further information and guidance can be found on their website[14].

Rainwater Harvesting

8.4.16 Rainwater harvesting is also recommended as a potential mitigation method to reduce surface water flood risk. The rainwater harvesting process is essentially the collection of rainwater from roofs into containers, which can be stored either above or below ground. The stored rainwater can then be re-used as and when required for every day non potable uses such as washing machines and toilets. Alternatively, collected rainwater can be released into the sewerage system or other water pathways, in a controlled and timely manner, once the rainfall event has subsided to reduce the risk of flooding and sewerage overflows.

8.4.17 The EA support the use of rainwater harvesting; however note that "storage in these types of systems will not usually be able to be counted towards the provision of on-site storage for surface water balancing. This is because the storage cannot be guaranteed to be available when required given the sporadic nature of the use of the harvested rainwater".

[13] http://www.wildlifegateway.org.uk/site/pdfs/naturalEngland/498.pdf
[14] http://www.environment-agency.gov.uk/business/sectors/91967.aspx Green roof toolkit, Environment Agency, June 2009

Pervious Pavements

8.4.18 A further SUDS method that would be suitable for Bolton is pervious pavements. Pervious pavements allow rainwater to infiltrate through the surface into underlying construction layers where water is stored prior to infiltration to the ground, reused or released to a surface water drainage system or watercourse at an attenuated rate.

8.4.19 Pervious surfaces can be incorporated into soft landscaping and oil interceptors can be added to improve pollutant retention and removal. In urban areas where there is a high percentage of hard cover the use of pervious surfaces for car parks and hard areas is a valuable technique that should be used wherever possible.

8.4.20 While pervious pavements are a good choice of SuDS for use within the study area, consideration of the proximity of basements and foundations must be made. Where pervious pavements are located within 5m of foundations or basements, an impermeable membrane liner is required to prevent infiltration.

8.4.21 Site geology should also be taken into account when deciding on suitable SUDS measures. Some SuDS systems rely on infiltration which in areas of low permeability may not be technically viable. If SuDS using infiltration are to be used, permeability tests should therefore be carried out to establish infiltration rates. Figure 8-1, Appendix 1 shows the SuDS map for Bolton from the AGMA Sub-Regional SFRAS, which can be used as a starting point for SuDS considerations.

8.4.22 Any surface water management system should be implemented in accordance with relevant policy and guidance such as PPS25, National SuDS Working Group (2004), BRE365, CIRIA C522 for SuDS, CIRIA 523 (SuDS Best Practice Manual) and CIRIA C697 (the SuDS Manual).

Pluvial Flood Risk

8.4.23 It is recommended that the ASTSWF map is used for high level investigation of possible pluvial flood risk to FRA site. Future developers should investigate the topography of development sites relative to their surrounding in more detail to determine whether they are likely to be affected by surface water flooding based on the EA maps showing Areas Susceptible to Surface Water Flooding or information derived from SWMPs. If there is any doubt, then the recommended standard for finished floor levels should apply (i.e. a minimum of 300mm above adjacent road levels). The topography of the site should also be investigated to avoid placing development on the path of flow and consequently increasing the risk of pluvial flooding to the site and third parties.

Flooding from Sewers and Drains

8.4.24 The risk of flooding from sewers and drains could not be properly assessed due to lack of data. Based on the information gathered as part of the Level 1 SFRA update, it is likely that the level of risk from sewer flooding within Bolton is low. Future FRAs should investigate the risk of flooding from sewers and drains and confirm runoff rates into sewers with United Utilities, Bolton MBC and the Environment Agency.

Risk of flooding from Canals and Reservoirs

8.4.25 The risk of flooding from canals and reservoirs in Bolton MBC is generally low. It is recommended that the Maps in Figure 5.7 and Figure 5.8 in Appendix 1 are used to assess the need for further investigation of flood risk from reservoirs and canals. If this initial assessment suggests a need for further investigation then an appropriate level of assessment, dependent on the general conditions, the nature of the site and its end use should be undertaken.

Climate Change

8.4.26 PPS25 and the accompanying Practice Guide recommend an increase in the peak rainfall intensity of up to 30%, as well as increase in peak flows in watercourses of up to 20%. This will significantly affect smaller urban catchments, leading to rapid runoff and subsequent increased flows within watercourses, surface water flooding, surcharging of gullies, drains and sewer flooding.

8.4.27 Sewer and surface water flooding are likely to become more frequent and widespread under urbanisation and climate change scenarios as the amount of impermeable surfaces and runoff increase, highlighting the importance of SuDS.

