Bedford Borough Council Level 2 Strategic Flood Risk Assessment

Final Report

May 2022

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Contract

This report describes work commissioned by Bedford Borough Council by an email dated 24 August 2021. Louise Goode, Edmund Mumford, Alex Clark and Dularee Goonetilleke of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

We would like to acknowledge the assistance of:

- Bedford Borough Council
- Environment Agency
- Anglian Water
- Canal and River Trust; and
- Planners at the neighbouring authorities

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Executive summary

Introduction and context

This Level 2 (L2) Strategic Flood Risk Assessment (SFRA) document was created with the purpose of supporting the production of the Bedford Borough Council Local Plan. It follows on from the Level 1 SFRA completed in 2020. This L2 SFRA assesses sites in Bedford Borough Council authority area only.

It involves the assessment of a wide range of proposed development sites of which there are 22 being assessed in this Level 2 assessment. This 2022 Level 2 SFRA has updated information on flood data and recommendations for the cumulative impact of development.

The 2020 Level 1 SFRA should be consulted for Planning Framework and Flood Risk policy, and Planning Policy for Flood Risk Management.

SFRA objectives

The Government's Planning Practice Guidance (PPG) on Flood Risk and Coastal Change advocates a tiered approach to risk assessment and identifies the Level 1 and Level 2 assessments.

The aim of the Level 2 assessment is to build on identified risks from Level 1 for proposed development sites, to provide a greater understanding of fluvial, surface water, groundwater, and reservoir related flooding risks to the sites. From this the Local Council and Developers can make more informed decisions and pursue development in an effective and efficient manner. The Level 2 assessment also identifies sites for further risk analysis at the site-specific Flood Risk Assessment (FRA) stage.

Level 2 SFRA outputs

The Level 2 assessment includes detailed assessments of the proposed site options. These include:

- An assessment of all sources of flooding including fluvial flooding, surface water flooding, groundwater flooding, mapping of the functional floodplain and the potential increase in fluvial flood risk due to climate change.
- Reporting on current conditions of flood defence infrastructure, where applicable.
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff.
- Advice on whether it is possible to implement development at the sites in accordance with the requirements of the second part of the Exception Test with regards to flood risk and on the requirements for a site-specific FRA.

Summary of Level 2 SFRA

Bedford Borough Council provided 472 sites for assessment. These were chosen through a combination of a site's potential for allocation and its flood risk as determined through the site assessment process. These sites were screened against flood risk datasets (Flood Zones, latest fluvial modelling, national surface water mapping, Surface Water Management Plan mapping and hotspots) to assess how many should appropriately be carried forward to a Level 2 SFRA assessment. In total, 35 sites were carried forward to a Level 2 assessment, and lower risk sites are also flagged in this report with general recommendations for developers. Eighteen (18) detailed site summary tables and GeoPDF mapping have been produced for the 35 sites as provided in Appendix A, as some sites were grouped into single assessments.

The summary tables set out the details of the actual flood risk at each site, including maps of extent, depth and velocity of flooding as well as hazard mapping for the 100-year defended with climate change events, where modelled outputs were available. Where there were no hydraulic models present, Flood Zone 2 was used as indicative extent for fluvial climate change and the 1,000-year surface water extent as an indication of surface water climate change. The surface water mapping depth and velocity data was also used as an indication of flood risk for small watercourses. Each table sets out the NPPF requirements for the site as well as guidance for site-specific FRAs. A broad scale assessment of suitable SuDS options has been provided, giving an indication where there may be constraints to certain types of SuDS techniques.

To accompany each site summary table, there is an Interactive GeoPDF map, with all the mapped flood risk outputs as these affect the respective sites. This is displayed centrally, with easy-to-use 'tick box' layers down the right-hand side and bottom of the mapping, to allow easy navigation of the data.

The following points summarise the Level 2 assessment:

- Roughly half of the sites with a detailed Level 2 summary table are at fluvial flood risk. The degree of flood risk varies, with some sites being only marginally affected along their boundaries (e.g. more to immediate access), and other sites being more significantly affected within the site, such as Sites 524, 636, 638, 713, 907, 1005, and 3245. A number of sites were located along the main River Great Ouse, where detailed model outputs were available. 9 of the 18 whole site areas at fluvial risk were only partially covered by detailed models and the EA's Flood Zones were used to interpret the flood risk. These will require more detailed baseline investigations to inform sequential site layouts, SuDS possibilities, safe access, and egress and so on, as part of a site-specific Flood Risk Assessment at the planning application stage.
- Most sites at fluvial risk are also at risk from surface water flooding, with an additional 19 sites assessed solely due to the presence of surface water risk. Surface water risk sometimes aligns with floodplain topography from following topographic flow routes or may form isolated areas of ponding in depressions. Some flow paths may bisect sites. As a result, some sites not at fluvial risk were subject to a Level 2 assessment where surface water risk was deemed to be significant from professional judgement, for example site 1246. Surface water should also be considered when assessing safe access and egress to and from the site. This assessment reflects the requirement that all sources of flood risk are considered when performing the Sequential Test, as the L2 assessment for surface water addresses the "part b" requirements of the Exception Test.
- Fluvial climate change mapping indicates that flood extents will increase over the lifetime of proposed development. As a result, the depths, velocities, and hazard of flooding may also increase. The significance of the increase tends to depend on the topography of site and the percentage allowance used; future extents would be larger than Flood Zone 3, but maximum future extents are likely to be similar to Flood Zone 2. The Council and the Environment Agency require the 100-year plus 19%, 30% and 58% **climate change** fluvial scenarios to be considered in future developments for the 2080s epoch as of July 2021. The 1,000-year surface water flood extent can also be used as an indication of climate change to surface water risk. Site-specific FRAs should confirm the impact of climate change using latest guidance.
- Residual risk was considered at the sites. Blockage locations were determined by visual inspection of the OS mapping and ground topography in the vicinity of the site, to determine whether a structure upstream, downstream, or within the site could have an impact on the site. These would need to be considered further as part of a site-specific assessment.
- A strategic assessment was conducted of SuDS options using regional datasets and JBA's Groundwater map. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.

- For some sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles. Also, consideration should be given to whether the risk forms a flow path or bisects the site where access from one side to another may be compromised. The responsibility for putting appropriate arrangements in place would most appropriately rest with the Council and the commitment and obligations involved should be considered accordingly.

The following policy recommendations from the cumulative impact assessment (Appendix B) apply to all catchments within the study area ranked as medium or high:

- Bedford Borough should work closely with neighbouring Local Authorities and other LLFAs to develop complementary local planning policies for catchments that drain into and out of Bedford Borough through other local authorities in order to minimise cross boundary issues of cumulative impacts of development.
- Developers should incorporate SuDS and provide details of adoption, ongoing maintenance and management on all development sites. Proposals will be required to provide reasoned justification for not using SuDS techniques, where ground conditions and other key factors show them to be technically feasible. Preference will be given to systems that contribute to the conservation and enhancement of biodiversity and green infrastructure in the borough where practicable. Where development falls within an area covered by the Bedford Group of IDBs, then the relevant IDB should be consulted at the planning stage. The Flood Risk Assessments performed to support the development applications for allocated sites should address the implications of the loss of natural surface water storage, flow routes and infiltration and demonstrate that the loss of greenfield land does not result in a loss of the associated Natural Flood Management capacity.
- Bedford Borough Council as LLFA will review Surface Water Drainage Strategies in accordance with their local requirements for major and non-major developments. These should take into account all sources of surface water flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere.
- Runoff rates from all development sites must be limited to greenfield rates (including brownfield sites) for all sites, with a minimum target for 20% betterment, unless it can be demonstrated that this is not practicable. Developers should refer to the **Bedford Borough Council Supplementary Planning Document for Sustainable Drainage Systems** for the requirements for SuDS in Bedford, including Technical and Development Type-specific Guidance for Developers.
- Bedford Borough Council should consider requiring developers to contribute to community flood defences outside of their site boundary in these catchments to provide wider benefit and help offset the cumulative impact of development and in particular consider how such measures can address climate change effects that potentially exacerbates flood risk for existing communities.
- In respect of cumulative impact assessment, there are a number of development sites proposed that have the potential to provide a betterment to existing communities downstream within the catchment. However, all of these developments also have the potential to increase flood risk offsite if both National and Local SuDS Standards are not applied. As described, the development of greenfield land potentially reduces the natural storage capacity of the land and potentially affects the performance of surface water flow. SuDS offer a great potential to enhance the wider Green and Blue Infrastructure of the local area through integrated planning for flood risk, sustainable drainage, biodiversity, amenity and sustainable transport provision but consideration should also be given to the cumulative loss of storage afforded as part of Natural Flood Management to avoid adverse cumulative effects.

- Developers proposing windfall sites in the high-risk Cumulative Impact Assessment catchments should demonstrate through a site-specific FRA how SuDS and surface water mitigation techniques will ensure that development does not increase flood risk elsewhere and seeks to reduce flood risk to existing communities. The catchment-based Cumulative Impact Assessment has been updated using the latest available data for the Level 2 SFRA and supersedes the catchment-based assessment in the Level 1 SFRA.

At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses where there are no detailed hydraulic models currently available. This is to verify flood extent (including latest **climate change allowances)** to inform development zoning within the site and demonstrate, if required, whether the relevant part of the Exception Test can be passed.

For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the scope of the Exception Test, which would vary in accordance with the magnitude of the hazard and risk associated with each site. At planning application stage, the developer must design the site so that it is appropriately flood resistant and resilient in line with the recommendations in National and Local Planning Policy and supporting guidance and those set out in this SFRA.

For developments that have not been allocated in the Local Plan, developers must undertake the Sequential Test followed by the Exception Test (if required) and present this information to the Local Planning Authority for approval. The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should look into in more detail to inform the Exception Test for windfall sites.

It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific Flood Risk Assessment and drainage strategies with both the Local Planning Authority and the LLFA, to identify any potential issues that may arise from the development proposals.

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Abbreviations and glossary of terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability – The probability (expressed as a percentage) of a flood event occurring in any given year.
AStGWf	Areas Susceptible to Groundwater flooding
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CIA	Cumulative Impact Assessment
CIRIA	Construction Industry Research and Information Association
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EU	European Union
Exception Test	Set out in the NPPF, the Exception Test is a method used to demonstrate that flood risk to people and property will be managed appropriately, where alternative sites at a lower flood risk are not available. The Exception Test is applied following the Sequential Test.
FEH	Flood Estimation Handbook
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Map for Planning	The Environment Agency Flood Map for Planning (Rivers and Sea) is an online mapping portal which shows the Flood Zones in England. The Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences and do not account for the possible impacts of climate change.
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
FWA	Flood Warning Area
FWMA	Flood and Water Management Act: Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a river
FRA	Flood Risk Assessment - A site-specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRM	Flood Risk Management
Greenfield	Undeveloped parcel of land
Ha	Hectare
JBA	Jeremy Benn Associates
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority

Term	Definition
m AOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NRD	National Receptor Database
NRW	National Resources Wales
NVZs	Nitrate Vulnerability Zones
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity.
RBMP	River Basin Management Plan
ReFH	Revitalised Flood Hydrograph
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Riparian owner	A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
RMA	Risk Management Authority - Operating authorities who's remit and responsibilities concern flood and/or coastal risk management.
RoFfSW	Risk of Flooding from Surface Water (formerly known as the Updated Flood Map for Surface Water (uFMfSW)
Sequential Test	Set out in the NPPF, the Sequential Test is a method used to steer new development to areas with the lowest probability of flooding.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SPZ	(Groundwater) Source Protection Zone
Stakeholder	A person or organisation affected by the problem or solution or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques

Term	Definition
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWDS	Surface Water Drainage Strategy
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
URBEXT	Urban extent catchment descriptor, describing the level of urbanisation in a catchment.
WFD	Water Framework Directive – Under the WFD, all waterbodies have a target to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. River Basin Management Plans (RBMPs) set out the ecological objectives for each water body and give deadlines by when objectives need to be met.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

> ***"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 160)

This Level 2 Strategic Flood Risk Assessment (SFRA) 2022 document provides an assessment of sites allocated within the Bedford Borough authority area and was prepared in accordance with the 2021 National Planning Policy Framework (NPPF), as updated in July 2021 and Planning Practice Guidance (PPG) which has been updated through the course of its existence so this SFRA is in accordance with the latest guidance.

1.2 Levels of SFRA

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

- **Level One:** where flooding is not a major issue in relation to potential development sites and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
- **Level Two:** where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the National Planning Policy Framework's (NPPF) 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 requirements of a **Level 2** SFRA.

1.3 SFRA objectives

The objectives of this 2022 Level 2 SFRA are:

1. An initial assessment of all sites submitted through the call for sites, grading each with a 'Red, Amber, Green' label to determine the flood risk from multiple sources of each site. This will assist with the preparation of the sequential test (not included in the SFRA).
2. The provision of the flood risk components supporting the sequential test to the council so that it can determine a short list of sites that will need to be included in the exception test.
3. Re-running all fluvial models to take account of the latest climate change allowances, where required.
4. Applying climate change to surface water modelling for the 1 in 100 event.
5. Conducting at a strategic scale "part b" of the exception test as identified in national policy on the short list of sites identified by the council. The provision of detailed site summaries and maps to demonstrate flood risk.
6. Identification of potential mitigation and adaptation requirements for those sites to demonstrate that, if allocated, development would be safe for its lifetime without increasing flood risk elsewhere.
7. A report including a summary on the latest guidance and legislations relating to flood risk and its assessment; the methodology used to conduct the exception test; the mitigation/adaptation methods most suited to countering flood risk on the sites

the exception test has been applied to. Advice needs to be written in terms that neighbourhood plan groups can understand.

8. As part of the design brief the following objectives need to be fulfilled:
    1. Updated maps demonstrating flood risk with the latest climate change allowances.
    2. Reviewing the guidance provided in previous reports and updating where required.

