Bath & North East Somerset Level 1 Strategic Flood Risk Assessment Update

(Final Report)

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This report describes work commissioned by Bath and North East Somerset Council, on behalf Kaoru Jacques, by an email dated 27 February 2018. Anna Hastings and Phil Emonson of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

JBA text

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Executive summary

Introduction

Bath and North East Somerset Council have commissioned a Level 1 Strategic Flood Risk Assessment (SFRA) to comprehensive evidence base to support the Bath and North East Somerset Local Plan. This updated SFRA replaces the previous 2008 SFRA.

SFRA Objectives

The key objectives of the review performed during the preparation of the 2018 SFRA are:

- To take into account the latest flood risk policy
- Take into account the latest flood risk information and available data which also considers climate change for the updated 2016 allowances.
- To provide a comprehensive set of maps displaying flood risk information
- To identify the requirements for site-specific flood risk assessments
- To consider opportunities to reduce flood risk to existing communities and developments
- To aid authorities in identifying when the Exception Test is required and when a more detailed Level 2 SFRA will be required, when determining strategic site allocations; and,
- To inform the Sustainability Appraisal of the authorities' Local Plans, so that flood risk taken into account when considering strategic site allocations

An over arching aim, in meeting these objectives is to put flood risk management policy and practice in place to provide for a strategic approach to the management of flood risk to address the needs of adaptation to climate change effects.

SFRA Outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Mapping of location and extent of the functional floodplain
- Assessment of the potential impact of climate change on flood risk
- Mapping areas covered by Environment Agency Flood Warnings and Alert areas
- Assessment of standard of protection and condition of existing flood risk management infrastructure within the study area
- Assessment of the potential impact of climate change upon flood risk
- Assessment of locations where additional development may increase flood risk elsewhere
- A review of flood risk and historical flood incidents within main settlements
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site specific flood risk assessments and the process for flood map challenges

Summary of Assessment

Appraisal of flood risk

There have been several recorded flood incidents across the study area from a combination of sources. These have been derived from Wessex Water sewer incidents dataset, Environment Agency historic outlines and B&NES flood incident database. The prominent source of historic flooding within Bath and North East Somerset has been identified from fluvial flooding. The settlements of Bath, Keynsham, Midsomer Norton, Radstock and Chew Magna are the areas which the most significant incidents of flooding within the study area. The most significant event was identified to be the 2012 Chew Magna flooding.

Fluvial flooding has been identified to be the most significant source of flood risk with events being associated with the main watercourses located in the study area. These watercourses have been identified as the River Avon, River Chew, Cam Brook and Wellow Brook being located within the study area.

There is an area upstream of Keynsham Weir on the River Avon which has been identified to be tidally influenced and therefore may be susceptible to tidal flooding. Due to sea level rise, this area may become more susceptible to tidal flooding in the future.

The Risk of Flooding from Surface Water (RoFfSW) dataset shows that surface water predominately follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. Surface water flood risk is identified in a number of settlements including: Chew Magna, West Harptree, Compton Martin and Priston. A SWMP has been produced for B&NES and details the risk from this source of flooding.

A number of defences are located within the settlements of Bath, Midsomer Norton and Radstock. The standard of protection for these defences as well as the condition is outlined within the review in this document. There is potential for these defences to fail or be overtopped, therefore should be considered as part of a detailed site-specific FRA. However, the worse case scenario of the undefended event should still be considered for a site-specific FRA. Whilst consideration of defences is logical, consideration should also be given to a worst-case scenario. Therefore, the undefended climate change scenario should be also considered as part of a site-specific FRA at locations where the actual risk is reduced by the presence of existing defences, or flood risk management measures.

There are currently 13 Flood Warning Areas and 7 Flood Alert Areas in the study area.

Climate Change

The NPPF and accompanying Planning Practice Guidance set out how the planning system should minimise vulnerability and provide resilience to the impacts of climate change. The Environment Agency published updated climate change guidance on 19th February 2016 (further updated on 3rd February 2017), which supports the NPPF and must now be considered in all new developments and planning applications. The Environment Agency has also published guidance to LPAs in the application of appropriate climate change allowances when considering climate change effects (updated April 2016 Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities).

When defining the scope of this commission, the climate change allowances were agreed by the Environment Agency and LLFA and are intended to assist with future planning across the combined study area. The climate change allowances used in this SFRA are detailed in Section 7. Climate change modelling for watercourses across the combined study area was undertaken where detailed models exist, were available and supplied at the time of preparing this SFRA. In areas where modelling was not available,

a climate change sensitivity buffer was applied to the study area based upon existing Flood Zones and LiDAR data.

Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments (FRAs) are documented with this SFRA along with guidance for planners and developers throughout this report. Links are provided to various relevant guidance documents and policies published by other Risk Management Authorities, such as the LLFA and the Environment Agency.

Relevant studies

There are many relevant regional and local key studies which complement the SFRA and have been considered, such as the Flood Risk Management Plan, Catchment Flood Management Plan, River Basin Management Plan, the Preliminary Flood Risk Assessment and the Local Flood Risk Management Strategies.

Policy Recommendations

The SFRA includes recommendations in relation to flood risk that are to be considered by Bath and North East Somerset Council in the development of specific policy within the Local Plan.

Sequential approach to development

The SFRA has identified the areas of Bath and North East Somerset that are at high risk of flooding from all sources. New development and re-development of land should wherever possible seek to avoid these areas and where not possible, opportunities to reduce overall level of flood risk at the site.

Sequential and Exception tests

The SFRA identified that areas of Bath and North East Somerset are at high risk of flooding from fluvial, surface water and groundwater sources. Therefore, proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF.

Site-specific Flood Risk Assessments

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), to inform development zoning within the site and provide appropriate evidence, as required, to support confirmation that the Sequential and Exception Tests are satisfied.

The Flood Zones, whilst generally accurate on a large scale, are not always shown on national mapping for land where the catchment area of the watercourse is less than 3km². There are a number of small watercourses and field drains which may pose a risk to development. Therefore, whilst these smaller watercourses may not be shown as having flood risk on the Environment Agency flood risk mapping, it does not necessarily mean there is no flood risk. As part of a site-specific FRA the potential flood risk and extent of flood zones should be determined for these smaller watercourses.

Where a site-specific FRA has produced modelling outlines which differ from the EAs Flood Map for Planning (Rivers and Sea), then a Flood Map Challenge may need to be undertaken. Where the modelling and results are deemed acceptable to the EA, amendments to the Flood Map for Planning (Rivers and Sea) may subsequently be made.

Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

All new development within the 1% Annual Exceedance Probability (AEP) flood extent including an allowance for climate change (for the lifetime of the development) must

not normally result in a net loss of flood storage capacity. Annual Exceedance Probability is the probability (expressed as a percentage) of a flood event occurring in any given year. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage. Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water, and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided where appropriate and the land made available for that purpose must be hydraulically linked to the area it is compensating for so that the total volume of the floodplain storage is not reduced.

Developers should consult with the relevant LPA (Bath and North East Somerset Council through their **planning permission portal**), the Environment Agency and Wessex Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling and drainage assessment and design.

Surface water management and SuDS

Planners should be aware of the conditions and local requirements set within the **West of England Sustainable Drain Developer Guide (2015),** the LLFA, for surface water management for major and minor developments and ensure development proposals and applications are compliant with the LLFA's policy.

The guidance provides information on how SuDS proposals for new developments will be considered by the LLFA, when to consult the LLFA, how to screen applications based on local flood risk and records, LLFA standing advice (for Ordinary Watercourse consenting, major development below LLFA thresholds and minor guidance. The technical guidance is split into the following themes:

- Local flood risk guidance
- Drainage hierarchy
- Infiltration testing guidance
- Runoff rates
- Runoff volumes
- Climate Change
- Management and maintenance
- Flood exceedance management

All new development should aim to minimise areas of impermeable ground to reduce surface water runoff. Sustainable drainage systems (SuDS) should be used on all new development.

It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will provide an appropriate standard of protection from surface water flooding to properties and critical infrastructure from flooding from surface water both on and off site. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. The 2015 DEFRA non-statutory technical standards for sustainable drainage systems should be followed, alongside the LLFA guidance note and national guidance.

For proposed developments, geotechnical investigations should be undertaken to determine whether the ground at the site has infiltration potential. This information should be representative of on-site conditions. If the ground at the site is found to have infiltration potential detailed infiltration testing should be undertaken in line with BRE

365 to establish representative infiltration rates. Infiltration mapping displaying further information can be found on the council's **website**.

Where sites lie within or close to a Groundwater Source Protection Zone (SPZ) or aquifer, treatment steps may be required ahead of discharge to the ground, sewers etc. Development proposals at sites across the area should assess the pollution risk to receiving waterbodies and include appropriate treatment steps ahead of any discharge to surface or groundwaters. The CIRIA C753 SuDS manual provides further guidance on this issue.

A management and maintenance plan of sustainable drainage and surface water systems covering the lifetime of the development will be required. Consideration must also be given to the residual risks associated with the use of SuDS.

Infrastructure and safe access

Finished floor level guidance has been established through consultation with the Environment Agency. Minimum finished floor levels for development should be set to whichever is the higher of the following:

- a minimum of 300mm* above the 1% AEP fluvial event plus an allowance for climate change
- a minimum of 300mm* above the 0.5% AEP tidal event plus an allowance for climate change
- a minimum of 300mm above surrounding ground levels

*A 300mm freeboard is only applicable where detailed modelling is available which is deemed to be reliable. If no detailed and reliable modelling is available, contact the Environment Agency to see if an appropriate freeboard can be provided. Some development may require detailed modelling to be carried out.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine the suitability of alternative flood mitigation approaches.

Safe access and egress will need to be demonstrated at all development sites. Ideally, access should be situated 300mm above the design flood level. If safe access and egress cannot be achieved, the **Defra/EA Technical Report: FD2320: Flood Risk Assessment Guidance for New Development** should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site which should be agreed with the authority.

Emergency vehicular access should be possible during times of flood.

Where development is located behind, or in, an area benefitting from defences, consideration should be given to the potential safety of the development, finished floor levels and the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

Resistance and resilience measures will be required if buildings are situated in the flood risk area, and as applicable in all cases of flood risk, opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. Further information is provided in the publications **"Improving the flood performance of new buildings"** and **"Prepare your property for flooding."**

Residual risk

Residual risk is the risk that remains after mitigation measures are considered. The residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences (or other flood risk management measures) or circumstances where there is a failure of the defences, e.g. flood banks collapse, reservoir failure etc.

Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed. Further, any developments located within an area protected by flood risk management measures, where the standard of protection is not appropriate, or where the failure of the intended level of service gives rise to unsafe conditions, should be identified.

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Using this document

Hyperlinks

Hyperlinks have been provided where there are useful reference points. These are shown as **blue text.**

Contents, list of figures, list of tables and references to other sections, figures and tables have also been hyperlinked to enable easy navigation around the report.

Abbreviations

Term	Definition
AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
CFMP	Catchment Flood Management Plan
CIRIA	Company providing research and training in the construction industry
DEFRA	Department of the Environment, Food and Rural Affairs (formerly MAFF)
DTM	Digital Terrain Model
EA	Environment Agency
FCRMGiA	Flood and Coastal Risk Management Grant in Aid
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FWA	Flood Warning Area
FWD	Flood Warnings Direct
FWS	Flood Warning Service
GIS	Geographical Information System
LIDAR	Light Detection and Ranging
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NFF	National Flood Forum
NPPG	National Planning Practice Guidance
NPPF	National Planning Policy Framework
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PLR	Property Level Resilience
PPG	Planning Policy Guidance
RBMP	River Basin Management Plan
RMA	Risk Management Authorities
RoFSW	Risk of Flooding from Surface Water

Term	Definition
SFRA	Strategic Flood Risk Assessment
SWMP	Surface Water Management Plan
SuDS	Sustainable Drainage Systems
SWFZ	Surface Water Flood Zones
UKCP09	UK Climate Projections
WFD	Water Framework Directive

Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

Strategic Flood Risk Assessments (SFRAs) form part of the evidence base of the Local Plan. A revised version of the NPPF was published on 24 July 2018 and sets out Government's planning policies for England and how these are expected to be applied. This revised Framework replaces the previous NPPF published in March 2012. The requirement for the preparation of SFRAs in Section 14 Paragraph 156 of the **National Planning Policy Framework (NPPF):**

> ***"...Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards."*** (National Planning Policy Framework, paragraph 156)

This Strategic Flood Risk Assessment (SFRA) 2018 document replaces the previous Level 1 SFRA (2008). The SFRA study area is shown in

Figure 2-1. The main purpose of the SFRA update is to provide a comprehensive and robust evidence base to support the production of the Local Plan and to support the selection of site allocations.

The key objectives of the 2018 SFRA are:

- To provide up to date information and guidance on flood risk for B&NES, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies
- To provide the basis for applying the flood risk Sequential Test, and if necessary the Exception Test
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as part of the evidence base for the local plan
- Identify the requirements for site-specific flood risk assessments and the application of Sustainable Drainage Systems

1.2 Levels of SFRA

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1 Level One: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.

2 Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

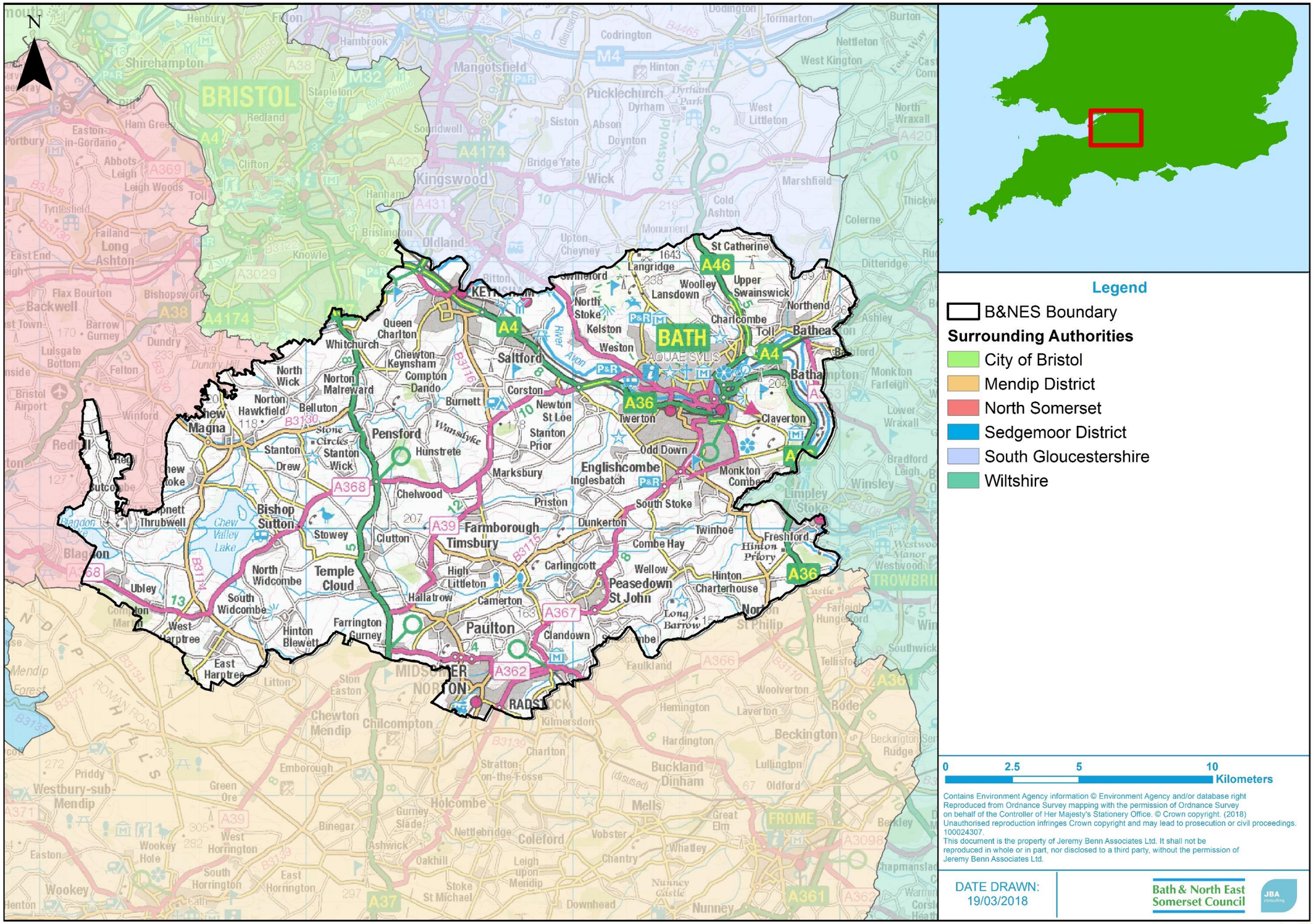
This report fulfils the Level One SFRA requirements.

1.3 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS)
- A review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc)
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments
- Mapping of location and extent of functional floodplain
- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation
- Mapping areas covered by an existing flood alert / warning
- Identify opportunities to reduce flood risk
- High-level screening of proposed development sites against flood risk information
- Flood defence infrastructure.

Figure 2-1: Study Area



1.4 SFRA user guide

Table 2-1: SFRA report contents

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
3.The Sequential, risk-based approach	Describes the Sequential Approach and application of Sequential and Exception Tests. Outlines cross-boundary issues and considerations.
4. Climate change	Outlines climate change guidance and the implications for B&NES
5. Sources of information used in preparing the SFRA	Outlines what information has been used in the preparation of the SFRA.
6. Understanding flood risk in B&NES	Introduces the assessment of flood risk and provides an overview of the characteristics of flooding affecting the district. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered. Outlines the flood warning service in B&NES and provides advice for emergency planning, evacuation plans and safe access and egress.
7. FRA requirements and flood risk management guidance	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the LLFA that should be followed.
8. Surface water management and SuDS	Advice on managing surface water run-off and flooding and the application of SuDS.
9. Strategic flood risk solutions	Overview of possible strategies to reduce flood risk
10. Summary	Review of the Level 1 SFRA.
11. Recommendations	Identifies recommendations for the council to consider as part of Flood Risk Management policy.
Appendix A: **Flood risk mapping**	Interactive maps showing flood risk information from all sources
Appendix B: **Flood warning coverage**	Maps of flood alerts and flood warning coverage

1.5 Consultation

The following parties have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Wessex Water
- Highways England
- Neighbouring authorities and LLFAs

1.6 Use of SFRA data

1.6.1 SFRA information and updates

It is important to recognise that SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

SFRAs should be a **'living document'**, and as a result should be updated when new information on flood risk, new planning guidance or legislation becomes available. New information on flood risk may be provided by Bath and North East Somerset Council. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed internally, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

2 The Planning Framework

2.1 Introduction

The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities.

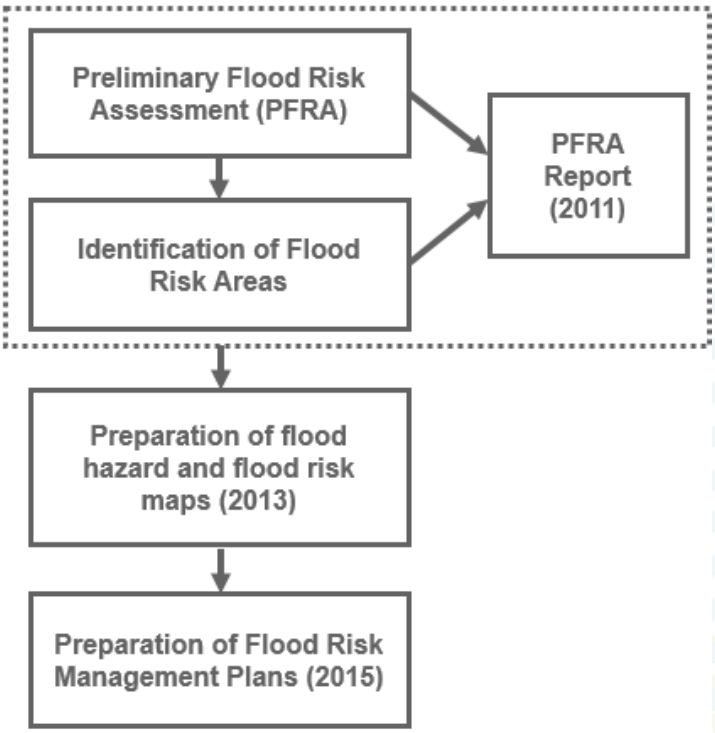
A revised version of the NPPF was published on 24 July 2018 and sets out Government's planning policies for England and how these are expected to be applied. This revised Framework replaces the previous NPPF published in March 2012. The online searchable version of the revised NPPF is not available at the time of writing, however a pdf version can be downloaded **here** Flood Risk Regulations (2009) and Flood and Water Management Act (2010)

2.1.1 Flood Risk Regulations (2009)

The Flood Risk Regulations (2009) translate the current EU Floods Directive into UK law and place responsibility upon all Lead Local Flood Authorities (LLFAs) to manage localised flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; however, responsibility for local and all other sources of flooding rests with LLFAs. In the instance of this SFRA, the LLFA is Bath and North East Somerset Council.

Figure 2-2 illustrates the steps that have initially been taken to implement the requirements of the EU Directive in the UK via the Flood Risk Regulations.

Figure 2-2: Flood Risk Regulation Requirements



2.1.2 Preliminary Flood Risk Assessments

In accordance with the Regulations, LLFAs have the task of preparing a Preliminary Flood Risk Assessment (PFRA) report on a 6-year cycle, the first being prepared and published in 2011.

PFRAs report on significant past and future flooding from all sources except from Main Rivers and reservoirs, which are covered by the Environment Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Wessex Water). PFRAs involve a high-level screening exercise and consider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The document that covers the study area is the **Bath and North East Somerset PFRA (2011).**

The first version of the PFRA for B&NES was produced in 2011. The PFRA highlights the importance of establishing data recording and sharing protocols between the different authorities and partners and promotes the recording of all flooding incidents from local sources. 4.1.9 of the 2011 PFRA provides a summary of Section 19 flood investigation reports published up until the date of writing. An outline and summary of these are provided within section 4.1.9 of the B&NES SWMP (2015).

Since the publication of the 2011 B&NES PFRA, an update has been published on the council website **(Bath and North East Somerset PFRA 2017)**. This document reviews flood risk areas identified within B&NES with more up to date flood risk data and information. The update found no significant change to the assessment of local flood risk for B&NES.

2.1.3 Flood Risk Management Plans (FRMPs)

Under the Regulations then Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. Instead they had to prepare and publish hazard and risk mapping and an FRMP.

The study area is covered by the **Severn River Basin District Flood Risk Management Plan (FRMP) (2016)**. The FRMP covers the period of 2015-2021. The FRMP draws on policies and actions identified with Catchment Flood Management Plans as well as incorporating information from the Local Flood Risk Management Strategies.

2.1.4 Flood and Water Management Act (FWMA) 2010

Following the 2007 floods, Sir Michael Pitt was appointed to chair an independent review into the floods. The final report was published in June 2008. The Flood and Water Management Act (2010)[1] implements some of Sir Michael Pitt's recommendations and aims to create a simpler and more effective means of managing both flood risk and coastal erosion.

The FWMA established Lead Local Flood Authorities (LLFAs). B&NES is a unitary authority and LLFA with duties that include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.

1 Flood and Water Management Act (2010): http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

- Consenting: When appropriate LLFAs will perform consenting of works on ordinary watercourses.

2.1.5 Local Flood Risk Management Strategy (2015)

The LFRMS is used as a means by which the LLFA co-ordinates flood risk management on a day to day basis. The LFRMS also sets measures to manage local flood risk i.e. flood risk from surface water, groundwater and ordinary watercourses.

Bath and North East Somerset Council is responsible for developing, maintaining, applying and monitoring the LFRMS for B&NES. To work with organisations, businesses and communities to manage flood risk and, where it is practicable, affordable and sustainable to do so, to reduce risk to life, property and livelihoods that may arise from local surface runoff, Ordinary Watercourse and groundwater flooding.

The **LFRMS (2015)** will seek to implement the following strategic objectives:

- **Objective 1**: Improve understanding of local flood risk
- **Objective 2**: Promote community awareness and build capability for appropriate action
- **Objective 3**: Manage local flood risk through capital and maintenance investment
- **Objective 4**: Prevent inappropriate development that creates or increases flood risk
- **Objective 5**: Improve flood preparedness, warning, ability to recover

2.1.6 LLFAs, surface water and SuDS

On 18 December 2014 a **Written Ministerial Statement** laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015. When considering planning applications, local planning authorities should consult the LLFA on the management of surface water in order to satisfy that:

- The proposed minimum standards of operation are appropriate
- There are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

In March 2015 the LLFA was made a statutory consultee which came into effect on 15 April 2015. As a result, Bath and North East Somerset Council will be required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as:

- Residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more.

The updated NPPF states that: 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165). When considering major planning applications, LPAs should consult the LLFA on the management of surface water in order to satisfy that:

- the proposed minimum standards of operation are appropriate

• there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

2.2 National Planning Policy and Guidance

The **National Planning Policy Framework** (NPPF) was published in July 2018, replacing the previous version published in March 2012. The NPPF sets out Government's planning policies for England and how these are expected to be applied. The Framework is based on core principles of sustainability and forms the national policy framework in England. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions.

The NPPF sets out the Government's requirements for the planning system and provides a framework within which local people and councils can produce distinctive local and neighbourhood plans to reflect the needs and properties of their communities. The NPPF must be taken into account by local planning authorities when preparing Local Plans and for applicants preparing planning submissions.

The key changes in the revised NPPF compared to the 2012 NPPF include:

• Strategic policies should also now consider the 'cumulative impacts in, or affecting, local areas susceptible to flooding' (para 156), rather than just to or from individual development sites;

• Future risk from climate change. The 'sequential approach' should be used in areas known to be at risk now or in the future from any form of flooding' (para 158);

• Natural Flood Management. 'Using opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques)' (para 157c);

• SuDS. 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165); and

• Emergency planning. Emergency plans should be agree as part of an FRA that includes the inclusion of safe access and egress routes (para 163e).

National Planning Practice Guidance (NPPG) was published in 2014 and sets out how the NPPF should be implemented. NPPG: Flood Risk and Coastal Change advises on how planning can account for the risks associated with flooding and coastal change in plan making and the application process. It sets out Flood Zones, the appropriate land uses for each zone, flood risk assessment requirements, including the Sequential and Exception Tests and the policy aims for developers and authorities regarding each Flood Zone.

The Sequential Test

"The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones, as refined in the Strategic Flood Risk Assessment for the area, provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required".

(National Planning Practice Guidance, paragraph 019)

The Exception Test

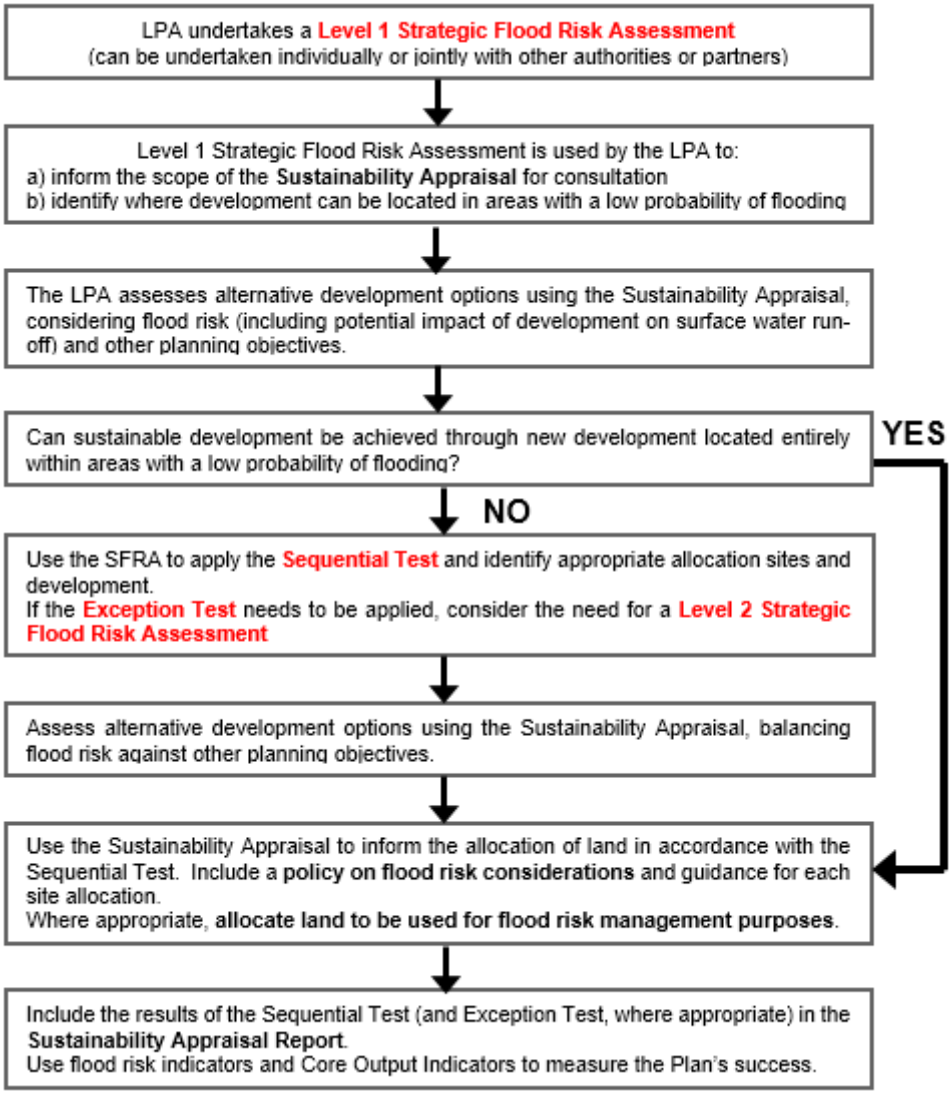
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.".

(National Planning Practice Guidance, paragraph 023)

A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance (Figure 2-).

Figure 2-3: Flood risk and the preparation of Local Plans



† Diagram 1 of NPPG: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

2.3 Water Cycle Studies

Climate Change is predicted to present unprecedented new challenges, such as more frequent and extreme rainfall events and rising global temperatures, which are expected to exert greater pressure on the existing infrastructure. Planning for water management therefore has to take these potential challenges into account. A large number of new homes for instance may cause the existing water management infrastructure to be overwhelmed which would result in adverse effects on the environment, both locally and in wider catchments.

Water Cycle Studies assist Local Authorities to select and develop sustainable development allocations so that there is minimal impact on the environment, water quality, water resources, and infrastructure and flood risk. This can be achieved in areas where there may be conflict between any proposed development and the requirements of the environment through the recommendation of potential sustainable solutions.

A Water Cycle Study has not been conducted within the SFRA study area.

2.4 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

2.4.1 Bath and North East Somerset Surface Water Management Plan (2015)

Bath and North East Somerset Council commissioned JBA Consulting in 2014 to produce a **SWMP (2015)** to assess the flood risk in the B&NES Council area. This was completed in 2015. Urbanisation and climate change were identified to have the potential to significantly impact surface water flood risk within the study area. Appropriate development management policies were deemed to be already in place to minimise the potential impacts and the importance of continuing to implement such policy was highlighted. One such policy is the inclusion of surface water flood mitigation measures included in any development plan following BANES SuDS policy.

As part of this commission, the BANES **Interactive Map of Local Flood Incidents** was created. This map summaries flood incidents and predicted surface water flood risk in Bath and North East Somerset and is based on flood incident data collected from BANES Council and Wessex Water. In addition, the BANES **Infiltration Potential Maps** were also created as part of this to indicates area compatible for SuDS infiltration.

2.4.2 Bath and North East Somerset WaterSpace Study

Bath and North East Somerset Council has worked in partnership with the Environment Agency, the Canal & River Trust and Wessex Water through the WaterSpace Study to develop an evidence base, undertake public and stakeholder consultation to identify opportunities to deliver enhancements to these waterways and adjoining land.