8.4.28 The location of future urban developments and flood defences within a catchment can heavily influence flood risk in the area and has the potential to further increase flood risk at sites downstream of such developments. Impacts of Climate Change include the lowering of the SoP offered by flood defences and the carrying capacity of culverts, drains, sewers and watercourse channels. These potentially leads to areas being at risk of flooding that were previously not at risk and highlights the increasing conflicts and pressures that are emerging between climate change scenarios and future development aspirations.

8.4.29 The PPS 1 Climate Change Supplement: *Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1*[15] sets out important objectives in order to tackle climate change, sea level rise and avoid flood risk. The purpose of design policies should be to ensure that developments are sustainable, durable and adaptable to natural hazards such as flooding. Following this guidance, it should be possible to mitigate against increased flood risk through incorporating 'flood proofing' measures such as raised finished floor levels into the development design, and/or development of compensatory storage and flood storage basins.

8.4.30 The Adaptation Strategies for Climate Change in the Urban Environment (ASCCUE) project is a study undertaken collaboratively by the University of Manchester, The University of Cardiff, University of Southampton and Oxford Brooks University. The project aimed to further the understanding of the impacts and risks of climate change on towns and cities through three 'exposure units' of human comfort, urban green space and the built environment. One of the aspects examined was surface water runoff during extreme rainfall events.

[15] http://www.communities.gov.uk/documents/planningandbuilding/pdf/ppsclimatechange.pdf

8.4.31 With an increase in development, there comes an increase in the amount of impermeable areas thus leading to increased runoff during storm events. In one of the worst-case modelled scenarios (large urban centre), an increase in rainfall of 56% by 2080, led to an increase in runoff of 82%.

8.5 Residual Risk Mitigation

8.5.1 Residual risks are those risks that remain after flood mitigation measures have been implemented.

8.5.2 As previously discussed, none of the proposed development sites are located behind defences (the informal defence wall at Church Wharf is not tied to higher ground downstream, therefore the area behind the wall will be flooded from downstream in extreme events) and therefore are not at risk of flooding through failure or overtopping of flood defences.

Flood Resilience and Resistance Measures

8.5.3 Paragraphs 6.29 to 6.35 of the PPS25 Practice Guide and the Department of Communities and local Government publication 'Improving the Flood Performance of New Buildings' (May 2007) have both provided guidance on the design of buildings to reduce residual risk of flooding. Further guidance is also provided in the CIRIA Research Project 624 'Development and Flood Risk: Guidance for the Construction Industry' (2004).

8.5.4 Flood proofing is a technique by which buildings are designed to withstand the effects of flooding. There are two main categories of flood proofing; dry proofing and wet proofing. Dry proofing methods are designed to keep water out of the building (flood resistance), and wet proofing methods are designed to improve the ability of the property to withstand the effects of flooding once the water has entered the building (flood resilience).

8.5.5 Table 8-2 summarises recommendations made within Table A3.6 of the report for flood proofing measures which can be incorporated within the design of buildings (subject to compliance with Building Regulations).

Table 8-2: Flood Proofing Options

Feature	Considerations To Improve Flood Proofing
External Walls	Careful consideration of materials: use low permeability materials to limit water penetration if dry proofing required. Avoid using timber frame and cavity walls. Consider applying a water resistant coating. Provide fittings for flood boards or other temporary barriers across openings in the walls (dry proofing).
Internal Walls	Avoid use of gypsum plaster and plasterboard; use more flood resistant linings (e.g. hydraulic lime, ceramic tiles). Avoid use of stud partition walls.
Floors	Avoid use of chipboard floors. Use concrete floors with integrated and continuous damp proof membrane and damp proof course. Solid concrete floors are preferable; if a suspended floor is to be used, provide facility for drainage of sub-floor void. Use solid insulation materials.
Fitting, Fixtures and Services	If possible, locate all fittings, fixtures and services above design flood level. Avoid chipboard and MDF. Consider use of removable plastic fittings. Use solid doors treated with waterproof coatings. Avoid using double-glazed window units that may fill with flood water. Use solid wood staircases. Avoid fitted carpets. Locate electrical, gas and telephone equipment and systems above design flood level. Fit anti-flooding devices to drainage systems.

Emergency Planning

8.5.6 Emergency access and egress is required to enable the evacuation of people from developments and also to provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

8.5.7 An emergency access and egress route is a route that is 'safe' for use by occupiers without the intervention of the emergency services or others. A route can only be completely 'safe' in flood risk terms if it is dry at all times. If a completely safe route is not available then a route with a low hazard should be considered.