1.4 Context of the Level 2 assessment

JBA Consulting were commissioned by Bedford Borough Council to prepare a Level 2 Strategic Flood Risk Assessment (SFRA), purely for the Bedford Borough administrative area, following on from the **Level 1 SFRA** completed in 2020. The purpose of this study is to provide a comprehensive and robust evidence base to inform the preparation of the **Local Plan** looking forward to 2040.

This 2022 Level 2 SFRA builds on the work undertaken in the Level 1 SFRA and assesses flood risk at potential site allocations. In addition, there have been updates to national and local planning policy, flood event data and recommendations for the cumulative impact of development.

The SFRA will be used in decision-making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

This Level 2 SFRA follows the Level 1 assessment published in 2020 and is written in accordance with the 2021 NPPF and PPG. Due to this update in July 2021 to the NPPF since the Level 1 SFRA, the implications of changes to policy and guidance from Chapters 2 and 3 of the Level 1 SFRA are reflected in this report. A new requirement in the NPPF requires that the Sequential Test should include all sources of flood risk. To address this requirement the SFRA performed has included sites affected by surface water flood risk in the Level 2 SFRA. This more detailed assessment addresses the actual surface water risk issues in regard to the requirements of part “b” of the Exception Test. The risk mapping and information on sewer flooding, reservoirs and groundwater is not of a comparable standard as that available for rivers and surface water and so consideration of these other forms of flood risk is addressed in the Sequential Approach. Prior to the July change to the NPPF the consideration of potential hazards from surface water flooding would not have necessarily been included in a Level 2 SFRA.

1.5 Consultation

SFRAs should be prepared in consultation with other risk management authorities. The following parties have been consulted during the preparation of this Level 2 SFRA:

- Bedford Borough Council – Planning and as LLFA
- Environment Agency
- Anglian Water
- Canal and Rivers Trust
- Neighbouring Authorities
    - Central Bedfordshire
    - Huntingdonshire
    - Milton Keynes
    - North Northamptonshire

1.6 How to use this report

Table 1-1: SFRA report guide

Section	Contents	How to use
1. Introduction	Outlines the purpose and objectives of the Level 2 SFRA	For general information and context.
2. The Planning Framework and Flood Risk Policy	Summarises the relevant planning framework, flood risk policy and flood risk responsibilities, and any changes since the Level 1 SFRA	Users should refer to this section in conjunction with the summary tables and GeoPDF mapping to understand the data presented. Developers should refer back to this section when understanding requirements for a site-specific FRA.
3. Planning Policy for Flood Risk Management	Summaries the relevant planning policy and flood risk management guidance, and any changes since the Level 1 SFRA	Users should refer to this section in conjunction with the summary tables and GeoPDF mapping to understand the data presented. Developers should refer back to this section when understanding requirements for a site-specific FRA.
4. Impact of Climate Change	Outlines the latest climate change guidance published by the Environment Agency and how this was applied to the SFRA. Sets out how developers should apply the guidance to inform site specific Flood Risk Assessments	This section should be used to understand the climate change allowances for a range of epochs and conditions, linked to the vulnerability of a development.
5. Sources of information used in preparing the Level 2 SFRA	Summarises the data used in the Level 2 assessments and GeoPDF mapping	Users should refer to this section in conjunction with the summary tables and GeoPDF mapping to understand the data presented. Developers should refer back to this section when understanding requirements for a site-specific FRA.
6. Level 2 Assessment Methodology	Summarises the sites taken forward to a Level 2 assessment and the outputs produced for each of these sites.	This section should be used in conjunction with the site summary tables and GeoPDF mapping to understand the data presented.
7. Flood risk management requirements for developers	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Refers back to relevant sections in the L1 SFRA for mitigation guidance.	Developers should use this section to understand requirements for FRAs and what conditions/ guidance documents should be followed. Developers should also refer to the L1 SFRA for further information on flood mitigation options.

Section	Contents	How to use
8. Surface water management and SuDS	An overview of any specific local standards and guidance for Sustainable Drainage Systems (SuDS) from the Lead Local Flood Authority. Refers back to relevant sections in the L1 SFRA for information on SuDS and surface water management.	Developers should use this section to understand what national, regional and local SuDS standards are applicable. Hyperlinks are provided. Developers should also refer to the L1 SFRA for further information on types of SuDS, the hierarchy and management trains information.
9. Summary of Level 2 assessment and recommendations	Summarises the results and conclusions of the Level 2 assessment, and signposts to the L1 SFRA for planning policy recommendations.	Developers and planners should use this section to see a summary of the Level 2 assessment and understand the key messages from the site summary tables. Developers should refer to the Level 1 SFRA recommendations when considering requirements for site-specific assessments.
Appendix A: Level 2 assessment - Site summary tables and Interactive mapping	Provides a detailed summary of flood risk for sites requiring a more detailed assessment. The section considers flood risk, emergency planning, climate change, broadscale assessment of possible SuDS, exception test requirements and requirements for site-specific FRAs. Provides interactive PDF mapping for each Level 2 assessed site showing flood risk at and around the site.	Planners should use this section to inform the application of the Sequential and Exception Tests, as relevant. Developers should use these tables to understand flood risk, access and egress requirements, climate change, SuDS, and FRA requirements for site-specific assessments. Planners and developers should use these maps in conjunction with the site summary tables to understand the nature and location of flood risk.
Appendix B: Cumulative impact of development and strategic solutions	Builds on recommendations from the Level 1 SFRA, identifying the cumulative impact of development in the site catchments and providing recommendations for storage and betterment for all potential development sites in the catchment.	Planners should use this section to help develop policy recommendations for the sites specified. Developers should use this section to understand the potential storage requirements and betterment opportunities for the sites assessed.

Hyperlinks to external guidance documents/websites are provided in **bold green** throughout the SFRA.

Advice to users has been highlighted in **amber boxes** throughout the document.

1.1 SFRA Study Area

Bedford Borough Council's administrative area covers an area of approximately 476km^2 and has a population of approximately 174,687 (2020, estimated from the Office for National Statistics), shown in Figure 1-1.

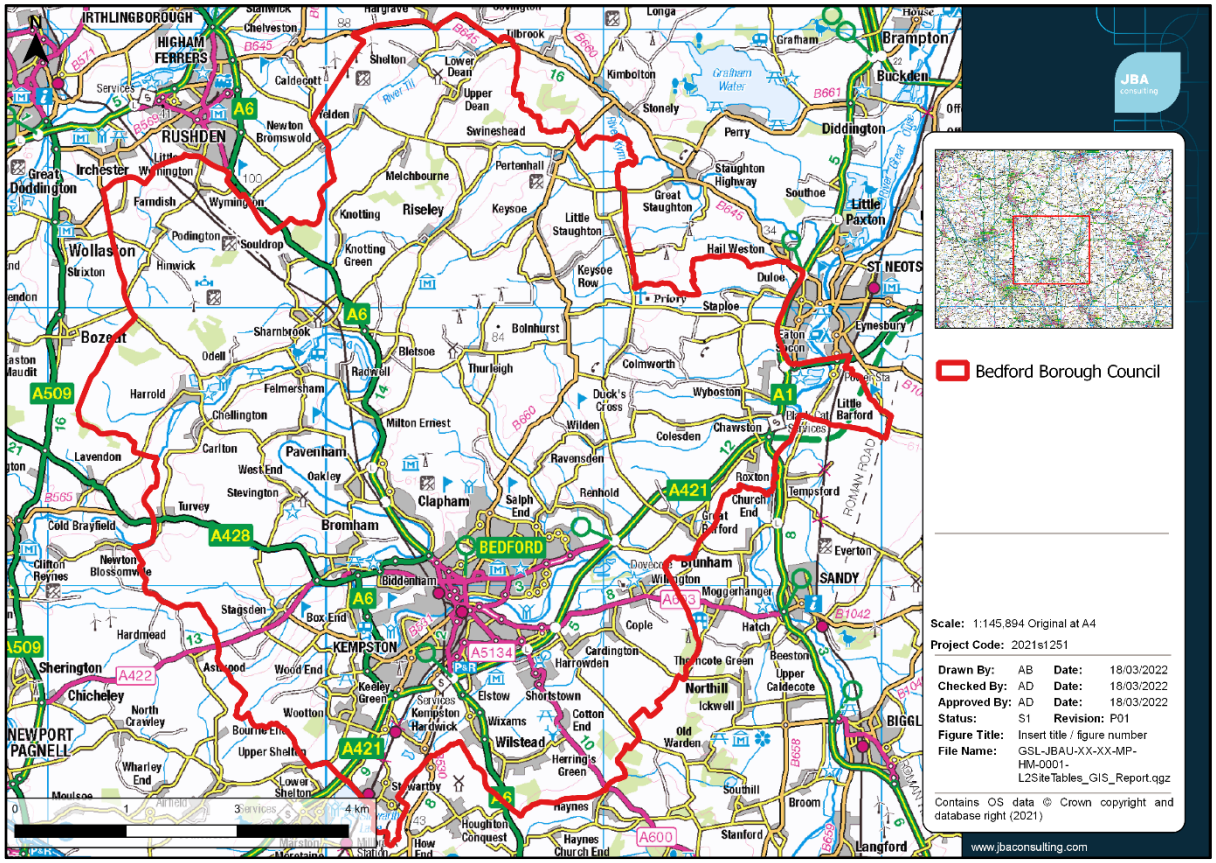


Figure 1-1: Bedford Borough Council authority area

The Bedford Borough Council area is bounded by Central Bedfordshire Council, North Northamptonshire Council, Huntingdonshire District Council and Milton Keynes Council. Bedford Borough is mostly rural, with Bedford being the primary urban area to the south of the Borough (Figure 1-2).

The main rivers in the study area are the River Great Ouse, the Pertenhall/Riseley Brook and the River Til. The River Great Ouse enters the borough to the west and flows east through Bedford with several tributaries joining it, before flowing out of the Borough. The Riseley Brook rises in the north at Riseley, and flows north into the Borough through Pertenhall where it becomes the Pertenhall Brook, it joins the River Kym out of the Borough. The River Til enters the Borough near Yelden, and flows north-east out of the Borough near Tilbrook where it also joins the River Kym.

There are also several other notable minor rivers and brooks within the Borough such as the Elstow Brook which joins the River Great Ouse near Willington. See Figure 1-3 for a map of the main watercourses in the area.