The WaterSpace project has gathered data, mapped information, and generated ideas to work with the community and public, private and voluntary bodies to identify 35 projects and project ideas to revitalise the waterways. Project ideas are provided within the report which can be utilised by developers. The final drafts of the report are available as **part 1** and **part 2**.

2.5 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Policy Units'. These policies are intended to cover the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The six national policies are:

- No active intervention (including flood warning and maintenance). Continue to monitor and advise.
- Reducing existing flood risk management actions (accepting that flood risk will increase over time).
- Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline).
- Take further action to sustain the current level of flood risk (responding to the potential increases in risk from urban development, land use change and climate change).
- Take action to reduce flood risk (now and/or in the future)
- Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

2.5.1 Bristol Avon Catchment Flood Management Plan (2012)

The **Bristol Avon Catchment Flood Management Plan (CFMP)** was published by the Environment Agency in December 2009, with a summary report later published in June 2012. The River Avon catchment covers 2200km2 and is predominantly rural, with major urban areas such as Bristol and Bath. There are also other smaller urban areas such as Chippenham, Frome and Keynsham. The policies for the study area within the Bristol Avon CFMP are:

- Lower Avon (Policy 3) – Areas of low to moderate flood risk where we are generally managing existing flood risk effectively
- Bath (Policy 5) – Areas of moderate to high flood risk where we can generally take further action to reduce flood risk

2.6 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts. The study area falls within the Severn River Basin District.

The updated **2015 Severn RBMP** identified a number of pressures on the water environment and significant water management issues.

The RBMP describes how development and land-use planning needs to consider a number of issues relevant to the RBMP including sustainable drainage systems, green and blue infrastructure. Sewage treatment options (tertiary phosphate treatments), water efficiency measures, infrastructure and development locations and the reduction of nutrients from diffuse pollution. The RBMP provides a summary of measures to protect and improve the water environment in the river basin district.

2.7 Roles and responsibilities of Risk Management Authorities in B&NES

The roles and responsibilities of Risk Management Authorities (RMAs) in B&NES are summarised below.

2.7.1 Bath to North East Somerset Council

As a Local Planning Authority, Bath and North East Somerset Council assess, consult on and determine whether development proposals are acceptable, ensuring that flooding and other, similar, risks are effectively managed.

The council will consult relevant statutory consultees as part of planning application assessments and may, in some cases, also contact non-statutory consultees, such as Wessex Water, that have an interest in the planning application.

Bath and North East Somerset Council is a unitary authority and is therefore the Lead Local Flood Authority (LLFA) for the area additionally. As an LLFA, B&NES duties include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate LLFAs will perform consenting of works on ordinary watercourses.

B&NES is also the Local Highway Authority and manages highway drainage, carrying out maintenance and improvement works on an on-going basis, as necessary, to maintain existing standards of flood protection for highways, making appropriate allowances for climate change. It also has the responsibility to ensure road projects to no increase flood risk.

2.7.2 Environment Agency

The Environment Agency is responsible for protecting and enhancing the environment and contributing to the government's aim of achieving sustainable development in England and Wales. The Environment Agency has powers to work on Main Rivers to manage flood risk. These powers are permissive, which means they are not a duty, and they allow the Environment Agency to carry out flood and coastal risk management work and to regulate the actions of other flood risk management authorities on main rivers and the coast.

The EA also has powers to regulate and consent works to Main Rivers. Prior written consent is required from the Environment Agency for any work in, under, over or within nine metres of a Main River or between the high-water line and the secondary line of defence e.g. earth embankment. The Environment Agency also has a strategic overview role across all types of flooding as well as other types of water management matters.

2.7.3 Water and wastewater providers

Wessex Water is the sewerage undertaker for B&NES. They have the responsibility to maintain surface, foul and combined public sewers to ensure the area is effectively drained. When flows (foul or surface water) are proposed to enter public sewers,

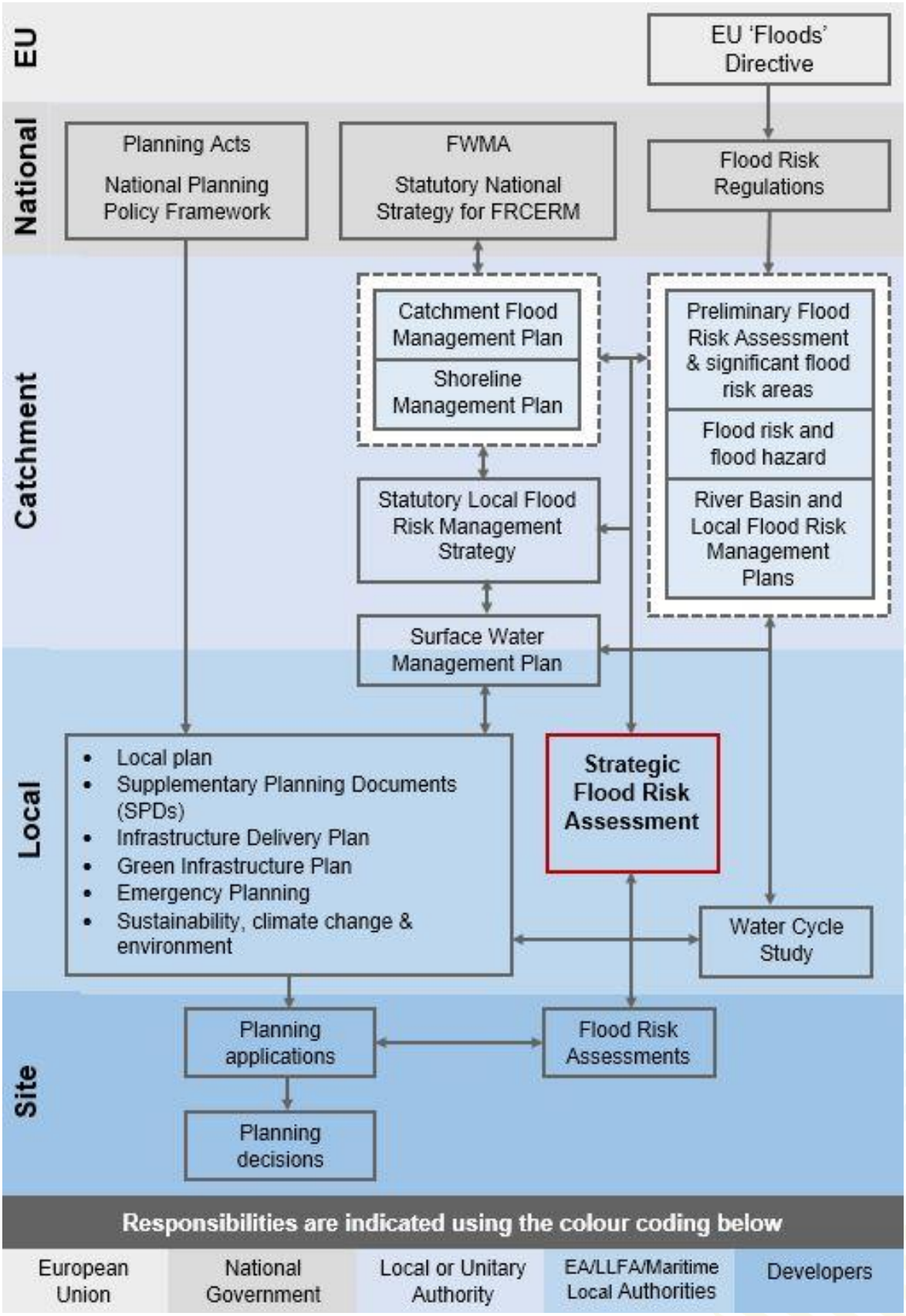
Wessex Water will assess whether the public system has the capacity to accept these flows as part of their pre-application service. If there is not available capacity, they will provide a solution that identifies the necessary mitigation. Wessex Water also comments on the available capacity of foul and surface water sewers as part of the planning application process. Further information can be found on their **website**.

Consent, prior to commencing work, is required from the relevant provider if installing water systems, or altering existing systems, is intended.

2.8 Key strategic planning links

Figure 2- outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and Flood and Water Management Act, have introduced a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

Figure 2-4: Strategic planning links and key documents for flood risk



3 The sequential, risk-based approach

3.1 The sequential, risk-based approach

This approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible.

When drawing up a local plan, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale and nature of the flood risks is required.

3.1.1 Flood Zones

Table 1 of NPPG Flood Risk and Coastal Change identifies the following Flood Zones. These apply to both Main River and ordinary watercourses. Flood risk vulnerability and flood zone compatibility is set out in **Table 3** of the NPPG. Table 3-1 summarises this information and also provides information on when an FRA would be required.

Table 3-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above and development of less than 1 ha where they could be affected by sources of flooding other than rivers and sea (for example surface water run-off and reservoirs) will require an FRA.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) are appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year. Developers and the local authorities should seek to reduce the overall level of flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify, in their SFRA, areas of functional floodplain, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. They must also be safe for users and not increase flood risk elsewhere. Essential Infrastructure will only be permitted if it passes the Exception Test.
		All developments in this zone require an FRA.

3.1.2 Surface water flood risk information

In 2016, the Environment Agency, working with LLFAs, produced the Risk of Flooding from Surface Water (RoFfSW) dataset. This superseded the previous Flood Map for Surface Water and Areas Susceptible to Surface Water Flooding maps. The RoFfSW is a national scale map and assesses flooding scenarios as a result of rainfall with the following chance of occurring in any given year. It is intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk.

The RoFfSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water (Appendix K).

Table 3-2: RoFfSW risk categories

Risk	Definition
High	Probability of flooding greater than 1 in 30 (3.3%) each year.
Medium	Probability of flooding between 1 in 100 (0.1%) and 1 in 30 (3.3%) each year.
Low	Probability of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%) each year.
Very Low	Probability of flooding of less than 1 in 1,000 (0.1%) each year

Although the RoFfSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

The surface water map is available via the Long term flood risk information page on the government's **website**, and is also provided in Appendix K of this SFRA. In addition to showing the extent of surface water flooding, there are depth and velocity maps for each risk category. These maps should be used when considering other sources of flooding when applying the Sequential and Exception tests.

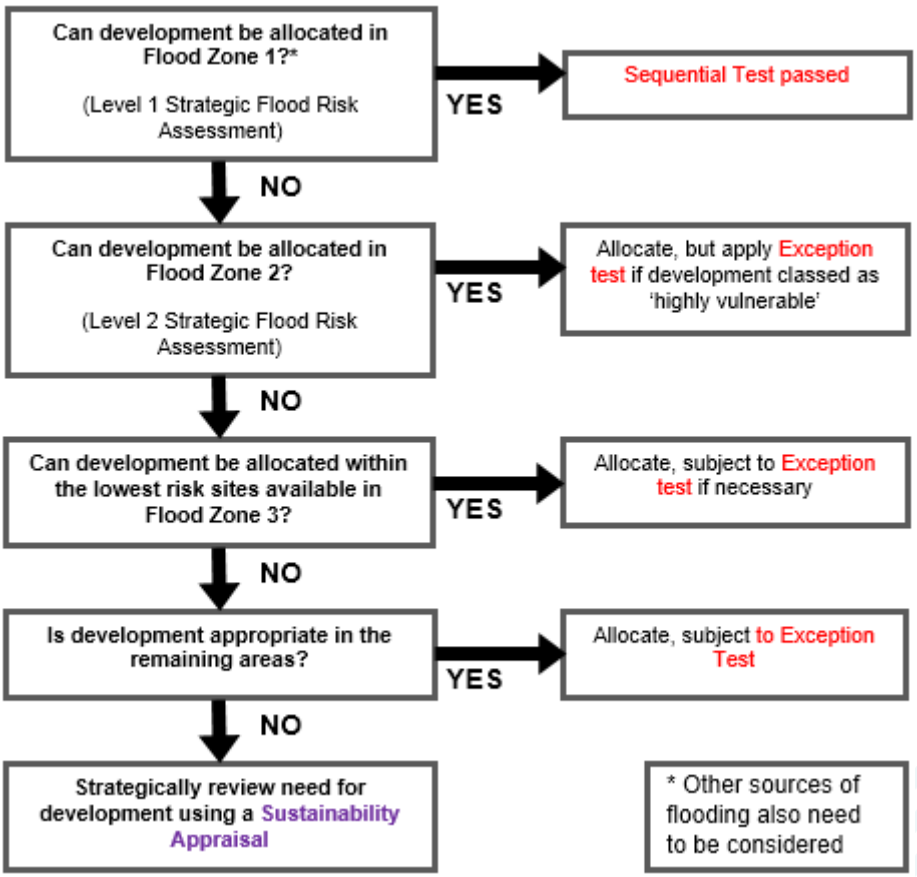
3.2 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a local plan, the local planning authority should demonstrate it has considered a range of site allocations, using SFRAs to apply the Sequential and Exception Tests where necessary using the Zone mapping in the SFRA.

The Sequential Test should be applied to the whole local planning authority area to increase the likelihood of allocating development in areas not at risk of flooding. It is recommended that the Council makes reference to the SFRA climate change maps when applying the Sequential Test for site allocations and windfall sites to understand the potential change in risk over the lifetime of proposed development. The Sequential Test can be undertaken as part of a local plan sustainability appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPG for Flood Risk and

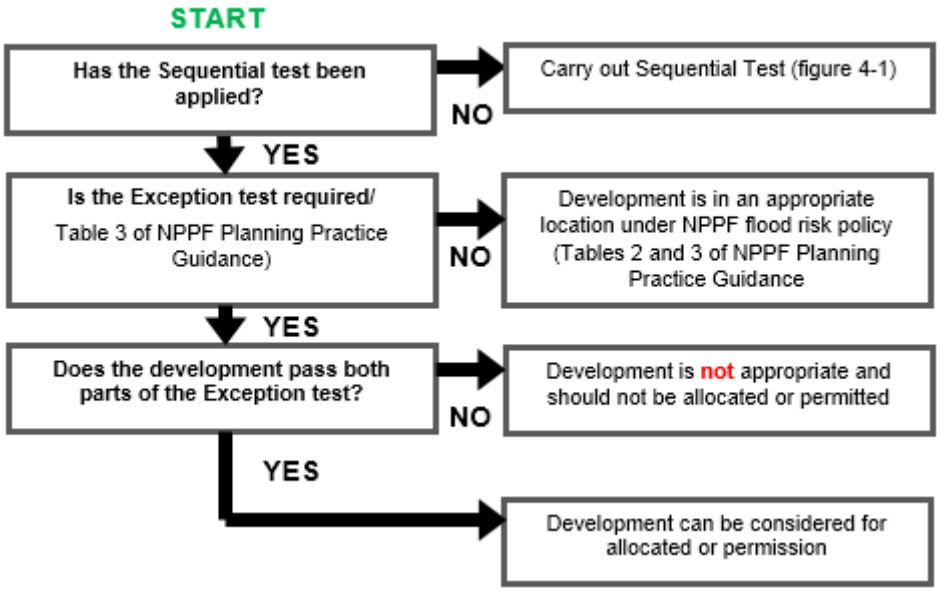
Coastal Change describes how the **Sequential Test should be applied in the preparation of a local plan** (Figure 3-1).

Figure 3-1: Applying the Sequential Test in the preparation of a local plan



The Exception Test should only be performed following the application of the Sequential Test and as set out in Table 3 of the NPPG Flood Risk and Coastal Change. The NPPG describes **how the Exception Test should be applied in the preparation of a Local Plan**

Figure 3-2: Applying the Exception Test in the preparation of a local plan



3.3 Applying the Sequential Test and Exception Test to individual planning applications

3.3.1 Sequential Test

Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other local plan policies. A pragmatic approach should be taken when applying the Sequential Test.

B&NES, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the application of the Sequential Test
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site)

It is normally reasonable to presume and state that individual sites that lie in Zone 1 satisfy the requirements of the Sequential Test. However, consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas. Also, care should be taken to provide appropriate information on Flood Zones at locations where national mapping has not been prepared or published (such as land adjacent to small watercourses and water features that potentially are associated with a flood risk, but appear to be in Zone 1 on the basis that no analysis has been performed). In these circumstances the FRA and information submitted should provide information on the Flood Zones and also evidence that the Sequential Test has been performed and is satisfied. In accordance with the 2018 update to the NPPF the sequential approach should be used when making decisions so consideration

is given to the effects of climate change and flood risk from all sources. In addition an assessment should be performed to understand the potential cumulative effects of proposed allocations so account can be taken of the potential implications.

3.3.2 Exception Test

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable uses, such as residential land can be allocated such that subsequent development can be implemented safely and is not located in areas where the hazards and consequences of flooding are inappropriate. For the test to be satisfied, the following two elements have to be addressed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.

Local Planning Authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused2.

- A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The site-specific Flood Risk Assessment should demonstrate that the site will be safe, and the people will not be exposed to hazardous flooding from any source For the lifetime of the development, the following should be considered[3] :

- The design of any flood defence infrastructure
- Access and egress
- Operation and maintenance
- Design of the development to manage and reduce flood risk wherever possible
- Resident awareness
- Flood warning and evacuation procedures
- Any funding arrangements required for implementing measures
- The potential effects of climate change and how these can be safely managed

The NPPG provides detailed information on how the Test can be applied. A level 2 SFRA provides strategic evidence on the magnitude of potential effects of flooding and if necessary the measures that should accompany proposed development to address potential adverse effects. In accordance with the NPPF the assessments should take account of the effects of climate change so that consideration is given to

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2 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014

3 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014

the impacts for the lifetime of proposed development. This assessment, as well as considering flood Zones, should also include evaluation of the actual flood risks as described in the next section.

3.4 Actual flood risk

If it has not been possible to allocate land such that all future development can be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) with appropriate climate change in any year; and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) with appropriate climate change in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed so it addresses the identified requirement
- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change may reduce the standard of protection afforded by flood risk management measures and defences, due to increased river flows and levels, and so commitment is needed to invest in the maintenance and upgrade of measures and defences if the present-day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset, rate of rise and duration of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where a) the consequences of flooding need to be mitigated or b) where it is proposed to place lower vulnerability development in areas of flood risk.

3.5 Residual flood risk

Residual risk refers to the risks that remain after measures have been taken to alleviate flooding (such as flood defences). It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be

- the effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; and/or

- failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner, or failure of pumping stations.

There are several formal flood defences located within the study area. Such flood defences primarily included flood walls, gabions, culverted channels and embankments in the surrounding areas of Bath and Midsomer Norton. However, there is still potential residual risk in the district from reservoirs.

3.6 Cumulative impact of additional development on flood risk

The 2018 NPPF states that "Strategic policies should be informed by a Strategic Flood Risk Assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards."

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting increase in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream.

Consideration must also be given to the potential cumulative impact of the loss of floodplain as a result of development. The effect of the loss of floodplain storage should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified.

Whilst the increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures.

The cumulative impact of development should also be considered at the planning application and development design stages and the appropriate mitigation measures undertaken, within an appropriate FRA, to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk.

4 Sources of information used in preparing the SFRA

4.1 Summary of SFRA mapping for all sources of flood risk

4.2 Fluvial

Flood Zones 2 and 3a are taken from the **Environment Agency's Flood Map for Planning** and where more recent updated modelling has been conducted, the undefended 100-year fluvial results have been spliced into Flood Zone 3a and the undefended 1,000-year fluvial results have been spliced into Flood Zone 2. This has been done so the SFRA Flood Zones represent the most up-to-date information. The Environment Agency's Flood Zones on their Flood Zone Map for Planning website may therefore differ to the maps in the SFRA for a short period of time, the latest modelling and mapping information used in the SFRA will be incorporated into the Environment Agency's Flood Map in due course.

Flood Zone 3b comprises land where water has to flow or be stored in times of flood (the functional floodplain). Flood Zone 3b, unlike other Zones, does show flood risk that takes account of the presence of existing flood risk management features and flood defences, as land afforded this standard of protection is not appropriately included as functional flood plain. The mapping in the SFRA identifies this Flood Zone as land which would flood with a 5% chance in each and every year (a 1 in 20-year annual exceedance probability (AEP)), where detailed modelling exists. Where the 5% AEP outputs are not available, the use of surrogate return periods (e.g. 1 in 25-year, if available), if this is not available, then the 1 in 100-year defended scenario will be used. If a proposed development is shown to be in Flood Zone 3, further investigation should be undertaken as part of a detailed site-specific FRA to define and confirm the extent of Flood Zone 3b. Mapping of these flood zones are displayed in Appendix J.

4.2.1 Climate Change

Climate change modelling with the latest specification is being used where available within the study area. However, where this modelling is not available, the approach adopted is based on the assumption that existing Flood Zone 2 provides a reasonable representation of the assumed future extent of Flood Zone 3. Where this methodology is not appropriate, instead of leaving it to the developers to address as part of the FRA process, a vertical buffering exercise has been performed beyond the extent of current Flood Zone 2 and is based on the topographical data as shown in LiDAR data. The results of this is displayed in appendix A.

Additionally, for the purpose of this SFRA, a version of the Bath to Avon Model has been prepared to account for climate change. Mapping of this scenario is displayed in Figure 7-1.

4.2.2 Potential modelling improvements

At the time of preparing the 2018 SFRA, there are several on-going flood modelling studies being conducted by or on behalf of the Environment Agency. In a number of cases, the flood modelling studies involve updating existing hydrology and hydraulic models and re-running the models for a suite of return periods. Most importantly these models are being updated with the latest climate change guidance and allowances. It is important that the Environment Agency are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

The Bath to Bristol Avon model has been reran to account for climate change for a section of the study area. However, this model was additionally not built to accommodate as high flows and therefore there are some discrepancies within the

model, this should be considered and addressed within the Level 2 SFRA for site specific sites. One factor not considered due to this issue is the future extent of Flood Zone 2 which should be considered within the level 2 SFRA.

4.3 Surface Water

Mapping of surface water flood risk in B&NES has been taken from the **Risk of Flooding from Surface Water (RoFfSW)** published online by the Environment Agency. These maps are intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk.

The RoFfSW is derived primarily from identifying topographical flow paths of existing watercourses or "dry valleys" that contain some isolated ponding locations in low-lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water (Table 4-1).

Table 4-1: RoFfSW risk categories

Category	Definition
High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year (annual probability of flooding 3.3%)
Medium	Flooding occurring as a result of rainfall of between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any given year.
Low	Flooding occurring as a result of rainfall of between 1 in 1,000 (0.1%) and 1 in 100 (1%) chance in any given year.
Very Low	Flooding occurring as a result of rainfall with less than 1 in 1,000 (0.1%) chance in any given year.

Although the RoFfSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high-level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFfSW in partnership with other sources of local flooding information, such as the modelling undertaken as part of the SWMPs which included re-running the uFMfSW modelling(which has now been replaced by the RoFfSW) for a 30% increase in rainfall to allow for climate change, to confirm the presence of surface water risk at that particular location.

4.4 Groundwater

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater (AStGWF) dataset. The AStGWF dataset is a strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any

specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

4.5 Sewers

Historical incidents of flooding are detailed by Wessex Water through their SIRF register (Table 5-). The SIRF database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding (on a 4-5 post code digit basis).

4.6 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. This information includes:

- Policy documents such as local plan policy and Green Infrastructure Strategy
- **EA NFM Mapping**

Infiltration mapping, produced as part of the Surface Water Management Plan, has been used to identify areas that may be suitable for infiltration drainage techniques. This data can be found on the B&NES **website**. The maps use British Geological Survey Infiltration SuDs Map data. It must be noted that these maps are provided as a guide only and ultimately site-specific infiltration tests and ground investigations will need to be conducted and provided to the Local Planning Authority for review.

5 Understanding flood risk in B&NES

One of the key purposes of this SFRA is to identify the influential local flood risk issues and to summarise recorded local flood incidents and predicted flood risk to the area. Flood risk can arise from a variety of different sources, as described within this section. Often however, flooding originates from a combination of courses as flood mechanisms are integrated.

5.1 How flood risk is assessed

A flood is now formally defined in the Flood and Water Management Act (2010) as "any case where land not normally covered by water becomes covered by water". The Act also states that a flood, as defined above, can be caused by:

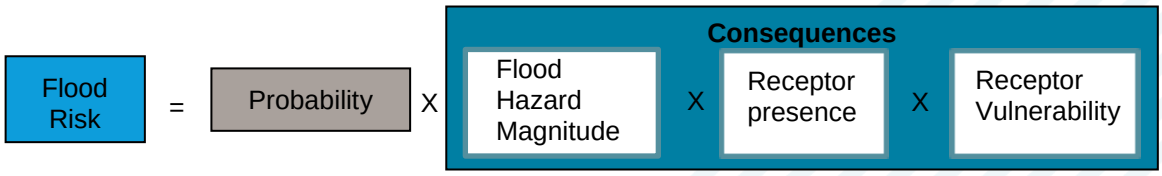
- A heavy rainfall
- A river overflowing, or its banks being breached
- A dam overflowing or being breaches
- Tidal waters
- Groundwater
- Anything else (including a combination of factors)

In the context of the FWMA (2010) a flood does not include:

- A flood from any part of a sewerage system, unless wholly or partly caused by an increase in the volume of rainwater (including snow and other precipitation) entering or otherwise affecting the system
- A flood caused by a burst water main (within the meaning given by section 219 of the Water Industry Act 1991)

The FWMA (2010) states that flood risk "means a risk in respect of flood", where risk is "assessed and expressed (as for insurance and scientific purposes) as combination of the probability of the occurrence with its potential consequences".

Thus, it is possible to define and express flood risk as:



5.2 Historical flooding

Bath and North East Somerset has a history of documented flood events with the main sources being from fluvial, surface water and sewer flooding. A number of different data sources have been used to understand the historic flood risk in Bath and North East Somerset which are outlined in this section.

5.2.1 Previously reported flood incidents in the Bath and North East Somerset SFRA (2008)

Fluvial Flooding

Historic incidents of river flooding were collected from various sources. Bath, Keynsham and Chew Magna were recorded as being affected the most referring to the 229 recorded incidents of flooding – 82% of the incidents were from fluvial flooding during the period of 1809 to 2008.

The floods of October and November 2000 closed roads and flooded homes, businesses and low-lying farmland as well as causing disruption to rail services. In 1960 Bath City centre was also severely flooded as the River Avon rose 20 feet above it's normal level.

The Chew Valley has also been impacted severely from flooding in the past. Water levels were recorded to reach 0.6m depth within the parish church at Pensford during flooding on November 12th 1894. In July 1968, the streets of Pensford and Keynsham were underwater resulting in the deaths of seven people.

Groundwater Flooding

The Environment Agency flood incident dataset (FRIS) used in the previous SFRA (2008) did not contain any incident of groundwater flooded at the time of writing and therefore no record of groundwater flooding was recorded in the previous SFRA. However, it did note that the Lam Brook is a spring fed watercourse and therefore it is probable that flood events in the north eastern area of Bath may be caused by a combination of river and groundwater flooding. More recent records, as shown in Table 5-2 do show that there have been incidences of groundwater flooding.

Surface Water Flooding

Flooding from surface water is the second largest source of flooding recorded within the B&NES 2008 SFRA. 42 (18%) of the 229 historic incidents recorded in the previous SFRA were recorded to be attributed to this source. Most of this have occurred in the impermeable upland areas of B&NES – particularly along roads. The main communities to be impacted by this sources are Chew Magna, West Harptree, Compton Martin and Priston.

Sewer Flooding

The previous SFRA (2008) states that the Environment Agency flood incident dataset (FRIS) did not contain any records of sewer flooding at the time of writing. Therefore, the primary source of data used to inform historical sewer flooding was supplied by Wessex Water. This reported 48 incidents of flooding across the study area, the largest number of incidents being in Bath (40%). The SFRA noted at the time of writing that the sewer system in Bath is aging and as such is likely to require considerable upgrade.

Reservoir Flooding

One historic event in relation to the failure of the Chew Magna Reservoir (owned by Bristol Water plc) in 1968 was reported in the previous SFRA following an internet search. The reservoir was reported to overflow into the Winsford Brook, further swelling the river. Later during the evening, one of the debris-stricken bridges succumbed to pressure and was demolished, sending a swirling torrent down to the next bridge, where the process was repeated and multiplied. Eye witnesses report a 'wall of water' that crashed down the Chew Valley, swamping buildings, destroying bridges and washing away parked vehicles as it the flood water progressed. The 3m tall wave reached Keynsham carrying a cargo of debris. Long standing road bridges at Pensford, Woollard and Keynsham were destroyed beyond repair, causing major traffic disruptions.

This incident provides an example of the potential impacts of a failing reservoir or any other asset and it's cascading effects, causing floodwater to build up at consecutive stages. It is likely that this flood even is attributed to 'river flooding' within Environment Agency FRIS dataset.

5.2.2 Bath and North East Somerset Surface Water Management Plan (SWMP) Flood Incidents dataset

Flooding incidents recorded by B&NES Council during a period of five years (2009 – 2014) are displayed as point data within an **online interactive map** (GeoPDF). The size of the point on the map represents the frequency of the flood incident. Data used

within this is local flood incidents (ordinary watercourse, surface water etc). In addition, Wessex Water surface water flooding incidents from 2013-2014 are also represented within this dataset by being categorized by postcode area and are coloured depending on frequency of flooding. The data displayed does not include foul sewer or private sewers.

5.2.3 Environment Agency Flood Reconnaissance Information System (FRIS)

The FRIS system was designed to provide links to flood related information such as historical event data, media reports and flood event questionnaires to record information relating to all sources of flooding including fluvial, groundwater, urban drainage etc. The dataset provided for the study area lists 229 events since 1925.

5.2.4 Environment Agency Recorded Flood Outline (RFO) dataset

The Environment Agency Recorded Flood Outlines dataset provides details of all recorded flood incidents by the Environment Agency from rivers, sea, groundwater and surface water. The absence of coverage by the dataset does not mean the area has never flooded, only that the Environment Agency does not currently have records in the area. This data set is provided using aerial photography, data from local authorities, surveys carried out by the Environment Agency and consultancies and visual accounts.

The dataset provides details of 162 flood incidents dating back to 1894 which are shown in Appendix D.

Table 5-1 below provides a summary of Environment Agency's FRIS and RFO datasets. Only a summary of key events has been recorded using both datasets. In addition to the summary below, an Interactive Map of Local Flood Incidents is available on BANES's website.

Table 5-1 Key flood events within the Environment Agency's Flood Reconnaissance Information System (FRIS) and the Environment Agency's Recorded Flood Outline dataset

Date	Location of reports	Source of flooding
January 31st 1925	Saltford, Bathford, Melksham and Limpley Stoke	Fluvial – Channel capacity exceeded (no raised defences)
1st May 1932	Limpley Stoke, Saltford, Keynsham, Bathford and Widdenham	Fluvial – Channel capacity exceeded (no raised defences)
26th November 1954	Norton and Radstock	Fluvial – Channel capacity exceeded (no raised defences) and an obstruction/blockage in a culvert was also reported at Coombe End Culvert.
12th May 1960	Bath, Freshford, Kaynsham, Pensford, Pristom, Saltford, Twerton	Fluvial – Channel capacity exceeded (no raised defences) and an obstruction/blockage of a culvert at Coombe End, Radstock.
18th November 1963	Radstock	Fluvial – Channel capacity exceeded (no raised defences). An obstruction/blockage of culverts at Coombe End, Radstock and Wellow, Radstock.