8.5.8 For developments located in areas at flood risk the EA consider 'safe' access and egress to be in accordance with 'FRA Guidance for new Developments FD2320' (DEFRA/EA), where the requirements for safe access and egress from new developments are as follows in order of preference:

- Safe, dry route for people and vehicles,
- Safe, dry route for people,
- If a dry route for people is not possible, a route for people where the flood hazard in terms of depth and velocity of flooding) is low and should not cause risk to people,
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

8.5.9 For commercial development ('less vulnerable') it is considered that dry access and egress from the site will be desirable during times of extreme floods. For all new residential development ('more vulnerable'), it is considered that dry access and egress from the development will be essential during times of extreme floods from each residential unit to an area outside of the floodplain. New properties within a 'dry island' of the fluvial floodplain will also require dry access due to the disruption to essential services (gas, water, etc.) that would be experienced during a flood event.

8.5.10 It is necessary to ensure that proposed roads levels in new developments are such that emergency access and egress routes are maintained or where possible constructed to the 1 in 100 year plus an allowance for climate flood level, as a minimum.

8.5.11 Details of how emergency access and egress will be achieved should be clearly described in site-specific FRAs. This should include:

- A review of any detailed river models (where available);
- A review of flood extents from broadscale modelling; and
- Comparison of flood extents/levels with local ground levels from topographical survey or digital elevation models.

8.5.12 A preliminary assessment undertaken as part of this Level 2 SFRA has identified that access and egress is possible. However, the assessment of feasible access and egress routes will require investigation of all potential sources of flooding within the site-specific FRAs for each site.

Flood Warning

8.5.13 Where developing in flood risk areas is unavoidable, it is recommended that the owners/occupiers sign up to the 'Floodline Warnings Direct' service operated by the EA where the area is designated to receive flood warnings (EA website16) as a means of mitigating flood risk to people. Where a particular site lies within an area not currently eligible to receive flood warnings, it can be registered with the local EA office as an 'area of interest' in order to receive such warnings. The flood warnings are provided by the service via mobile, telephone, fax or pager.

8.5.14 More detailed information on the likely extent and time scale of these warnings can be obtained by request from the EA, by their 'Quickdial' recorded information service, or via their website.

8.5.15 For any proposed commercial or industrial developments within a designated floodplain, or those providing a service to vulnerable groups such as elderly care homes or hospitals, a system for monitoring flood warnings should be developed with designated responsible persons able to monitor and disseminate the warnings. This will provide more time to enable emergency evacuation of staff or residential occupants from the local area which may become flooded during a flood event (including routes for egress) prior to inundation.

[16] http://www.environment-agency.gov.uk/subjects/flood/?lang=_e

8.5.16 Flood warning systems should also enable sufficient time to implement protection measures for any commercial goods or personal belongings on site through sealing of all external doors to prevent flood inflow into such buildings as a precaution.

8.5.17 The exact nature of these emergency plans and procedures should be determined from the results obtained through the detailed FRAs for the individual sites and may be needed in conjunction with other mitigation measures. The need for, and feasibility of flood warning systems for a development should be discussed with the FRA.

8.5.18 Where there are exceptional circumstances in which development is allowed, which is reliant on evacuation, the relevant LPA will need to assess whether the proposals are acceptable to their own emergency planners and the local emergency services. It is not the remit of the EA to make recommendations on this matter.

9 Conclusions and Recommendations

9.1 Conclusions

Level 1 Update

9.1.1 The Level 1 update was undertaken to fill data gaps in relation to flood risk from non-fluvial sources of flooding. The fluvial flood risk data was also updated with the most recent information received from the Environment Agency. Data availability was a key issue for the SFRA which has limited the assessment of flood risk from other sources in particular. The extent of the Level 1 Update was therefore tailored to suit the data availability for each source of flooding and the conclusions are stated below.

9.1.2 The risk of fluvial flooding within the District of Bolton MBC is generally low. Flood zone 3b is generally within the river banks. Flood zone 3a and flood zone 2 extend out of bank at some locations but the spread of the flood zones beyond the river banks is generally limited by the narrow valleys. The area at greatest risk of fluvial flooding is in Kearsley downstream of the confluence of the Croal and the Irwell. Based on the EA flood map, the area of Watersmeeting also has significant numbers of commercial and residential properties at risk. No significant developments are planned in these areas. A small area in the Church Wharf area in Bolton Town Centre is shown to be within flood zone 3a. The risk of flooding to this site is from the River Croal.

9.1.3 The ASTSWF map for Bolton shows a wide distribution of areas susceptible to surface water flooding within the District. Generally, the low lying areas along the river valleys and along the course of culverted watercourses as well as natural low spots appear to be most susceptible. Areas susceptible to surface water flooding have been identified within Bolton Town Centre, the Renewal Areas of Inner Bolton, Farnworth and Breightmet, and to a lesser extent the two strategic sites of Cutacre and Horwich Loco Works, although there is no evidence of large scale surface water flooding in the district.

9.1.4 Due to lack of model data a detailed analysis of flood risk from sewer and drains could not be undertaken. Historical data suggest that the risk of flooding from sewers and the drainage system is low.