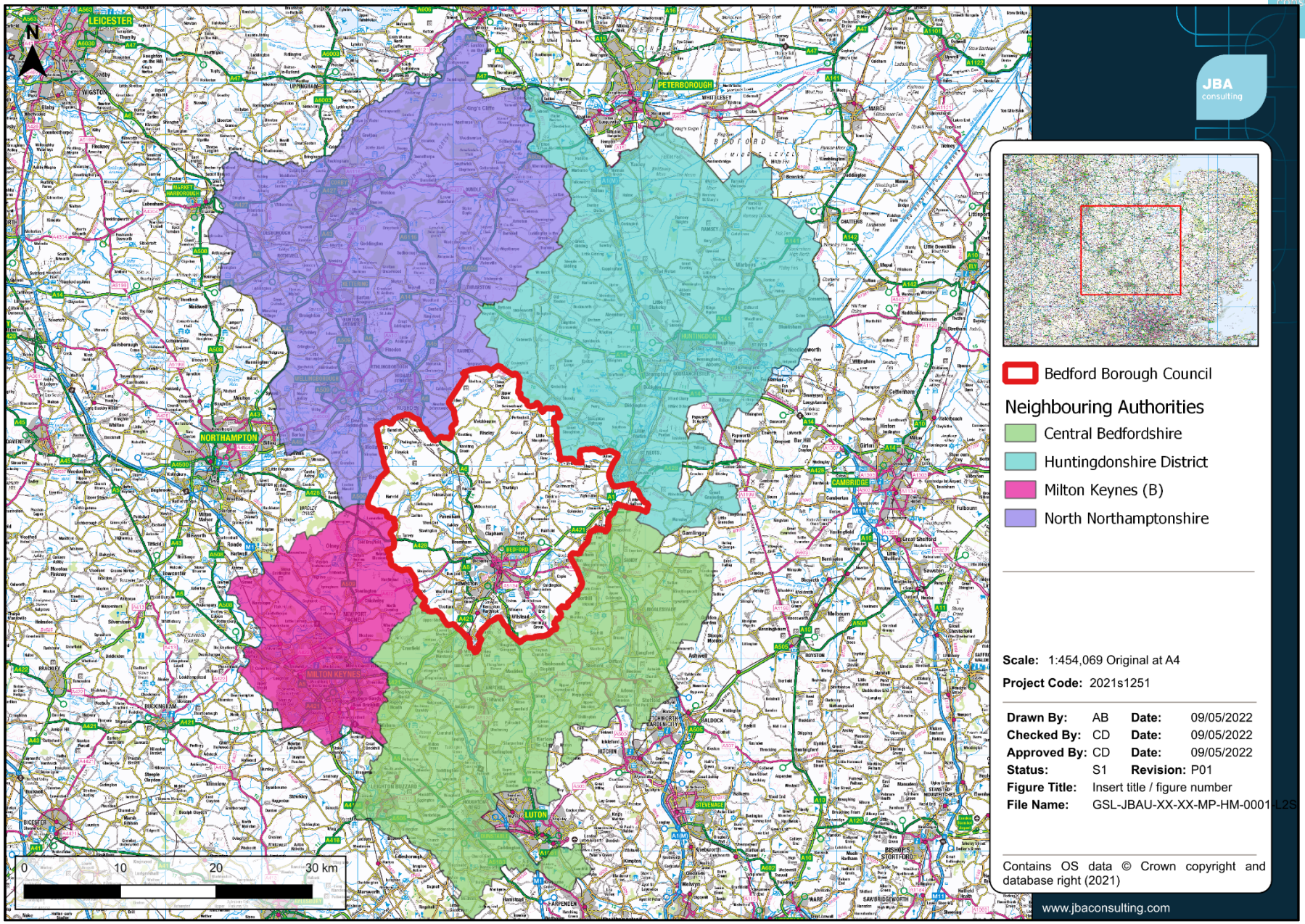


Figure 1-2: Bedford Borough and neighbouring Local Authority Boundaries

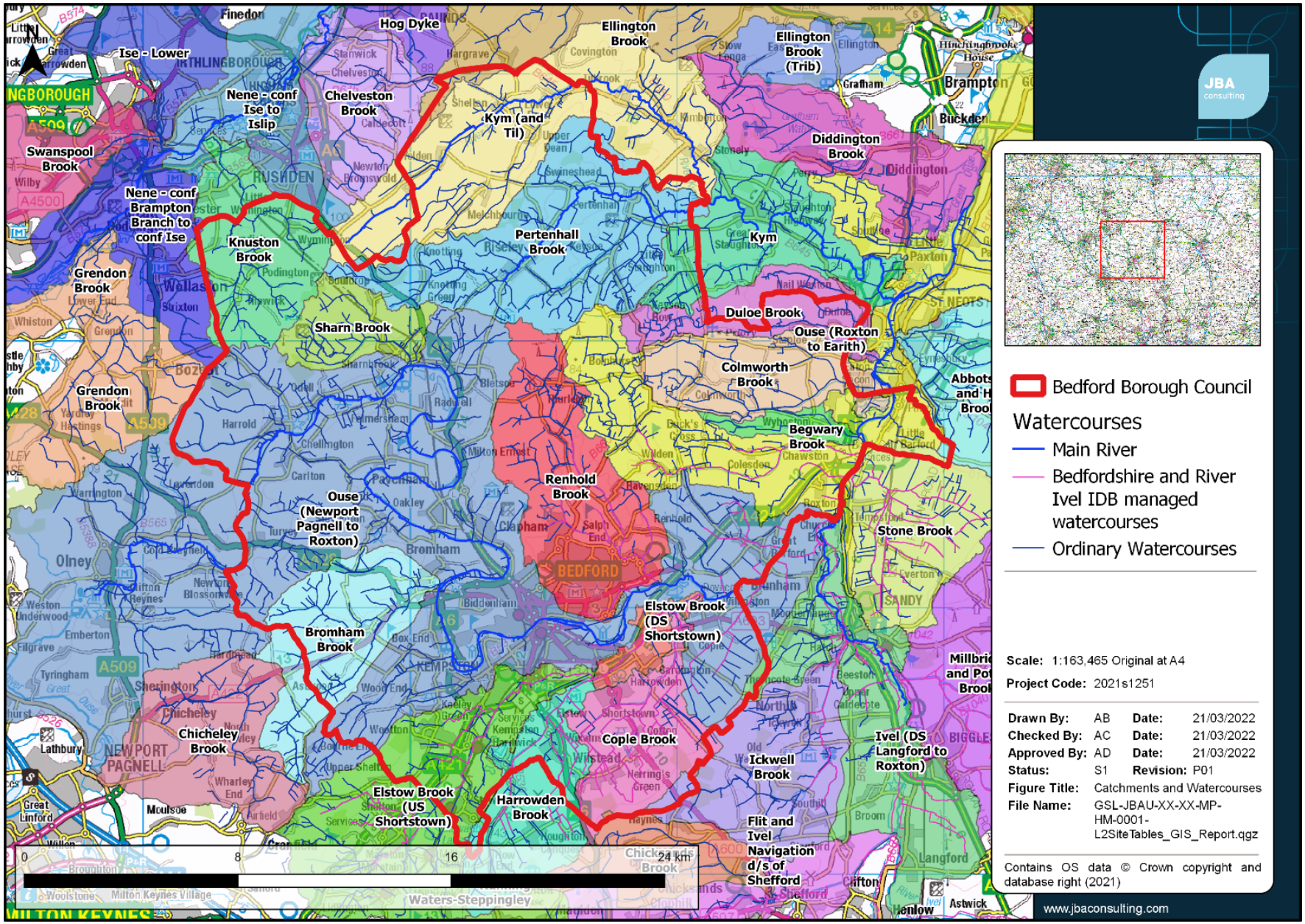


Figure 1-3: Main rivers and ordinary watercourses and their catchments within and surrounding Bedford Borough

2 The Planning Framework and Flood Risk Policy

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 considered at every stage of the planning process. This section of the Level 2 SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities, given the changes since the Level 1 SFRA and updated guidance. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and considered.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of Catchment Flood Management Plans (CFMPs), Surface Water Management Plans (SWMPs) and Water Cycle Strategies (WCSs).

2.2 Roles and Responsibilities for Flood Risk Management

There are a number of different organisations in and around Bedford that have responsibilities for flood risk management, known as Risk Management Authorities (RMAs). These are shown below in Table 2-1, with a summary of their responsibilities.

It is important to note that land and property owners are responsible for the maintenance of watercourses either on or next to their properties. Property owners are also responsible for the protection of their properties from flooding. More information can be found in the Environment Agency publication **Owning a Watercourse** (2018).

When it comes to undertaking works to reduce flood risk, the Environment Agency and Bedford Borough Council as LLFA do have powers, but limited resources must be prioritised and targeted to where they can have the greatest effect. Permissive powers mean that Risk Management Authorities are permitted to undertake works on watercourses but are not obliged to do so.

Table 2-1: Roles and Responsibilities for Flood Risk Management

Risk Management Authority	Strategic Level	Operational Level	Planning Role
Environment Agency	• Strategic overview for all sources of flooding • National Strategy • Reporting and general supervision	• Main rivers • Reservoirs	• Statutory consultee for development in Flood Zones 2 and 3 for coastal and fluvial extents
Bedford Borough Council - Lead Local Flood Authority (LLFA)	• Preliminary Flood Risk Assessment • Local Flood Risk Management Strategy	• Surface Water • Groundwater • Ordinary Watercourses (consenting and enforcement) • Ordinary watercourses (works)	• Statutory consultee for all major developments
Bedford Borough Council - Local Planning Authority (LPA)	• Local Plans as Local Planning Authority	• Determination of Planning Applications as Local Planning Authority • Production of the Local Plan as the LPA • Managing open spaces under Council ownership	• As left
Water Companies: Anglian Water	• Asset Management Plans supported by Periodic Reviews (business cases) • Develop Drainage and Wastewater management plans, Water Resource management plans, and Water Resources long term plans	• Public sewers	• Non-statutory consultee for all major developments. Also provides comments below this threshold where a specific request is received from Council' • Adoption of SuDS under Sewerage Sector Guidance
Highways Authorities: Highways England - motorways and trunk roads	• Highway drainage policy and planning	• Highway drainage • Local Highway Authority is able to adopt some highway drainage features	• Internal planning consultee regarding highways and design standards and options

2.3 Relevant Legislation

The following legislation is relevant to development and flood risk in Bedford authority area:

- **Flood Risk Regulations (2009)** transpose the EU Floods Directive (2000) into UK law and require the Environment Agency and LLFAs to produce Preliminary Flood Risk Assessments (PFRAs) and identify where there are nationally significant Flood Risk Areas. For the Flood Risk Areas, detailed flood maps and a Flood Risk

Management Plan are produced. This is a six-year cycle of work and the second cycle started in 2017.

- **Town and County Planning Act (1990)**, **Water Industry Act (1991), Land Drainage Act (1991), Environment Act (2005)** and **Flood and Water Management Act (2010)** – as amended and implanted via secondary legislation. These set out the roles and responsibilities for organisations that have FRM role.
- **Land Drainage Act (1991)** and **Environmental Permitting Regulations (2016)** define where developers need to apply for additional permission (and Planning Permission) to undertake works to an ordinary watercourse or Main River.
- **Water Environment Regulations (2017)** transpose the European Water Framework Directive (2000) into law, requiring the Environment Agency to produce River Basin Management Plans (RBMPs). These aim to ensure that the water quality of aquatic ecosystems, riparian ecosystems and wetlands reach 'good status'.
- **Flood and Water Management Act (2010)** aims to improve both flood risk management and the way we manage our water resources. It creates clearer roles and responsibilities which help define a more risk-based approach to dealing with flooding. The content and implications of the FWMA provide considerable opportunities for improved and integrated land use planning and flood risk management by LAs and other key partners.
- Other environmental legislation such as the **Habitats Directive (1992), Environmental Impact Assessment Directive (2014)** and **Strategic Environmental Assessment Directive (2001)** also apply as appropriate to strategic and site-specific developments to guard against environmental damage.
- Note that secondary UK legislation implementing EU Directives such as the Flood Risk Regulations and Water Environment Regulations are subject to repeal/ amendment following the UK exit from the EU. At the time of publishing this report the references here are correct.

2.4 Relevant Flood Risk Policy and Strategy Documents

Table 2-2 summarises some of the relevant national, regional and local flood risk policy and strategy documents and how these apply to development and flood risk. There are hyperlinks to the documents in the table. These documents may:

- Provide useful and specific local information to inform flood risk assessments within the local area.
- Set the strategic policy and direction for Flood Risk Management (FRM) and drainage – they may contain policies and action plans that set out what future mitigation and climate change adaptation plans may affect a development site. A developer should seek to contribute in all instances to the strategic vision for FRM and drainage in Bedford borough.
- Provide guidance and/ or standards that informs how a developer should assess flood risk and/ or design flood mitigation and SuDS.

Table 2-2: National, Regional and Local Flood Risk Guidance, Policy and Strategy Documents

Level	Document, lead author and date	Information	Policy and Measures	Development Design Requirements	Next Update Due
National	**Flood and Coastal Management Strategy** (Environment Agency) 2020	No	Yes	No	Due to be reviewed in 2026
National	**National Planning Policy Framework and Guidance** (MCHLG) updated July 2021	No	Yes	Yes	-
National	**Building Regulations Part H** (MCHLG) 2015	No	No	Yes	-
National	**Sewerage Section Guidance** (UK Water) 2020	Yes	No	Yes	-
Regional	**The River Great Ouse Catchment Flood Management Plan** (Environment Agency) 2009	Yes	Yes	No	-
Regional	**Climate Change Guidance for Development** (Environment Agency) 2021	No	No	Yes	-
Regional	**Drainage and Wastewater Management Plan (Anglian Water)** due 2022	Yes	Yes	Yes	2022
Regional	**Anglian River Basin Management Plan** (Environment Agency) 2018	No	Yes	No	-
Local	**Bedford Borough and Central Bedfordshire detailed Water Cycle Study** 2012	Yes	No	Yes	-
Local	**Local Flood Risk Management Strategy** (BBC) 2015	Yes	Yes	No	2022 (**draft online**)
Local	**Bedford Borough Council Level 1 SFRA** (BBC) 2020	Yes	Yes	Yes	-
Local	**Bedford Borough Council Sustainable Drainage Supplementary Planning Document** (BBC) 2018	Yes	Yes	Yes	-

2.5 Relevant Flood Risk Management Studies and Documents

2.5.1 National Flood and Coastal Erosion Risk Management Strategy for England (2020)

The **National Flood and Coastal Erosion Risk Management (FCERM) Strategy** for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. The Strategy was completed in 2020. The Environment Agency brought together a wide range of stakeholders to develop the strategy collaboratively. The Strategy is much more ambitious than the previous one from 2011 and looks ahead to 2100 and the action needed to address the challenge of climate change.

The emphasis of The Strategy is on developing resilient places and communities. The Strategy has been split into three high level ambitions: climate resilient places, today's growth and infrastructure resilient in tomorrow's climate, and a nation ready to respond and adapt to flooding and coastal change. Measures include:

- updating the national river, coastal and surface water flood risk mapping and the understanding of long-term investment needs for flood and coastal infrastructure,
- trialling new and innovative funding models,
- flood resilience pilot studies,
- developing an adaptive approach to the impacts of climate change,
- seeking nature-based solutions towards flooding and erosion issues,
- integrating natural flood management into the new Environmental Land Management scheme, considering long term adaptive approaches in Local Plans,
- maximising the opportunities for flood and coastal resilience as part of contributing to environmental net gain for development proposals,
- investing in flood risk infrastructure that supports sustainable growth, aligning long term strategic planning cycles for flood and coastal work between stakeholders,
- mainstreaming property flood resilience measures and 'building back better' after flooding, consistent approaches to asset management and record keeping,
- updating guidance on managing high risk reservoirs in light of climate change,
- critical infrastructure resilience, education, skills, and capacity building,
- research, innovation and sharing of best practise,
- supporting communities to plan for flood events,
- developing world leading ways of reducing the carbon and environmental impact from the construction and operation of flood and coastal defences,
- development of digital tools to communicate flood risk and transforming the flood warning service and increasing flood response and recovery support.

The Strategy was published alongside a New National Policy Statement for Flood and Coastal Erosion Risk Management. The Statement sets out five key commitments which will accelerate progress to better protect and better prepare the country for the coming years:

1. Upgrading and expanding flood defences and infrastructure across the country,
2. Managing the flow of water to both reduce flood risk and manage drought,

3. Harnessing the power of nature to not only reduce flood risk, but deliver benefits for the environment, nature, and communities,
4. Better preparing communities for when flooding and erosion does occur, and
5. Ensuring every area of England has a comprehensive Local Plan for dealing with flooding and coastal erosion.

2.6 LLFAs, Surface Water and SuDS

The 2021 NPPF states that: 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 169). 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
- Through the use of planning conditions or planning obligations there are clear arrangements for on-going maintenance over the development's lifetime.

Bedford Borough Council's SuDS requirements for new developers are set out in the **Bedford Borough Council Sustainable Drainage Supplementary Planning Document**. The 2021 NPPF states that flood risk should be managed "using opportunities provided by new development to reduce causes and impacts of flooding". As such, the LLFA expects SuDS to be incorporated on minor development as well as major development. Masterplans should be designed to ensure that space is made for above ground SuDS features. Underground tanks should only be used on sites as a last resort.