9th December 1965	Radstock, Newton St Loe, Freshford and Witham Friary	Fluvial - Channel capacity exceeded (no raised defences)
30th June 1968	Bathford, Dapp's Hill, Monkton Coombe. Woodborough Mill, Woollard Radstock, Pensford, Castle Combe, Colerne, Chew Magna, Keynsham, Chew Stoke and Freshford Mill	Fluvial - Channel capacity exceeded (no raised defences)
7th October 1968	Camerton, Chew Magna, Chew Stoke, Compton Dando, Freshford, Hallatrow, Keynsham, Pensford, Priston, Publow, Radford, South Widecombe, Stanton Drew, Temple Cloud, Twerton, Winford, Woollard	Fluvial
11th February 1974	Midsomer Norton, Whitchurch and Hanham	Fluvial and Surface Water - Channel capacity exceeded (no raised defences) and local drainage/surface water flooding.
30th May 1979	Chew Magna, Pensford and Midsomer Norton	Fluvial – Channel capacity exceeded (no raised defences)
28th December 1979	Freshford and Bradford on Avon	Fluvial – Channel capacity exceeded (no raised defences)
16th March 1982	Keynsham and Hanham Abbots	Fluvial – Channel capacity exceeded (no raised defences)
23rd - 26th December 1985	Hanham, Keynsham, Swineford Lock, Saltford, Hanham and Bathampton	Fluvial – Channel capacity exceeded (no raised defences)
28th January 1986	Keynsham, Swineford, Saltford, Hanham, Limpley Stoke, Warkeigh, Freshford Mill, Farleigh Hungerford and Bathampton	Fluvial – Channel capacity exceeded (no raised defences)
3rd January 1995	Paulton Hill, Ham Lane, Farringdon Road, Bath Road, General flooding of farmland	Fluvial and surface water
8th January 1995	Chew Stoke, Bathampton, Saltford, Keynsham, Wellow, Camerton, Monkton Combe, Clutton, Freshford, Compton Dando, Kingswood, Farmborough, Batheaston, West Harptree	Fluvial and surface water

19th January 1999	Chew Magna, Freshford, Windford Brook, Portbridge Mill, Hencliffe, East Twerton, Bathampton, Bath, Keynsham, Saltford, Coombe and Warleigh	Fluvial – Channel capacity exceeded (no raised defences) and overtopping of defences.
30th October 2000	Bath, Keynsham, Saltford, Swineford, Bathford Mill, Hanham Mill, Wellow and Pensford	Fluvial - Channel capacity exceeded (no raised defences)
1st January 2003	Bath, Bathampton, Keynsham, Saltford	Fluvial and surface water
15th January 2008	Portbridge, Chew Magna and Winford	Fluvial – Channel capacity exceeded (no raised defences)
21st November 2012	Bath, Bathampton, Biship Sutton, Chew Stoke, Compton Dando, Keynsham, Pensford, Stanton Drew, East Harptree, West Harptree and Radstock	Fluvial, Surface Water and Groundwater – Channel capacity exceeded (no raised defences), high water table (groundwater incident), local drainage (surface water flooding)
24th – 29th December 2013	Bathford, Keynsham, Swineford, Walcot, Bathampton, Bathwick and Freshford	Fluvial – Channel capacity exceeded (no raised defences)
Note: Based on data supplied on 04/05/2018. Further analysis and data on other flood incidents within the study area can be found within **BANES's SWMP**.		

5.2.5 Wessex Water Sewage Incident Report File (SIRF) dataset for Bath and North East Somerset

Historical incidents of flooding are detailed by Wessex Water in their Sewage Incident Report File (SIRF). This database records incidents of flooding relating to public foul, combined or surface water sewers and identifies which properties suffered flooding. The flooding incidents are coded to indicate where investigations into the flooding have been raised, are underway or where schemes have been completed. Wessex Water are represented on the B&NES Strategic Flood Board and work in partnership with other risk management authorities to investigate issues where flood risk is apparent from a number of sources.

For confidentially reasons, this data has been supplied on a postcode basis. The data from the SIRF is summarised in Table 5-2. The SIRF indicates a total of 199 recorded flood incidents in Bath and North East Somerset. The more frequently flooded postcodes are BS31 (51 incidents). BS39 (41 incidents), BA2 (35 incidents) and BA1 (31 incidents). It is important to recognise the SIRF does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages. Also, the SIRF represents a snap shot in time and will get outdated with properties being added to the register following rainfall events, whilst risk will be reduced in some locations by capital investment to increase the capacity of the network. As such the SIRF is not a comprehensive 'at risk register'.

Wessex Water also providing mapping of sewer flooding incidents (non-operational) since 2004 (Appendix C). This mapping displays sewer incidents which are associated with exceptionally high river levels. Several of these incidents are shown to be located within the centre of Bath. Additionally, the majority of incidents in Bath have had investigations completed with no action taken. Additionally, there are areas where a scheme has been completed/ problem solved or investigations are done or underway. Keynsham is another area of significant high density of flood incidents. In this location,

instigations are currently underway or have been completed. Two areas are displayed to currently have schemes raised.

Table 5-2: Wessex Water Recorded flood incidents within Bath and North East Somerset

Postcode	Recorded flood incidents
BA1	31
BA2	35
BA3	19
BS14	2
BS31	51
BS39	41
BS40	13
Total: 199	
Note: Based on data supplied on 23/03/2018	

5.2.6 Summary of historic flood incidents

Using the Wessex Water and Bath and North East Somerset datasets, a table of counts of incidents per postcodes has been produce (Table 5-1). This table also summaries the number of incidents per flood source.

Table 5-1: Summary of flood incidents per ward for each flooding source using the combined datasets of BANES Council and Wessex Water

Ward	Total	Fluvial	Groundwater	Sewer	Surface Water	No Flooding	Unknown
Bathavon North Ward	42	11	0	4	1	0	26
Mendip Ward	30	2	0	16	5	3	4
High Littleton Ward	12	2	0	5	1	0	4
Chew Valley South Ward	1	1	0	0	0	0	0
Clutton Ward	18	2	0	6	4	2	4
Chew Valley North Ward	24	14	0	1	6	1	2
Publow and Whitchurch Ward	9	5	1	1	0	0	2
Farmborough Ward	18	5	0	3	0	0	10
Bathavon West Ward	21	13	0	0	6	0	2
Bathavon South Ward	18	8	0	5	2	1	2
Midsomer Norton North Ward	4	0	0	1	0	0	3
Radstock Ward	10	0	0	6	0	0	4
Paulton Ward	11	2	0	1	3	0	5
Timsbury Ward	5	1	0	0	2	1	1
Peasedown Ward	2	0	0	0	1	0	1
Keynsham East Ward	56	4	1	22	1	0	28
Saltford Ward	17	7	0	4	0	0	6
Lyncombe Ward	2	0	0	1	0	0	1
Combe Down Ward	0	0	0	0	0	0	0
Weston Ward	3	1	0	2	0	0	0
Lansdown Ward	4	0	0	0	0	1	3
Bathwick Ward	3	2	0	0	0	0	1
Lambridge Ward	14	10	0	0	0	0	4
Keynsham North Ward	12	7	0	1	0	0	4
Midsomer Norton Redfield Ward	6	0	0	5	0	0	1
Westfield Ward	1	0	0	0	0	0	1
Southdown Ward	0	0	0	0	0	0	0
Twerton Ward	1	0	0	0	0	0	1
Newbridge Ward	7	1	0	0	1	0	5
Odd Down Ward	2	0	0	2	0	0	0
Oldfield Ward	4	0	0	1	0	1	2
Westmoreland Ward	1	0	0	1	0	0	0
Widcombe Ward	4	1	0	1	0	1	1
Kingsmead Ward	8	1	0	2	1	1	3
Abbey Ward	11	4	0	3	1	0	3
Walcot Ward	9	0	0	6	0	0	3
Keynsham South Ward	19	2	1	9	0	2	5
Total	**325**	**91**	**3**	**84**	**28**	**11**	**108**

5.2.7 Previous documents and reports describing flood incidents

The B&NES SWMP (2015) provides a summary of previous investigations reports up until the time of writing in section 4.1.9. These include:

- Chew Stoke, Chew Magna and Broadmead Lane Industrial Estate
- Chew Magna Flood Investigation Report 2013
- Chew Stoke Flood Investigation Report 2013
- Broadmead Lane Industrial Estate, Keynsham Flood Investigation Report 2014

Since the publication of the SWMP, the Farrington Gurney, Rush Hill and Pitway Lane (June 2016) and Timsbury and Farmborough (May 2016) have since been published. These are available on BANES's website.

5.3 Topography, geology and soils

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

5.3.1 Topography

The topography of B&NES is shown in Appendix E. The Lower Avon valley in the north east corner of B&NES is the lowest lying area of land and slopes gently in a westward direction towards the Severn Estuary. The remaining area is fairly steep and generally slopes in a north easterly direction to meet the Lower Avon. Topography data used for analysis was LiDAR (Light Detecting and Ranging) data.

5.3.2 Geology and soils

Appendix G and Appendix F show the soils and geology within B&NES. The area surrounding Bath is underlain by limestone and clays, mostly consisting of Great OOLITE, Inferior Oolite, Upper Lias and Lower Lias characteristics of the Cotswolds to the east. This area is dominated by a lime rich loamy over clayey soils with a slight impeded drainage and in the high regions as layer of freely draining, shallow lime rich soils. The semi-permeable geology and steep gradients allow for the emergence of springs, including the famous hot springs, which may cause flooding within the study area. The river valley and floodplains are underlain with Lower Lias Clays and Alluvium. The combination of low lying ground, soils with slightly impeded drainage and a semi-permeable underlying geology can lead to surface water flooding.

The lower lying areas located in the north of B&NES where the River Avon and River Chew flow into Keynsham are underlain by Triassic mudstones and Upper Westphalian Limestone (and coal beds). In a low-lying area with a mixture of both impermeable and semi-permeable geology, only a reduced amount of water can penetrate into the underlying geology and therefore, there is a higher risk of surface water flooding. Along the Chew Valley, before the confluence with the River Avon, the river is underlain by acid loamy and clayey soils which are either naturally or seasonally wet with high groundwater levels. This puts the town and its surrounding area at risk of both groundwater and surface water flooding.

The Cam and Wellow Brook catchments are areas of high ground, underlain by Triassic Mudstones with a band of Inferior Oolite separating the two streams. The town of Midsomer Norton is situated near the source of the Wellow Brook at the top of the Cam Valley. The soils consist of acid loamy and clayey soils which are slowly permeable with impeded drainage in the higher to middle reaches of the two streams, changing to

seasonally wet acid loamy and clayey soils which are slowly permeable and freely draining in the lower reaches. In the higher reaches of the two streams, the emergence of springs indicates a possible risk of groundwater flooding within this area. The mid reaches of the two streams are at risk from surface water flooding due to the underlying impermeable geology and soils with impeded drainage.

The Chew Valley Lake, a low-lying lake that is situated at the northern edge of the Mendips, is underlain by Triassic mudstone but is surrounded by the limestone hills of the Mendips to the south and ridge of Inferior Oolite to the West and North. The soils of the low-lying land around the lake are slightly acid loamy and clayey soils with slightly impeded drainage. Due to the mixed geology and topography, the area is particularly at risk from surface water flooding as the water is unable to freely drain into the soil and underlying geology.

The soils covering the limestone ridge of the Mendips in the south consist of slightly acid but base rich soils which are freely draining. In the north and west, the limestone ridges are covered with freely draining shallow lime rich soils. This area has a low risk of flooding due to the topography of the land and freely draining soils.

5.4 Hydrology

There are a number of watercourses that flow through the study area. These include main rivers and ordinary watercourses. Appendix H shows the location of Main Rivers and Ordinary Watercourses in B&NES. An outline summary of the principal watercourses in the SFRA study area is provided in Table 5-2.

Table 5-2: Watercourses in the study area

Watercourse	Classification	Description
River Avon	Main River	Major river in South West England and is the largest river located within B&NES. It rises in Wiltshire and flows through Bath and Bristol before joining the River Severn at Avonmouth. Where it flows through the centre of Bath, it is known as Lower Avon. Downstream of Bath, it forms the northern boundary of B&NES. Flow on the Lower Avon through Bath are controlled by a series of weirs. Flooding is controlled by a series of embankments and walls in Bath
River Chew	Main River	The River Chew rises from the limestone hills of the Mendips in the western side of B&NES. It flows north west through Chew Valley Reservoir, a large artificial reservoir owned by Bristol Water plc that attenuates flow, before flowing through the Chew Valley towards its confluence with the River Avon at Keynsham.
Cam Book	Main River	The Cam Brook is a tributary of the River Avon and joins with the Wellow Brook to form the Midford Brook at Midford. Both the brooks rise from springs in the south of B&NES bear Midsomer Norton. The valleys are well defined with the brooks free to meander across their floodplain.
Wellow Brook	Main River	The Wellow Brook was a tributary of the River Avon and joins with the Cam Brook to form the Midford Brook at Midford. Both the brooks rise from springs in the south of B&NES bear Midsomer Norton. The valleys are well defined with the brooks free to meander across their floodplain. Flooding on the River Somer, a tributary of the Wellow Brook, is controlled in Midsomer Norton by a bypass tunnel.

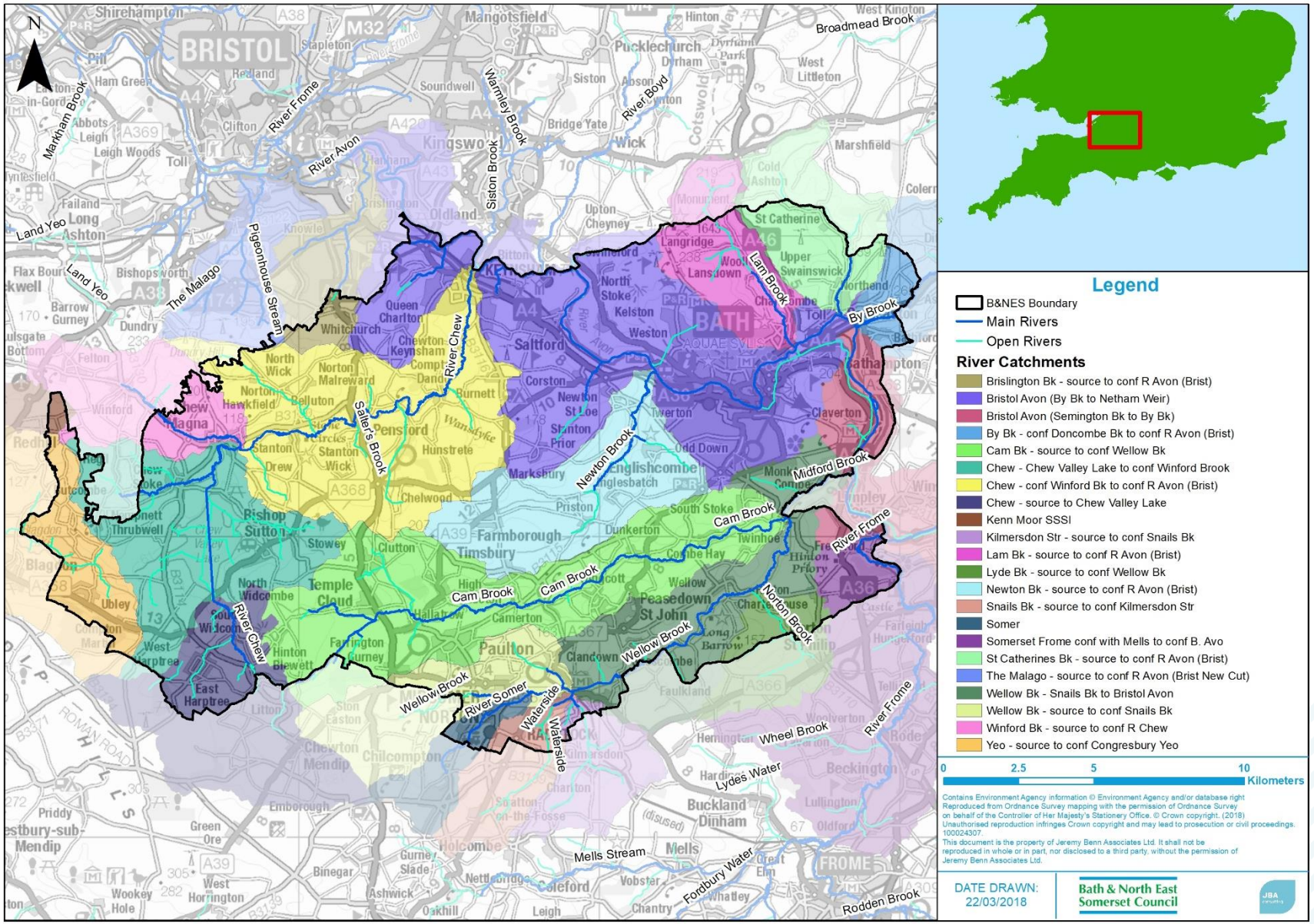
5.4.1 Main Rivers

There tend to be larger streams and rivers, though some of them are smaller watercourses of local significance. These are displayed in the **Main River Map**. The Environment Agency has permissive powers to carry out maintenance, improvement or construction work on Main Rivers to manage flood risk. Consultation with the Environment Agency will be required for any development projects within 20m of a Main River or flood defence.

5.4.2 Ordinary Watercourses

These are all watercourses not designated as Main Rivers or IDB watercourses. The local authority or IDB has permissive powers to maintain them, but the responsibility lies with the riparian owner.

Figure 5-1: Watercourses and river catchments within Bath and North East Somerset



5.5 Fluvial flood risk

Fluvial flood risk occurs when water levels rise higher than the bank levels within a river channel, causing floodwater to spill onto adjacent land (floodplain). The main reasons for this to occur are:

- Intense and long duration rainfall causing runoff and flow to increase in rivers resulting in flows exceeding the capacity of the river channel. This can be further exacerbated by wet antecedent conditions or where there are significant contributions of groundwater
- Constrictions within the river channel resulting in flood water backing upstream.
- Blockage of structures or within the river channel itself causing flood water to back up upstream.
- High water levels and/or flood gates prevention discharge out the outlet of the watercourse.

Flooding in Bath and North East Somerset is predominately fluvial flooding, Significant rivers and their tributaries within the district that contribute towards flood risk include:

- River Avon
- River Chew
- The Cam and Wellow Brooks

Mapping of fluvial flood risk can be found on the EA's **Flood Map for Planning website.** Additional, fluvial flood within the study area has been mapped in Appendix I.

It should be noted that the flood Map for Planning shows the flood risk assuming that there are no flood risk management features in place (such as flood defences).

5.6 Surface water flood risk

Surface water runoff occurs when rainfall fails to infiltrate to the ground or enter the drainage system, causing water to pond or flow over the ground surface. The likelihood of flooding is dependent on the rate of runoff and the condition of the surface water drainage system.

The Risk of Flooding from Surface Water (RoFSW) dataset shows that surface water predominately follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding in low lying areas. Areas at risk from surface water flooding within B&NES is shown in Appendix J.

5.7 Groundwater flood risk

Groundwater flooding is the term used to describe flooding caused by unusually high groundwater levels. It occurs as excess water emerging at the ground surface or within manmade underground structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and it can result in significant damage to property.

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Under the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on Major Aquifers. However, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high groundwater levels in mudstones, clays and superficial alluvial deposits, very few records are available. Additionally, there is increased risk of groundwater flooding where long reaches of watercourse are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

As part of the SFRA deliverables, mapping of B&NES has been provided and shows the Areas Susceptible to Groundwater Flooding (AStGWf). This information is provided in Appendix K. The AStGWf is a strategic-scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for Preliminary Flood Risk Assessment (PFRA) studies and allow the LLFAs to determine whether they may be at risk of flooding from groundwater. This data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. Absence of values for any grid square means that no part of that square is identified as being susceptible to groundwater emergence.

It does not show the likelihood of groundwater flooding occurring, nor does it take account of the chance of flooding from groundwater rebound (rising groundwater levels resulting from a reduction in abstraction rates from groundwater). This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWf data should be used only in combination with other information, for example local or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. It should be noted that although an area may be designated as susceptible to groundwater flooding, this does not mean that groundwater flooding will definitely be a problem within these areas, rather it provides an indication of potential risk.

The AStGWf dataset shows that most of the study area has less than 25% of the area susceptible to groundwater flood emergence. The areas more susceptible to groundwater flooding are generally associated with the valleys of watercourses – for example the River Avon in the north of BANES, and the River Chew and Chew Valley Lake.

Following analysis of the study area, along with using the known locations of springs within B&NES, western areas by Chew Valley are indicated to be at high risk of groundwater flooding due to the more permeable geology and lower topography in this location (Appendix E, Appendix F and Appendix G). The rest of the study area remains to be medium to low risk. Overall, the geology of the rest of B&NES is relatively impermeable therefore it is reasonable to expect a low to medium risk of groundwater flooding within the study area. Only three incidents historic incidents of flooding from groundwater also contributes to the verification of this finding.

5.8 Tidal flood risk

Flooding from the sea occurs when water levels in the sea rise above ground levels of the coast. This can occur during normal tides, extreme atmospheric events and wind driven action causes water levels of the sea to rise. Despite B&NES being land locked, the tidal limit of the River Avon extends as far as Keynsham Weir, which is within B&NES, during high spring tides. Due to this, tidal flooding needs to be considered for present and the future due to the predicted increase in sea level. The greatest concern rises from the potential threat of a combined tidal and extreme fluvial event. Tide locking would reduce the ability of the Avon to discharge water and as such, increase flood levels. The probability of this occurring is significantly less than both events occurring independently. Developers should therefore consider tidal flood risk when making land use planning decisions in respect to the design life of developments.

The assessment performed for the previous Level 1 SFRA for B&NES (2008) found tidal flood risk had negligible impact on modelled water levels within B&NES. When tide levels were increased, the influence on modelled water levels increased, but the effects were reduced significantly upstream of Keynsham weir. Baseline 0.5 and 0.1% AEP extreme tide events increased peak levels by approximately 0.3m and 0.45m during a 20% AEP river flood event downstream of Keynsham weir. Water levels are only increased by 0.1m upstream of Keynsham weir. The conclusion of flooding from the sea not being expected to present a risk to Keynsham now or in the near future was made with flooding from rivers being the dominant source of flooding within the Lower Avon.

5.9 Artificial sources

Artificial sources of flooding within B&NES includes the Kennet and Avon Canal owned by the Canal and Rivers Trust, Chew Valley Lake and Chew Magna Reservoir owned by Bristol water plc. Flooding may occur is there were to overtop, leak or beach. Whilst a breach of reservoir embankments has a very low probability, the consequences could be catastrophic.

5.9.1 Flooding from canals

Canals may pose a flood risk if they overtop or breach, but impacts will depend on the topography. The Kennet Avon and Canal is situated within B&NES and follows the Bristol to Avon natural course of the River Avon before it links it to the River Kennet at Newbury.

5.9.2 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low. Recent changes to legislation under the Flood and Water Management Act require the Environment agency to designate the risk of flooding from these reservoirs. The Environment agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate, but it is less likely than flooding from rivers or surface water. It may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

The Environment Agency maps represent a credible worst-case scenario. In these circumstances, it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include
  - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
  - operation: discharge rates / maximum discharge;
  - discharge during emergency drawdown; and
  - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site. The following questions should be considered
  - can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?
  - can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
  - can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?
- Consult with relevant authorities regarding emergency plans in case of reservoir breach
- In addition to the risk of inundation those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

The Chew Valley Lake and Chew Magna Reservoir owned by Bristol water plc are two reservoirs located within B&NES and are potential sources of artificial reservoir flooding. The spillway at Chew Magna Reservoir in the study area was damaged in July 1968.

5.9.3 Flooding from sewers

Sewers are the underground network of pipes which remove waste water from properties. They are categorised by the type of waste water they remove. The categories include:

- Foul sewer
- Surface Water sewer
- Combined sewer
- Treated effluent

Foul sewers and treated effluent both convey waste water. Surface water sewers convey collected surface runoff and combined sewers convey a mixture of both foul water and surface water.

Rainwater frequently drains into surface water sewers or sewers both containing surface and waste water – these are known as combined sewers. These sewers can become overwhelmed during storm events and become blocked or are not designed to have adequate capacity, resulting in flooding of the surrounding area until the water

can be drained away. This is a particular issue for combined sewers because it runs the high risk of contaminated water flooding a property internally.

Wessex Water is responsible for the Public sewer networks in this area. Wessex Water are represented on B&NES Strategic Flood Board and work in partnership with other risk management authorities to investigate issues where flood risk is apparent from a number of sources.

The performance of the sewer network serving communities in the Chew Valley is currently under investigation by Wessex Water as part of their Drainage Area Plan (DAP) programme. This is due to be completed in 2019 and will be shared with partners to consider issues and opportunities to reduce flood risk. DAPs in the B&NES area will help form a new industry wide initiative to produce Drainage and Wastewater Management Plans (DWMPs) providing a consistent and integrated long-term approach to drainage and waste water planning to reduce flood risk within B&NES. Details of this will be available on Wessex Water's website upon completion. DWMPs will enable effective planning for drainage and wastewater requirements generated by climate change, development, resilience, and the protection and enhancement of the environment.

Any allocated or new development will need to address the impact on the existing capacity of the sewer system, any associated sewage treatment works and ensure close liaison with Wessex Water to agree the phasing of improvement works. Surface water strategy must follow the SuDS hierarchy. Wessex Water pursue a policy of reducing surface water flows to combined sewers and preventing surface water connections to sewers designed for foul flows only.

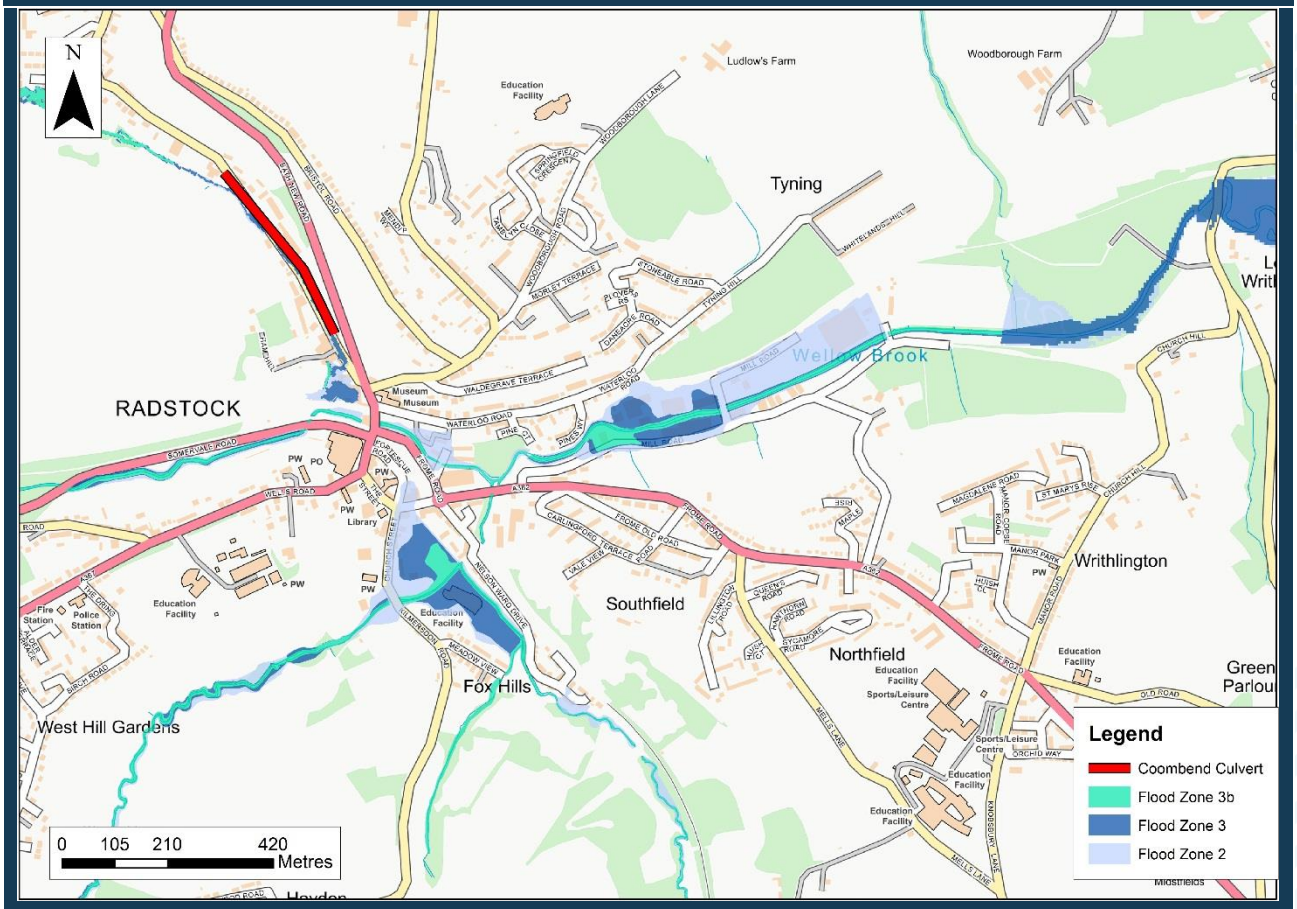
Wessex Water has provided a list of sewer flooding incidents for the B&NES area for the last 12 years. These records include sewer flooding attributable to surface water. Wessex Water provided the postcode locations for 199 occurrences of sewer flooding (Table 5-).

5.10 Summary of flood risk by location

A high-level review of the flood risk to 12 different settlements has been undertaken. Table 5-3 summaries the flood risk to the 12 settlements. The summary review draws on mapping and risk information in the SFRA and reference should be made to the previous sections in this chapter for interpretation of the comments with respect to the uncertainty and assumptions associated with the mapping.

Table 5-3: Summary of flood risk to 12 settlements located with Bath and North East Somerset

1 - Radstock

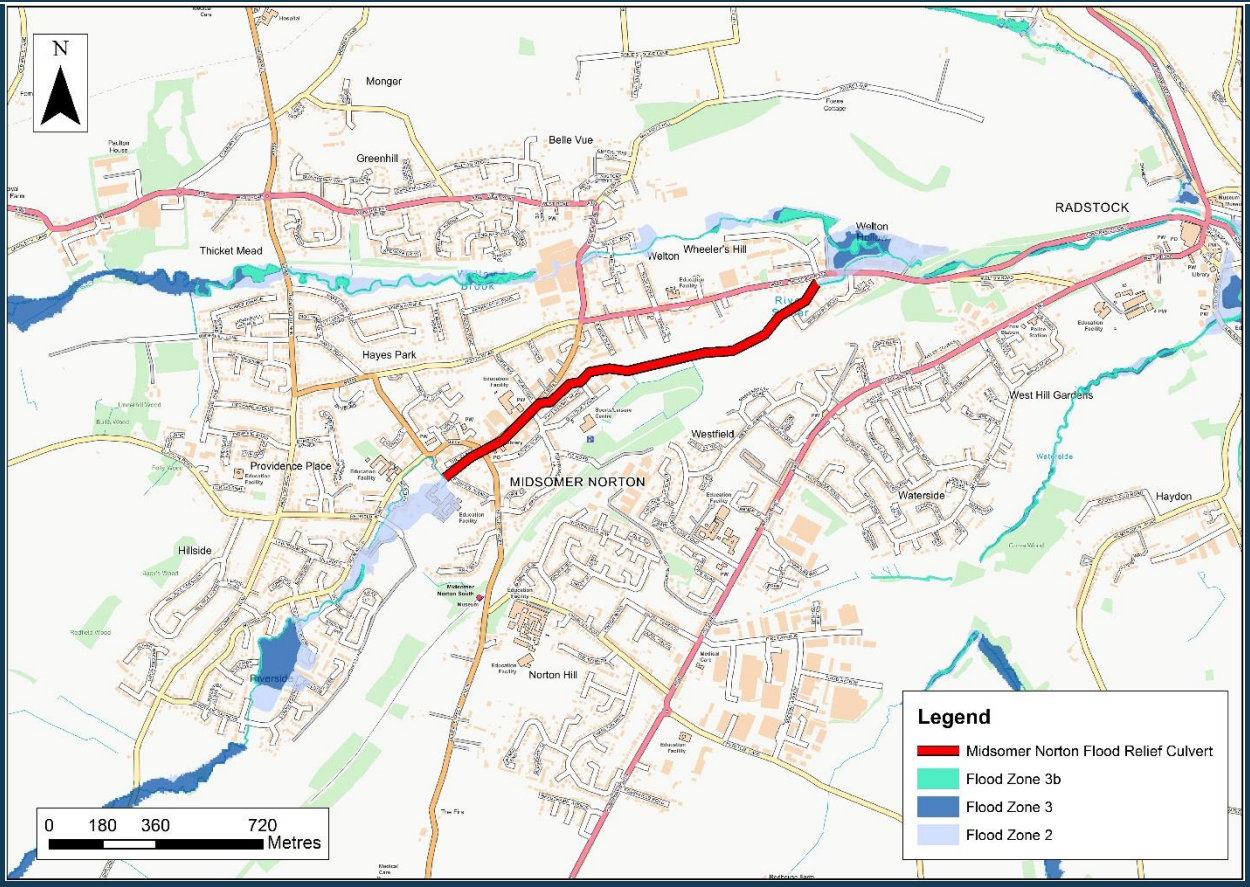


Flood risk summary

Flood history	Flooding has been recorded in Radstock from the Wellow Brook and Waterside. 26/11/1954 – Fluvial flooding of Wellow Brook caused by overtopping and a culvert obstruction/blockage. 27/10/1960 – Fluvial flooding caused by a culvert obstruction/blockage. 5/12/1960 – Fluvial flooding of Wellow Brook and Waterside caused by overtopping in a period of heavy rainfall. 18/11/1963 – Fluvial flooding caused by culvert obstruction/blockage. 09/12/1965 – Fluvial flooding of Wellow Brook caused by overtopping in a period of heavy rainfall. 10/07/1968 – Fluvial flooding of Wellow Brook caused by overtopping in a period of heavy rainfall. 02/12/1972 – Fluvial flooding of Wellow Brook caused by overtopping in a period of heavy rainfall.