9.1.5 Analysis of reservoirs and canal data within the District suggests that the risk of flooding from these artificial sources is generally low; however there is a residual risk which are highlighted on the maps in Figure 5-7, Appendix 1 and Figure 5-8, Appendix 1.

9.1.6 Analysis of data on groundwater and consultations with the Environment Agency suggest that the risk of groundwater flooding within the District is low.

Town Centre Level 2 SFRA

9.1.7 Detailed hydraulic modelling of the Croal was used to determine flood zones and depths in the Town Centre Development Area. The hydraulic modelling shows the following areas to be at risk:

- A limited area within the car park in the Church Wharf area and in Queens Park lies within flood zone 3a with flood depths between 0.3m and 1.5m (risk for some, risk for most). With Climate Change the extent of flooding within the Church Wharf Development Area increases up to Brown Street;
- Most of the area bounded by Manor Street, Brown Street/Well Street, the A666 and the River Croal in the Church Wharf development area lies within flood zone 2;
- In the Central Street/St Edmund Street Development Area, most of the area bounded by Bark Street, Marsden Road, Knowsley Street and the left bank of the Croal lies within flood zone 2. Similarly part of the land on the right bank from Knowsley Street to Marsden Road lies within flood zone 2;
- A significant area on both sides of the river lies within flood zone 2 in the reach between Marsden Road and Queens Park;
- All other areas in Bolton Town Centre lie within flood zone 1.

Flood Risk Management

9.1.8 The impact of protecting the Town Centre to a standard of protection of 1% AEP was investigated with the hydraulic model by raising bank levels to stop flooding to properties adjacent to the river. The hydraulic modelling work has shown that raising river bank levels to increase the standard of protection to the 1% AEP does not have a negative impact on flood risk downstream of the Town Centre Development Area. Within the Town Centre Development Area raising the standard of protection to the 1% AEP level causes an increase of water levels by up to 1m, with the maximum increase occurring within the Church Wharf Area.

9.2 Recommendations

9.2.1 To ensure a holistic approach to flood risk management and make sure that flooding is taken into account at all stages of the planning process, the findings of this report should be incorporated into the emerging LDF for Bolton MBC to ensure that:

- Development is located in the lowest flood risk areas,
- New development is flood-proofed to a satisfactory degree and does not increase flood risk elsewhere where avoidance of risk through the sequential approach is not possible,
- Surface water is managed effectively on site.
- Development in Flood Zone 2 or Flood Zone 3 is safe.

9.2.2 The 0.1% AEP flood outline is considered to be very conservative due to the seemingly overestimated flows in the model. Updating the 0.1% AEP flows is beyond the scope of the SFRA. It is therefore recommended that Bolton MBC work with the Environment Agency to update the flows in the Croal model and flood outline for the 0.1%AEP event.

9.2.3 It is recommended that Bolton MBC should work with the Environment Agency to investigate the possibility of replacing the coarse trash screen at Church Wharf with an appropriately designed trash screen (using Environment Agency Guidance) in due course, to reduce the effect of the screen on water levels and risk of blockage. Similarly Bolton MBC should work with the Environment Agency to investigate the possibility of replacing the coarse trash screen at Marsden Road with an appropriately designed trash screen at Central Street upon completion of the culvert extension between Central Street and Knowsley Street.

9.2.4 Developments within the Renewal Areas of Inner Bolton, Farnworth and Breightmet are likely to be more sparse, therefore a Level 2 SFRA is not recommended in these areas. It is understood that flood risk assessments for the Horwich Loco Works site and Cutacre site are either ongoing or nearly completed; therefore a Level 2 SFRA is not recommended for these sites. However, the flood risk assessments for the Horwich Loco Works site and the Cutacre site should refer to the findings and recommendations of this SFRA.

9.2.5 The flood risk assessment for the Horwich Loco Works site should assess the risk of flooding from Pearl Brook and the culverted watercourse (a tributary of Pearl Brook) running close to the southern border of the site. Similarly, an appropriate level of assessment should be undertaken for the minor watercourses within the Cutacre site. A surface water flood risk assessment and surface water strategy should be included in the FRA for these two sites.

9.2.6 PPS25 states that a Level 2 SFRA should identify the need (or not) for an SWMP. It is considered prudent to undertake an SWMP for Bolton MBC to determine surface water flood risk more accurately. One of the key objectives of future SWMPs should be to determine CDA boundaries within the District to enable implementation of policies to reduce surface water flood risk.

9.2.7 It is recommended that the Level 2 SFRA is updated as and when more flood risk data becomes available. This reflects the ‘Living Document’ nature of the SFRA and will ensure that the document uses the best available information.

Appendix 1 Maps

Appendix 2 Summary of Planning Data

Appendix 3 Flood Defence Inspection Report