There are currently no active flood risk management schemes and strategies ongoing in Bedford Borough.

2.7 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken, when required, 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 an area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

Bedford Borough Council does not currently have a SWMP. However, there is a Marston Vale Surface Waters Plan (2002). The Surface Waters Plan, prepared on behalf of the Marston Vale Surface Waters Group created in 1997, looks into the main opportunities and challenges faced when managing the surface water in the Forest of Marston Vale. The Group comprises the Forest of Marston Vale, the Environment Agency, Bedford Group of IDBs and three local authorities, of which Bedford Borough is one.

The **Marston Vale Surface Waters Plan** (2002) aims to pinpoint areas at risk, identify the causes and consider the best ways of managing urban drainage to reduce future flooding. It plans to do this through a series of integrated and sustainable policies for major proposed developments in the area. The Surface Water Plan's main purpose is to:

- Promote the policies of the Surface Waters Group.
- Support local plan policies dealing with flooding and surface water drainage.
- Assist with consideration of development proposals.
- Identify solutions for dealing with the impact of development pressure on watercourses and lakes.
- Provide guidance to landowners and developers on approaches to management of surface water.

- Encourage schemes that result in a range of benefits including management of flood risk and enhancement of the environment.

In 2008, the Surface Waters Plan was included in DEFRA's 'Integrated Urban Drainage Pilot Studies', which reviewed the adoption and implementation of the plan through consultation with key stakeholders. The review highlighted that the Plan effectively promotes the need for a sustainable approach to flood risk. Whilst not adopted as a Supplementary Planning Document, the Plan is the preferred strategy for development as it ensures that development does not increase the risk from flooding, because the assets are designed strategically and will be maintained in the future by a public body to ensure they continue to operate as designed.

3 Planning Policy for Flood Risk Management

3.1 National Planning Policy Framework and Guidance

The revised **National Planning Policy Framework (NPPF)** was published in July 2021, replacing the 2019 version. The NPPF sets out Government's planning policies for England. It must be taken into account in the preparation of Local Plans and is a material consideration in planning decisions. The NPPF defines Flood Zones, how these should be used to allocate land and flood risk assessment requirements, although the 2021 update states that the Sequential and Exception Tests aim to steer development towards areas of the lowest risk of flooding from any source of flooding (not just fluvial and tidal). The 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*"

Planning Practice Guidance on flood risk was published in March 2014 and is updated regularly and sets out how the policy should be implemented. **Diagram 1 in the NPPG** sets out how flood risk should be considered in the preparation of Local Plans.

3.2 The Risk Based Approach

The NPPF takes a risk-based approach to development in flood risk areas. A risk-based approach sets out requirements in a way that is proportionate to the risk present. Therefore, in the context of a strategic flood risk assessment, recommendations made are proportionate to the level of risk present on site. This risk-based approach informs the Sequential test set out in 3.4 below.

3.3 The Flood Zones – river and sea flood risk

The definition of the Flood Zones is provided below in Table 3-1. The Flood Zones described in the table below depict the flooding from rivers and the sea. The Flood Zones do not consider defences. This is important for planning long-term developments as long-term policy and funding for maintaining flood defences over the lifetime of a development may change over time.

The Flood Zones do not consider surface water, sewer or groundwater flooding or the impacts of canal or reservoir failure. They do not consider climate change. Hence there could still be a risk of flooding from other sources and that the level of flood risk will change over time during the lifetime of a development.

Table 3-1: Flood Zone Summary – Flooding from Rivers and Sea

Zone	Probability	Description
Zone 1	Low	• This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1% AEP). • All land uses are appropriate in this zone. • For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
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 (1% - 0.1% AEP) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5% AEP) 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% AEP) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5% AEP) in any year. Developers and the local authorities should seek to reduce the overall level 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. SFRAs should identify this Flood Zone in discussion with the LPA and 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 storage, no impediment to water flows and no increase in flood risk elsewhere. • All developments in this zone require an FRA.

3.4 Flood zone – surface water flood risk

For the purpose of performing the Sequential Test it has been assumed that any site that is affected by surface water flood risk establishes the requirement that part "b" of the Exception Test must be satisfied. However, if development at a site affected by surface water flood risk can be located outside of the extent of the area affected by surface water flood risk then there would not necessarily be a requirement to satisfy part "b" of the Exception Test, although proposals would need to appropriately address surface water drainage issues. As surface water flood risk normally affects a smaller proportion of sites than locations affected by river flooding and flood durations for surface water can be shorter than for river flooding it is normally possible to identify site design proposals and mitigation measures that appropriately address the risks. Much can be achieved by careful planning of open space and layout of development components that can be permitted to temporarily become inundated during surface water flood events. The summary sheets provided outline the predicted levels of hazard at the existing sites to inform consideration of how these can be addressed in the implementation of development that is safe and does not adversely affect third parties.

3.5 The Sequential Test

Firstly, land at the lowest risk of flooding from all sources should be considered for development, i.e land in Flood Zone 1 with no surface water or other sources of flood risk. In line with the NPPF, the impacts of climate change over the lifetime of the development should be taken into account when considering actual and residual flood risk. A test called the 'Sequential Test' is applied to do this, to ensure land at lowest risk of flooding is considered first. Information contained in this SFRA is used to assess potential development sites against the EA's Flood Map for Planning Flood Zones (and any available additional modelling outputs), other sources of flooding including surface water, and development vulnerability compatibilities.

This is a step-by-step process, but a challenging one, as a number of the criteria used are qualitative and based on experienced judgement. The process must be documented, and evidence used to support decisions recorded. The available risk mapping for river, sea and surface water flood risk can be used to directly inform the Sequential Test and as necessary the Exception Test. Consideration can be given to other forms of flood risk to inform the Sequential Approach at the selected sites.

In addition, the risk of flooding from all sources, including surface water and the impact of climate change must be considered when assessing which sites are suitable to allocate.

The LPA will apply the Sequential Test in determining their spatial strategy and potential site allocations as well as to any strategic allocations within their Local Plan. For all other developments, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test.

The LPA should work with the Environment Agency to define a suitable area of search for the consideration of alternative sides in the Sequential Test. 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. Where other sustainability criteria outweigh flood risk issues, the decision-making process should be transparent with reasoned justifications for any decision to allocate land in areas at high flood risk in the sustainability appraisal report.

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development, the Flood Zone it is proposed for, and the risk to the site from other sources of flooding, such as the extent of surface water. **Table 2 of the NPPG** defines the vulnerability of different development types to flooding. **Table 3 of the NPPG** whether, having applied the Sequential Test first,

that vulnerability of development is suitable for that Flood Zone and where further work is needed.

Table 3-2 below shows how site allocation is determined by the Flood Zone - this forms only part of the Sequential Test, and the risk from all other sources of flooding should also be considered.

Table 3-2: Local Plan Sequential Approach to Site Allocation

Development location	Appropriateness for site allocation
Flood Zone 1	Appropriate for allocation.
Flood Zone 2	Appropriate for allocation if highly vulnerable development can be located in Flood Zone 1.
Flood Zone 3a	Appropriate for allocation if: • highly vulnerable development is located in Flood Zone 1 or 2. • can demonstrate that there are wider strategic planning objectives for the development in high risk areas. • can demonstrate that that development would remain safe and not increase the flood risk elsewhere.
Flood Zone 3b	Not appropriate for development (except water compatible infrastructure such as amenity, biodiversity and public open space, and essential infrastructure passing the Exception Test).

3.6 The Exception Test

It will not always be possible for all new development to be allocated on land that is not at risk from flooding. To further inform whether land should be allocated, or planning permission granted, a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required.

The Exception Test should only be applied following the application of the Sequential Test. It applies in the following instances, where it is not possible for development to be located in areas with a lower risk of flooding:

- More vulnerable in Flood Zone 3a
- Essential infrastructure in Flood Zone 3a or 3b
- Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)
- At risk from surface water flooding

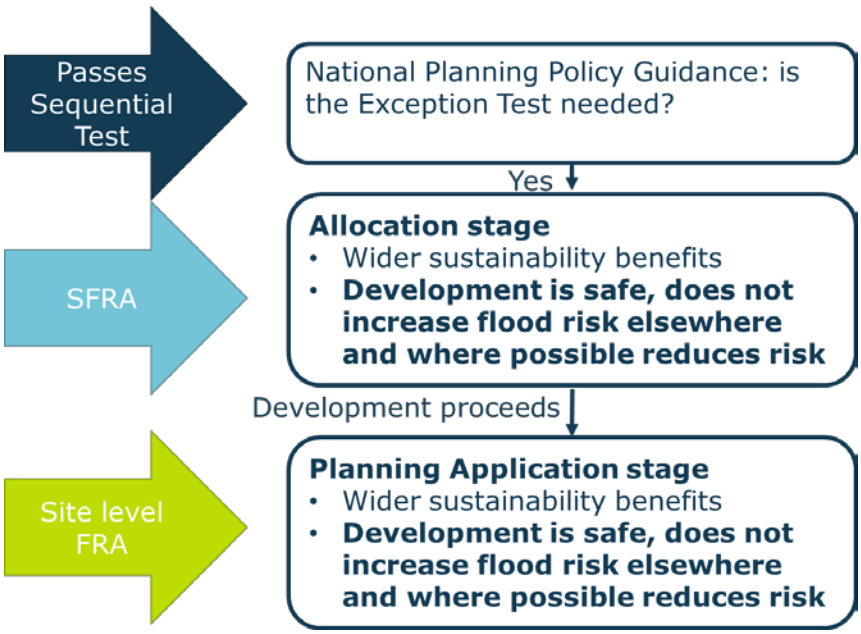
The Exception Test may also need to be applied where a site is at significant risk from other sources of flooding.

Figure 3-1 below shows what the Exception Test informs at each level of assessment. For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the Exception Test. At planning application stage, the developer must design the site such that is appropriate flood resistant and resilient in line with the recommendations in National and Local Planning Policy and supporting guidance and those set out in this SFRA. This should demonstrate that the site will still pass the flood risk element of the Exception Test based on the detailed site level analysis.

For developments that have not been allocated in the Local Plan, developers must undertake the Exception Test and present this information to the Local Planning Authority for approval. The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should look into in more detail to inform the Exception Test for windfall sites. The Level 2 SFRA considers this for strategic allocations; other sites

should prepare an Exception Test and present this information to the Local Planning Authority for approval.

Figure 3-1: The Exception Test



There are two parts to demonstrating a development passes the Exception Test as set out in paragraph 164 of the NPPF:

> *(a) Demonstrating that the development would provide wider sustainability benefits to the* community *that outweigh the flood risk.*

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 refused.

At the stage of allocating development sites, Local Planning Authorities should consider wider sustainability objectives, such as those set out in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

The Local Planning Authority should consider the sustainability issues the development will address and how doing so will outweigh the flood risk concerns for the site, e.g. by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

> *(b) Demonstrating 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.*

A Level 2 SFRA is likely to be needed to inform the Exception Test in these circumstances for strategic allocations. At planning application stage, a site-specific Flood Risk Assessment, considering all sources of flooding, will be needed.

Both would need to consider the actual and residual risk and how this will be managed over the lifetime of the development.

3.7 Making a Site Safe from Flood Risk over its Lifetime

Local Planning Authorities will need to consider the actual and residual risk of flooding and how this will be managed over the lifetime of the development:

- The actual risk is the risk to the site considering existing flood mitigation measures. The fluvial 1% AEP chance flood in any year event (and 0.5% AEP chance for tidal) is a key event to consider because the National Planning Policy Guidance refers to this as the 'design flood' against which the suitability of a proposed development should be assessed and mitigation measures, if any, are designed. Consideration must also be given to surface water flood risks for the design event.
- Safe access and egress should be available during the design flood event. Firstly, this should seek to avoid areas of a site at flood risk. If that is not possible then access routes should be located above the design flood event levels. Where that is not possible, access through shallow and slow flowing water that poses a low flood hazard may be acceptable.

  Shelter in situ in a safe, dry accessible space for all occupants that has an external escape route may be suitable for some developments when the duration of flooding is not likely to be significant. This would need to be above the 0.1% AEP flood event flood level taking account of climate change. Access for emergency services should be considered and this is more likely to be appropriate for smaller infill developments than larger strategic ones where access routes should be planned such that access is available as a minimum for emergency services. A Flood evacuation and warning plan that is regularly tested would be necessary.
- Residual risk is the risk that remains after the effects of flood defences have been taken into account and/ or from a more severe flood event than the design event. The residual risk can be:
  - The effects of an extreme 0.1% AEP chance flood in any year event. Where there are defences this could cause them to overtop, which may lead to failure if this causes them to erode, and/ or breach.
  - Structural failure of any flood defences, such as breaches in embankments or walls.
  - The performance or failure of performance of surface water drainage or surface water culverts (potential blockage is material).

Flood resistance and resilience measures should be considered to manage any residual flood risk by keeping water out of properties and seeking to reduce the damage it does, should water enter a property. Emergency plans should also account for residual risk, e.g. through the provision of flood warnings and a flood evacuation plan where appropriate. These plans should consider requirements of the **ADEPT** guidance on the preparation of the Flood Emergency Plans. Where emergency plans are required, suitability of the site and appropriate use of the site should be considered.

In line with the NPPF, the impacts of climate change over the lifetime of the development should be considered when considering actual and residual flood risk.

3.8 The Sequential Test and Exception Test and Individual Planning Applications

3.8.1 The Sequential Test

Bedford Borough Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied.

Developers are required to apply the Sequential Test to all development sites, unless the site is:

- A strategic allocation and the test has already been carried out by the LPA, or
- A change of use (except to a more vulnerable use), or
- A minor development (householder development, small non-residential extensions with a footprint of less than 250m2), or
- A development in Flood Zone 1 unless there are other flooding issues in the area of the development (i.e. surface water, ground water, sewer flooding).