1 - Radstock	
	21/11/2012 – Fluvial flooding of Wellow Brook caused by overtopping in a period of heavy rainfall. Data from Environment Agency Recorded Flood Outlines.
Fluvial flood risk	Radstock is at risk of flooding from the Wellow Brook and other unnamed streams. A road in the north as well as areas in the south and east are located in Flood Zone 3, including multiple properties. Flood zone 2 reaches further in these areas, affecting roads in the south and east as well as areas near the town centre. Most of Radstock is located in Flood Zone 1 and is at low risk of fluvial flooding.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Radstock is at risk of surface water flooding. The extents of 3.3% and 1% AEP events are notable along the west side of the town, affecting roads and multiple properties. A 0.1% AEP event would affect additional properties and roads, particularly reaching east. Isolated ponding occurs in open spaces and gardens.
Groundwater flood risk	The AStGWF indicates that less than 25% of the area is susceptible to groundwater flood emergence.
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there have been multiple incidents of sewer flooding on Fortescue Road and singular incidents on Duchy Close, Mill Road and Old Bath Road.
Flood Defence Structures	There are two Environment Agency masonry wall structures which provide a 100-year standard of protection for Radstock. In addition, there is also the Coombend Flood Relief Culvert which provides protection for the settlement. The standard of protection of this structure was unavailable at the time of writing.
Strategic flood risk considerations	
Development should preferably be located outside of areas shown to be at current or future risk of flooding where possible. If there is a need to locate development in areas at risk it is likely that a Level 2 SFRA study will be required to provide evidence that demonstrates the principle of development can be supported in the Exception Test for land that could be affected by flood risk.	

2 - Midsomer Norton

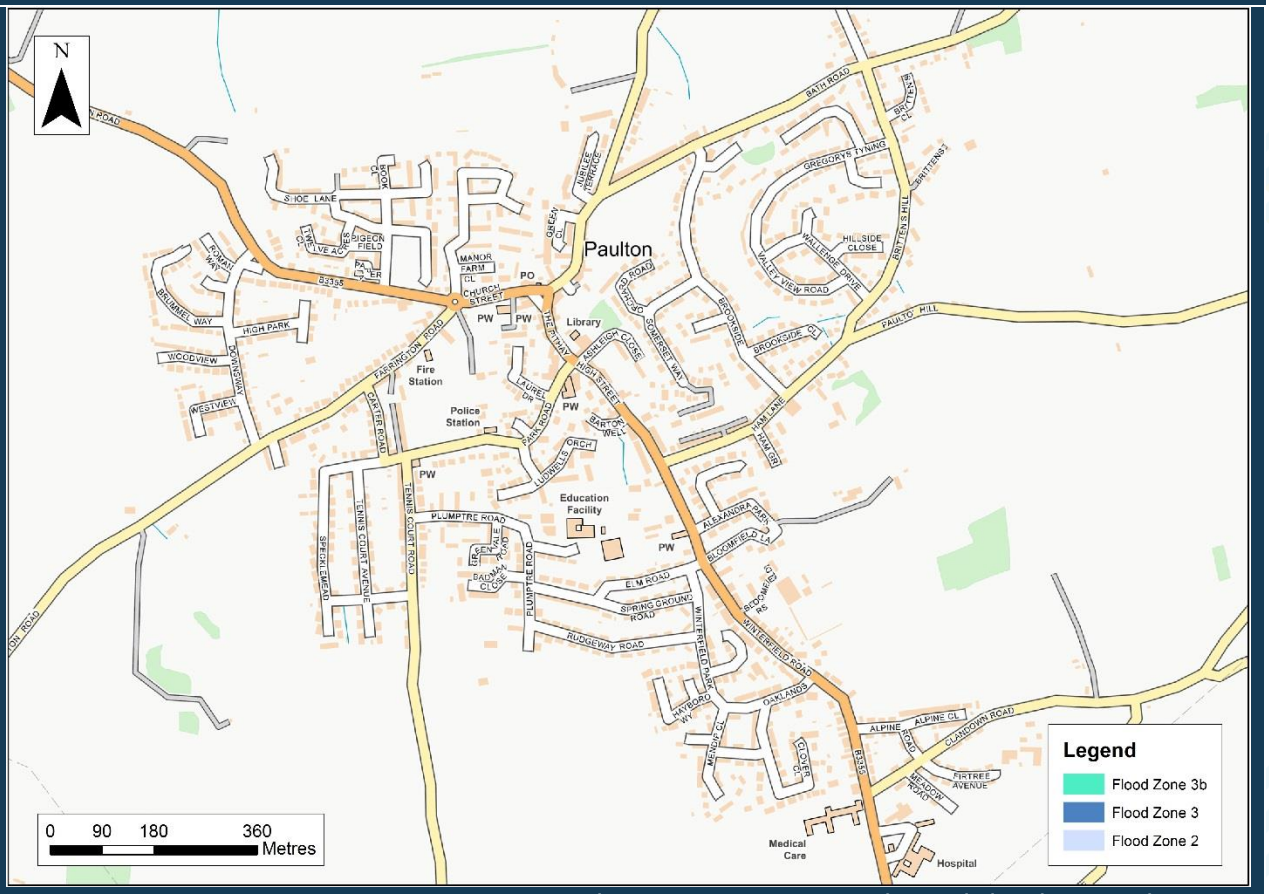


Flood risk summary

Flood history	Flooding has been recorded in Midsomer Norton from the River Somer. 26/11/1954 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 04/12/1960 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 18/11/1963 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 09/12/1965 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall.. 10/07/1968 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 02/12/1972 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 11/02/1974 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 28/01/2975 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall. 30/05/1979 – Fluvial flooding of River Somer caused by overtopping in a period of heavy rainfall.

2 - Midsomer Norton	
	Data from Environment Agency Recorded Flood Outlines. 27/09/1974 – Incidents along the River Somer. Source and cause unknown, but likely fluvial. 28/01/1975 – Incident along the River Somer. Source and cause unknown, but likely fluvial. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Fluvial flood risk in Midsomer Norton is from the River Somer and Wellow Brook. Flood Zone 3 is primarily confined to rural areas except in Welton Hollow where it affects a few properties. Flood Zone 2 affects more properties and roads in the area and a number of properties and roads in Riverside and towards the town centre. Most of Midsomer Norton is located in Flood Zone 1 and is at low risk of fluvial flooding. The Flood Relief Culvert at Midsomer Norton provides a protection against fluvial flooding.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Midsomer Norton, areas at risk of surface water flooding are largely located along the road network, extending to open spaces and properties with incidents of isolated ponding occurs in open spaces and gardens. There are properties at risk of flooding in the 3.3% AEP event.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence. Some areas to the north and south are not identified as being susceptible to groundwater flood emergence.
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there have been incidents of sewer flooding recorded on Chilcompton Road, Riverside Walk, Phillis Hill, Westhill Road and Somer Avenue.
Flood Defence Structures	As noted within Chapter 8, flood defence structures are present within Midsomer Norton. These vary in standard of protection, condition and type. At the time of writing, further data and clarity is required for this. However, the soon to be completed Midford catchment modelling should be used to inform the standard of protection of Midsomer Norton. The main structure of protection at this location is the Midsomer Norton Flood Alleviation Tunnel which at the time of it's construction in 1978, was designed to provide a 50-year standard of protection. However since it's construction, advances in modelling techniques as well as climate change may have changed this.
Strategic flood risk considerations	
Development should preferably be located outside of areas shown to be at current or future risk of flooding where possible. If there is a need to locate development in areas at risk it is likely that a Level 2 SFRA study will be required to provide evidence that demonstrates the principle of development can be supported in the Exception Test for land that could be affected by flood risk.	

3 - Paulton



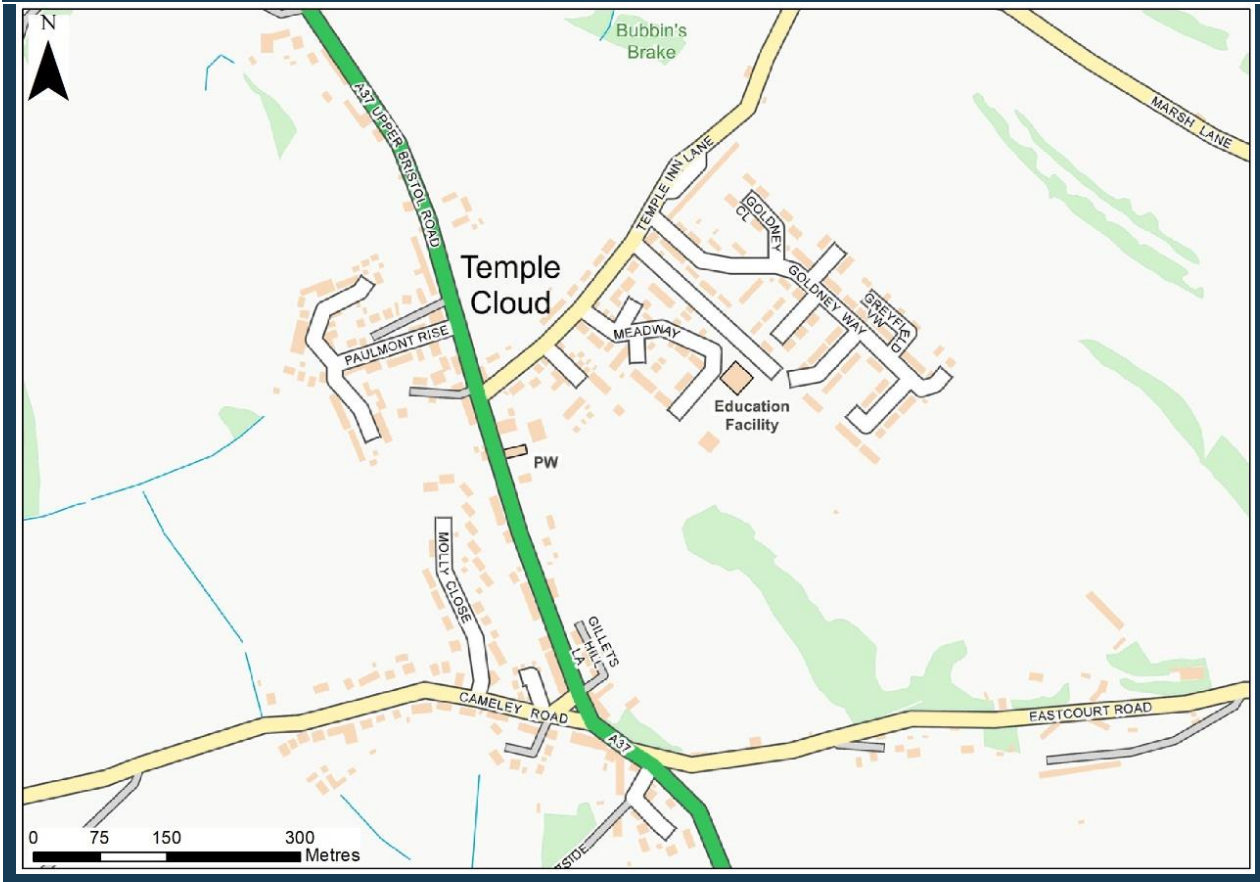
Flood risk summary	
Flood history	Flooding has been recorded in Paulton. 03/01/1995 – Fluvial and surface water flooding in three locations caused by a period of heavy rainfall. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Paulton is entirely located within Flood Zone 1 and is at low risk from fluvial flood risk.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Paulton, areas at surface water flood risk largely follow topography towards watercourses, although isolated ponding occurs in open spaces and gardens. There is a high risk of surface water flooding on the east side of the town. There are properties at risk of flooding in the 3.3% AEP event.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence. Some areas are not identified as being susceptible to groundwater flood emergence.

3 - Paulton	
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there have been multiple incidents of sewer flooding recorded on South View and a single sewer flooding incident on Bristol Road.

Strategic flood risk considerations

Whilst Paulton is located in Flood Zone 1, developments greater than 1 hectare located in Flood Zone 1 will still require a site-specific Flood Risk Assessment as will smaller sites at risk of other sources of flooding. The current and future flood risk from all sources should also be assessed and mitigated. Development should also be located outside of any areas shown to be at current or future risk of flooding where possible.

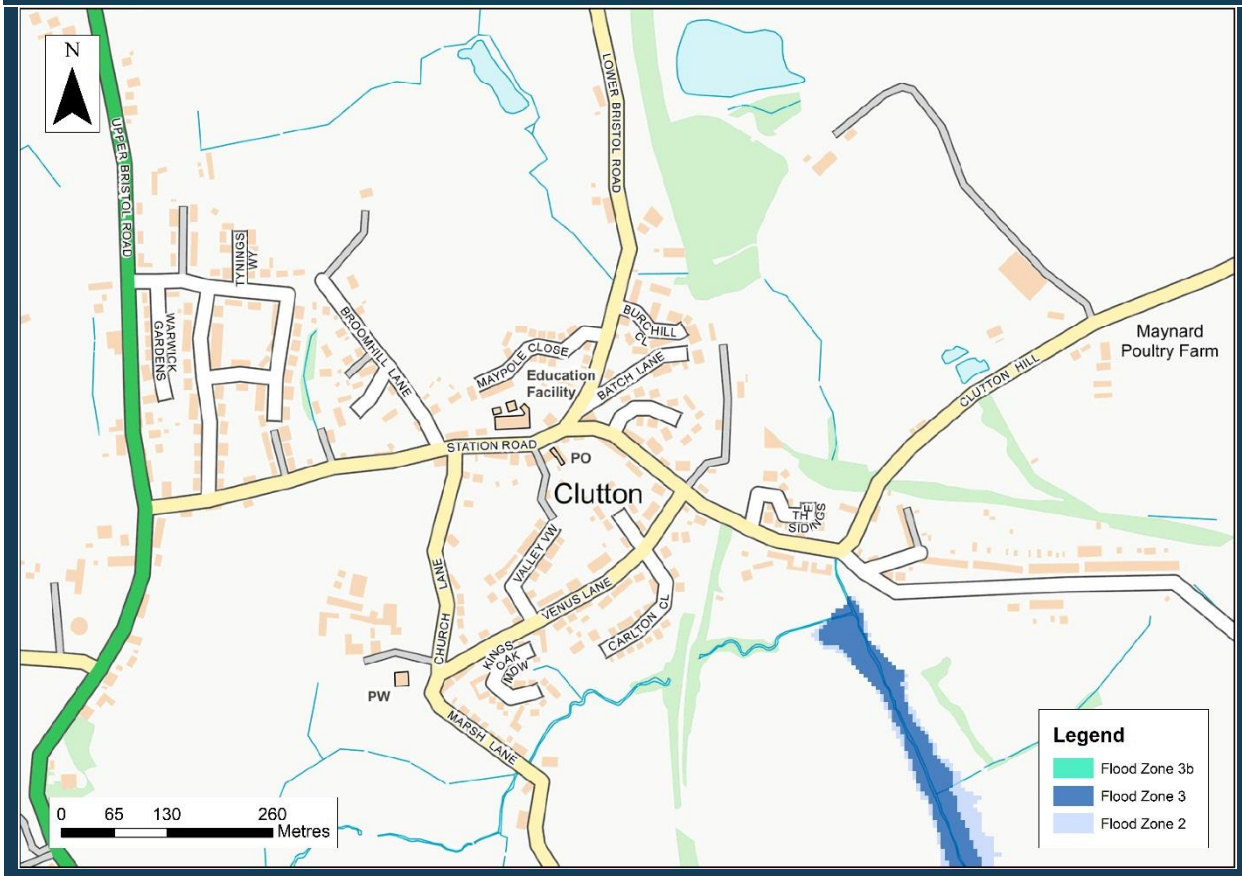
4 - Temple Cloud



Flood risk summary	
Flood history	Flooding has been recorded near Temple Cloud. 08/01/1995 – Source and cause of flooding unknown. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Temple Cloud is located entirely within Flood Zone 1 and is at low risk from fluvial flood risk.

4 - Temple Cloud	
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	The majority of Temple Cloud is at low risk of surface water flooding. The areas at risk are partially located along the road network and largely follow topography towards watercourses, although isolated ponding occurs in open spaces, gardens and roads. There are properties at risk of flooding in the 3.33% AEP event.
Groundwater flood risk	The AStGWF indicates that less than 25% of the area is susceptible to groundwater flood emergence.
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there have been multiple incidents of sewer flooding recorded on Cameley Road.
Strategic flood risk considerations	
Whilst Temple Cloud is located in Flood Zone 1, developments greater than 1 hectare located in Flood Zone 1 will still require a site-specific Flood Risk Assessment as will smaller sites at risk of other sources of flooding. The current and future flood risk from all sources should also be assessed and mitigated. Development should also be located outside of any areas shown to be at current or future risk of flooding where possible.	

5 - Clutton



Flood risk summary

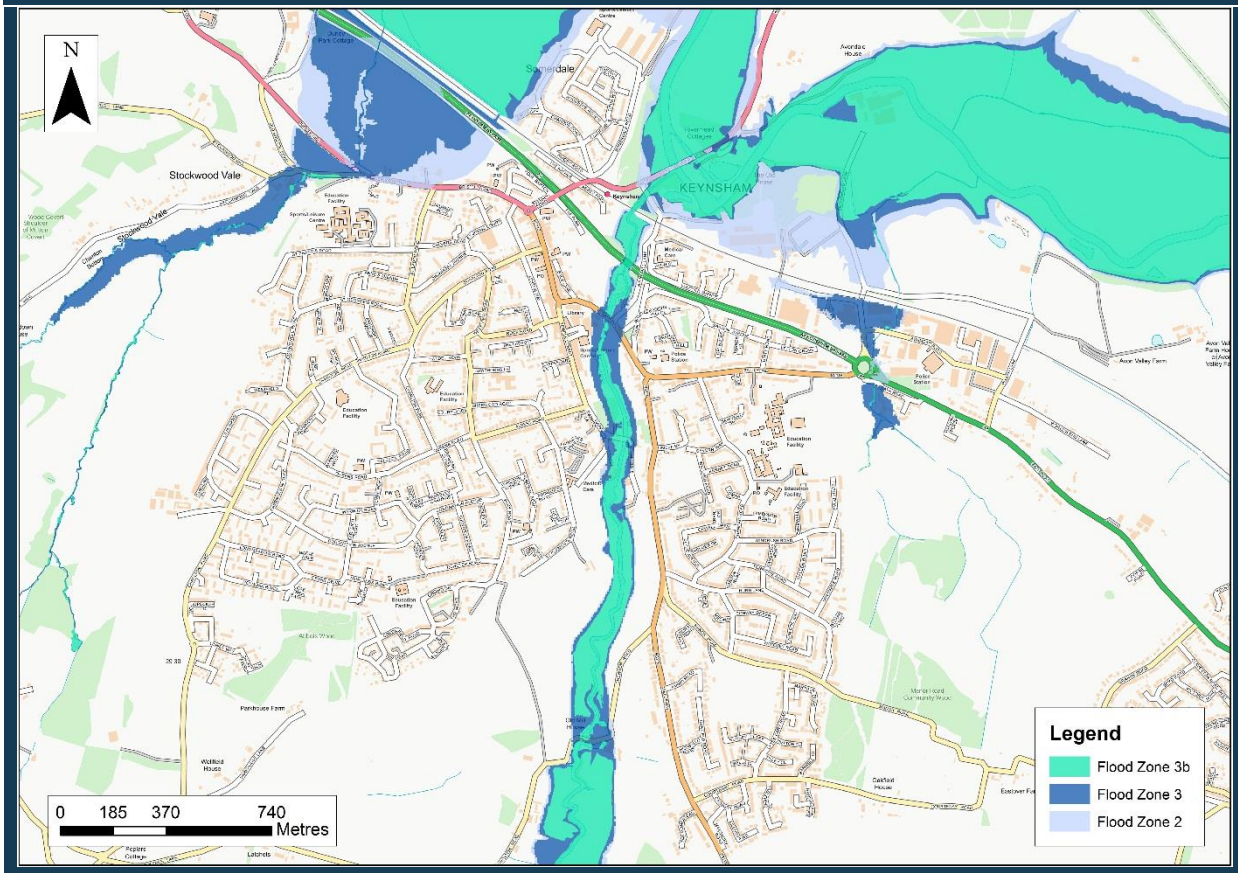
Flood history	There are no records of flooding in Clutton.
Fluvial flood risk	Clutton is located entirely within Flood Zone 1 and is at low risk from fluvial flood risk.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Clutton, areas at surface water flood risk are largely located on the east side of the town, along the road network and following topography towards watercourses, although isolated ponding occurs in open spaces and gardens. The majority of the town is at low risk, but there are properties at risk of flooding in the 3.33% AEP event around the eastern edge of the town.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence.
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there have been multiple incidents of sewer flooding recorded on Greensbrook and Venus Lane.

5 - Clutton

Strategic flood risk considerations

Whilst Clutton is located in Flood Zone 1, developments greater than 1 hectare located in Flood Zone 1 will still require a site-specific Flood Risk Assessment as will smaller sites at risk of other sources of flooding. The current and future flood risk from all sources should also be assessed and mitigated. Development should also be located outside of any areas shown to be at current or future risk of flooding where possible.

6 - Keynsham



Flood risk summary

Flood history	There are an extensive number of recorded flood events in Keynsham, the majority of which are from the River Chew, though some are from the River Avon and smaller streams. 04/12/1960 – Fluvial flooding of the River Chew and River Avon due to overtopping in a period of heavy rainfall. 16/03/1982 – Fluvial flooding of the River Avon due to overtopping in a period of heavy rainfall. 23/12/1985 – Fluvial flooding of the River Avon due to overtopping in a period of heavy rainfall. 28/01/1986 – Fluvial flooding of the River Chew and River Avon due to overtopping in a period of heavy rainfall.

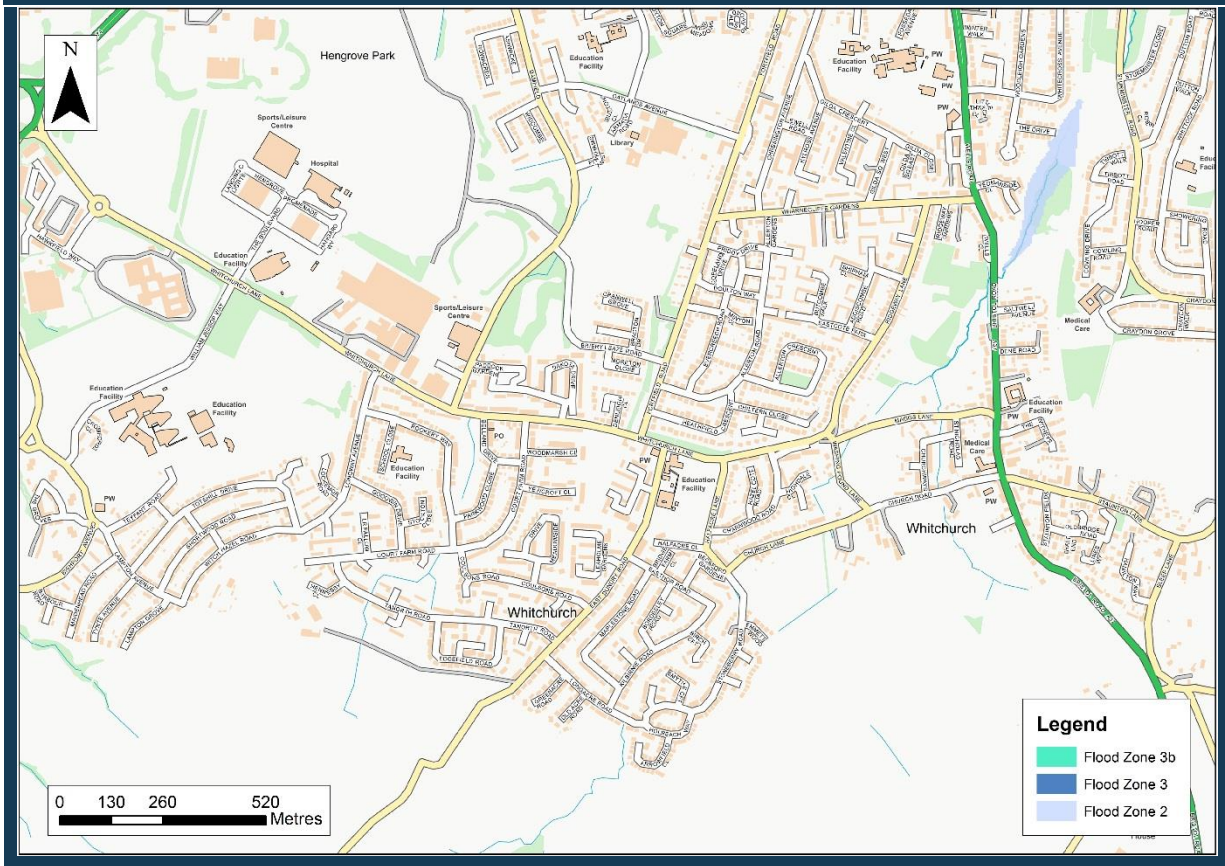
6 - Keynsham	
	19/01/1999 – Fluvial flooding of the River Avon due to overtopping in a period of heavy rainfall. 30/10/2000 – Fluvial flooding of the River Avon due to overtopping in a period of heavy rainfall. 10/02/2009 – Fluvial flooding of the River Avon due to overtopping in a period of heavy rainfall. 09/01/2014 – Fluvial flooding of the River Avon due to overtopping of flood defences in a period of heavy rainfall. Data from Environment Agency Recorded Flood Outlines. 12/04/1960 – Source and cause of flooding unknown. The majority of the points are along the River Chew with some on the River Avon. Fluvial flooding caused by overtopping in a period of heavy rainfall is likely. 12/05/1960 – Fluvial flooding of the River Chew, River Avon and two unnamed tributaries due to overtopping in a period of heavy rainfall. 30/11/1960 – Source and cause of flood unknown. 30/06/1968 – Fluvial flooding of the River Chew due to overtopping in a period of heavy rainfall. 07/10/1968 – Fluvial flooding of the River Chew, River Avon and an unnamed tributary due to overtopping in a period of heavy rainfall. 08/01/1995 – Fluvial flooding of the River Chew, River Avon and two unnamed tributaries due to overtopping in a period of heavy rainfall. Some flood incidents during this event unknown in source and cause, though likely due to fluvial or surface water flooding. 30/10/2000 – Fluvial flooding of the River Chew due to overtopping in a period of heavy rainfall. 01/01/2003 – Fluvial flooding of the River Avon due to overtopping in a period of heavy rainfall. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Fluvial flood risk in Keynsham is from the River Chew and the River Avon. For the River Chew, Flood Zones 2 and 3 are do not extend far beyond the river, though include some properties and roads in the immediate vicinity. Flood Zones 2 and 3 are far more extensive for the River Avon, but primarily include rural areas. However, some roads and properties are included. The majority of Keynsham is located within Flood Zone 1 and is at low risk of fluvial flooding.
Tidal flood risk	The tidal limit of the River Avon extends as far as Keynsham Weir during high spring tides. Tidal flooding should be considered particularly given the predicted rise in sea level.
Surface water flood risk	Within Keynsham, areas at surface water flood risk are largely located along the road network and following topography towards watercourses, however some areas are at risk of property flooding in the 3.3% AEP event, primarily in the northern parts of the town. Isolated ponding occurs in open spaces and gardens.

6 - Keynsham	
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence. Some areas to the south are not identified as being susceptible to groundwater flood emergence. To the north, 50%-75% of the area is susceptible.
Other sources of flood risk	Areas including some properties and roads in close proximity with the River Chew the northern extent of Keynsham (south of the River Avon) are at risk of reservoir flooding. Historical incidents of sewer flooding provided by Wessex Water indicate that there have been multiple incidents of sewer flooding recorded on numerous roads.

Strategic flood risk considerations

Development should preferably be located outside of areas shown to be at current or future risk of flooding where possible. If there is a need to locate development in areas at risk it is likely that a Level 2 SFRA study will be required to provide evidence that demonstrates the principle of development can be supported in the Exception Test for land that could be affected by flood risk .

7 - Whitchurch



Flood risk summary

7 - Whitchurch	
Flood history	There are records of flooding in Whitchurch. 15/11/1974 – Surface water flooding caused by local drainage. Data from Environment Agency Recorded Flood Outlines.
Fluvial flood risk	Whitchurch is located entirely within Flood Zone 1 and is at low risk from fluvial flood risk.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Whitchurch, areas at surface water flood risk are primarily isolated ponding in open spaces and gardens, though there is some flooding along the road network in 1% and 0.1 AEP events. There are properties at risk of flooding in the 3.33% AEP event.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence. Some areas to the east are not identified as being susceptible to groundwater flood emergence.
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there has been an incident of sewer flooding on Bridge Close and Churchways.
Strategic flood risk considerations	
Whilst Whitchurch is located in Flood Zone 1, developments greater than 1 hectare located in Flood Zone 1 will still require a site-specific Flood Risk Assessment as will smaller sites at risk of other sources of flooding. The current and future flood risk from all sources should also be assessed and mitigated. Development should also be located outside of any areas shown to be at current or future risk of flooding where possible.	

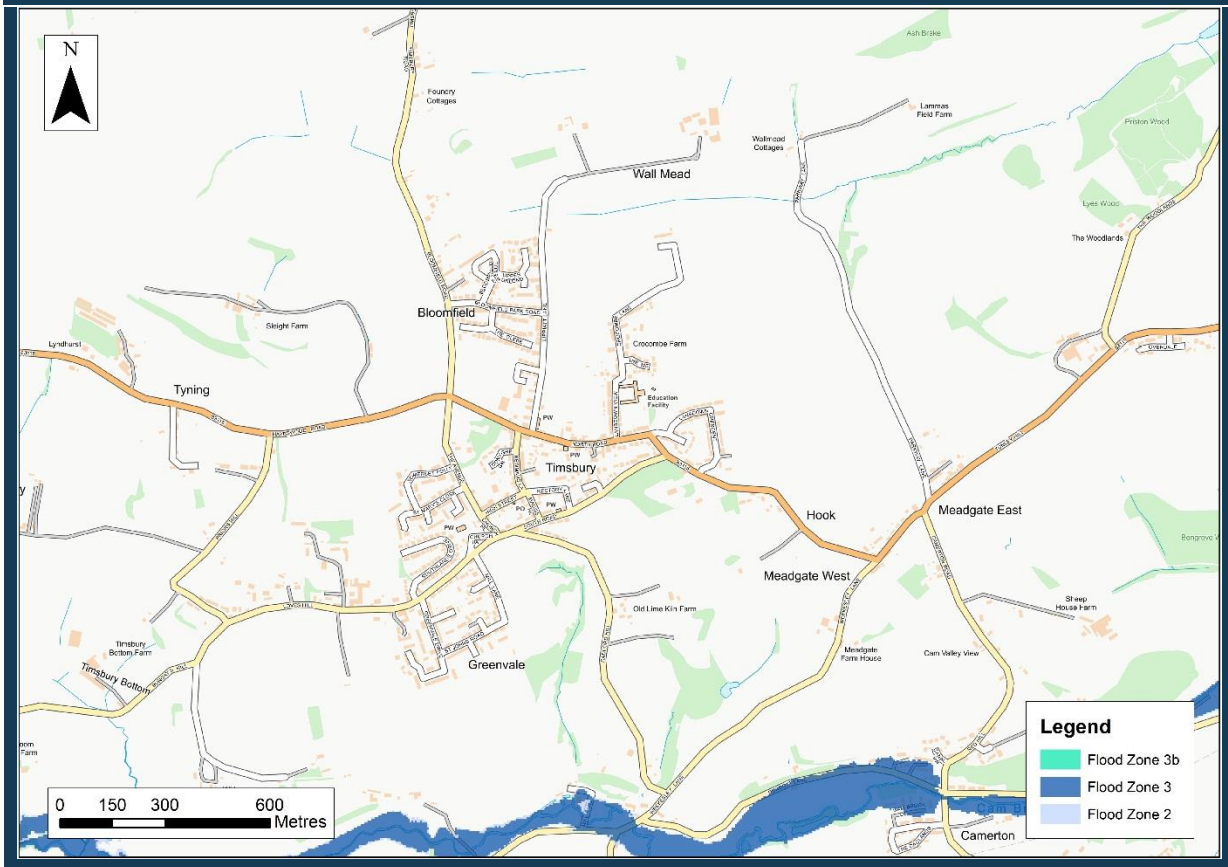
8 - Peasedown St John

Flood risk summary

Flood history	Flooding has been recorded in Peasedown St John. 08/01/1995 – Surface water flooding of unknown causes. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Peasedown St John is located entirely within Flood Zone 1 and is at low risk from fluvial flood risk.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Peasedown St John, areas at surface water flood risk are largely located along the road network and following topography towards watercourses, although isolated ponding occurs in open spaces and gardens. Areas at highest risk are near or on the A367. There are properties at risk of flooding in the 3.33% AEP event.
Groundwater flood risk	The AStGWF indicates that most of Peasedown St John is not identified as being susceptible to groundwater flood emergence, however there are some areas to the north and west where less than 25% of the area is susceptible.

8 - Peasedown St John	
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there has been an incident of sewer flooding on Albert Avenue.
Strategic flood risk considerations	
Whilst Peasedown St John is located in Flood Zone 1, developments greater than 1 hectare located in Flood Zone 1 will still require a site-specific Flood Risk Assessment as will smaller sites at risk of other sources of flooding. The current and future flood risk from all sources should also be assessed and mitigated. Development should also be located outside of any areas shown to be at current or future risk of flooding where possible.	

9 - Timsbury

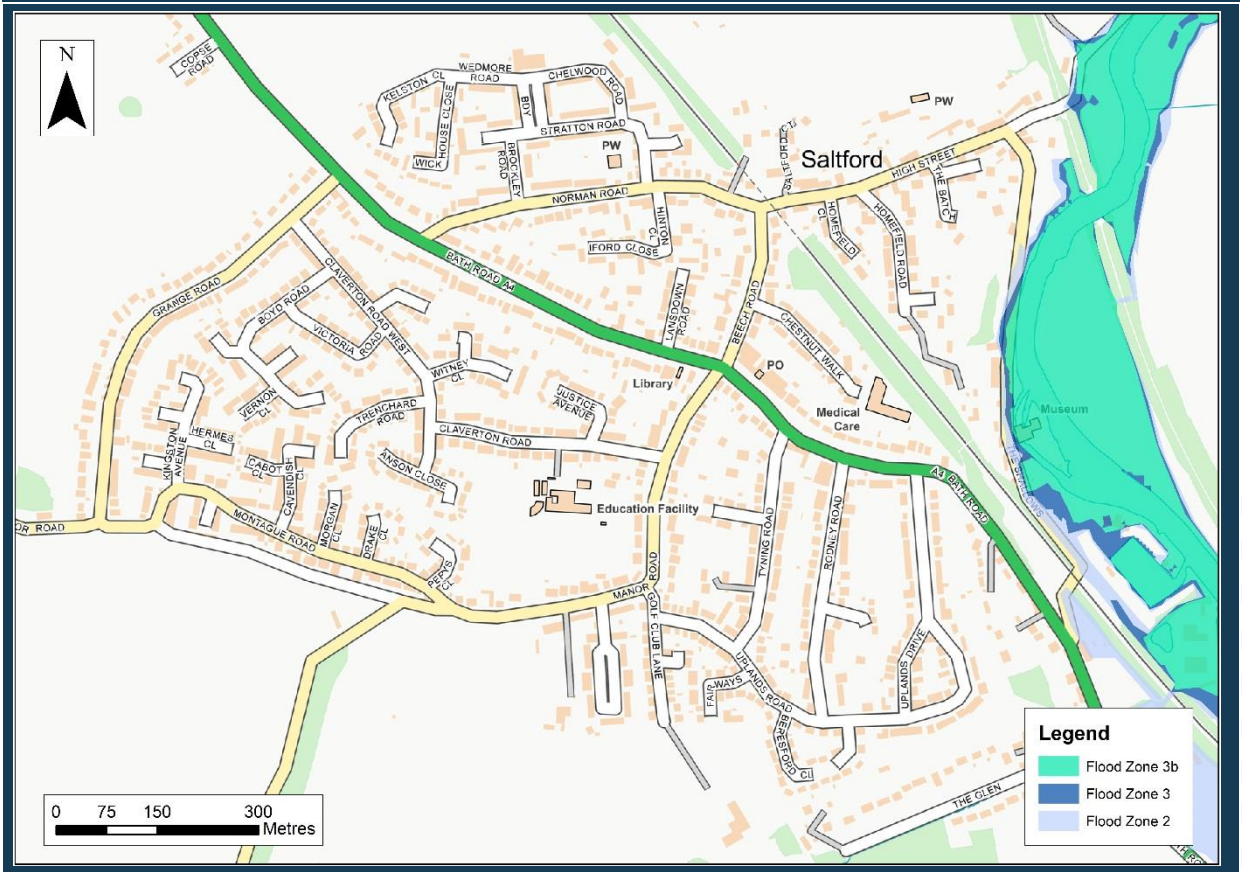


Flood risk summary	
Flood history	There are no records of flooding in Timsbury.
Fluvial flood risk	Timsbury is located entirely within Flood Zone 1 and is at low risk from fluvial flood risk.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	The majority of Timsbury is at low risk of surface water flooding. These areas at are largely located along the road network, although some isolated ponding occurs in open spaces and gardens. There are properties at risk of flooding in the 3.33% AEP event.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence.
Other sources of flood risk	Historical incidents of sewer flooding provided by Wessex Water indicate that there has been an incident of sewer flooding on Mill lane.
Strategic flood risk considerations	

9 - Timsbury

Whilst Timsbury is located in Flood Zone 1, developments greater than 1 hectare located in Flood Zone 1 will still require a site-specific Flood Risk Assessment as will smaller sites at risk of other sources of flooding. The current and future flood risk from all sources should also be assessed and mitigated. Development should also be located outside of any areas shown to be at current or future risk of flooding where possible.

10 - Saltford

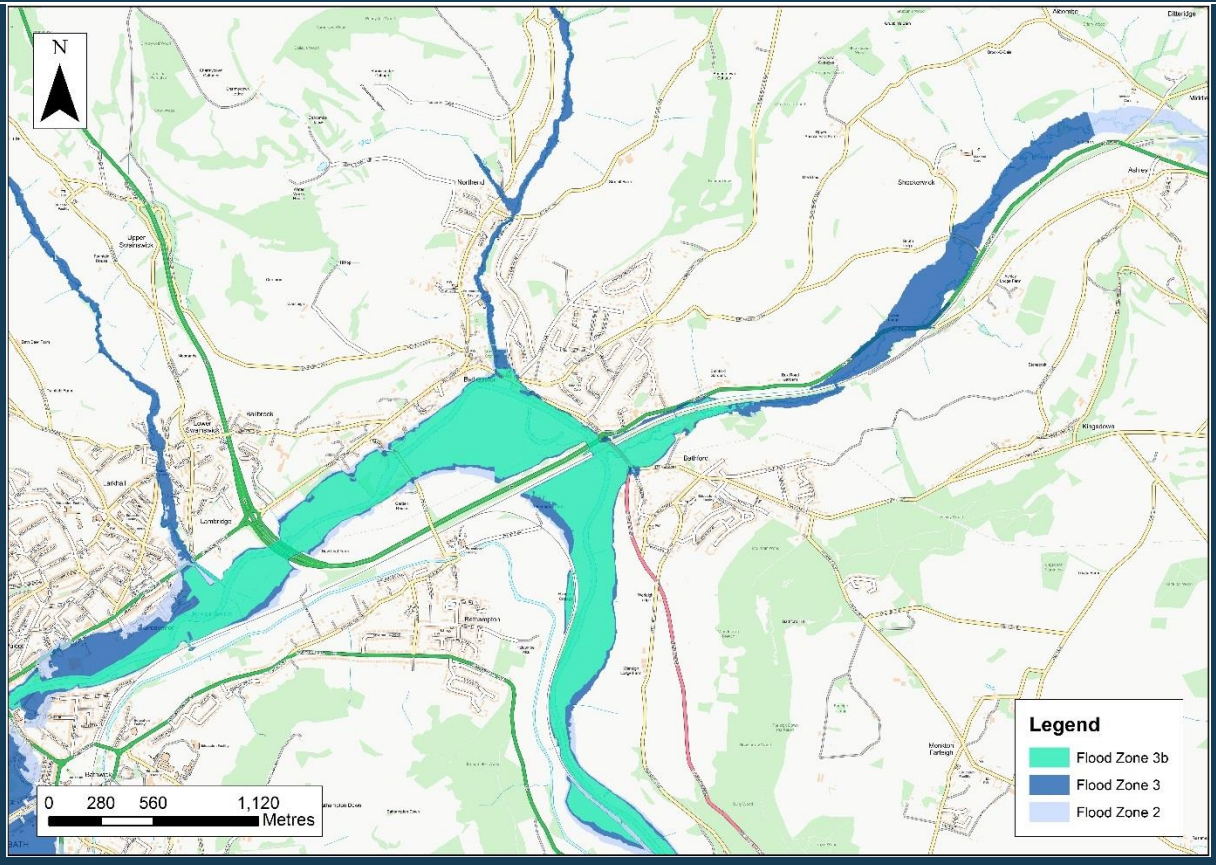


Flood risk summary

Flood history	Flooding is has been recorded in Saltford from the River Avon. 01/01/1925 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 01/05/1932 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 04/12/1960 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 16/03/1982 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 23/12/1985 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall.

10 - Saltford	
	29/01/1986 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 19/01/1999 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 30/10/2000 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 10/02/2009 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 09/01/2014 – Fluvial flooding of the River Avon due to overtopping of flood defences during a period of heavy rainfall. Data from Environment Agency Recorded Flood Outlines. 12/04/1960 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 30/11/1979 – Fluvial flooding of the River Avon likely due to overtopping during a period of heavy rainfall. 08/01/1995 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Saltford is at risk of fluvial flooding from the River Avon. Though Flood Zones 2 and 3 are largely confined to rural areas, there are some areas at risk in the east of the town in the vicinity of the River Avon. Most of Saltford is located in Flood Zone 1 and is at low risk of fluvial flooding.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Saltford, there is high risk of surface water flooding along the of the parts of the road network and low risk along the majority of the road network. There are some occurrences of isolated ponding in open spaces and gardens. There are properties at risk of flooding in the 3.33% AEP event.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence. The west is not identified as being susceptible to groundwater flood emergence.
Other sources of flood risk	The properties and roads on the eastern edges of Saltford, along the River Avon are within extent for flood risk from reservoirs. Historical incidents of sewer flooding provided by Wessex Water indicate that there have been incidents of sewer flooding on Hinton Close.
Strategic flood risk considerations	
Development should preferably be located outside of areas shown to be at current or future risk of flooding where possible. If there is a need to locate development in areas at risk it is likely that a Level 2 SFRA study will be required to provide evidence that demonstrates the principle of development can be supported in the Exception Test for land that could be affected by flood risk.	

11 - Batheaston/Bathampton



Flood risk summary

Flood history

Flooding is has been recorded in Batheaston/ Bathampton.

01/01/1925 – Fluvial flooding of the River Avon and By Brook due to overtopping during a period of heavy rainfall.

03/05/1932 – Fluvial flooding of the River Avon and By Brook due to overtopping during a period of heavy rainfall.

04/12/1960 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall.

16/03/1982 – Fluvial flooding of the River Avon and By Brook due to overtopping during a period of heavy rainfall.

24/12/1985 – Fluvial flooding of the River Avon and St Catherine's Book due to overtopping during a period of heavy rainfall.

28/01/1986 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall.

19/01/1999 – Fluvial flooding of the River Avon due to overtopping the river banks and defences during a period of heavy rainfall.

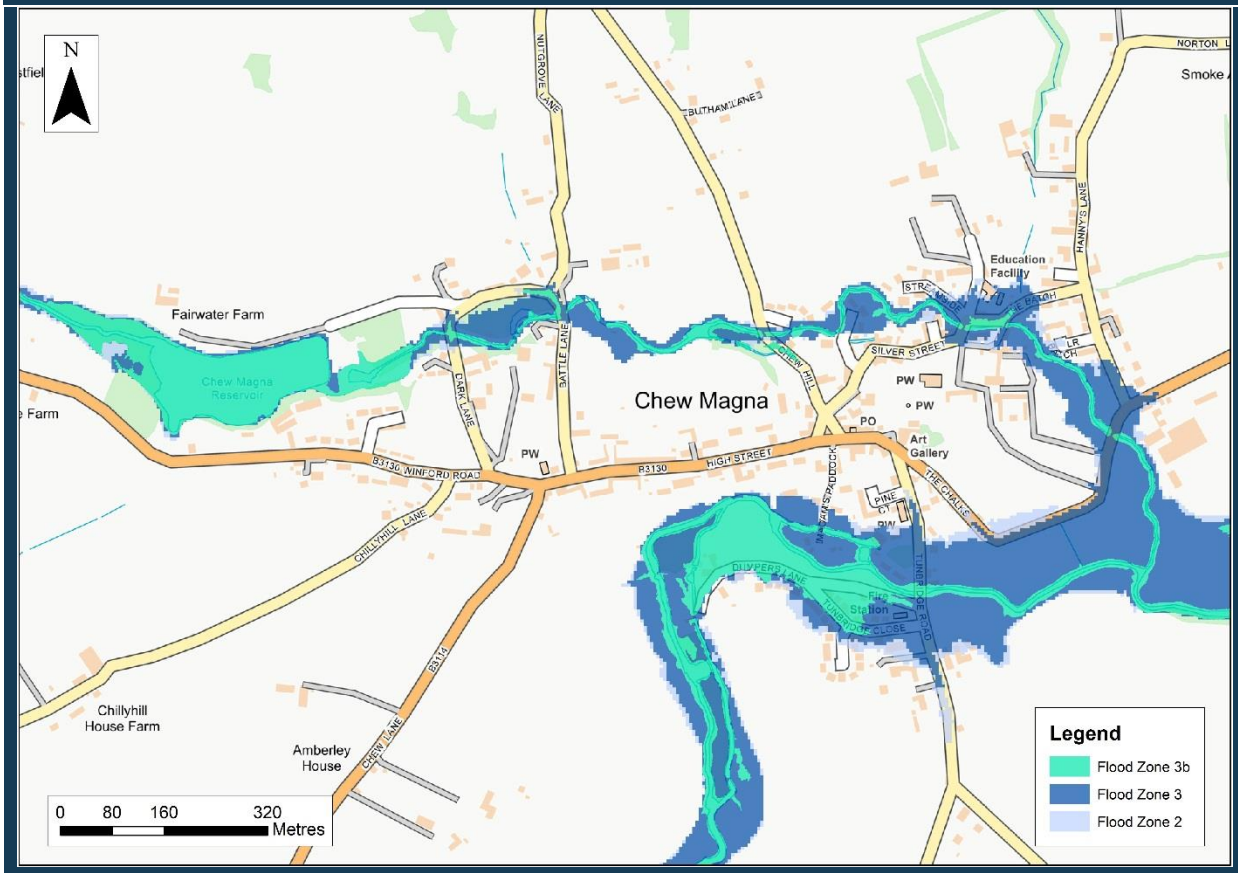
30/10/2000 – Fluvial flooding of the River Avon due to overtopping the river banks and defences during a period of heavy rainfall.

10/02/2009 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall.

11 - Batheaston/Bathampton	
	22/11/2012 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 23/11/2012 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. Data from Environment Agency Recorded Flood Outlines. 20/11/1963 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. 30/06/1968 – Fluvial flooding of St Catherine's Brook due to overtopping during a period of heavy rainfall. 08/01/1995 – Fluvial flooding of the River Avon and St Catherine's Book due to overtopping during a period of heavy rainfall. 01/01/2003 – Fluvial flooding of the River Avon due to overtopping during a period of heavy rainfall. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Fluvial flood risk in Batheaston is from the River Avon, St Catherine's Brook and the By Brook. The majority of Batheaston is within Flood Zone 1, however roads and properties in the close vicinity of the river and brooks are within Flood Zones 2 and 3. Bathampton is located entirely within Flood Zone 1 and is at low risk of being flooded.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Batheaston/Bathampton, areas at surface water flood risk are largely located along the road network and following topography towards watercourses, although isolated ponding occurs in open spaces. There is high risk of flooding near the watercourses and in parts of bathampton. The major extents of flooding are located in greenfield sites, however there are properties at risk of flooding in the 3.33% AEP event in both towns.
Groundwater flood risk	The AStGWF indicates that in Batheaston and Bathampton, generally 25-50% of the area is susceptible to groundwater flood emergence, however in some areas in close proximity to the River Avon, 50-75% of the area is susceptible.
Other sources of flood risk	Areas including some properties and roads in close proximity with St Catherine's Brook in Batheaston are at risk of reservoir flooding. The majority of reservoir flooding along the River Avon is limited to the greenfield site to the south of the river, though a few properties are at risk. Historical incidents of sewer flooding provided by Wessex Water indicate that there have been incidents of sewer flooding on Bannerdown Road, Down Lane, Morris Lane, Holcombe Vale and Kennet Park. The first three occurred on the same day.
Strategic flood risk considerations	

11 - Batheaston/Bathampton
Development should preferably be located outside of areas shown to be at current or future risk of flooding where possible. If there is a need to locate development in areas at risk it is likely that a Level 2 SFRA study will be required to provide evidence that demonstrates the principle of development can be supported in the Exception Test for land that could be affected by flood risk.

12 - Chew Magna



Flood risk summary

Flood history

Flooding has been recorded in Chew Magna from The River Chew and Winford Brook.

10/07/1968 – Fluvial flooding of the Winford Brook due to overtopping during a period of heavy rainfall.

30/05/1979 – Fluvial flooding of the River Chew and Winford Brook due to overtopping during a period of heavy rainfall.

30/12/1981 – Fluvial flooding of the Winford Brook due to overtopping during a period of heavy rainfall.

19/01/1999 – Fluvial flooding of the Winford Brook due to overtopping during a period of heavy rainfall.

15/01/2008 – Fluvial flooding of the Winford Brook due to overtopping during a period of heavy rainfall.

24/09/2012 – Fluvial flooding of the River Chew and Winford Brook due to overtopping during a period of heavy rainfall.

21/11/2012 – Fluvial flooding of the River Chew and Winford Brook due to overtopping during a period of heavy rainfall.

Data from Environment Agency Recorded Flood Outlines.

07/10/1968 – Fluvial flooding of the River Chew and Winford Brook due to overtopping during a period of heavy rainfall.

30/04/1979 – Flooding of unknown source and cause.

12 - Chew Magna	
	30/11/1981 – Fluvial flooding of Winford Brook due to overtopping during a period of heavy rainfall. 08/01/1995 – Fluvial flooding of the River Chew flooding due to overtopping and surface water flooding in a period of heavy rainfall. 30/10/2000 – Fluvial flooding of the River Chew due to overtopping during a period of heavy rainfall. Data from Bath and North East Somerset flood incident dataset.
Fluvial flood risk	Fluvial flood risk in Chew Magna comes from the River Chew and Winford Brook which flows east from Chew Magna reservoir through the town. Flood Zone 3 along Winford Brook does not reach far beyond the stream, however Flood Zone 2 includes a number of roads and properties. Flood Zone 3 along the River Chew has a larger extent and includes some roads and properties with Flood Zone 2 covering the majority of the south of Chew Magna. Properties around the High Street and north east of Chew Magna are in Flood Zone 1 and at low risk of fluvial flooding.
Tidal flood risk	Tidal flood risk in this area is considered to be negligible.
Surface water flood risk	Within Chew Magna, areas at surface water flood risk largely follow topography towards watercourses with some located along the road network. Areas at high risk are close to watercourses. The majority of the areas at risk are on the eastern side of the town, curving around the centre. There is some isolated ponding in open spaces and gardens and there are properties at risk of flooding in the 3.33% AEP event.
Groundwater flood risk	The AStGWF indicates that generally less than 25% of the area is susceptible to groundwater flood emergence.
Other sources of flood risk	The majority of Chew Magna is at risk of reservoir flooding. Historical incidents of sewer flooding provided by Wessex Water indicate that there have been incidents of sewer flooding on Dark Lane.

Strategic flood risk considerations
Development should preferably be located outside of areas shown to be at current or future risk of flooding where possible. If there is a need to locate development in areas at risk it is likely that a Level 2 SFRA study will be required to provide evidence that demonstrates the principle of development can be supported in the Exception Test for land that could be affected by flood risk.

6 Flood warning and emergency planning

6.1 Emergency planning

Emergency planning is an option to help manage flood related incidents. From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding.

6.2 NPPF

In development planning, a number of emergency planning activities are already integrated in national building control and planning policies e.g. the NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. However; safety is a key consideration for any new development and includes residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.

The **NPPF Planning Practice Guidance** outlines how developers can ensure safe access and egress to and from development to demonstrate that development satisfies the second part of the Exception Test. As part of an FRA, the developer should review and agree the acceptability of the proposed access in consultation with B&NES and when appropriate the Environment Agency.

There are circumstances where a flood warning and evacuation plan[4] is required and / or advised:

- It is a **requirement under the NPPF** that a flood warning and evacuation plan is prepared for sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels) and for essential ancillary sleeping or residential accommodation for staff required by uses in this category [water-compatible development], subject to a specific warning and evacuation plan.
- The **Environment Agency and DEFRAs standing advice** for undertaking flood risk assessments for planning applications states that details of emergency escape plans will be required for any parts of the building that are below the estimate flood level.

It is recommended that Emergency Planners at B&NES (where appropriate) are consulted prior to the production of any emergency flood plan.

In addition to the **flood warning and evacuation plan considerations listed in the NPPF / PPG**, it is advisable that developers also acknowledge the following:

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a breach.
- Proposed new development that places additional burden on the existing response capacity of the Councils will not normally be considered to be appropriate.
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.

[4] Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop emergency plans.

Further emergency planning information links:

- **2004 Civil Contingencies Act**
- **DEFRA (2014) National Flood Emergency Framework for England**
- **How to register with the Environment Agency's Flood Warnings Direct service**
- **National Flood Forum**
- **GOV.UK Make a Flood Plan guidance and templates**
- **FloodRe**
- Bath and North East Somerset Council resilience team **website**.

6.3 Flood Warnings

Flood warnings can be established for particular locations and, along with evacuation plans, can inform emergency flood plans or flood response plans. The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. Flood Warnings are supplied via the Flood Line Warnings Directive (FWD) service, to homes and business within Flood Zones 2 and 3. The different levels of warning are shown in Table 6-1.

Table 6-1: Environment Agency Warnings explained

Flood Warning Symbol	What it means	What to do
	Flood Alerts are used to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early preparations. It is issued earlier than a flood warning, to give customers advance notice of the possibility of flooding, but before there is full confidence that flooding in Flood Warning Areas is expected.	• Be prepared to act on your flood plan • Prepare a flood kit of essential items • Monitor local water levels and the flood forecast on the Environment Agency website • Stay tuned to local radio or TV • Alert your neighbours • Check pets and livestock • Reconsider travel plans
	Flood Warnings warn people of expected flooding and encourage them to take action to protect themselves and their property.	• Move family, pets and valuables to a safe place • Turn off gas, electricity and water supplies if safe to do so • Seal up ventilation system if safe to do so • Put flood protection equipment in place • Be ready should you need to evacuate from your home • 'Go In, Stay In, Tune In'
	Severe Flood Warnings warn people of expected severe flooding where there is a significant threat to life.	• Stay in a safe place with a means of escape • Co-operate with the emergency services and local authorities • Call 999 if you are in immediate danger
Warnings no longer in force	Informs people that river or sea conditions begin to return to normal and no further flooding is expected in the area. People should remain careful as flood water may still be around for several days.	• Be careful. Flood water may still be around for several days • If you've been flooded, ring your insurance company as soon as possible

It is the responsibility of individuals to sign-up to this service in order to receive the flood warnings via FWD. Registration and the service is free and publicly available. It is recommended that any household considered at risk of flooding signs-up. Developers should also encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.

There are currently 13 Flood Warning Areas (FWA) and 7 Flood Alert Areas (FAAs) covering flood risk in B&NES. These are displayed in Appendix L. A list of the FWA in Table 6-2 and a list of FAAs in Table 6-3.

Table 6-2: Flood Warning Areas within Bath and North East Somerset

Flood Warning Code	Flood Warning Name	Description	Watercourse
112FWFAVN50A	Bristol Avon (middle) from Melksham to Bathford, not including Bradford on Avon	Bristol Avon from Challymead Bridge to Bathford Bridge not including Bradford on Avon. Including Whaddon, Staverton, Avoncliff, Limpley Stoke and Claverton	Bristol River Avon
112FWFAVN60A	Bristol Avon at Bath, riverside properties	Upstream at Bathampton Bridge and Sports Fields to riverside properties at Twerton and Locksbrook. Including Pulteney Weir and nearby Sports Centre and Cricket Ground	Bristol River Avon
112FWFAVN60B	Bristol Avon at Bath, low lying properties set back from the river	Grosvenor and Kensington Meadows, St Johns Road, Henrietta Park, North Parade Road, the A36 and other riverside roads in Kingsmead	Bristol River Avon
112FWFAVN60C	Bristol Avon at Bath, other properties set back from the river	Grosvenor Bridge Road, Forester Avenue, Henrietta Gardens, Pulteney Road, Ferry Lane, the bus station, Victoria Bridge Road and Brassmill Lane in the Locksbrook area	Bristol River Avon
112FWFAVN60D	Bristol Avon at Bath, properties furthest from the river	Dolmeads area including Broadway Street and Archway Street, Dorchester Street, Manvers Street, Kingsmead area including Avon Street, James Street West and East Twerton including Lower Bristol Road and Brassmill Lane trading estate	Bristol River Avon
112FWFAVN70A	Bristol Avon (lower) from Twerton to Bristol	Bristol Avon from New Bridge to Netham including Saltford, Mead Lane, Swineford, Broad Mead, Keynsham Road, Hanham Mills, Riverside Cottages and St Annes Park	Bristol River Avon
112FWFCHE10A	Chew Stoke Stream and River Chew at Chew Stoke and Chew Magna	Home Orchard, School Lane, Mill Lane, The Street, Pilgrims Way, Quarry Hay, Bristol Road and Bilbie Road in Chew Stoke and Dumpers Lane, Madams Paddock, Tunbridge Close and Tunbridge Road in Chew Magna	River Chew, Chew Stoke Stream
112FWFCHE20A	River Chew from Stanton Drew to the Bristol Avon at Keynsham	River Chew from Stanton Drew to the Bristol Avon including Pensford, Publow, Woollard, Compton Dando, Chewton Place and Dapps Hill and Bath Hill in Keynsham	River Chew
112FWFMCW20A	Midford Brook, Cam and Wellow Brooks	Cam Brook including Temple Bridge, Hallatrow and Camerton. Wellow Brook from Lower Writhlington to Midford including Wellow and the Midford Brook including Midford and Monkton Combe Mill	Midford Brook, Cam Brook, Wellow Brook
112FWFSFR30A	Somerset Frome from Frome to Freshford	Spring Gardens to Freshford including Oldford, Lullington Weir, Beckington Mill, Eden Vale Farm, Shawford, Rode, Stowford Mill, Farleigh Hungerford, Iford Bridge and Friary	Somerset Frome
112FWFWEL11A	Wellow Brook and River Somer at Midsomer Norton and Radstock,	Wellow Brook including Thicketmead Bridge in Midsomer Norton and Mill Road in Radstock. Coomb End Culvert including Coombend and Market Place. The Snails and Kilmersdon Brooks including Church Street and St Nicholas Primary School and the River Somer	Wellow Brook, River Somer

	Thicketmead Bridge and Coombend areas		
112FWFWEL11B	Wellow Brook and River Somer at Midsomer Norton and Radstock, Riverside, Welton and Mill Road areas	Wellow Brook including Station Road and Welton Hollow in Midsomer Norton and Fortescue Road, Waterloo Road, Pine Court and Mill Road Industrial Estate in Radstock. River Somer including Riverside, Steam Mills, St Chads Green and Somervale School	Wellow Brook, River Somer
112FWFWIN10A	Winford Brook at Chew Magna	Chew Magna Reservoir to the River Chew including Dark Lane, Battle Lane, Spratts Bridge, Streamleaze, Silver Street, Streamside, Butham Lane, The Batch, Lower Batch and Norton Lane	Winford Brook

Table 6-3: Flood Alert Areas within Bath and North East Somerset

Flood Alert Code	Flood Alert Name	Description	Watercourse
112WAFTMBC	Midford Brook catchment	River Cam, Wellow and Midford Brooks and tributaries	River Cam, Wellow Brook, Midford Brook
112WAFTMBA	Mid Bristol Avon Area	Mid River Avon and tributaries including Melksham and Bradford on Avon	Bristol River Avon
112WAFTNSA	North Somerset Area	rivers in North Somerset including Congresbury Yeo, Cheddar Yeo, Axe and tributaries	Congresbury Yeo, Cheddar Yeo, River Axe, River Banwell
112WAFTLBA	Lower Bristol Avon Area	Lower River Avon, River Boyd, By and Brislington Brooks and tributaries	Bristol River Avon, River Boyd, By Brook, Brislington Brook
112WAFTRCC	River Chew catchment	River Chew from Chew Stoke to Keynsham, Chew Stoke Stream and Winford Brook	River Chew, Chew Stoke Stream, Winford Brook
112WAFTSFA	Somerset Frome Area	River Frome and Mells, and the Whatley and Nunney Brooks and tributaries	Somerset Frome, River Mells, Whatley Brook, Nunney Brook

6.4 Local arrangements for managing flood risk

The Bath and North East Somerset Council's **website** provides advice on reporting flooding, flood alerts, health advice and advice for protecting property during a flood event. A **Flood Emergency Plan** is in place for Bath and North East Somerset and has been prepared by The Business Continuity & Emergency Planning team of Bath & North East Somerset Council. The Flood Plan highlights the matters that need to be considered when developing a Flood Emergency Plan (FEP), including flood warnings, safe routes and evacuation options.

6.5 Emergency planning and development

6.5.1 NPPF

The NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. It is essential that any development which will be required to remain operational during a flood event is located in the lowest flood risk zones so that, in an emergency, operations are not impacted on by flood water or that such infrastructure is resistant to the effects of flooding such that it remains serviceable/operational during 'upper end' events, as defined in the Environment Agency's Climate Change allowances (February 2016). For example, the NPPF classifies police, ambulance and fire stations and command centres that are required to be operational during flooding as Highly Vulnerable development, which is not permitted in Flood Zones 3a and 3b and only permitted in Flood Zone 2 providing the Exception Test is passed. Essential infrastructure located in Flood Zone 3a or 3b must be operational during a flood event to assist in the emergency evacuation process. All flood sources such as fluvial, surface, groundwater, sewers and artificial sources (such as canals and reservoirs) should be considered. In particular sites should be considered in relation to the areas of drainage critical problems highlighted in the SWMP.