The SFRA contains information on all sources of flooding and taking into account the impact of climate change. This should be considered when a developer undertakes the Sequential Test, including the consideration of reasonably available sites at lower flood risk.

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 e.g. school catchments, in other cases it may be identified by other Local Plan policies. For some sites e.g. regional distribution sites, it may be suitable to widen the search area beyond LPA administrative boundaries.

The sources of information on reasonably available sites may include:

- Site allocations in Local Plans
- Site with planning permission but not yet built out
- Strategic Housing and Economic Land Availability Assessments (SHELAAs)/ five-year land supply/ annual monitoring reports
- Locally listed sites for sale

It may be that a number of smaller sites or part of a larger site at lower flood risk form a suitable alternative to a development site at high flood.

Ownership or landowner agreement in itself is not acceptable as a reason not to consider alternatives.

3.8.2 The 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 required (as set out in Table 3 of the NPPG). Developers are required to apply the Exception Test to all applicable sites.

The applicant will need to provide information that the application can pass both parts of the Exception test:

- *(a) Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk.*

  Applicants should refer to wider sustainability objectives in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

  Applicants should detail the suitability issues the development will address and how proceeding with development will outweigh the flood risk concerns for the site e.g. by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

- *(b) Demonstrating 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. The FRA should consider actual and residual risk and how this will be managed over the lifetime of the development, including:

  - The design of any flood defence infrastructure
  - Operation and maintenance
  - Access and egress
  - Design of the development to manage and reduce flood risk wherever possible
  - Resident awareness
  - Flood warning and evacuation procedures, including whether the developer would increase the pressure on emergency services to rescue people during a flood event; and
  - Any funding arrangements required for implementing measures.

4 Impact of Climate Change

The NPPF sets out that flood risk should be managed over the lifetime of a development, taking climate change into account. This section sets out how the impact of climate change should be taken into account.

4.1 Revised climate change guidance

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050.

In 2018, the government published new UK Climate Projections (UKCP18). The Environment Agency has translated these projections into published **updated climate change guidance** in 2022 on how allowances for climate change should be included in both strategic and site specific FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development. At the time of writing this report, the updated peak rainfall allowances were released. Developers should check on the government website for the latest guidance before undertaking a detailed Flood Risk Assessment.

4.2 Applying the climate change guidance

To apply the climate change guidance, the following information needs to be known:

- The vulnerability of the development.
- The likely lifetime of the development – in general 60 years is used for commercial development and 100 for residential, but this needs to be confirmed in an FRA.
- The River Basin that the site is in – Bedford lies within the Anglian River Basin District
- The Management Catchment that the site is in – The Upper and Bedford Ouse.
- 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).
- The 'built in' resilience measures used, for example, raised floor levels.
- The capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

4.3 Relevant allowances for Bedfordshire

Table 4-1 shows the peak river flow allowances that apply to Bedfordshire for fluvial flood risk, and

Table 4-2 shows the peak rainfall intensity allowances that apply in Bedfordshire for small catchments (less than 5km^2) and urban catchments for surface water flood risk. For large catchments (more than 5km^2) or are rural, the allowances in

Table 4-2 are used for peak rainfall intensity. Both the central and upper end allowances should be considered to understand the range of impact.

Table 4-1: 2021 Peak river flow allowances for the Upper and Bedford Ouse Management Catchment

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	24%	30%	58%
Higher central	10%	11%	30%
Central	5%	4%	19%

Table 4-2: 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 2061 to 2125
Upper end	10%	40%	40%
Central	5%	20%	25%

4.4 Representing climate change in the Level 2 SFRA

For this Level 2 SFRA, the sites at fluvial flood risk were located on or near the River Great Ouse and its associated minor tributaries. Hydraulic models were not re-run in the present day for this study but the 100-year fluvial event (1% AEP) was uplifted by the latest July 2021 EA allowances for the Ouse Upper and Bedford Management Catchment for the 2080s epoch (Central +19%, Higher Central +30% and Upper End +58%).

For any sites not covered by the EA's detailed modelling, Flood Zone 2 was used as an indicative climate change extent. This is appropriate given the Higher Central and Upper End flows are often similar to the Flood Zone 2 extents.

The 1,000-year surface water extent was also used as an indication of surface water risk, and risk to smaller watercourses, which are too small to be covered by the EA's Flood Zones. The 100-year surface water event (1% AEP) was uplifted by the latest climate change rainfall allowances of +20% and +40%.

Developers may need to undertake a more detailed assessment of climate change as part of the planning application process when preparing FRAs, using the percentage increases which relate to the proposed lifetime and the vulnerability classification of the development. Since no updated present-day modelling has been undertaken for the region, some sites may require development of a 'detailed' hydraulic model, using channel topographic survey. The Environment Agency should be consulted to provide further advice for developers on how best to apply the new climate change guidance.

Climate change mapping has been provided for the sites assessed in Appendix A: GeoPDFs. In summary, the climate change outputs on the GeoPDF maps for the SFRA may be from:

- 'Climate Change Central, Higher Central and Upper End': Where detailed hydraulic models exist and were run for the EA latest July 2021 allowances in this Level 2 SFRA (River Great Ouse and its minor tributaries).
- 'Indicative Climate Change (FZ2)': Flood Zone 2, which is used outside of the areas covered by specific flood models and should be considered to be indicative.

It is important to note that although the flood extent may not increase noticeably on some watercourses, the flood depth, velocity, and hazard may increase compared to the 100-year current-day event. It is recommended that the impact of climate change on a proposed site is considered as part of a detailed Flood Risk Assessment, using the percentage increases which relate to the proposed lifetime and the vulnerability classification of the development. The Environment Agency should be consulted to provide further advice for developers on how best to apply the new climate change guidance.

When undertaking a site-specific Flood Risk Assessment, developers should:

- Confirm which national guidance on climate change and new development applies by visiting **GOV.uk.**
- Apply this guidance when deciding the allowances to be made for climate change, having considered the potential sources of flood risk to the site (using this SFRA), the vulnerability of the development to flooding and the proposed lifetime of the development. If the site is just outside the indicative climate change extents in this SFRA, the impact of climate change should still be considered because these may get affected should the more extreme climate change scenarios materialise.

4.5 Impact of climate change on groundwater flood risk

The effect of climate change on groundwater flooding, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. There is no technical modelling data available to assess climate change impacts on groundwater. It would depend on the flooding mechanism, historic evidence of known flooding and geological characteristics, for example prolonged rainfall in a chalk catchment. Flood risk could increase when groundwater is already high or emerged, causing additional overland flow paths or areas of still ponding.

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.

A high likelihood of groundwater flooding may mean infiltration SuDS are not appropriate and groundwater monitoring may be recommended.

4.6 Impact of climate change on the functional floodplain

The potential impacts from Flood Zone 3b (20-year modelled extent) plus climate change may need to be considered at site-specific assessment stage. If this is not explicitly modelled, the modelled 20-year output could be compared against a return period similar to that expected if the 20-year flow was to be uplifted by say 29%, 39% or 61% as per the EA's guidance. This may equate to a 75-year or 100-year flood event in the future (possibly higher in some locations). Elsewhere, it could be assumed that FZ3a could be considered an indicative extent for FZ3b with climate change.

4.7 Impact of climate change on sewers

Surface water and fluvial flooding with climate change have the potential to impact on the sewerage system, so careful management of these is needed for development. Due to differing ages of settlements, there will be drainage systems consisting of different types of sewers. Increasing pressures from climate change, urban creep and infill development could impact on the performance of the sewerage system.

Anglian Water advise that surface water is to be kept separate from foul sewerage wherever possible, as this will result in a more resilient sewerage system.

4.8 Adapting to climate change

The **NPPG Climate Change guidance** contains information and guidance for how to identify suitable mitigation and adaptation measure in the planning process to address the impacts of climate change. Examples of adapting to climate change include:

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

- Considering the standard of protection of defences and sites for future development, in relation to sensitivity to climate change. The Council and developers will need to work with RMAs and use the SFRA datasets to understand whether development is affordable or deliverable. Locating development in such areas of risk may not be a sustainable long-term option.

It is recommended that the differences in flood extents from climate change are compared by the Council when allocating sites, to understand how much additional risk there could be, where this risk is in the site, whether the increase is marginal or activates new flow paths, whether it affects access/ egress and how much land could still be developable overall.

5 Sources of information used in preparing the Level 2 SFRA

This chapter outlines the datasets used in assessing the sites in the Level 2 SFRA.

5.1 Data used to inform the SFRA

Table 5-1 provides an overview of the supplied data, used to inform the appraisal of flood risk for Bedford Borough Council.

Table 5-1: Overview of supplied data for Bedford Council Level 2 SFRA

Source of flood risk	Data used to inform the assessment	Data supplied by
Historic (all sources)	Historic Flood Map and Recorded Outlines Hydraulic Modelling Reports, where provided	Environment Agency
Historic (all sources)	2020 L1 SFRA	Bedford Borough Council
Historic (all sources)	Historic flood incidents/records and detailed studies	Bedford Borough Council
Fluvial (including climate change)	Hydraulic models have been updated for climate change allowances: the Upper and Lower Ouse and minor tributaries. Flood Zones Risk of Flooding from Rivers and Sea	Environment Agency
Surface Water	Risk of Flooding from Surface Water dataset Local Flood Risk Management Strategy Communities at Risk	Environment Agency
Groundwater	Areas Susceptible to Groundwater Flooding dataset Bedrock geology/superficial deposits dataset	Environment Agency
Sewer	At Risk Register Historic flooding records	Anglian Water
Reservoir	National Inundation Reservoir Mapping	Environment Agency

5.2 Flood Zones 2 and 3a

Flood Zones 2 and 3a have been taken from the Flood Zones derived in the Level 1 SFRA, which incorporated the Environment Agency's Flood Map for Planning.

5.2.1 Flood Zone 3b

Flood Zone 3b has been identified as land which would flood with an annual probability of 1 in 20 years (5% AEP). Flood Zone 3a from the Environment Agency's Flood Map for Planning has been used as an indication of Flood Zone 3b at locations where there are no model outputs for the 1 in 20 year event.

Note on the Environment Agency Flood Map for Planning

Where flood outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is generally accurate on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse falls below 3km^2.

For watercourses with smaller catchments, the Risk of Flooding from Surface Water map provides an indication of the floodplain of small watercourses and ditches. It is more accurate in upper to mid river valley locations than lower valley locations near the coast. This is because it does not represent the floodplain for small watercourses as well in largely flat areas.

Even where more detailed models of Main Rivers have been used by the Environment Agency to inform the Flood Map for Planning, they will be largely based on remotely detected ground model data and not topographic survey. In this area, the Flood Map for Planning does not include all modelled outputs, hence the Level 1 SFRA derived its own Flood Zones based on latest available data, and any further modelling updates since 2018 for the L2 SFRA has been accounted for.

For this reason, the Flood Map for Planning is not of a resolution to be used as planning application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. Accordingly, for site-specific assessments it will be necessary to perform more detailed studies in circumstances where flood risk is an issue.

5.3 Climate change

For this Level 2 SFRA, the sites at fluvial flood risk were located on or near the River Great Ouse and its minor tributaries. The latest available hydraulic models were obtained for these watercourses and the 100-year event (1% AEP) was uplifted by the latest July 2021 EA climate change allowances for the Ouse Upper and Bedfordshire Management Catchment for the 2080s epoch (Central +19%, Higher Central +30% and Upper End +58%).

For any sites not covered by the EA's detailed modelling, Flood Zone 2 was used as an indicative climate change extent. This is appropriate given the Higher Central and Upper End flows are often similar to the Flood Zone 2 extents.

The 1,000-year (0.1% AEP event) surface water extent was also used as an indication of surface water risk, and risk to smaller watercourses, which are too small to be covered by the EA's Flood Zones.

Developers may need to undertake detailed modelling of climate change allowances as part of a site-specific FRA, following the **climate change guidance** set out by the Environment Agency. They should also contact the Environment Agency to determine the latest models publicly available, given the ongoing phased modelling studies.

5.4 Surface Water

Mapping of surface water flood risk in Bedford Borough has been taken from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) mapping. Surface water flood risk is subdivided into the following four categories:

- **High**: An area has a chance of flooding greater than 1 in 30 (3.3%) each year.
- **Medium**: An area has a chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%) each year.
- **Low**: An area has a chance of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%) each year.
- **Very Low**: An area has a chance of flooding of less than 1 in 1,000 (0.1%) each year.

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 required to illustrate the flood risk more accurately at a site-specific scale. Such an assessment should use the RoFSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

5.5 Groundwater

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. 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-water table 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.

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater Flooding (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.

5.6 River networks

Main Rivers are represented by the Environment Agency's Statutory Main River layer. Ordinary Watercourses are represented by the Environment Agency's Detailed River Network (DRN) layer. Caution should be taken when using these layers to identify culverted watercourses which may appear as straight lines but in reality, are not.

Developers should be aware of the need to identify the route of and flood risk associated with culverts. CCTV condition survey will be required to establish the current condition of the culvert and hydraulic assessments will be necessary to establish culvert capacity of both culverts on site and those immediately offsite that

could pose a risk to the site. The risk of flooding should be established using site survey, including the residual risk of culvert blockage.

The policy in the Bedford Borough Council Local Flood Risk Management Strategy encourages the opening of culverts and re-naturalisation of watercourses as part of redevelopments. Developers should seek to open-up existing old culverts and should not construct new culverts on site, except for short lengths to allow essential infrastructure crossings. Evidence would need to be provided showing there is no other economically viable alternative and that appropriate mitigation measures are being implemented to offset any ecological or flood risk impacts. Permission from the EA is unlikely to be granted without these requirements.

5.7 Flood warning

Flood Warning Areas and Flood Alert Areas are represented by the Environment Agency's Flood Warning Area GIS dataset.