The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements. This includes the nominated rest and reception centres (and perspective ones), so that evacuees are outside of the high-risk Flood Zones and will be safe during a flood event.

6.5.2 Safe access and egress

The NPPF Planning Practice Guidance outlines how developers can secure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development. The NPPF Planning Practice Guidance sets out that:

- Access routes should allow occupants to safely access and exit their dwellings in design flood conditions. In addition, vehicular access for emergency services to safely reach development in design flood conditions is normally required; and
- Where possible, safe access routes should be located above design flood levels and avoid flow paths including those caused by exceedance and blockage. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage etc. to make it safe. The acceptable flood depth for safe access will vary as this will be dependent on flood velocities and risk of debris in the flood water. Even low levels of flooding can pose a risk to people in situ (because of, for example, the

presence of unseen hazards and contaminants in floodwater, or the risk that people remaining may require medical attention).

The depth, velocity and hazard mapping from hydraulic modelling should help inform the provision of safe access and egress routes.

As part of an FRA, the developer should review the acceptability of the proposed access in consultation with Bath and North East Somerset Council and the Environment Agency. Site and plot specific velocity and depth of flows should be assessed against standard hazard criteria to ensure safe access and egress can be achieved.

6.5.3 Potential evacuations

During flood incidents, evacuation may be considered necessary. The NPPF Planning Guidance states practicality of safe evacuation from an area will depend on[5].

1. the type of flood risk present, and the extent to which advance warning can be given in a flood event;
2. the number of people that would require evacuation from the area potentially at risk;
3. the adequacy of both evacuation routes and identified places that people could be evacuated to (and taking into account the length of time that the evacuation may need to last); and
4. sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

The vulnerability of the occupants is also a key consideration. The NPPF and application of the Sequential Test aims to aims to avoid inappropriate development in flood risk areas. However, developments may contain proposals for mixed use on the same site. In this instance, the NPPF Planning Practice Guidance states that layouts should be designed so that the most vulnerable uses are restricted to higher ground at lower risk of flooding, with development which has a lower vulnerability (parking, open space etc.) in the highest risk areas, unless there are overriding reasons to prefer a different location[6]. Where the overriding reasons cannot be avoided, safe and practical evacuation routes must be identified.

The Environment Agency and DEFRA provide standing advice for undertaking flood risk assessments for planning applications. Please refer to **the government website** for the criteria on when to following the standing advice. Under these criteria, details must be provided of emergency escape plans for parts of the building that are below the estimated flood level. The plans should show:

- single storey buildings or ground floors that do not have access to higher floors can access a space above the estimated flood level, e.g. higher ground nearby;
- basement rooms have clear internal access to an upper level, e.g. a staircase; and
- occupants can leave the building if there is a flood and there is enough time for them to leave after flood warnings[7].

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5 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 057, Reference ID: 7-057-20140306) March 2014

6 NPPF Planning Practice Guidance, Flood Risk and Coastal Change (Paragraph: 053 Reference ID: 7-053-20140306) March 2015

7 Environment Agency and DEFRA (2012) Flood Risk Assessment: Standing Advice

Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. developments located immediately behind a defence and at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where appropriate, a site-specific Flood Risk Assessment to help develop appropriate emergency plans.

6.5.4 Flood warning and evacuation plans

Flood warning and evacuation plans are potentially mitigation measures to manage the residual risk, as stated in the NPPF Planning Practice Guidance. It is a requirement under the NPPF that a flood warning and evacuation plan is prepared and agreed for sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels).

A flood warning and evacuation plan should detail arrangements for site occupants on what to do before, during and after a flood as this will help to lessen its impact, improve flood response and speed up the recovery process. The Environment Agency provides practical advice and templates on how to prepare a flood plans for individuals, communities and businesses (see text box for useful links).

It is recommended that emergency planners at Bath and North East Somerset Council are consulted prior to the production of any emergency flood plan. The council will provide guidance to help local communities to protect their home and valuables and understand what to do before, during and after a flood.

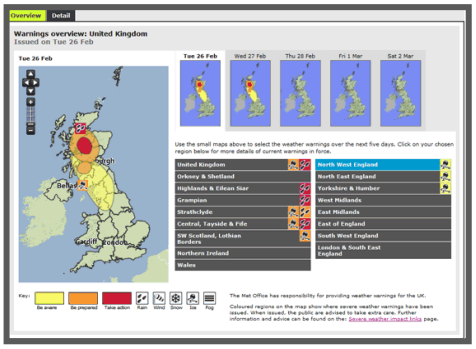
Once the emergency flood plan is prepared and agreed, it is recommended that it is distributed to emergency planners at Bath and North East Somerset Council and the emergency services. When developing a flood warning and evacuation plan, it is recommended that it links in with any existing parish / community level plan.

Guidance documents for preparation of flood response plans

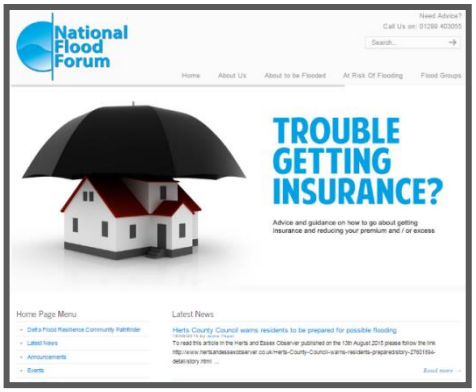
- **Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups**
- **Environment Agency (2014) Community Flood Plan template**
- **Environment Agency Personal flood plans**
- **Flood Plan UK 'Dry Run' - A Community Flood Planning Guide http://www.bathnes.gov.uk/services/planning-and-building-control/planning/planning-advice-and-guidance/flood-emergency-plan**
- **Bath and North East Somerset Council – Flood Emergency Plan Advice**

6.5.5 Other sources of information

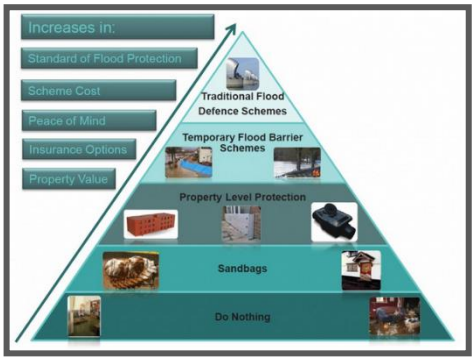
As well as being a statutory consultee for new development at risk of flooding, the Environment Agency can offer independent technical advice. The Environment Agency website contains a breadth of information on flood risk and there are numerous publications and guidance available. For example, the **"flooding from groundwater"** guide has been produced by the Environment Agency and Local Government Association to offer practice advice to reduce the impact of flooding from groundwater.



The Met Office provides a National Severe Weather Warning Service about rain, snow, wind, fog and ice. The severity of warning is dependent upon the combination of the likelihood of the event happening and the impact the conditions may have. In simplistic terms, the warnings mean: Yellow: Be Aware, Amber: Be Prepared, Red: Take Action. This service does not provide flood warnings. The Met Office provide many other services and products. For further information, please visit their **website**.



The **National Flood Forum** (NFF) is a national charity, set up in 2002 to support those at risk and affected by flooding. The NFF helps people to prepare and recover from flooding as well as campaigning on behalf of flood risk communities, including providing advice on matters such as insurance.



Individual Property Level Resilience (PLR) measures are design to help protect homes and businesses from flooding. These include a combination of flood resistance measures - trying to prevent water ingress – and flood resilience measures - trying to limit the damage and reduce the impact of flooding, should water enter the building. It is important that any measures have the BSI Kitemark. This shows that the measure has been tested and ensures that it meets industry standards. Please visit the **Government website: "Prepare for flooding"** for more information.

7 Climate change

7.1 Climate change and the NPPF

The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to address the potential effects of climate change. NPPF and NPPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

7.2 Revised climate change guidance

The Environment Agency published updated climate change guidance on 19 February 2016, which supports the NPPF and must now be considered in all new developments and planning applications. The document contains guidance on how climate change should be taken into account when considering development, specifically how allowances for climate change should be included with FRAs. The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice

7.3 Climate change allowances

By making an allowance for climate change it will help reduce the vulnerability of the development and provide resilience to flooding in the future.

The 2016 climate change guidance includes climate change predictions of anticipated change for peak river flow and peak rainfall intensity. There allowances are based on climate change projections and difference scenarios of carbon dioxide emissions to the atmosphere.

Due to the complexity of projecting climate change, there are uncertainties attributed to climate change allowances. As a result, the guidance presents a range of possibilities to reflect the potential variation in the certainty in the prediction of climate change impacts over three periods (referred to as epochs).

7.4 Using climate change allowances

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for a development or development plan allocation, the following should be considered:

- likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s)
- vulnerability of the proposed development types or land use allocations to flooding
- 'built in' resilience measures used, for example, raised floor levels
- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

Flood Risk Assessments (FRAs) are required to demonstrate future implications of climate change have been considered, and risks managed where possible, for the lifetime of the proposed development. This may include for instance:

- Consideration of the vulnerability of the proposed development types or land use allocations of flooding and directing the more vulnerable away from areas at higher risk due to climate change
- Use of 'built in' resilience measures. For example, raised flood levels.
- Capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

The last consideration acknowledges that there may be instances where some flood risk management measures are not necessarily needed now but may be in the future.

The latest guidance on climate change allowances for FRA released by the Environment Agency [8] provides predictions of anticipated change. The allowances to be considered in FRAs for developments in Bath and North East Somerset's authoritative area are:

- Peak rainfall intensity;
- Peak river flow
- Sea level rise

The Environment Agency provides peak rainfall intensity climate change allowances to be considered in FRAs. The guidelines which should be used in FRAs are outlined in the following sections.

7.5 Peak river flows

Climate change is expected to increase the frequency, extent and impact of flooding, reflected in peak river flows. Wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff and there may be increased storm intensity in summer. Rising river levels may also increase flood risk.

The peak river flow allowances provided in the guidance show the anticipated changes to peak flow for the river basin district within which the subject watercourse is located. Once the river basin district has been identified, guidance on uplift in peak flows are provided for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it is located.

These allowances (increases) are provided, in the form of figures for the total potential changed anticipated, for three climate change periods:

- The '2020s' (2015 to 2039)
- The '2050s' (2040 to 2069)
- The '2080s' (2070 to 2115)

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development. Further information on what is considered to be the lifetime of development is provided in the **NPPG**.

The allowances for the Severn River Basin District are provided in Table 7-1.

[8] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 7-1: Peak river flow allowances for the Severn river basin district

Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	25%	40%	70%
Higher central	15%	25%	35%
Central	10%	20%	25%

The upper reaches of ordinary watercourses in the far eastern part of the district, flow into the Severn river basin; the **allowances for the Severn River Basin District** should be used in this area.

When considering development, the development design should consider the lifetime of the property, therefore for development with a life expectancy beyond 2080, the '2080s' (2070 to 2115) should be used for assessing flood risk of future development.

7.5.1 High++ allowances

High++ allowances only apply in assessments for developments that are very sensitive to flood risk, for example large scale energy generating infrastructure, and that have lifetimes beyond the end of the century. H++ estimates represent the upper limit of plausible climate projections and would not normally be expected for schemes of plans to be designed to or incorporate resilience for the H++ estimate. Further information is provided in the Environment Agency publication, **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.**

7.5.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. Vulnerability classifications are found in the **NPPG**. The guidance states the following:

Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

7.6 Peak rainfall intensities

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments. These allowances should be used for small catchments and urban drainage sites. For catchments, larger than 5km^2, the guidance suggests the peak river flow allowances should be used.

For flood risk assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Table 7-2: Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

As previously stated for catchments which are not small in size or urban (Table 7-1), when considering development, the development design should consider the lifetime of the property, therefore for development with a life expectancy beyond 2060, the 2060 to 2115 should be used for assessing flood risk of future development.

For further information on the use on how to use climate change allowances, information can be located on the Flood Risk Assessments Climate Change Allowances guidance **weblink**.

7.7 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months.

The eastern area of B&NES is susceptible to groundwater flooding due to more permeable geology and a low topography being present here. The overall risk within Bath is low to medium. This risk is relation to the springs around the city.

7.8 Tidal Flood Risk

The previous Level 1 SFRA for B&NES (2008) found to have negligible impact on modelled water levels within B&NES. When tide levels were increased, the influence on modelled water levels increased, but the effects were reduced significantly upstream of Keynsham weir. Baseline 0.5 and 0.1% AEP extreme tide events increased peak levels by approximately 0.3m and 0.45m during a 20%AEP river flood event downstream of Keynsham weir. Water levels are only increased by 0.1m upstream of Keynsham weir. The conclusion of flooding from the sea not being expected to present a risk to Keynsham now or in the near future was made with flooding from rivers being the dominant source of flooding within the Lower Avon.

Climate change was also modelled to include the impact of tidal events. This found water levels to increase by 0.9m downstream of Keynsham weir in comparison to the baseline scenario. Water levels were found to only increase by 0.4m upstream of the weir. Only 0.12m was considered to be attributed to climate change increased in flows.

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

7.9 The impact of climate change in B&NES

7.9.1 UK Climate Projection 2009

The **UK Climate Projection 2009** (UKCP09) predict the following climatic changes to the study area:

South West England

- Increased summer temperatures of 5.1°C by 2050.
- Increased winter temperatures of 3.5°C by 2050.
- Reduced summer rainfall of 16% by 2050 making summers much drier.
- Increased winter rainfall of 41% by 2050.

7.10 Adapting to climate change

NPPG Climate Change contains information and guidance for how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change.

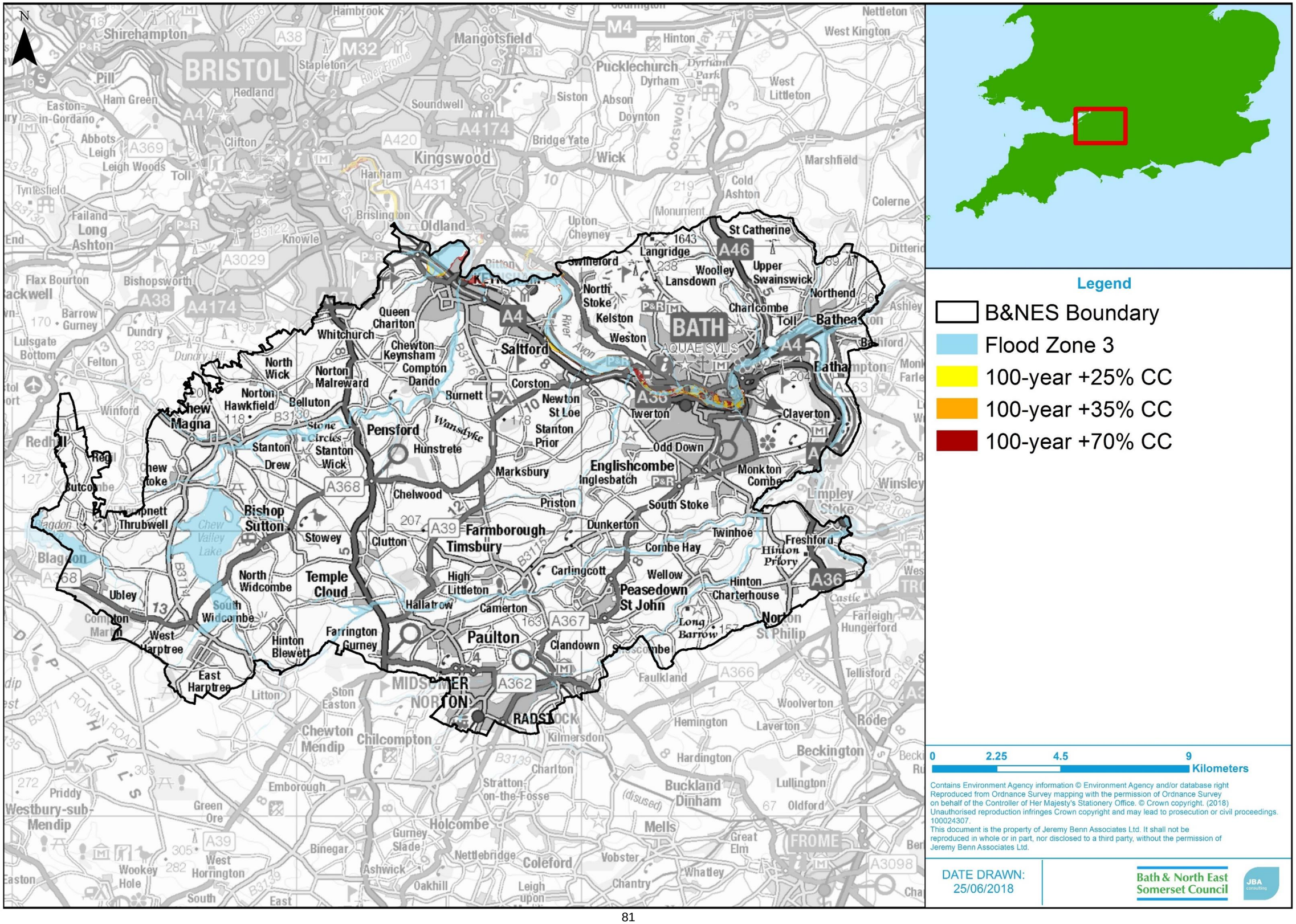
- Considering future climate risks when allocating development sites to ensure risks are understood over the development's lifetime
- Considering the impact of and promoting design responses to flood risk and coastal change for the lifetime of the development
- Considering availability of water and water infrastructure for the lifetime of the development and design responses to promote water efficiency and protect water quality
- Promoting adaptation approaches in design policies for developments and the public realm for example by building in flexibility to allow future adaptation if needed, such as setting new development back from watercourses

Identifying no or low-cost responses to climate risks that also deliver other benefits, such as green infrastructure that improve adaptation, biodiversity and amenity, for example by leaving areas shown to be at risk of flooding as public open space.

7.11 Modelling outputs

The Bath to Bristol Avon model has been ran to consider climate change for the study area. Results of this are displayed within Figure 7-1. Future Flood Zone 2 has not been considered as part of the Level 1 SFRA and should be considered as part of the Level 2 SFRA.

Figure 7-1: Climate Change future Flood Zone 3 modelling outputs



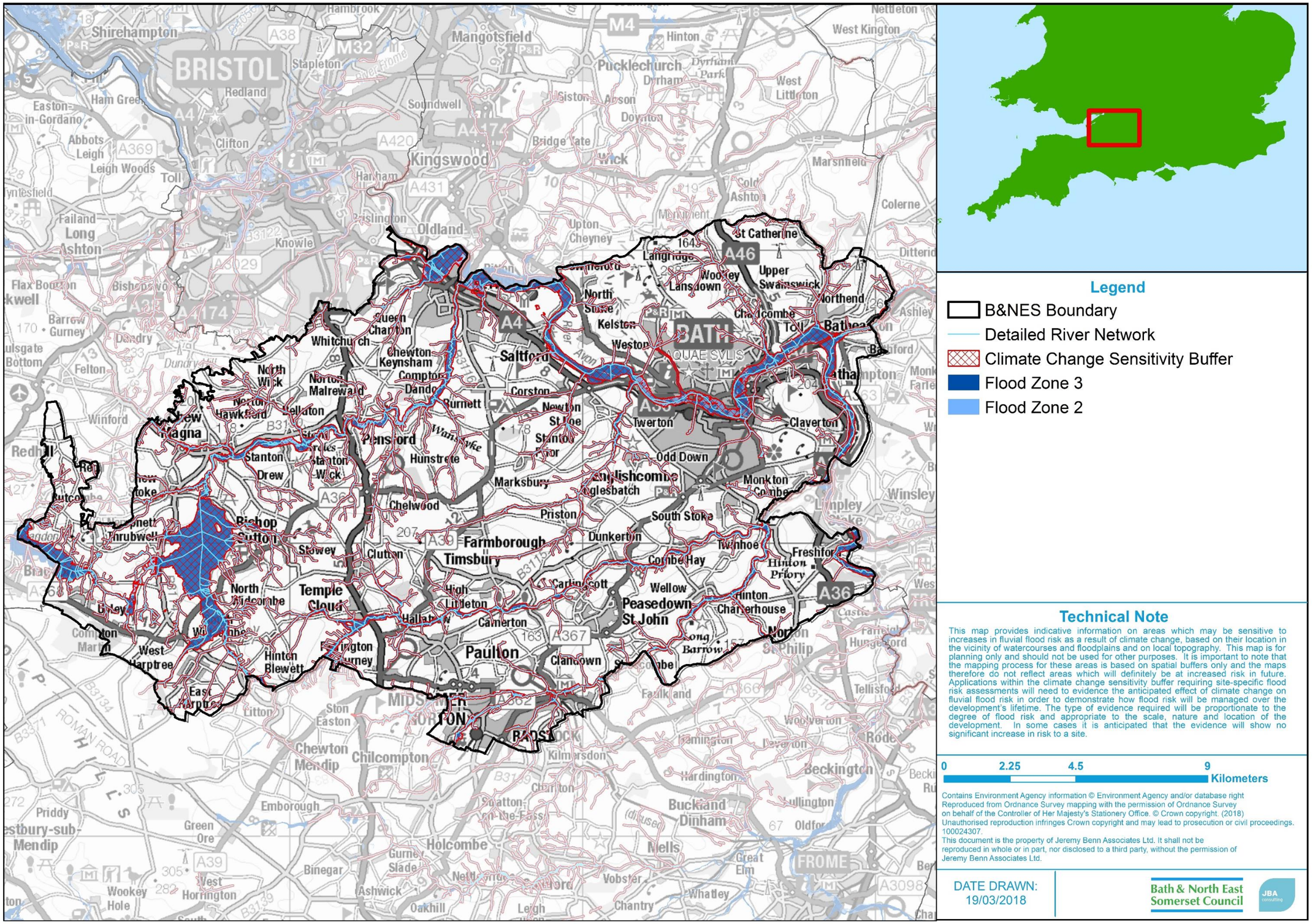
7.12 Climate Change Sensitivity Buffering

Climate Change sensitivity buffering was conducted for key settlements within B&NES. This was done to provide indicate informative on areas which may be sensitive to increases in fluvial flood risk as a result of climate change based on their vicinity to a watercourse and floodplains as well as the local topography. It is important to note that the mapping process for these areas is based upon spatial buffering only and therefore mapping does not reflect areas that will definitely be at an increased risk in the future. Additionally, buffering conducted does not account for updated modelling and therefore hasn't accounted for recent flood mitigation schemes such as Bath Quay North and South.

Figure 7-2 displays results of climate change sensitivity buffering within B&NES. Appendix A displays mapping of areas which are situated within the climate change sensitivity buffer. Development within the buffer will require a site-specific flood risk assessment which will need to evidence the anticipated effect of climate change on fluvial flooding in order to demonstrate how flood risk will be managed over a developments lifetime. A technical note is also attached as Appendix B.

If a development is located within a climate change sensitivity buffer, this will not trigger an FRA but gives an indication that an FRA may be required.

Figure 7-2: Mapping of climate change sensitivity buffering



8 Flood Defences

A high-level review of formal flood defences was carried out for this SFRA interrogating existing information that gives their condition and standard of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment. The assessment has considered man-made defences and not natural defences which may arise for instance due to the presence of naturally high ground adjacent to a settlement.

The formal defences and their location are summarised in the following sections.

8.1 Defence standard of protection and residual risk

One of the principal aims of the SFRA is to outline the present risk of flooding across Bath and North East Somerset including consideration of the effect of flood risk management measures (including flood banks and defences). The modelling that informs understanding of flood risk within the district is typically of a catchment-wide nature, suitable for preparing evidence on possible site options for development. In cases where a specific site risk assessment is required, more detailed studies should be performed to seek to refine the current understanding of flood risk from all sources.

Consideration of the residual risk behind flood defences has been undertaken as part of this study. The residual risk of flooding in a flood event or from failure of defences should also be carefully considered. Developers should also consider the standard of protection provided by defences and residual risk as part of a detailed Flood Risk Assessment (FRA).

8.2 Environment Agency Defence condition

Formal structural defences are given a rating based on a grading system for their condition[9]. A summary of the grading system used by the Environment Agency for condition is provided in Table 8-1. This detail, in addition to descriptions and standard of protection for each, were provided by the Environment Agency for the purpose of preparing this SFRA which reports on the standard of protection using this information.

Table 8-1: Defence asset condition rating

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation required.
5	Very Poor	Severe defects resulting in complete performance failure.

Source: Condition Assessment Manual – Environment Agency 2006

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future requires consideration as part of the risk based sequential approach and, in light of this, whether possible site options for development are appropriate and sustainable. In addition, detailed FRAs will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

[9] Condition Assessment Manual, Environment Agency (2006)

A review of key defences across Bath and North East Somerset, their condition and standard of protection is included in the following sections. Formal flood defences within Bath and North East Somerset have been derived from the Environment Agency Spatial Flood Defences dataset. The type of flood defences in the district have been determined from the asset type field. This SFRA has not considered natural defences (i.e. naturally high ground).

8.3 Standard of Protection

The standard of protection of flood defence structures should also be considered.

Standard of Protection

Flood defences are designed to give a specific standard of protection, reducing the risk of flooding to people and property in flood prone areas. For example, a flood defence with a 1% AEP standard of protection means that the flood risk in the defended area is reduced to a 1% chance of flooding in any given year.

Although flood defences are designed to a standard or protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to climate change

For the purpose of this study, structures which are categorised to be natural banks and have a standard of protection lower than 10 have not been included within analysis.

For the purpose of this study, to calculate the standard of protection for structures within Bath, the Bath Western Riverside and Bath Quays (2017) modelling has been used. However, it should be noted that this modelling considers the currently under construction Flood Defences in this location. At the time of writing, it is unknown when these defences will be completed therefore have not been included in this study.

In addition, standard of protection studies has not been conducted for Midsomer Norton, therefore it has been inferred a standard of protection of 50-years for the tunnel located her. This is based upon the building design conducted in 1978, however with advances in modelling techniques and climate change, this may differ in the present day. It is recommended that the soon to be completed Midford catchment modelling is therefore used to infer the standard of protection for Midsomer Norton.

The Environment Agency manage flood defences as group structures, rather than as individual assets. These are termed 'management units' and are managed through System Asset Management Plans (SAMPS). Data provided by B&NES displays Flood Risk Management Systems across the study area and their standard of protection. These are displayed in Figure 8-5. The council's dataset subdibided B&NES into 9 areas which are outlined within Table 8-2.

Table 8-2: System Asset Management Plans which cover BANES

Name	Flood Risk Management Number	Standard
Avon Keynsham to Conham	FR/14/S075	High
Avon at Bath	FR/14/S081	High
Chew & Catchment	FR/14/S078	High
Wellow Midford Cam	FR/14/S085	Low
Somer & Wellow Brook HMR	FR/14/S084	High
Somerset Frome Mells to Avon	FR/14/S086	Low
Avon Bath to Keynsham	FR/14/S079	Medium
Avon Staverton to Bath	FR/14/S083	Medium
By Brook & Catchment	FR/14/S082	High

Bath and North East Somerset Flood Defence Structures Review Mapping (Figure 8-1, Figure 8-2, Figure 8-3 and Figure 8-4) as well as summary tables of assets (Table 8-3, Table 8-4 and Table 8-5) provide a summary of the defence type, data source, standard of flood protection and condition within Bath and North East Somerset with focus upon Bath, Midsomer Norton and Radstock. The numbers on the mapping relate to the unique IDs given to each flood defence structure which have corresponding information within the tables below. Data provided is based on the Environment Agency's Spatial Flood Defence dataset, Environment Agency provided asset mapping and the Fluvial Flood Defence dataset provided by Bath and North East Somerset. This is the most up to date information available at the time of writing. No asset condition information was provided within the council's dataset.

The Bath Flood Defence Scheme consists largely of hard engineering concrete flood wall structures. The condition of which range between 2 to 3 with one concrete wall being a category 4 and another wall being category 5. Defences within Bath are also protected to a varying standard of protection. Both council and Environment Agency defences are located here. Currently there are new flood defences under construction within the centre of Bath. Information regarding these as well as completion date is unavailable at the time of writing. Therefore, these defences will need to be considered and evaluated in the future as part of a site-specific flood risk assessment.

The Midsomer Norton Flood Alleviation Tunnel is listed to be a section of culverted channel built to provide a 50-year standard of protection. However, this is based upon time of construction in 1978 where there has since been advances in modelling techniques as well as climate change. Currently, the Midford catchment modelling is in the progress of being completed and is recommended to be used to inform the standard of protection following the completion of modelling. In additional, summary tables of assets currently list asset types to be 'high ground'. The term 'high ground' is a generic classification for a bank which is not raised. Therefore, it can include reveted banks, walled banks, natural bank and sheet piling to name a few.

Three structures are also present in Radstock according to Environment Agency datasets. These structures are listed to be masonry walls and have been built to provide a 100-year standard of protection. One structure is listed to have a condition category of 4 and the other 2. Additionally, in Midsomer Norton, Environment Agency data lists concrete flood walls and gabion lined banks to be present. These structures are all listed to provide a 100-year standard of protection with a condition category of 2. In addition to these two structures, there is also the Coombend Flood Relief Culvert.