5.8 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been identified from the Environment Agency's **Long Term Flood Risk Information website**.

5.9 Sewer flooding

Historical incidents of flooding are detailed by Anglian Water through their sewer flooding register. The sewer flooding register records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. Due to licencing and confidentiality restrictions, sewer flooding data has not been represented on the mapping.

5.10 Historic flooding

Historic flooding was assessed using the Environment Agency's Historic Flood Map, as well as any incidents provided by Bedford Borough Council as LLFA.

5.11 Flood defences

Flood defences are represented by Environment Agency's Asset Information Management System (AIMS) Spatial Defences data set. Their current condition and standard of protection are based on those recorded in the tabulated shapefile data. The Council's asset register was also obtained in the Level 1 SFRA.

5.12 Residual risk

The residual flood risk to sites is identified as where potential blockages or overtopping/ breach of defences could result in the inundation of a site, with the sudden release of water with little warning.

Potential culvert blockages that may affect a site were identified on OS Mapping and the Environment Agency's Detailed River Network Layer to determine where watercourses flow into culverts or through structures (i.e. bridges) in the vicinity of the sites. Any potential locations were flagged in the site summary tables. These will need to be considered by the developer as part of a site-specific Flood Risk Assessment.

Residual risk from breaches to flood defences, whilst rare, needs to be considered in Flood Risk Assessments. Considerations include the location of a breach, when it would occur and for how long, the depth of the breach (toe level), the loadings on the defence and the potential for multiple breaches. There are currently no national standards for breach assessments and there are various ways of assessing breaches using hydraulic modelling. Work is currently being undertaken by the Environment Agency to collate and standardise these methodologies. It is recommended that the Environment

Agency are consulted if a development site is located near to a flood defence, to understand the level of assessment required and to agree the approach for the breach assessment, if required.

5.13 Depth, velocity and hazard to people

The Level 2 assessment seeks to map the probable depth and velocity of flooding as well as the hazard to people during the defended fluvial 100-year (1% AEP) plus climate change (Central/ Higher Central) flood event, because the Level 2 assessment helps inform the Exception Test and usually flood mitigation measures and access/ egress requirements focus on flood events lower than the 1,000-year event (0.1% AEP) (e.g. the 100-year plus climate change event).

Where detailed model outputs were available, i.e. along River Great Ouse the 100-year plus climate change depth, velocity and hazard data has been used. This data is only present where models have a 2D element, representing the floodplain in detail.

In the absence of detailed hydraulic models (or models with detailed 1D-2D outputs), the Risk of Flooding from Rivers and Sea dataset has been used, as well as the Risk of Flooding from Surface Water datasets. The depth, hazard, and velocity of the 100-year surface water flood event has also been mapped and considered in this assessment. Sites where this applies are:

- 713 – Land South of Goldington Road
- 761 – East of Water Lane, Renhold
- 764 – North of St Neots Rd
- 907 – Little Barford
- 941 – Land west of Police HQ
- 1004 – South of Wixams
- 1336 – Chantry Avenue, Kempston
- 1355 – Land at Roxton, SW of Black Cat Roundabout
- 3233 – East of Wixams.

Hazard to people has been calculated using the below formula as suggested in Defra's FD2321/TR2 "Flood Risk to People". The different hazard categories are shown in Table 5-2. Developers should also test the impact of climate change depths, velocities, and hazard on the site, at Flood Risk Assessment stage.

Table 5-2: Defra's FD2321/TR2 "Flood Risks to People" classifications

Description of Flood Hazard Rating	Flood Hazard Rating	Classification Explanation
Very Low Hazard	< 0.75	Flood zone with shallow flowing water or deep standing water"
Danger for some (i.e. children)	0.75 - 1.25	"Danger: flood zone with deep or fast flowing water"
Danger for most	1.25 - 2.00	Danger: flood zone with deep fast flowing water"
Danger for all	>2.00	"Extreme danger: flood zone with deep fast flowing water"

As part of a site-specific FRA, developers will need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood depth, velocity and hazard based on the relevant 100-year plus climate change event, using the relevant climate change allowance based on the type of development and its

associated vulnerability classification. Not all this information is known at the strategic scale.

5.14 Note on SuDS suitability

The hydraulic and geological characteristics of each site were assessed to determine the constraining factors for surface water management. This assessment is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

The assessment is based on catchment characteristics and additional datasets such as the AStGWF map and British Geological Survey (BGS) Soil maps of England and Wales which allow for a basic assessment of the soil characteristics on a site-by-site basis. LIDAR data was used as a basis for determining the topography and average slope across each development site. Other datasets were used to determine other factors. These datasets include:

- Historic landfill sites
- Groundwater Source Protection Zones
- Detailed River Network
- Flood Zones derived as part of this Level 2 SFRA.

This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable at a site. SuDS techniques were categorised into five main groups, as shown in Table 5-3. This assessment should not be used as a definitive guide as to which SuDS would be suitable but used as an indicative guide of general suitability. Further site-specific investigation should be conducted to determine what SuDS techniques could be used on a particular development, informed by detailed ground investigations.

Table 5-3 Summary of SuDS categories

SuDS Type	Technique
Source Controls	Green Roof, Rainwater Harvesting, Pervious Pavements, Rain Gardens
Infiltration	Infiltration Trench, Infiltration Basin, Soakaway
Detention	Pond, Wetland, Subsurface Storage, Shallow Wetland, Extended Detention Wetland, Pocket Wetland, Submerged Gravel Wetland, Wetland Channel, Detention Basin
Filtration	Surface Sand filter, Sub-Surface Sand Filter, Perimeter Sand Filter, Bioretention, Filter Strip, Filter Trench
Conveyance	Dry Swale, Under-drained Swale, Wet Swale

The suitability of each SuDS type for the site options has been described in the summary tables, where applicable. The assessment of suitability is broadscale and indicative only; more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. Bedford Borough Council as LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors. SuDS in Bedford borough must be designed so that they are in accordance the **Bedford Borough Council SuDS supplementary planning guidance** which gives guidance across the area.

6 Level 2 assessment methodology

This chapter outlines how sites were screened against flood risk datasets to determine which sites needed a Level 2 assessment. It also identifies other sites at lower risk with general recommendations for developers.

6.1 Background

The Level 1 SFRA (Section 8) undertook a Local Plan sites assessment using sites provided at the time, as an early indication of what considerations may be required. This identified five Strategic Recommendations, following the Sequential Test application:

- Strategic Recommendation A - consider withdrawing the site based on significant level of fluvial flood risk.
- Strategic Recommendation B - Exception Test required if site passes Sequential Test.
- Strategic Recommendation C - consider site layout and design around the identified flood risk, if site passes Sequential Test.
- Strategic Recommendation D - site can be permitted on flood risk grounds due to limited perceived risk, subject to consultation with the LPA / LLFA.
- Strategic Recommendation E - can be allocated on flood risk grounds subject to consultation with the LPA / LLFA.

This helped the Council identify early on which sites may not be suitable for development, which require the Exception Test, which may require mitigation, and which have low/ negligible risk. This background work has been taken into account in the site screening process outlined below, applying the methodology to the latest sites provided and latest data received.

6.2 Site screening

Bedford Borough Council initially provided 35 sites for assessment in the 2022 Level 2 SFRA. These sites were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site, including:

- The proportion of the site in each Flood Zone derived from the Level 1 SFRA
- Whether the site is shown to be at risk from surface water flooding in the RoFfSW and, if so, the lowest return period from which the site is at surface water flood risk
- Whether the site is shown to be at risk of fluvial and/or surface water flooding when climate change allowances are applied
- Whether the site is within, or partially within, the Environment Agency's Historic Flood Map.

The screening was undertaken using JBA's in-house software called "FRISM". FRISM is a GIS package that computes a range of flood risk metrics based on flood and receptor datasets.

The results of the screening provide a quick and efficient way of identifying sites that are likely to require a Level 2 Assessment, assisting Bedford Borough Council with Sequential Test decision-making so that flood risk is taken into account when considering allocation options.

The screening also provides an opportunity to identify sites which may show to be 100% in Flood Zone 1, but upon visual inspection in GIS, have an ordinary watercourse flowing through or adjacent to them but for which no Flood Zone information is currently available. *Note: although there are no Flood Zone maps available for these*

watercourses, it does not mean the watercourse does not pose a risk, it just means modelling has not yet been undertaken to identify the risk.

The Flood Zones are not provided for specific sites or land where the catchment of the watercourse falls below 3km^2. For this reason, the Flood Zones are not of a resolution to be used as application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. The Risk of Flooding from Surface Water has been used in these cases because this provides a reasonable representation of the floodplain of such watercourses to use for a strategic assessment.

6.3 Sites taken forward to a Level 2 assessment

Out of the 472 sites provided by Bedford Borough Council, 35 sites were carried forward to a Level 2 assessment. Some of these sites were grouped based on location, meaning the total number of sites is 18.

A Red-Amber-Green system was applied to the sites on the basis, that:

- Red sites needed a Level 2 (due to fluvial risk or significant surface water risk)
- Amber sites did not need a Level 2 due to lower flood risk but are flagged in this report for developer considerations (recommendations provided in section 6.4), and
- Green sites that had no/ negligible risk.

In order to assess whether a site was deemed to have significant surface water risk, professional judgment was used based on the extent and location of the surface water issues relative to the site and access and egress. For example, if there was an area of deep ponding, a prominent flow route bisecting a site, immediate constraints to site access at the boundary, potential for highly vulnerable types of development to occupy a site etc.

For other sites with less significant but still noteworthy surface water issues, these have been highlighted in Table 6-2 and the LLFA expect the developer to take these into account at an early stage when planning the form and layout of the site, the surface water drainage system and any surface water mitigation measures that may be necessary.

Table 6-1 summarises the sites which have been taken forward to the Level 2 assessment on this basis.

Table 6-1: Sites carried forward to a Level 2 assessment

Site Code	Reason for Level 2*	Updated Flood Zones % ** FZ3b	Updated Flood Zones % ** FZ3a	Updated Flood Zones % ** FZ2	Updated Flood Zones % ** FZ1	Risk of Flooding from Surface Water % *** 3.3% AEP	Risk of Flooding from Surface Water % *** 1% AEP	Risk of Flooding from Surface Water % *** 0.1% AEP
505 436	Surface Water Risk	0	0	0	100	2.76	7.67	19.85
524	Fluvial risk	83	22	54	46	<1	<1	9
636, 636, 636, 636, 1333, 1333	Fluvial and surface water risk	0	16	19	100	8	11	24
638	Fluvial	12	15	18	82	1	3	7

Site Code	Reason for Level 2*	Updated Flood Zones %** FZ3b	Updated Flood Zones %** FZ3a	Updated Flood Zones %** FZ2	Updated Flood Zones %** FZ1	Risk of Flooding from Surface Water %*** 3.3% AEP	Risk of Flooding from Surface Water %*** 1% AEP	Risk of Flooding from Surface Water %*** 0.1% AEP
	risk							
713	Fluvial risk	22	29	32	68	5	8	22
745, 809, 898, 898, 1050, 905	Fluvial risk	3	11	40	100	4	9	25
761	Surface water risk	0	0	0	100	<1%	1%	6%
764	Surface water risk	0	0	0	100	5	7	13
907, 907, 907, 907, 907	Fluvial risk	29	30	32	100	3	5	14
941	Surface water risk	0	0	0	100	4	16	29
1004, 1004	Fluvial and surface water risk	0	9	13	87	16	24	53
1005	Fluvial risk	58	47	55	45	0	<1	2
1246, 1246	Fluvial and surface water risk	0	0	1	100	36	40	49
1336	Surface water risk	0	0	0	100	0	4	10
1355	Surface water risk	0	0	0	100	3	5	11
1513	Fluvial and surface water risk	0	31	33	67	3	8	34
3233	Fluvial and surface water risk	0	26	28	72	4	10	36
3245	Fluvial risk	35	39	44	56	<1	3	23

**'Fluvial risk' indicates fluvial flood risk only; 'Surface water risk' indicates surface water flood risk only; 'Combined' indicates the presence of both fluvial and surface water flood risk to the site.*

***Flood Zones may be updated using latest modelling data; hence these may differ from the EA's Flood Map for Planning Flood Zones.*

****The surface water percentages are based on the RoFfSW dataset; in the site assessments, the updated 1D-2D modelling from the SWMP has also been used to assess risk.*

***** Where multiple sites have been grouped together the maximum risk has been displayed within Table 6-1.*

The Flood Zone values quoted show the percentage of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone. For example: If 50% of a site is in the Flood Zones, taking each Flood Zone individually, 50% would be in Flood Zone 2 but say only 30% might be in Flood Zone 3a and only 10% in Flood Zone 3b. This would be displayed as stated above, i.e. the total % of that particular Flood Zone in that site. Flood Zone 1 is the remaining area of the site outside of Flood Zone 2, so Flood Zone 2 + Flood Zone 1 will equal 100%.

6.4 Recommendations for sites not taken forward to a Level 2 assessment

The 'Amber' sites identified as having some lower-level flood risk, but not requiring a Level 2 assessment, are shown in Table 6-2 below. These pose a risk from surface water flooding, or an ordinary watercourse does not present in the EA's Flood Zones due to catchment size.