Figure 8-1: Flood defence structures located within Midsomer Norton

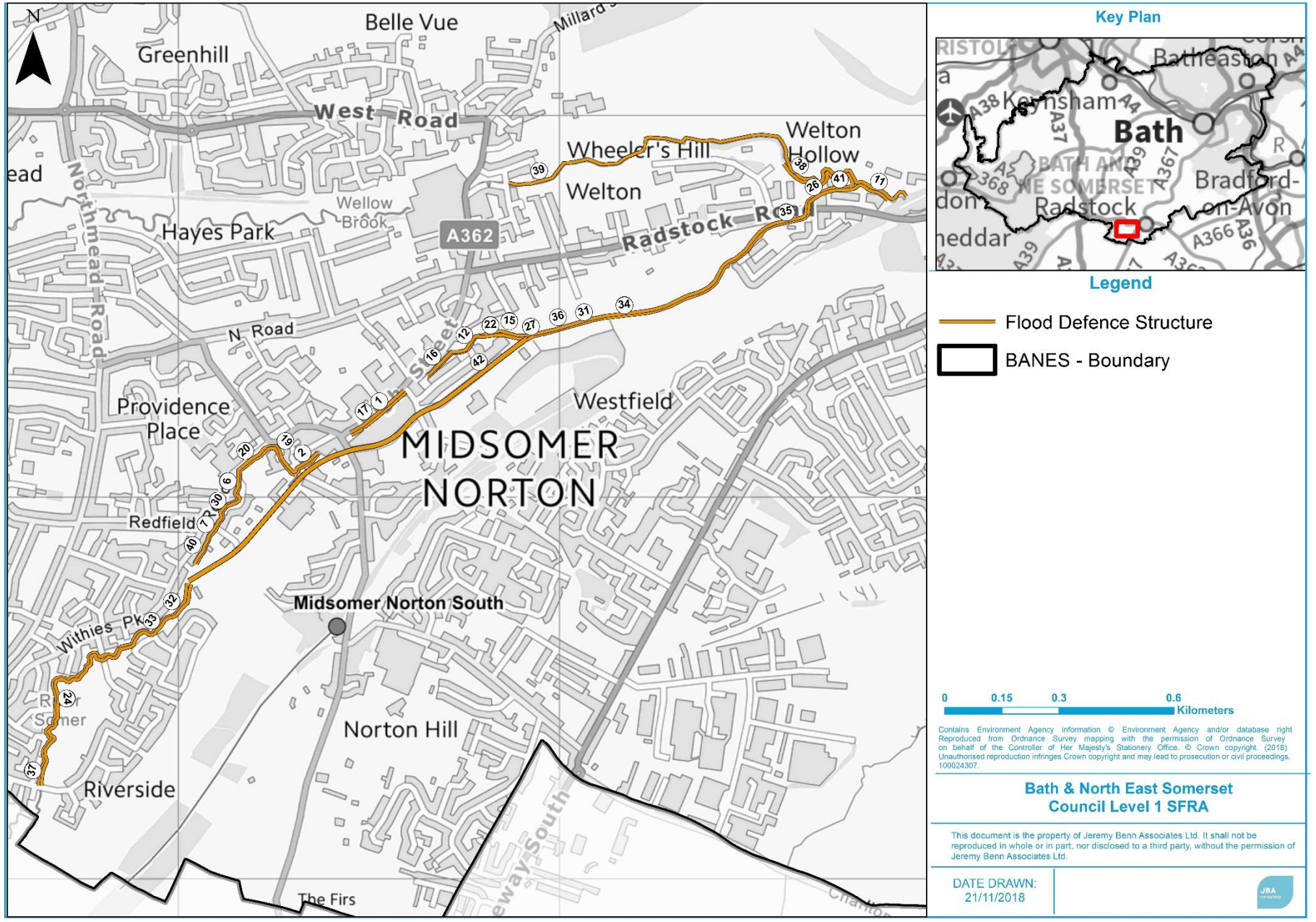


Table 8-3: Assets and Structures located within Midsomer Norton

Asset ID	Asset Type	Environment Agency Asset Reference	Standard of Protection
1	Midsomer Norton Flood Relief Culvert	1123024000102R04	50-year
2	High Ground	1123024000102R06	N/A
3	High Ground	1123024000102R07	N/A
4	High Ground	1123024000102R08	N/A
5	High Ground	1123024000102R10	N/A
6	High Ground	1123024000102R11	N/A
7	High Ground	1123024000102R13	N/A
8	High Ground	1123024000102R15	N/A
9	High Ground	1123024000101L02	N/A
10	High Ground	1123024000101L03	N/A
11	Midsomer Norton Flood Relief Culvert	1123023910403R03	50-year
12	High Ground	1123024000102R02	N/A
13	High Ground	1123024000101L05	N/A
14	Midsomer Norton Flood Relief Culvert	1123024000101R03	50-year
15	Midsomer Norton Flood Relief Culvert	1123024000102L01	50-year
16	Midsomer Norton Flood Relief Culvert	1123024000102L02	50-year
17	High Ground	1123024000102L04	N/A
18	High Ground	1123024000102L07	N/A
19	High Ground	1123024000102L08	N/A
20	High Ground	1123024000102L09	N/A
21	Midsomer Norton Flood Relief Culvert	1123024000102L10	50-year
22	High Ground	1123024000102R01	N/A
23	High Ground	1123024000104L02	N/A
24	High Ground	1123024000103L02	N/A
25	High Ground	1123024000101L01	N/A
26	Midsomer Norton Flood Relief Culvert	1123024000101R02	50-year
27	High Ground	1123024000101R07	N/A
28	High Ground	1123024000102L06	N/A
29	High Ground	1123024000102R09	N/A
30	Midsomer Norton Flood Relief Culvert	1123024000102R12	50-year
31	High Ground	1123024000101R06	N/A
32	High Ground	1123024000103L01	N/A
33	Midsomer Norton Flood Relief Culvert	1123024000103R01	50-year
34	High Ground	1123024000101R05	N/A
35	Midsomer Norton Flood Relief Culvert	1123024000101R04	50-year
36	High Ground	1123024000101L04	N/A
37	High Ground	1123024000103R02	N/A
38	High Ground	1123023910403R04	N/A
39	High Ground	1123023910403L02	N/A
40	High Ground	1123024000102L11	N/A
41	High Ground	1123024000101R01	N/A
42	Midsomer Norton Flood Relief Culvert	N/A	50-year

Figure 8-2: Flood defence structures located within Southfield and Fox Hills

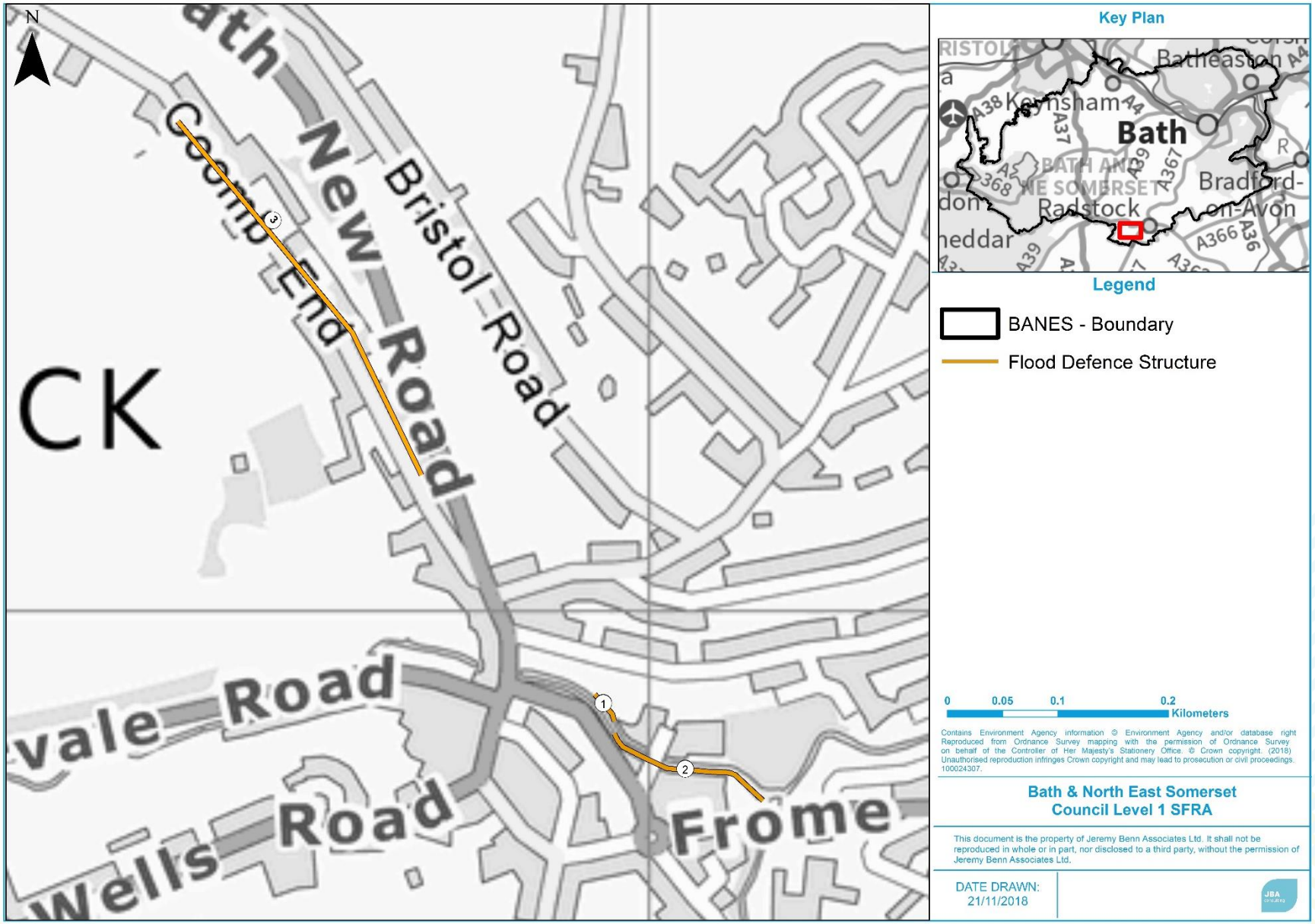


Table 8-4: Assets and Structures located within Radstock, Southfield

Defense ID	Asset Type	Asset Reference	Standard of Protection
1	Masonry Wall	n/a	100
2	Masonry Wall	n/a	100
3	Coombend Flood Relief Culvert	n/a	n/a

Figure 8-3: Flood defence structures located within West of Bath

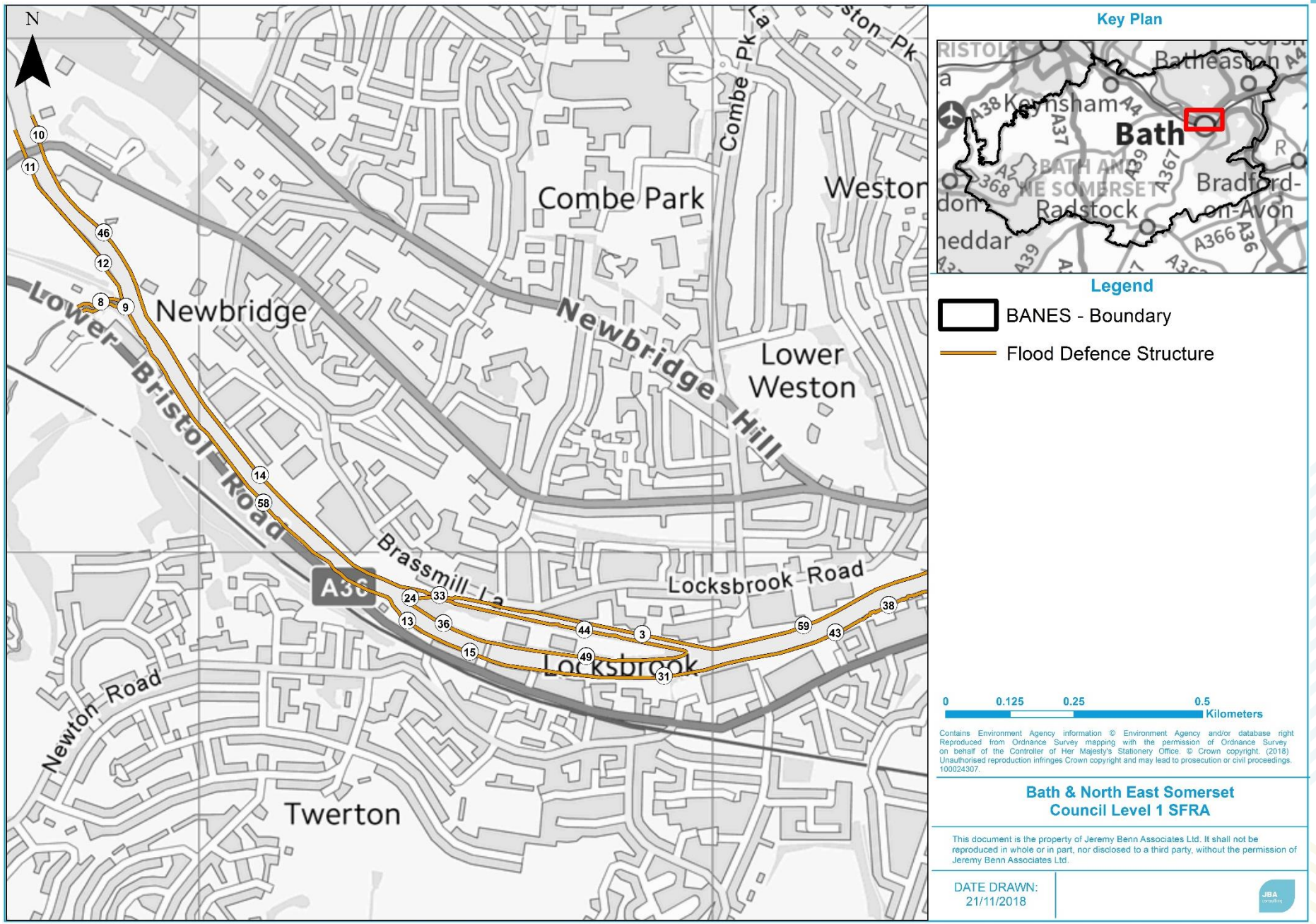


Figure 8-4: Flood defence structures located within East of Bath

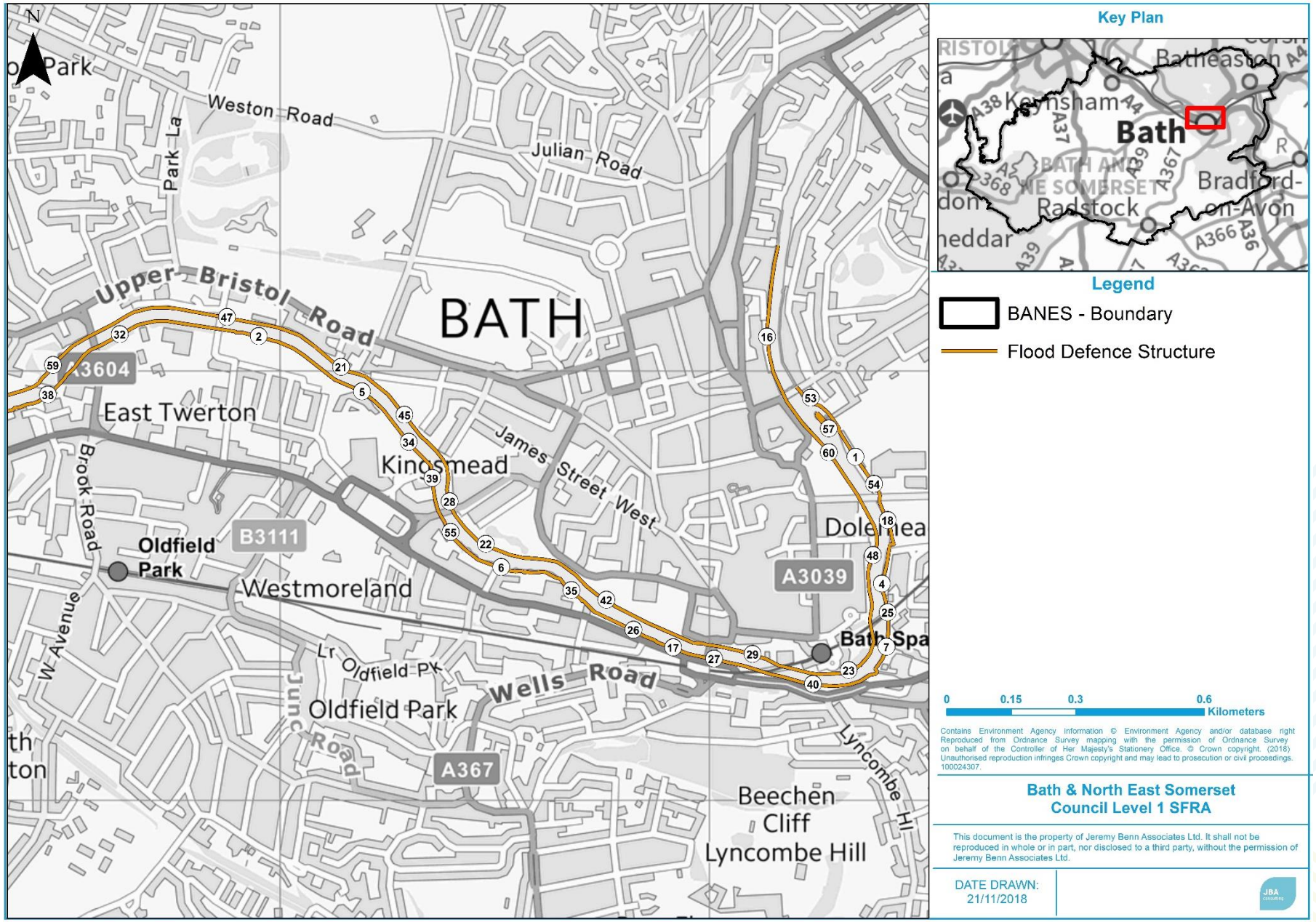
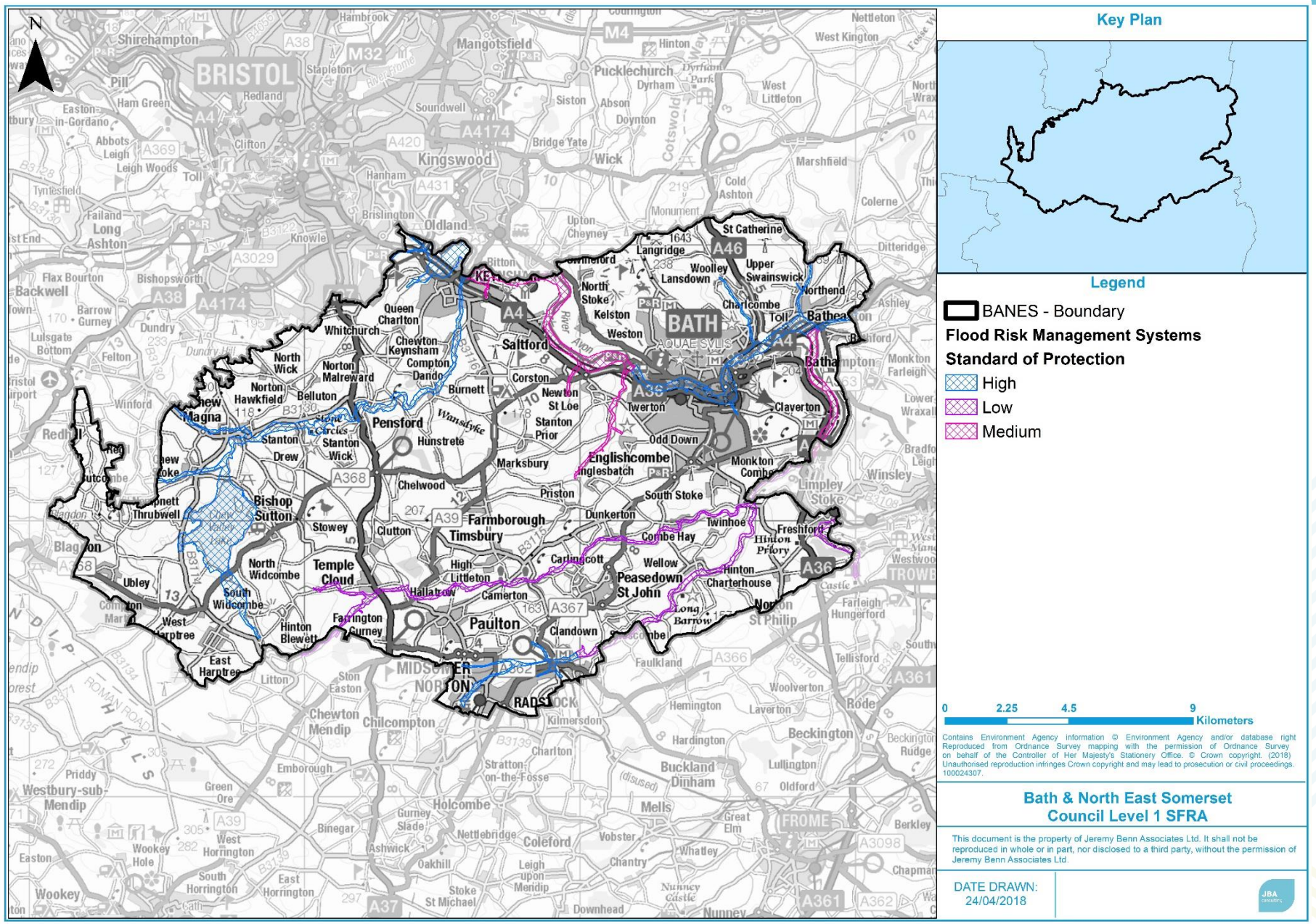


Table 8-5: Assets and Structures located within the centre of Bath

Defense ID	Asset Type	Environment Agency Asset Reference	Standard of Protection
1	Partially Stone Revetted Bank	1123020110901L01	5
2	Sheet Piling	1123020110802L06	25
3	Natural Bank	1123020110802R02	30
4	Masonry Faced Reinforced Concrete Wall	1123020110803L09	10
5	Sheet Piling	1123020110803L01	5
6	Natural Bank, open channel	1123020110803L04	100
7	Sheet Piling	1123020110803L07	5
8	Natural Bank, open channel	1123021310101L01	30
9	Natural Bank, open channel	1123021310101R01	30
10	Open Channel, natural bank	1123020110701R03	5
11	Natural Bank, open channel	1123020110702L01	5
12	Natural Bank, open channel	1123020110702L02	5
13	high_ground	1123020110801L02	100
14	Natural Bank, open channel	1123020110801R01	10
15	Concrete Wall	1123020110802L01	100
16	Walled Bank	1123020110901R03	n/a
17	Flood Wall	1123020110803L13	100
18	Masonry Faced Reinforced Concrete Wall	1123020110803L10	10
19	Masonry Wall	1123020110804L01	100
20	Masonry Wall	1123020110804L02	100
21	Natural Bank and concrete channel	1123020110804R01	10
22	Natural Bank and Concrete Channel	1123020110804R04	20
23	Concrete Wall and Steel Sheet Piling	1123020110804R07	100
24	Sheet Piling	1123020110805R01	100
25	Masonry Wall	1123020110803L08	30
26	Flood Wall	1123020110803L11	100
27	Masonry Wall	1123020110803L14	100
28	Natural Bank and concrete channel	1123020110804R03	30
29	Masonry Wall	1123020110804R06	100
30	Masonry Wall	1123020110901R02	100
31	Walled Bank	1123020110802L02	100
32	Concrete Wall	1123020110802L05	75
33	Masonry Wall	1123020110802R01	100
34	Concrete Wall	1123020110803L02	30
35	Masonry Wall	1123020110803L05	50
36	Concrete Wall	1123020110806R01	100
37	Masonry Faced Reinforced Concrete Wall	1123020110901L02	10
38	Natural Bank, open channel	1123020110802L04	30
39	Sheet Piling	1123020110803L03	50
40	Walled Bank	1123020110803L06	100
41	Flood Wall	1123020110803L12	100
42	Walled Bank	1123020110804R05	100
43	Natural Bank, open channel	1123020110802L03	100

Defense ID	Asset Type	Environment Agency Asset Reference	Standard of Protection
44	Natural Bank, open channel	1123020110804L03	100
45	Natural Bank, open channel	1123020110804R02	30
46	Natural Bank, Open Channel	1123020110701R04	5
47	Natural Bank and concrete channel	1123020110803R02	10
48	Natural Bank, Open Channel	1123020110804R08	5
49	Partially Stone Revetted Bank	1123020110806R02	100
51	Concrete Wall	1123020110805L01	100
52	Concrete Wall	1123020110805R02	100
53	Masonry Faced Reinforced Concrete Wall	1123020110901L08	20
54	Embankment	1123020110901L07	5
55	Sheet Piling	1123020110803L03A	100
56	Natural Bank and concrete channel	1123020110804R03A	10
57	Flood Wall	1123020110901L09	100
58	Natural Bank, open channel	1123020110801L01	30
59	Natural Bank, open channel	1123020110803R01	20
60	Partially Stone Revetted Bank	1123020110901R01	100

Figure 8-5 : System Asset Management Plans which cover B&NES



8.4 Areas Benefitting from defences

The Environment Agency has a dataset called "Areas Benefiting from Defences". This dataset for England shows those areas that benefit from the presence of defences in a 1 in 100 (1%) chance of flooding each year from rivers; or 1 in 200 (0.5 %) chance of flooding each year from the sea. No areas in Bath and North East England are identified by the Environment Agency to benefit from flood defences. It is important to note that the Environment Agency "Areas Benefiting from Defences" does not show all areas that benefit from defences.

8.5 Flood Risk Assessment considerations

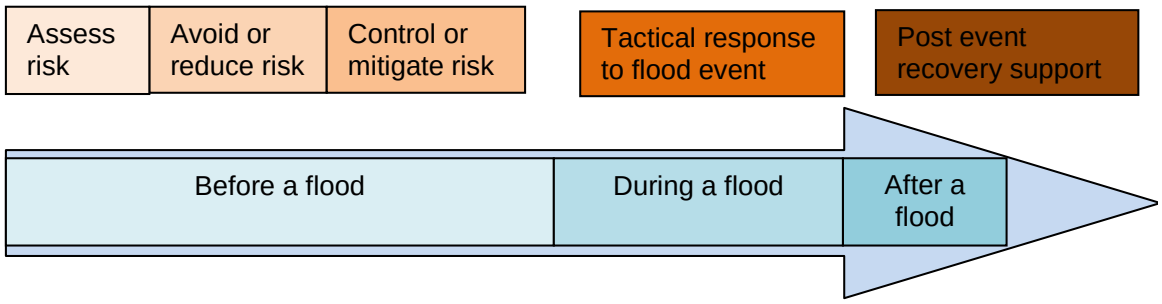
Flood Risk Assessments (FRAs) will need to thoroughly explore the condition of defences, especially where any defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

9 FRA requirements and flood risk management guidance

9.1 Using SFRA risk information

The SFRA contains information that can be used at strategic, operational and tactical levels as shown in Figure 9-1. The flood risk data contained within this SFRA should be updated following flood events.

Figure 9-1: Use of SFRA information



9.2 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within B&NES. Due to the strategic scope of the study, prior to any construction or development, site-specific assessments will need to be undertaken for individual development proposals (where required) so all forms of flood risk at a site are fully addressed. It is the responsibility of the developer to provide an FRA with an application.

It should be acknowledged that a detailed FRA may show that a site is not appropriate for development of a particular vulnerability or even at all. Where the FRA shows that a site is not appropriate for a particular usage, a lower vulnerability classification may be appropriate.

9.3 Requirements for site-specific flood risk assessments

9.3.1 What are site specific FRAs?

Site specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

Paragraph 068 of the NPPG Flood Risk and Coastal Change Planning Practice Guidance sets out a checklist for developers to assist with site specific flood risk assessments.

Site specific FRAs are required in the following circumstances:

- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)
- Proposals of 1 hectare or greater in Flood Zone 1
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding
- Proposals of less than one hectare in Flood Zone 1 where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water)

- It should be noted that proposed development next to watercourses or features on small catchments might not be shown to be within a Flood Zone, as no modelling or mapping has been prepared. In circumstances where it is considered there could be a risk that is not shown, an FRA should be prepared to define the Zones to enable the Sequential and if necessary the Exception Test to be performed.

9.3.2 Objectives of site specific FRAs

Site specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature and location of the development. Site specific FRAs should establish

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;
- the evidence, if necessary, for the local planning authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs for sites located in B&NES should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and B&NES. Guidance and advice for developers on the preparation of site specific FRAs include

- Standing Advice on Flood Risk (Environment Agency);
- Flood Risk Assessment for Planning Applications (Environment Agency); and
- Site-specific Flood Risk Assessment: CHECKLIST (NPPF PPG, Defra).

Guidance for local planning authorities for reviewing flood risk assessments submitted as part of planning applications has been published by Defra in 2015 – **Flood Risk Assessment: Local Planning Authorities.**

9.4 Flood risk management guidance – mitigation measures

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

9.4.1 Site layout and design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from flood zones, to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas. However, vehicular parking in floodplains should be based on the nature of parking, flood depths and hazard including evacuation procedures and flood warning.

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives.

Landscaping should ensure safe access to higher ground from these areas and avoid the creation of isolated islands as water levels rise.

9.4.2 Making space for water

The NPPF sets out a clear policy aim in Flood Zone 3 to create space for flooding by restoring functional floodplain.

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

The provision of a buffer strip can 'make space for water', allow additional capacity to accommodate climate change and ensure access to the watercourse and structures is maintained for future maintenance purposes.

It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

B&NES can use Section 106 agreements of the Town and Country Planning Act 1990 to use planning to manage flood risk; in line with the 'Making Space for Water' concept, Section 106 agreements can be put in place to ensure new SuDS features will be maintained in the future.

Catchment and floodplain restoration

Floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain. There are a number of culverted sections of watercourse located throughout the district which if returned to a more natural state would potentially reduce flood risk to the local area
- Apply the Sequential Approach to avoid new development within currently undefended floodplain.

For those sites considered within the Local Plan and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. Loss of floodplain connectivity in rural upper reaches of tributaries which flow through urban areas in the District, could potentially increase flooding within the urban areas. This will also negate any need to build flood defences within the sites. It is acknowledged that sites located on the fringes of urban areas within the district are likely to have limited opportunity to restore floodplain in previously developed areas.

9.4.3 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood.

If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable finished flood levels should be set a minimum of 600mm above the 1% AEP plus climate change peak flood level. The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Access should be situated 600mm above the design flood level and waterproof construction techniques used.

9.4.4 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution.

Temporary or demountable defences are not acceptable forms of flood protection for a new development.

9.4.5 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property; in most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary.

Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land or property.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment.

9.4.6 Developer contributions

In some cases, and following the application of the sequential test, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS). The LFRMS Action Plan reinforces that developers may be required to make necessary contributions to the cost of SuDS and flood risk management activities.

DEFRA's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[10] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the Council and the Environment Agency.

The appropriate route for the consideration of strategic measures to address flood risk issues is the LFRMS. The LFRMS should describe the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

The Environment Agency is also committed to working in partnership with developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions.

Community Infrastructure Levy

The Community Infrastructure Levy (CIL) allows local authorities to raise funds from developers undertaking new building projects in their administrative area. The CIL rate is set locally, within a Charging Schedule. The CIL can be used for a variety of local infrastructure needs arising from new development in the district including flood defences. Further information on CIL can be found on the Councils **website**.

9.5 Flood risk management guidance – resistance measures

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 1 in 1,000-year scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter

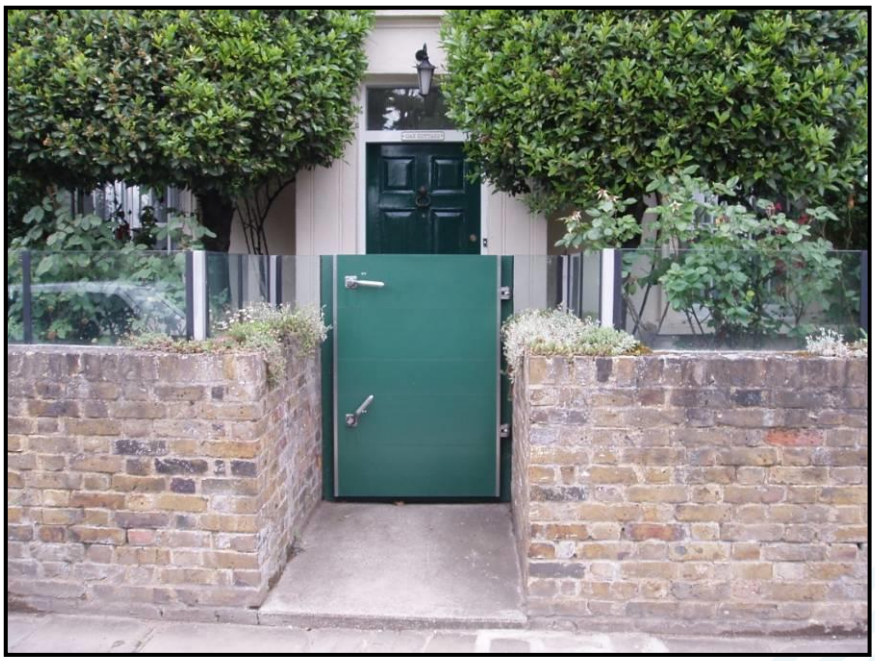
10 Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2012)

a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system to user the measures are deployed in advance of an event. The following measures are often deployed:

Permanent barriers

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

Figure 9-2: Permanent flood barriers



Temporary barriers

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

Community resistance measures

These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

9.6 Flood risk management guidance – resilience measures

Wet-proofing

Interior design to reduce damage caused by flooding, for example:

- Electrical circuitry installed higher level with power cables being carried down from the ceiling not up from the floor level.
- Water-resistant materials for floors, walls and fixtures.

If redeveloping existing basements new electrical circuitry installed higher level with power cables being carried down from the ceiling not up from the floor level to minimise damage if the basement floods.

Non-Return Valves

Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains, within the property's private sewer upstream of the public sewerage system. These need to be carefully installed and should be regularly maintained. The CIRIA publication, 'Low cost options for prevention of flooding from sewers', provides further information. Additionally, manhole covers within the property's grounds could be sealed to prevent surcharging.

Pumps

When redeveloping existing buildings it may be acceptable to install pumps in basements as a resilience measure against surface water or groundwater flooding. However, for new development this is unlikely to be considered an acceptable solution.