Table 6-2: Sites flagged at lower flood risk

Site Code	Nature of low flood risk / considerations for the developer	Risk of Flooding from Surface Water % 3.3% AEP	Risk of Flooding from Surface Water % 1% AEP	Risk of Flooding from Surface Water % 0.1% AEP
283	• Surface water risk in the 1% and 0.1% AEP events. • No ordinary watercourse pass through or adjacent to the site and there is no fluvial risk to the site. • Residual risk to the site in the event of a blockage of the culvert passing under Northill Road 210m southeast of the site. It would therefore be prudent to run a blockage scenario of the culvert to inform any constraints to the future development of this part of the site.	0	14	28
687	• A very small region along the eastern edge of the site falls into Flood Zones 2, 3a and 3b. This fluvial risk exists since the site is located 350 west of the River Great Ouse. Some flooding associated with the high storage capacity of the nearby Wyboston Lakes may also be expected along the eastern edge of the site. • Surface water risk is present during the 3.3%, 1% and 0.1% AEP events but flow path and ponding extents are minimal.	<1	1	3
874	• Surface water risk is present during the 3.3%, 1% and 0.1% AEP events. Only one surface water pond occurs towards the south of the site.	1	7	22

Site Code	Nature of low flood risk/ considerations for the developer	Risk of Flooding from Surface Water % 3.3% AEP	Risk of Flooding from Surface Water % 1% AEP	Risk of Flooding from Surface Water % 0.1% AEP
884	• The northern half of the site lies within Flood Zone 2 due to the proximity of the site to the River Great Ouse. The northern boundary of the site is adjacent to Flood Zone 3a and 3b. • Whilst no ordinary watercourses run through the site, there is a residual risk of flooding to the northwest of the site in the event of a blockage of the culvert passing under The Branston Way. A precautionary recommendation would be to run a blockage scenario of this culvert to inform constraints for future developments within this site. • Surface water flood risk occurs during the 3.3%, 1% and 0.1% AEP events and predominantly exists towards the north and west of the site where topography is lower as the site nears the River Great Ouse.	4	7	30

Some recommendations are stated in Chapter 9 for consideration at the site-specific Flood Risk Assessment stage.

6.5 Site summary tables

As part of the Level 2 SFRA, detailed site summary tables have been produced for the sites listed above in Table 6-1. The summary tables can be found in Appendix A.

Where available, the results from existing detailed Environment Agency hydraulic models were used in the assessment to provide depth, velocity, and hazard information.

Detailed site summary tables have been produced for the site options (see Appendix A). Each table sets out the following information:

- Basic site information
    - Location of site in the catchment
    - Area, type of site, current land use (greenfield/ brownfield), proposed site use
- Sources of flood risk
    - Existing drainage features
    - Fluvial – proportion of site at risk including description from mapping/ modelling
    - Surface Water – proportion of site at risk including description from RoFfSW mapping
    - Reservoir
    - Groundwater
    - Sewers
- Flood history
- Flood risk management infrastructure

    - Defences – type, Standard of Protection, and condition (if known), and description
    - Description of residual risk (e.g. blockage or breach potential)
- Emergency Planning
    - Flood Warning Areas
    - Access and egress
- Climate change
    - Summary of climate change allowances and increase in flood extent compared to Flood Zones
- Requirements for drainage control and impact mitigation
    - Broadscale assessment of possible SuDS to provide indicative surface water drainage advice for each site assessed for the Level 2 SFRA.
    - Groundwater Source Protection Zone
    - Historic Landfill Site
- NPPF Planning implications
    - Exception Test requirements
    - Requirements and guidance for site-specific FRA (including consideration of opportunities for strategic flood risk solutions to reduce flood risk)
- Key messages – summarising considerations for the Exception Test to be passed
- Mapping information – description of data sources for the following mapped outputs:
    - Flood Zones
    - Climate change
    - Fluvial depth, velocity, and hazard mapping
    - Surface water
    - Surface water depth velocity and hazard mapping

6.5.1 Interactive GeoPDF mapping

To accompany each site summary table, there is an Interactive GeoPDF map, with all the mapped flood risk outputs per site. This is displayed centrally, with easy-to-use 'tick box' layers down the right-hand side and bottom of the mapping, to allow navigation of the data.

Flood risk information in the GeoPDF's include:

- Site boundary and Council boundary
- Title bar showing area, grid reference, site name, proposed development use (e.g. residential/ employment) and percentage Flood Zone coverage
- Flood Zones 2, 3a and 3b (functional floodplain) and indicative FZ3b (FZ3a in the absence of detailed models)
- Fluvial climate change extents – Central, Higher Central and Upper End allowances (where detailed models are available) and Indicative climate change extents (FZ2, where no detailed models are available)
- RoFfSW 30-year, 100-year and 1,000-year depth, velocity, and hazard rating
- RoFfSW climate change extents with updated allowances applied
- Areas Susceptible to Groundwater Flooding

- Risk of Flooding from Rivers and Sea
- Flood Warning and Flood Alert Areas
- Historic Flood Map
- Defences (embankment and wall)
- Main Rivers/ Ordinary watercourses

6.6 Cumulative Impact Assessment Findings

As part of the Level 2 SFRA, a Cumulative Impact Assessment (CIA) was undertaken. The full assessment can be found in Appendix B.

The CIA included a broadscale assessment and a catchment-level (area) analysis. The broadscale assessment reviewed the assessment undertaken for the Level 1 SFRA.

The catchments identified as 'high risk' in the 2020 Level 1 SFRA were:

- River Great Ouse - from the confluence with Sharn Brook to Roxton
- Renhold Brook
- Stone Brook

The catchments identified as 'high risk' in this updated CIA for the Level 2 SFRA, and therefore supersede those identified in the L1 SFRA, were:

- Elstow Brook (Upstream of Shortstown)
- Harrowden Brook
- Pertenhall Brook

Additionally, 8 areas were identified as Surface Water Flooding Hotspots:

- Wootton
- Marston Moretaine
- Wixams
- Kempston Hardwick
- Houghton Conquest
- Riseley
- Keysoe
- Pertenhall

These areas were taken forward for catchment-level analysis in the Level 2 SFRA. This is a higher resolution analysis of the high-risk catchments as identified within the broad scale assessment, and take into consideration existing urban extent, topography, and location within the wider river drainage network. The results are shown in Appendix B.

7 Flood risk management requirements for developers

This chapter provides guidance on site specific Flood Risk Assessments (FRAs). These 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, considering climate change and vulnerability of users.

The report provides a strategic assessment of flood risk in Bedford borough. Prior to any construction or development, site-specific assessments will need to be undertaken in accordance with national policy and guidance (see Section 7.2.1) so all forms of flood risk and any defences at a site are considered in more detail. 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 the sequential approach within the site and prove, if required, whether the Exception Test can be satisfied.

A detailed Flood Risk Assessment (FRA) may show that a site is not appropriate for development of a particular use class vulnerability or even at all. However, a detailed Flood Risk Assessment undertaken for a windfall site[1] may find that the site is entirely inappropriate for development of a particular vulnerability, or even at all. The Sequential and Exception Tests in the NPPF apply to all developments and an FRA should not be seen as an alternative to proving these tests have been met.

7.1 Principles for new developments

Apply the Sequential and Exception Tests

Developers must provide evidence that the Sequential Test has been passed for windfall developments. If the Exception Test is needed, they must also provide evidence that all parts of the Test can be met for all developments, based on the findings of a detailed Flood Risk Assessment.

Developers should also 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 layout?
- 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 the statutory consultees at an early stage to understand their requirements

Developers should consult with the Environment Agency, Bedford Borough Council as LLFA and Anglian Water as the water and sewerage company, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling and drainage assessment and design.

Consider the risk from all sources of flooding and that they are using the most up to date flood risk data and guidance

The SFRA can be used by developers to scope out what further detailed work is likely to be needed to inform a site-specific Flood Risk Assessment. At a site level, developers will need to check before commencing on a more detailed Flood Risk

1 'Windfall sites' is used to refer to those sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan.

Assessment that they are using the latest available datasets. Developers should apply the latest Environment Agency climate change guidance and ensure the development has taken into account climate change adaptation measures.

Ensure that development does not increase flood risk elsewhere and in line with the NPPF, seeks to reduce the causes and impacts of flooding

Chapter 9 sets out these requirements for taking a sustainable approach to surface water management. Developers should also ensure mitigation measures do not increase flood risk elsewhere and that floodplain compensation is provided where necessary.

Ensure the development is safe for future users

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. Developers should consider both the actual and residual risk of flooding to the site.

Further flood mitigation measures may be needed for any developments in an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard.

Enhance the natural river corridor and floodplain environment through new development

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted. Where possible, developers should identify and work with partners to explore all avenues for improving the wider river corridor environment.

Developers should open up existing culverts and should not construct new culverts on site except for short lengths to allow essential infrastructure crossings. Evidence would need to be provided showing there is no other economically viable alternative and that appropriate mitigation measures are being implemented to offset any ecological or flood risk impacts. Permission from the Environment Agency is unlikely to be granted without these requirements.

Consider and contribute to wider flood mitigation strategy and measures in Bedford borough and apply the relevant local planning policy

Wherever possible, developments should seek to help reduce flood risk in the wider area e.g., by contributing to a wider community scheme or strategy for strategic measures, such as defences or natural flood management or by contributing in kind by mitigating wider flood risk on a development site. Developers must demonstrate in an FRA how this has been considered at a site level.

7.2 Requirements for site-specific Flood Risk Assessments

7.2.1 When is an FRA required?

Site-specific FRAs are required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals for new development (including minor development such as non-residential extensions, alterations which do not increase the size of the building or householder developments 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).

- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

An FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1); the Environment Agency should be contacted to agree the breach assessment approach.
- Where evidence of historical or recent flood events have been passed to the LPA.
- In an area of significant surface water flood risk.

7.2.2 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 will be at risk of flooding, from all sources, both now and in the future, taking into account climate change.
- 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 should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Bedford Borough Council. 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);
- **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.**

7.3 Local requirements for mitigation measures

The Level 1 SFRA provides details on the following mitigation measures in Section 8, and should be referred to alongside this report:

- Site layout and design (8.3.1)
- Modification of ground levels (8.3.2)
- Raised floor levels (8.3.3)
- Development and raised defences (8.3.4)
- Resistance and Resilience measures (8.6)

7.4 Flood warning and emergency planning

Section 8.8 of the Level 1 SFRA discusses NPPF requirements and what an Emergency Plan will need to consider and other relevant information on emergency planning. Further information is provided by the **Bedfordshire Local Resilience Forum** in reducing flood risk from other sources.

Section 5.6-5.9 of the Level 1 SFRA discusses how to reduce flood risk from other sources, such as groundwater, surface water and sewer flooding.

7.5 Reservoirs

The risk of reservoir flooding is extremely low. However, there remains a residual risk to development from reservoirs which developers should consider during the planning stage:

- Developers should contact the reservoir owner for information on:
- the Reservoir Risk Designation
- reservoir characteristics: type, dam height at outlet, area/volume, overflow location
- operation: discharge rates/maximum discharge
- discharge during emergency drawdown; and
- inspection/maintenance regime.
- The EA and National Resource Wales (NRW) online Reservoir Flood Maps contain information on the extents, depths and velocities following a reservoir breach (note: only for those reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975). Consideration should be given to the extent, depths and velocities shown in these online maps.
- The GOV.UK website on **Reservoirs: owner and operator requirement** provides information on how to register reservoirs, appoint a panel engineer, produce a flood plan and report and incident.

Developers should consult the **Bedfordshire Local Resilience Forum** about emergency plans for reservoir breach.

Developers should use the above information to:

- Aid in the application of the sequential approach to locating development within the site.
- Consider the impact of a breach and overtopping, particularly for sites proposed to be located immediately downstream of a reservoir. This should consider whether there is sufficient time to respond, and whether in fact it is appropriate to place development immediately on the downstream side of a reservoir.
- Assess the potential hydraulic forces imposed by sudden reservoir failure event and check that that the proposed infrastructure fabric could withstand the structural loads.
- Develop site-specific Emergency Plans and/ or off-site plans if necessary and ensure the future users of the development are aware of these plans. This may need to consider emergency drawdown and the movement of people beforehand, similar to the response to the Toddbrook Reservoir incident in Whaley Bridge, Derbyshire, 2019.

7.6 Duration and onset of flooding

The duration and onset of flooding affecting a site depends on a number of factors:

- The position of the site within a river catchment, with those at the top of a catchment likely to flood sooner than those lower down. The duration of flooding tends to be longer for areas in lower catchments.
- The River Great Ouse drains a large area of the East. Upstream reservoirs in these catchments, will provide some online flood storage that reduce the flood risk downstream and delays the onset of flooding. At the confluence of the larger watercourses and smaller tributaries, there may be different timings of

peak flows, for example smaller tributaries would peak much earlier than the larger catchments.

- The principal source of flooding: where this is surface water, depending on the intensity and location of the rainfall, flooding could be experienced within 30 minutes of the heavy rainfall event e.g., a thunderstorm. Typically, the duration of flooding for areas at risk of surface water flooding or from flash flooding from small watercourses is short (hours rather than days).
- The preceding weather conditions prior to the flooding: wet weather lasting several weeks will lead to saturated ground. Rivers respond much quicker to rainfall in these conditions.
- Whether a site is defended, noting that if the defences were to fail, a site could be affected by very fast flowing and hazardous water within 15 minutes of a breach developing (depending on the size of the breach and the location of the site in relation to the breach), causing danger to life.
- Catchment geology, for example chalk catchments take longer to respond than typical clay catchments.

Table 7-1: Guidelines on the duration of and onset of flooding

Principal source of flooding	Duration	Onset
Surface water	Up to 4 hours	Within 30 minutes
Fluvial	4 – 24* hours	Within 2 - 8 hours

**Depending on where in the catchment a site is located, flooding could be rapid and flashy in the upper catchment (e.g. small tributaries), and slower responding and longer in duration in the lower catchment.*

It is recommended that a site-specific Flood Risk Assessment refines this information, based on more detailed modelling work where necessary.

8 Surface water management and SuDS

This chapter provides guidance and advice on managing surface water runoff and flooding.

The Level 1 SFRA summarises guidance and advice on managing surface water runoff and flooding in Chapter 9. Below is a guide to what is included in sections of the Level 1 SFRA not expanded on in this Level 2 SFRA which should be referenced alongside this information:

- Section 9.1 – Role of the LLFA and LPA in surface water management
- Section 9.2 – Sustainable Drainage Systems (SuDS)

8.1 Sources of SuDS guidance

8.1.1 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) provides guidance on planning, design, construction and maintenance of SuDS. 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.