9.6.1 Chew Magna Property-level protection scheme

Such resilience measures have been implemented within Bath and North East Somerset as part of the Chew Magna Property-level protection scheme. Chew Magna is located within a rapid response catchment with challenging flood management issues. A total funding allocation of £325,000 by the end of the scheme in March 2011 had allowed for the provision of measures to 69 properties across Chew Magna – the largest of all Defra's Pilot Schemes and was recognised as a good example of all partners working positively together to find solutions to reduce flood risk in a challenging location. A summary of the protection measures installed in the 69 properties is given in Table 9-1. Further information is provided within the **Chew Magna PLP Evaluation Report (2013).**

Table 9-1: Summary of property-level protection measures provided to 69 properties in Chew Magna

Protection Measure	Number provided
Single Door Flood Barriers	136
Double Door Flood Barriers	80
Window Flood Barriers	32
Self Closing Airbricks	374
Non-return Valves (in sewers)	42
Non-return Valves (other)	157
Toilet Bungs	64
Sump & Pump	2
External Wall Treatment (Waterstop)	69

9.6.2 Further guidance

The Environment Agency recommend that consideration is given to the use of flood proofing measures to reduce the impact of flooding if / when it occurs. To minimise the disruption and cost implications of a flood event the Environment Agency encourage development to incorporate flood resilience/resistance measures up to the 1 in 1,000-year (extreme) event plus climate change flood level. Both flood resilience and resistance measures can be used for flood proofing. Further information can be found

in the following publications: **'Improving the flood performance of new buildings' and 'Prepare your property for flooding'**.

9.7 Reducing flood risk from other sources

9.7.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution.

9.7.2 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and the wider area. It is important that a drainage impact assessment shows that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk.

When redeveloping existing buildings, the installation of some permanent or temporary flood-proofing and resilience measures could protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.

9.7.3 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of greenfield surface water drainage by encouraging water to flow along natural flow routes and thereby reduce runoff rates and volumes during storm events while providing some water treatment benefits. SuDS also have the advantage of providing effective blue and green infrastructure and ecological and public amenity benefits when designed and maintained properly.

The 2018 NPPF states that: 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165). Further information on SuDS is available in Section 9.

The inclusion of SuDS within developments should be seen as an opportunity to enhance ecological and amenity value, and promote green infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. Advice on best practice is available from the **West of England Sustainable Drainage Developer Guide (2015)** and the **Construction Industry Research and Information Association (CIRIA)'s SuDS Manual**.

10 Surface water management and SuDS

10.1 What is meant by surface water flooding?

Surface water flooding includes

- **pluvial flooding**: flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- **overland flows entering the built up area from the rural/urban fringe**: includes overland flows originating from groundwater springs.
- **To be classed as surface water flooding it must not have entered a watercourse, drainage system or public sewer**.

10.2 Role of the LLFA and Local Planning Authority in surface water management

From April 2015 local planning policies and decisions on planning applications relating to major development or major commercial development should ensure that Sustainable Drainage Systems for management of run-off are put in place as the LLFA encourages a sustainable approach to surface water drainage. The approval of sustainable drainage solution lies with the Local Planning Authority. B&NES encourages all developers to consider drainage and flood risk at an early stage and suggests developers consider the Council's Pre-application Advice service.

B&NES is the lead Local Flood Authority and is a Statutory Consultee for major planning applications and will scrutinise applications in terms of surface water flood risk and sustainable drainage.

Major developments are defined as

- residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of one hectare or more.

The LLFA will also provide advice on minor development on a non-statutory basis.

When considering planning applications, local planning authorities should seek advice from the relevant flood risk management bodies, principally the LLFA on the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime.

When applications for development are submitted, B&NES encourages developers to consider the following guidance and legislation:

Surface water drainage guidance for development

- **West of England Sustainable Drainage Developer Guide** (West of England Partnership, 2015)
- **Bath & North East Somerset Council's Surface Water Management Plan**
- **Non-statutory technical standards for sustainable drainage systems** (Department for Environment, Food & Rural Affairs, 2015)

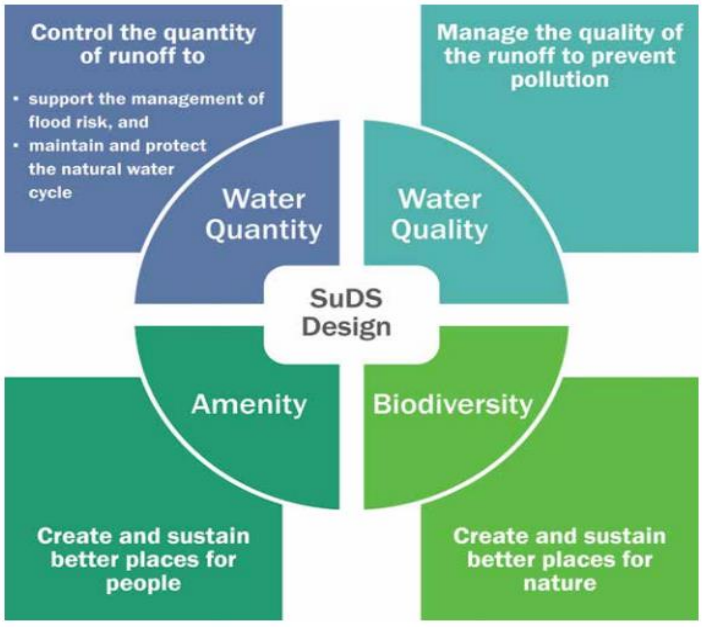
- **Planning Practice Guidance** (Department for Communities and Local Government)
- **Environment Agency Local Flood Risk Standing Advice for Bath & North East Somerset** (Environment Agency, 2014)

Surface water drainage policies and legislation for development

- **National Planning Policy Framework** (Paragraph 103)
- **Sustainable drainage systems: Written statement** (HCWS161)
- **Building Regulations Part H** – Drainage and Waste Disposal
- **Bath & North East Somerset Council's Core Strategy**: Policy CP5 Flood Risk Management and CP7 Green Infrastructure

Judgement on what SuDS system would be reasonably practicable should be through reference to Defra's **'Non-statutory technical standards for SuDS' document** and should take into account design and construction costs.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These four principles are shown in Figure 10-1.



Source: The SuDS Manual (C753)

Figure 10-1: Four pillars of SuDS design

10.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are designed to maximise the opportunities and benefits that can be secured from surface water management practices.

SuDS provide a means of dealing with the quantity and quality of surface water whilst offering additional benefits over traditional systems of improving amenity and biodiversity. The correct use of SuDS can also allow developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing ground water supplies. SuDS if properly designed can improve the quality of life within a development offering addition benefits such as:

- Improving air quality

- Regulating building temperatures
- Reducing noise
- Providing education opportunities
- Cost benefits over underground piped systems

Given the flexible nature of SuDS they can be used in most situations within new developments as well as being retrofitted into existing developments. SuDS can also be designed to fit into the majority of spaces. For example, permeable paving could be used in parking spaces or rainwater gardens into traffic calming measures.

If is a requirement for all new major development proposals to ensure that Sustainable Drainage Systems for management of runoff are put in place. Likewise, minor developments should also ensure sustainable systems for runoff management are provided. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

10.3.1 Types of SuDS System

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 10-1). Techniques can include soakaways, infiltration trenches, permeable pavements, grassed swales, green roofs, ponds and wetlands and these do not necessarily need to take up a lot of space. The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Construction Industry Research and Information Association (CIRIA) e.g. **the CIRIA SuDS Manual C753 (2015)**.

Table 10-1: Examples of SuDS techniques and potential benefits

SuDS Technique	Flood Reduction	Water Quality Treatment & Enhancement	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds	✓	✓	✓
Constructed wetlands	✓	✓	✓
Balancing ponds	✓	✓	✓
Detention basins	✓	✓	✓
Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices	✓	✓	✓
Soakaways	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements	✓	✓	
Tanked systems	✓		
Over-sized pipes/tanks	✓		
Storm cells	✓		

10.3.2 Treatment

A key part of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the "SuDS management train". To maximise the treatment within SuDS, CIRIA recommends[11] the following good practice is implemented in the treatment process:

- **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.
- **Treat surface water runoff on the surface:** This allows treatment performance to be more easily inspected and managed. Sources of pollution and potential flood risk is also more easily identified. It also helps with future maintenance work and identifying damaged or failed components.
- **Treat a range of contaminants:** SuDS should be chosen and designed to deal with the likely contaminants from a development and be able to reduce them to acceptably low levels.
- **Minimise the risk of sediment remobilisation:** SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than what the component may have been designed.
- **Minimise the impact of spill:** Designing SuDS to be able to trap spills close to the source or provide robust treatment along several components in series.

The number of treatment stages required depends primarily on the source of the runoff. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

10.3.3 SuDS Management

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. Collectively this concept is described as a SuDS Management Train (Figure 10-2). The number of treatment stages required within the Management Train depends primarily on the source of the runoff and the sensitivity of the receiving waterbody or groundwater. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

11 C753 CIRIA SuDS Manual (2015)

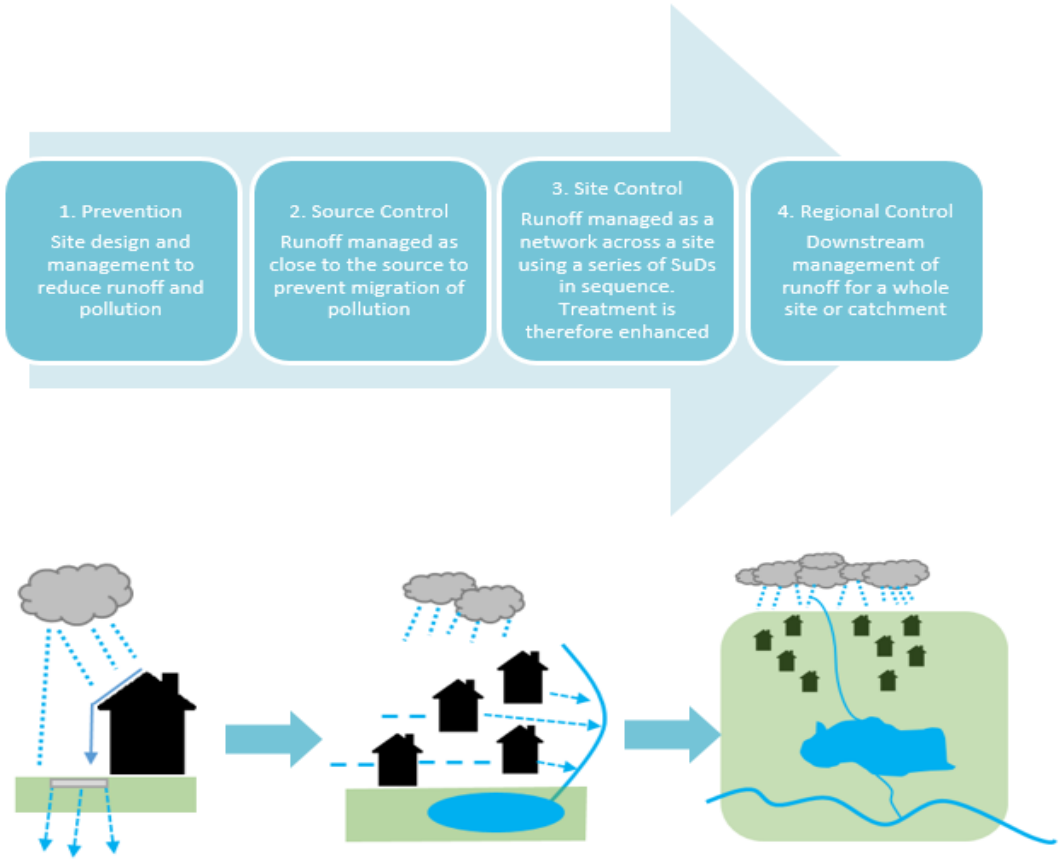


Figure 10-2: SuDS management train

SuDS components should be selected based on design criteria and how surface water management is to be integrated within the development and landscaping setting. By using a number of SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development.

10.3.4 Overcoming SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Table 10-2 details some possible constraints and how they may be overcome.

Table 10-2: Example SuDS design constraints and possible solutions

Considerations	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example, features such as permeable paving and green roofs can be used in urban areas where space may be limited.
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.

Considerations	Solution
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable line or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table.
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Facts such as siltation after a flood event should also be taken into account during the design phase.
Future adoption and maintenance	Local Planning Authority should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to groundwater protection zones (GSPZs) or aquifers, further restrictions may be applicable, and guidance should be sought from the LLFA and the Environment Agency.

10.4 Sources of SuDS guidance

West of England Sustainable Drain Developer Guide (2015) is the local SuDS guidance for B&NES. This document also contains standards and should be read alongside the national non-statutory standards. B&NES is part of a local authority's partnership with Bristol City, North Somerset and South Gloucestershire. A sustainable approach to drainage is adopted to mitigate the potential impact of new development upon flood risk and so resilience against flooding is obtained.

10.4.1 C753 CIRCA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual (2015)**[12] replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA

[12] C753 CIRIA SuDS Manual (2015):

http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

utilise the information within the manual to help design SuDS which are appropriate for a development.

10.4.2 Surface Water Advice Note – Using SuDS on new developments (June 2015)

When considering SuDS as part of a major planning application, local planning authorities need to satisfy themselves that the minimum standard of operation is appropriate for SuDS and ensure through the use of planning conditions that clear arrangements are in place for their ongoing maintenance over the lifetime of the development.

The NPPF expects local planning authorities to give priority to the use of SuDS in determining planning applications. Where SuDS are used, it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems. This is a material planning consideration for all major applications as of the 6 April 2015 and should therefore be given full consideration in an application.

10.4.3 Non-Statutory Technical Guidance, Defra (March 2015)

Non-Statutory Technical guidance has been developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released providing amendments as to what is expected by the LPA to meet the National standards. The guidance provides a valuable resource for developers and designers outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations. It considers the following: flood risk inside and outside the development, peak flow, volume control, structural integrity, designing for maintenance considerations and construction.

The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable.

10.5 Other surface water considerations

10.5.1 Groundwater Vulnerability Zones

The Environment Agency have published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise the underlying bedrock. The maps show the vulnerability of groundwater at a location based on the hydrological, hydrogeological and soil properties within a one-kilometre grid square.

Two maps are available:

- Basic groundwater vulnerability map: this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability
- Combined groundwater vulnerability map: this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas.

10.5.2 Groundwater Source Protection Zones (GSPZ)

In addition to the AStGWF data the Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- Zone 1 (Inner Protection Zone) – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- Zone 1c (Inner zone – subsurface activity only) – Extends Zone 1 where the aquifer is confined and may be impacted by deep drilling activities
- Zone 2 (Outer Protection Zone) – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction
- Zone 2c (Outer Protection Zone – subsurface activity only) – Extends Zone 2 where the aquifer is confined and may be impacted by deep drilling
- Zone 3 (Total Catchment) - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management
- Zone 3c (Total Catchment – subsurface activity only) – Extends Zone 3 where the aquifer is confined and may be impacted by deep drilling activities
- Zone 4 (Zone of special interest) – A fourth zone SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone

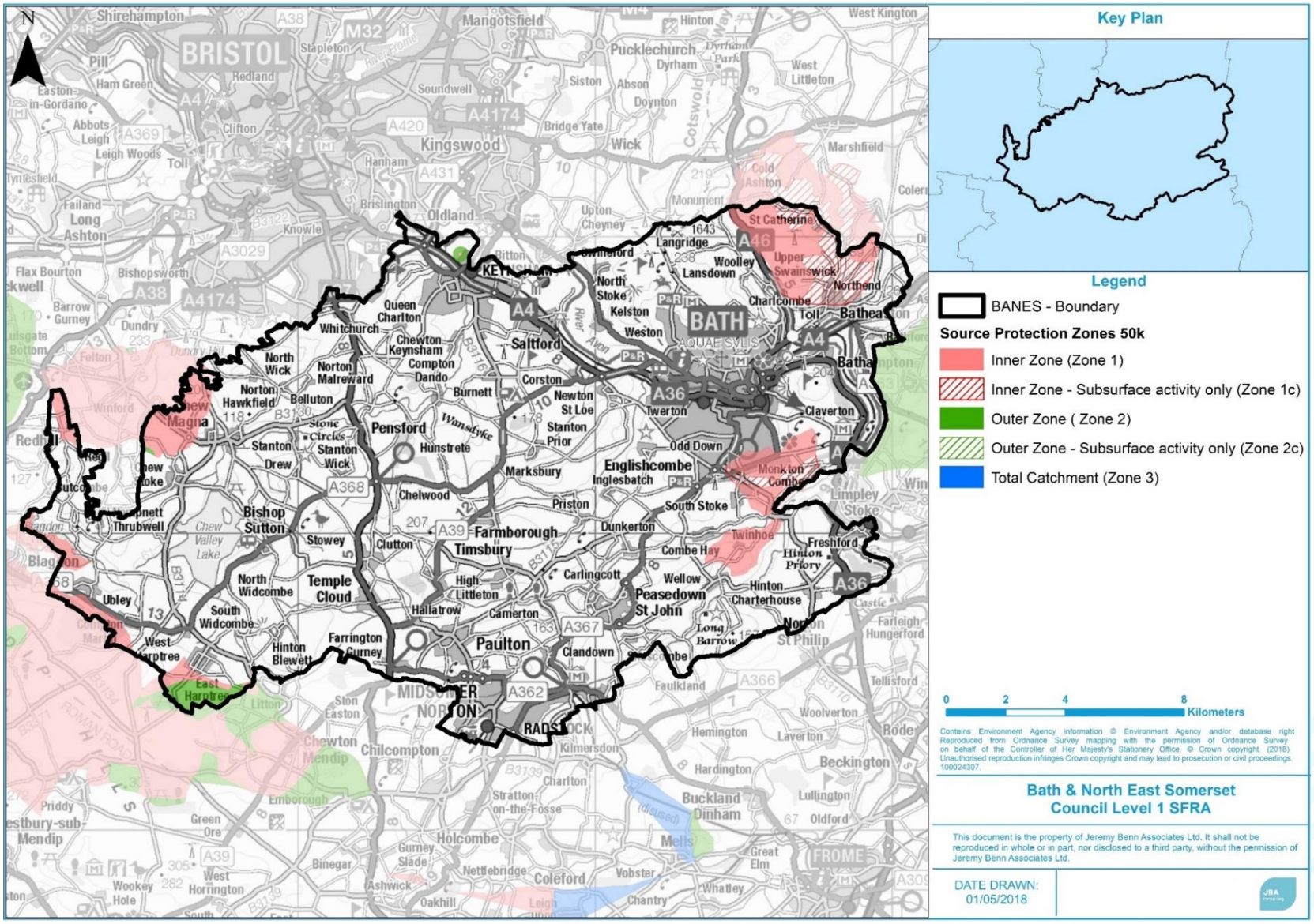
A number of GSPZs have been identified through Bath and North East Somerset with the locations of Groundwater SPZs displayed in Figure 10-3.

As shown in Appendix K, the study areas is underlain by principal aquifers in the eastern region of BANES as well as small clusters in the south west, north west and norther east corners of the study area. The water resources in these areas may be at risk from development in areas outside of groundwater PSC e.g. private supplies, may not have associated Groundwater SPZ.

Where sites lie within or close to Groundwater Source Protection Zones (SPZs) or are underlain by an aquifer, treatment steps may be required ahead of discharge to the ground, sewers etc. Development proposals at sites across the area should assess the pollution risk to receiving waterbodies and include appropriate treatment steps ahead of any discharge to surface water or groundwater. **Chapter 8 of the CIRIA SuDS Manual C753 (2015)** provides information and guidance on how to design SuDS in areas with particular constraints. Further restrictions may be applicable, and guidance should be sought from the LLFA. Where potentially polluting activities are proposed, the Environment Agency should also be consulted.

Where development is located in a SPZ, it is recommended that consultation with the relevant stakeholders (e.g. the EA for pollutant matters and the LLFA for SuDS) is undertaken as early as possible.

Figure 10-3: Location of Environment Agency Source Protection Zone



10.5.3 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies. The level of nitrate contamination will potentially influence the choice of SuDS and should be assessed as part of the design process. The definition of each NVZ is as follows:

- Groundwater NVZ – water held underground in the soil or in pores and crevices in rock, which has, or could have if action is not taken, a nitrate concentration greater than 50mg/l.
- Surface Water NVZ – areas of land that drain into a freshwater water body which has, or could have is action is not taken, a nitrate concentration greater than 50mg/l.
- Eutrophic NVZ – bodies of water, mainly lakes and estuaries, that are, or may become, enriched by nitrogen compounds which cause a growth of algae and other plant life that unbalances the quality of the water and to organisms present in the water.

As with Groundwater SPZs, NVZs could affect the suitability of surface water drainage features and the level of treatment required. No groundwater NVZs occupy areas of Bath and North East Somerset.

11 Strategic flood risk solutions

11.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the district. The following sections outline different options which could be considered for strategic flood risk solutions. Any strategic solutions should ensure they are consistent with wider catchment policy and the local policies set out by B&NES.

11.2 Land Consent for Ordinary Watercourses

If you wish to undertake work on a watercourse then you will require permission from the appropriate authority. This depends on whether the watercourse is classed as a Main River or an Ordinary Watercourse. Watercourses that are classed as Main River require consent from the Environment Agency. Ordinary Watercourses are watercourses that are not Main River, such as streams, drains and ditches. Work affecting Ordinary Watercourses may require consent from Bath & North East Somerset Council.

Only certain types of works, under the Land Drainage Act, require consent such as constructing or altering a mill, dam, weir, and any culvert which is likely to obstruct the flow of water. Both permanent and temporary works affecting the flow of a watercourse may require consent.

Further information regarding land consent for work upon watercourses can be located on BANE's **website**.

11.3 Flood storage schemes

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[13]:

- enlarging the river channel;
- raising the riverbanks; and/or
- constructing flood banks set back from the river.

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

11.3.1 Promotion of SuDS

Surface water flood risk is present in the area. By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. Regionally SuDS should be implemented on all new developments to ensure the quantity and quality of surface water is dealt with sustainably to reduce flood risk. Given the various policies and guidance available on SuDS, developers should use this information to produce technically proficient and sustainable drainage solutions that conform with the non-statutory standards for SuDS (2015).

The design and implementation of SuDS schemes should, where appropriate take consideration of the potential cumulative effects of land allocated for development and

13 http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter10.aspx?pagenum=2

application proposals. This will be particularly relevant if there are locations downstream of proposed development that are already at high risk of flooding, or where the risk could become higher under climate change conditions. In such circumstances the assessment should take account of the cumulative effects and if appropriate identify strategic provisions (or land required) to mitigate potential adverse effects.

11.4 Catchment and Floodplain restoration

Compared to flood defences and flood storage, floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures are recommended to be adopted following consultation with the EA:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain.
- Apply the Sequential Approach to avoid new development within the floodplain.

For those sites considered within the Local Plan and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. Loss of floodplain connectivity could potentially increase flooding.

11.4.1 Upstream natural catchment management

Opportunities to work with natural processes to reduce flood and erosion risk as well as benefit the natural environment and reduce costs of schemes should be sought, through integrated catchment management. It also requires partnership working with neighbouring authorities, organisations and water management bodies. The EA has developed **Natural Flood Management mapping** which displays opportunities for NFM.

Consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example. With flood prevention schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

11.4.2 Structure Removal and/ or modification (e.g. Weirs)

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers including alterations to the geomorphology and hydraulics of the channel through water impoundment and altering sediment transfer regime, which over time can significantly impact the channel profile including bed and bank levels, alterations to flow regime and interruption of biological connectivity, including the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring

natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

In the case of weirs, whilst weir removal should be investigated in the first instance, in some cases it may be necessary to modify a weir rather than remove it. For example, by lowering the weir crest level or adding a fish pass. This will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

For removal of structures and/ or modifications, consent will be required for structures on both main rivers and ordinary watercourse structures.

11.4.3 Bank Stabilisation

Bank erosion should be avoided, and landowners encouraged to avoid using machinery and vehicles close to or within the watercourse.

There are several techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spilling, can be particularly effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils.

11.4.4 Re-naturalisation

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

11.5 Flood defences

Flood mitigation measures should only be considered if, after application of the Sequential Approach, development sites cannot be located away from higher risk areas. If defences are constructed to protect a development site, it will need be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

11.6 Flood mitigation schemes to address cumulative effects

It might be necessary to consider strategic schemes to address the potential cumulative effects of proposed allocations. Usually such schemes would be identified at locations where flood risk to existing communities was predicted to be exacerbated by proposed development. In such circumstances the provision of mitigation measures on land at the respective allocation sites might not be capable of providing for appropriate levels of mitigation to address cumulative effects and so strategic measures would be required.

12 Summary

12.1 Overview

This Level 1 SFRA delivers a strategic assessment of all sources of flooding in Bath and North East Somerset. An overview of policy and guidance is provided for planners and developers. The study area comprises of the administration are of Bath and North East Somerset.

The dominant flood source found to be affecting the B&NES study area is fluvial flood risk from rivers originating from the principal watercourses of the Lower Avon, River Chew, Cam Brook and Wellow Brook. Additional, flood incidents form other sources such as surface water and sewer flood incidents are also shown to be a significant within B&NES. There is an holistic nature in the occurrence of flood incidents, for example some historical sewer flood incidents being associated with high river levels. Flooding from artificial sources such as sewer incidents is of high importance due to the severity of the impacts which occur as a result.

12.2 SFRA summary

12.2.1 Sources of flood risk

The main areas identified to be at flood risk within B&NES are:

- Bath – At risk to a combined number of flooding sources: Fluvial, artificial (sewer), surface water and groundwater flooding from springs.
- Keynsham – At risk from fluvial flooding which can also be tidally influenced, surface water flooding, sewer and artificial sources
- Midsomer Norton/Radstock – At risk from fluvial flooding, surface water and sewers
- Chew Magna and associated downstream communities – At risk from fluvial flooding, surface water and artificial sources.

12.2.2 Flood Defences

A number of defences are location within the settlements of Bath, Midsomer Norton and Radstock to protect these areas from fluvial flooding. The standard of protection for these defences as well as the condition is outlined within the review in this document. The residual risk of flood defences failing or being overtopped should be considered as part of a detailed site-specific FRA.

12.2.3 Climate change

The NPPF and accompanying Planning Practice Guidance set out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. The Environment Agency published **updated climate change guidance** on 19 February 2016 (further updated on 3 February 2017), which supports the NPPF and must now be considered in all new developments and planning applications. The 2018 NPPF states that 'sequential approach should be used in areas known to be at risk now or in the future from any form of flooding' (para 158) in relation to the impacts of climate change. The Environment Agency has also published guidance to LPAs in the application of appropriate climate change allowances when considering climate change effects (updated April 2016 **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities**). The SFRA has considered the impact of climate change on fluvial, tidal and surface water flooding.

Climate change impacts will potentially increase the frequency and magnitude of storm events therefore resulting more frequent and higher magnitude flood events. Additionally, due to the tidal boundary being present up to Keynsham Weir, the very

furthest downstream extent of the B&NES area is also potentially vulnerable to climate change due to sea level rise as the tidal limit moves further inland, resulting in a higher tidal flood risk.

Areas which are most likely to experience the greatest increase in flood risk in the future due to climate change are:

- Bath – An increase in flood events due to more frequent and intense storm events resulting in an increase fluvial, surface water and sewer flood risk.
- Keynsham – An increase in flooding due to more frequent and intense storm events and therefore fluvial, surface water and sewer flood risk is expected to increase. Additionally, Fluvial flood risk is likely to become more tidally influenced due to sea level rise and thus movement of the tidal limit.
- Midsomer Norton/Radstock – An increase in fluvial, surface water and sewer flooding due to an increase in frequency and magnitude of storm events.
- Chew Magna – An increase in fluvial and surface water flooding due to an increase in frequency and magnitude of storm events.

A study into investigating areas which may become sensitive to climate change was conducted using vertical buffering methodology based upon existing flood zones and topographic data. These areas would require further analysis into the potential impact of climate change at the site-specific FRA stage of development applications.

12.2.4 Key policies

There are many relevant regional and local key policies which have been considered within the SFRA, such as the CFMPs, RBMPs, the PFRA and LFRMS. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

12.2.5 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and FRAs have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the LLFA and the Environment Agency.

The Sequential and Exception Test procedures for site-specific FRAs has been documented, along with guidance for planner and developers. Links have also been provided for various guidance documents and policies published by Bath and North East Somerset Council and the Environment Agency.

12.2.6 Relevant studies

There are many relevant regional and local key studies which complement the SFRA and have been considered within the writing of this document. These include the PFRA, LFRMSs, the SWMP and CFMPs. Other policy consideration have also been incorporated, such as sustainable development principles, climate change and flood risk management.

13 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA. Following this, several recommendations have been made for Bath and North East Somerset Council to consider as part of Flood Risk Management in the study area.

13.1 Development management

13.1.1 Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within Bath and North East Somerset. The 2018 NPPF now also states that strategic policies should also consider the 'cumulative impacts in, or affecting, local areas susceptible to flooding' (para 156), rather than just to or from individual development sites.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance. The revised 2018 NPPF states that: 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165).
- Relocating development to zones with lower flood risk
- A ground investigation should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.
- Creating space for flooding – include consideration of Green Infrastructure to provide mitigation and risk reduction for surface water flooding.

13.1.2 Site-specific flood risk assessments

Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, to provide supplementary evidence to enable the Sequential Test to be performed and to demonstrate the development passes part b of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk. Any flood risk management measures should be consistent with the wider catchment policies set out in the CFMP, FRMPs and LFRMS.

13.1.3 Sequential and Exception tests

The SFRA has identified areas that are at high risk of flooding from multiple sources. Therefore, several proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Developers should consult with Bath and North East Somerset Council, the Environment Agency and Wessex Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed overland flow modelling, consideration of climate change and drainage assessment and design.

13.1.4 Council review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding. When considering planning permission for developments, planners may wish to consider the following:

- Will the natural watercourse system which provides drainage of land be adversely affected?
- Will a minimum 8m width access strip be provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses), for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits?
- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up?
- Have SuDS been given priority as a technique to manage surface water flood risk?
- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk?
- Is the application compliant with the conditions set out by the LLFA?

13.1.5 Drainage strategies and SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan. Wherever possible, SuDS should be promoted:

- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration, and the LLFA's SuDS guidance and requirements
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure

13.1.6 Cumulative impact of development

The cumulative impact of development should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk.

13.1.7 Residual risk

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage. They should seek to contact the reservoir owner to obtain information and should apply the sequential approach to locating development within the site. Developers should also consult with relevant authorities regarding emergency plans in case of reservoir breach.

Any development within the vicinity of either of the canals flowing through the district should consider the residual risk from the canal, including the possibility of breach. Consideration should be given to the potential for safe access and egress in the event of rapid inundation of water due to a breach with little warning.

13.1.8 Safe access and egress

Safe access and egress will need to be demonstrated at all development sites and emergency vehicular access should be possible during times of flood. Where development is located behind flood defences, consideration should be given to the potential safety of the development, finished floor levels and for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning. Resilience measures will be required if buildings are situated in the flood risk area. Finished Floor Levels should be 600mm above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

13.1.9 Future flood management

- Development should take a sequential approach to site layout
- Upstream storage schemes are often considered as one potential solution to flooding. However, this is not a solution for everywhere. Upstream storage should be investigated fully before being adopted as a solution
- Floodplain restoration represents a sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state.

13.1.10 Potential modelling improvements

The Environment Agency regularly reviews its flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

13.1.11 Updates to SFRA

SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. This SFRA has been developed using the best available information, supplied at the time of preparation. This relates both to the current risk of flooding from all sources and the potential impacts of future climate change. The Environment Agency regularly reviews its flood risk mapping and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA. Other datasets used to inform this SFRA mat also be periodically updated and following the publication of this SFRA, new information on flood risk may be provided by Risk Management Authorities.

Appendices

A Appendix A – Climate Change Sensitivity Mapping

B Appendix B – Climate Change Sensitivity Technical Note

C Appendix C – Wessex Water Sewer Flood Incident Map

D Appendix D – EA Recorded Flood Outlines

E Appendix E – Topography

F Appendix F – Superficial deposits

G Appendix G – Bedrock

H Appendix H – Watercourses and Catchments

I Appendix I – Flood Zones

I.b Appendix I.b Flood Zone Grids

J Appendix J – Surface Water Flooding

J.b Appendix J.b Surface Water Flooding Grids

K Appendix K – Groundwater Vulnerability

L Appendix L – Flood Warning and Alerts

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