8.1.2 Non-statutory Technical Guidance, Defra (March 2015)

Non-Statutory Technical guidance provides non-statutory standards on the design and performance of SuDS. It outlines peak flow control, volume control, structural integrity, flood risk management and maintenance and construction considerations.

In February 2021, Defra published its **research project** to review and recommend updates to the Non-Statutory Technical guidance. The proposals have not yet been adopted but would bring the standards in line with current best practice according to the construction industry research and information association (CIRIA) SuDS Manual.

8.1.3 Non-statutory Technical Guidance for Sustainable Drainage Practice Guidance, LASOO (2016)

The Local Authority SuDS Officer Organisation LASOO produced their **Practice guidance** in 2016 to give further detail to the Non-statutory technical guidance.

8.1.4 Bedford Borough Council Sustainable Drainage System SPD

Bedford Borough Council have published a comprehensive **SuDS SPD** which includes specific guidance for the design and implementation of SuDS in new developments. There is also further **information for planners and developers on the Bedford Borough Council website,** which outlines their requirements for the submission of drainage strategies as part of planning applications.

8.2 Other considerations

8.2.1 Groundwater Vulnerability Zones

The Environment Agency published groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise of the underlying bedrock. The map shows the vulnerability of groundwater at a location based on the hydrological, hydro-ecological and soil propertied within a one-kilometre grid square.

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. Groundwater vulnerability maps can be found on **Defra's interactive mapping.**

8.2.2 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones (SPZs) near groundwater abstraction points. These protect areas of groundwater used for drinking water. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. Groundwater Source Protection Zones can be viewed on the **Defra website.**

The west of Bedford borough is located within a Groundwater Source Protection Zone which follows the wider valley of the River Great Ouse to the north-west of Bedford. The rest of Bedford is located outside of a Groundwater Source Protection Zone.

8.2.3 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 NVZ coverage can be viewed on **Defra's interactive mapping.**

8.3 SuDS suitability across the study area

The suitability of SuDS techniques is dependent upon many variables, including the hydraulic and geological characteristics of the catchment.

The permeability of the underlying soils can determine the infiltration capacity and percolation capacities. As such, a high-level review of the soil characteristics has been undertaken using BGS soil maps of England and Wales which allow for a basic assessment of the soil characteristics and infiltration capacity. The results of the assessment and mapping of the soil characteristics are shown in the Level 1 SFRA.

This strategic assessment should not be used as a definitive site guide as to which SuDS would be suitable but rather as an indicative guide of general suitability based solely on soil type. Several other factors can determine the suitability of SuDS techniques including land contamination, the depth and fluctuation of the water table, the gradient of local topography and primary source of runoff etc. When considering NVZs and if areas have pollutants, infiltration may only be suitable where treatment measures are provided, prior to any discharge to surface or groundwaters.

Further site-specific investigation should be conducted to determine what SuDS techniques could be utilised at a particular development. The result of this assessment does not remove the requirements for geotechnical investigation or detailed infiltration testing and does not substitute the results of site-specific assessments and investigations. The LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors.

9 Summary of Level 2 assessment and recommendations

9.1 Assessment methods

As part of the Level 2 SFRA, 18 detailed site summary tables have been produced for the 35 Level 2 sites assessed.

The summary tables set out the flood risk to each site, including Food Zone coverage, maps of extent, depth, and velocity of flooding as well as hazard mapping for the 100-year + climate change defended event, where available. Climate change mapping has also been produced to indicate the impact which different climate change allowances may have on the site (where models are available) or using Flood Zone 2 as an indication of climate change. A range of surface water datasets have been used: the national Risk of Flooding from Surface Water, updated detailed modelling from the Surface Water Management Plan (SWMP) and hotspot locations from the SWMP. Each table also sets out the NPPF requirements for the site as well as guidance for site-specific FRAs.

A broadscale assessment of suitable SuDS options has been provided giving an indication where there may be constraints to certain sets of SuDS techniques. This assessment is indicative and more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. It may be possible that those SuDS techniques highlighted as possibly not being suitable can be designed to overcome identified constraints. Where residual risk was thought to be a potential concern, comments were made on potential culvert blockages at sites.

Interactive mapping is shown in Appendix A and should be viewed alongside the detailed site summary tables.

9.2 Summary of key site issues

- Roughly half of the sites with a detailed Level 2 summary table are at fluvial flood risk. The degree of flood risk varies, with some sites being only marginally affected along their boundaries (e.g. more to immediate access), and other sites being more significantly affected within the site, such as sites 524, 636, 638, 713, 907, 1005, and 3245. A number of sites were located along the main River Great Ouse, where detailed model outputs were available. 9 of the 18 whole site areas at fluvial risk were only partially covered by detailed models and the EA's Flood Zones were used to interpret the flood risk. These will require more detailed baseline investigations to inform sequential site layouts, SuDS possibilities, safe access, and egress and so on, as part of a site-specific Flood Risk Assessment at the planning application stage.
- Most sites at fluvial risk are also at risk from surface water flooding, with an additional 19 sites assessed solely due to the presence of surface water risk. Surface water risk sometimes aligns with floodplain topography from following topographic flow routes or may form isolated areas of ponding in depressions. Some flow paths may bisect sites. As a result, some sites not at fluvial risk were subject to a Level 2 assessment where surface water risk was deemed to be significant from professional judgement, for example site 1246. Surface water should also be considered when assessing safe access and egress to and from the site. This assessment reflects the requirement that all sources of flood risk are considered when performing he Sequential Test, as the L2 assessment for surface water addresses the "part b" requirements of the Exception Test.
- Fluvial climate change mapping indicates that flood extents will increase over the lifetime of proposed development. As a result, the depths, velocities, and hazard of flooding may also increase. The significance of the increase tends to depend on the topography of site and the percentage allowance used; future extents

would be larger than Flood Zone 3, but maximum future extents are likely to be similar to Flood Zone 2. The Council and the Environment Agency require the 100-year plus 19%, 30% and 58% **climate change** fluvial scenarios to be considered in future developments for the 2080s epoch as of July 2021. The 1,000-year surface water flood extent can also be used as an indication of climate change to surface water risk. Site-specific FRAs should confirm the impact of climate change using latest guidance.

- Residual risk was considered at the sites. Blockage locations were determined by visual inspection of the OS mapping and ground topography in the vicinity of the site, to determine whether a structure upstream, downstream, or within the site could have an impact on the site. These would need to be considered further as part of a site-specific assessment.
- A strategic assessment was conducted of SuDS options using regional datasets and JBA's Groundwater map. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.
- For some sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles. Also, consideration should be given to whether the risk forms a flow path or bisects the site where access from one side to another may be compromised. The responsibility for putting appropriate arrangements in place would most appropriately rest with the Council and the commitment and obligations involved should be considered accordingly.
- In respect of cumulative impact assessment, there are a number of development sites proposed that have the potential to provide a betterment to existing communities downstream within the catchment. However, all of these developments also have the potential to increase flood risk offsite if both National and Local SuDS Standards are not applied. They also offer a great potential to enhance the wider Green and Blue Infrastructure of the local area through integrated planning for flood risk, sustainable drainage, biodiversity, amenity and sustainable transport provision.

9.2.1 Considering the Exception Test for the proposed sites in Bedford borough

In principle, it is possible for the majority of sites assessed in the Level 2 SFRA to pass the flood risk element of the Exception Test, for example by:

- siting development away from the highest areas of risk into Flood Zone 1 (in the majority of sites assessed, the risk is along a site boundary, so steering away from this is advised),
- considering safe access/ egress in the event of a flood (from all parts of the site, if say the site is severed by a flood flow path),
- using areas in Flood Zone 2 for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. Residential development should not be permitted in Flood Zone 3a and no development at all should be permitted in Flood Zone 3b (aside from essential infrastructure, such as a bridge crossing the lowest points of a site),
- testing flood mitigation measures if these are to be implemented, to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another),
- considering space for green infrastructure in the areas of highest flood risk where this is appropriate.

Some sites present more significant development challenges in the 100-year + climate change events and above, where they are fully inundated. In some areas of Bedford borough, more detailed fluvial modelling has been carried out in recent years, providing a more accurate representation of the Flood Zones. The catchment modelled is the River Great Ouse.

Consideration must also be given to the surface water risk within Bedford borough, particularly around Wootton, Marston Moretaine, Wixams, Kempston Hardwick, Houghton Conquest, Riseley, Keysoe. and Pertenhall, which are known surface water hotspots. For example, a site may pass the Exception Test based on fluvial flood risk alone, but greater risk may come from surface water at sites assessed in these areas. However, the national surface water mapping does not account for culverts, structures, channel hydraulics or sewer capacity, and therefore this is deemed to overestimate risk and therefore the confidence in this dataset is reduced. It is recommended that developers investigate surface water risk in more detail at the planning application stage and may need to consider undertaking integrated modelling.

For larger sites, for example Site 907, that comprises a number of smaller land parcels for development, and some of those parcels are in areas of flood risk, the Exception Test may need to be re-applied by the developer at the planning application stage.

9.3 Planning Policy recommendations

The Planning Policy recommendations in Chapter 10 of the Level 1 SFRA still stand for the site allocations and any windfall development that comes forward. Recommendations in the L1 are made in relation to:

- Considering flood resilience measures for new development.
- Combining infiltration (e.g. permeable surfaces) and attenuation (e.g. balancing ponds and flood storage reservoirs) SuDS techniques to overcome constraints to the area of a site set aside for infiltration systems caused by development pressures.
- Seeking opportunities for betterment where possible, where surface water flooding issues are present.
- Encouraging the use of permeable surfacing in gardens and use measures to optimise drainage and reduce runoff.
- Considering opportunities for water conservation through rainwater harvesting and water butts where appropriate for new and existing development.
- Promoting land management practices where appropriate to attenuate runoff and alleviate potential issues downstream.

Further catchment-specific recommendations have been made in the Level 2 report regarding Cumulative Impact Assessment. These are made in Appendix B.

9.4 Guidance for windfall sites and sites not assessed in the L2

- For sites not represented in the Environment Agency's Flood Zones, or where Flood Zones do exist, but no detailed hydraulic modelling is present, it is recommended that developers construct detailed hydraulic models at these sites as part of a site-specific FRA using channel, structure and topographic survey, to confirm flood risk. This representation may be absent as Flood Zones do not extend into a watercourse any further than the point where the upstream catchment is less than 3km^2.
- If a site's extents either include or borders a Main River (including a culverted reach of Main River), an easement of 8m is required from either bank for access

and maintenance. Any future development will require a flood risk permit from any activity within 8m of a Main River.

- If an ordinary watercourse is within or immediately adjacent to the site area, consultation with the Lead Local Flood Authority should be undertaken. If alterations or discharges are proposed to the watercourse, a land drainage consent will be required.
- Where necessary, blockages of nearby culverts may need to be simulated in a hydraulic model to confirm residual risk to the site.
- Surface water risk should be considered in terms of the proportion of the site at risk in the 30-year, 100-year or 1,000-year events, whether the risk is due to isolated minor ponding or deeper pooling of water, or whether the risk is due to a wider overland flow route.
- Surface water risk and mitigation should be considered as part of a detailed site-specific Flood Risk Assessment and Surface Water Drainage Strategy.
- Access and egress should be considered at the site, but also in the vicinity of the site, for example, a site may have low surface water risk, but in the immediate locality, access/ egress to and from the site could be restricted for vehicles and/ or people.
- Sites where there is a canal within or immediately adjacent to the site area, developers should consult the Canal and Rivers Trust. Any proposed alterations to the canal or discharges must be agreed with the Canal and Rivers Trust.
- If a site is located within 250m of a landfill site, there could be amenity, dirt and contamination issues. Sites could be sensitive from the perspective of controlled waters and therefore any redevelopment must ensure there is no pollution risk to the water environment.

9.5 Use of SFRA data and future updates

It is important to recognise that 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.

The SFRA should be a 'living document', and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Bedford Borough Council, the Highways Authority, Canal and Rivers Trust, Anglian Water and the Environment Agency. Such information may be in the form of:

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

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 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.

9.5.1 Neighbourhood Plans

Flood risk should be fully addressed in development plan preparation and in bringing forward policies for the allocation of land and therefore the SFRA findings should be used in the production of Neighbourhood Plans.

Neighbourhood planners can use the information in the Level 1 and Level 2 SFRA on the sources of flood risk across Bedford borough and the flood risk mapping, to assess the risk of flooding to sites within their community. The SFRA will also be helpful for developing community level flood risk policies in high flood risk areas.

The Level 1 SFRA highlights on a broad scale where flood risk from fluvial, surface water, groundwater and the effects of climate change are most likely. The maps are useful to provide a community level view of flood risk but may not identify if an individual property is at risk of flooding or model small scale changes in flood risk. Local knowledge of flood mechanisms will need to be included to complement this broadscale mapping.

Similarly, all known recorded historical flood events for Bedford borough are listed in the Level 1 SFRA and this can be used to supplement local knowledge regarding areas worst hit by flooding. Ongoing and proposed flood alleviation schemes planned by Bedford Borough Council and the EA are outlined in Chapter 5. The Level 2 SFRA uses the same updated information as the 2020 Level 1 report to assess sites; this includes latest flood incident data from the LLFA. Please contact the Council to obtain further information.

Appendices

A Level 2 Assessment

A.1 Site Summary Tables

A.2 GeoPDF mapping

Instructions for using GeoPDFs

1. GeoPDFs should be opened with Adobe. They display the mapping datasets relevant to this report for each site

2. Datasets shown in the legend can be switched on and off using the tick boxes. If nothing displays, it means there is no data available associated with that location.

B Cumulative Impact Assessment

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