Local Plan for Buckinghamshire Level 1 Strategic Flood Risk Assessment

Final Report

June 2024

Prepared for:

Buckinghamshire Council

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Contract

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This report describes work commissioned by Buckinghamshire Council, by an instruction dated 21 December 2022. The Client's representative for the contract was David Broadley, Aude Pantel and Trinidad Galindo of Buckinghamshire Council. Emily Christopherson, Evie Whatling, Amy Ewens and Fiona Barraclough of JBA Consulting carried out this work.

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Abbreviations

Term	Definition
AEP	Annual Exceedance Probability. The probability that a flood of a given (or larger) magnitude will occur within a period of one year.
AVDC	Aylesbury Vale District Council (former district council)
BC	Buckinghamshire Council. Created on 1 April 2020 from the merger of Buckinghamshire County Council, Aylesbury Vale District Council, Wycombe District Council, Chiltern District Council and South Bucks District Council.
BCC	Buckinghamshire County Council (former county council)
BGS	British Geological Survey. Independent research organisation providing geoscientific data and information.
BNG	Biodiversity Net Gain. A way to contribute to the recovery of nature while developing land. It is making sure the habitat for wildlife is in a better state than it was before development. This will apply from November 2023 for developments covered under the Town and Country Planning Act 1990, unless exempt. It will apply to small sites from April 2024.
Brownfield	Previously developed parcel of land.
CC	Climate change. Long term variations in global temperature and weather patterns caused by natural and human actions.
CDC	Chiltern District Council (former district council)
CFMP	Catchment Flood Management Plan. A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association.
Defra	Department for Environment, Food and Rural Affairs.
Designated Feature	A form of legal protection or status reserved for certain key structures or features that are privately owned and maintained, but which contribute to the flood or coastal erosion risk management of people and property at a particular location.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
EA	Environment Agency. The EA is responsible for managing the flood risk and erosion from Main Rivers and the sea in England. The Environment Agency has powers to conduct flood defence work on Main Rivers, and to regulate works by other parties on Main Rivers.
EU	European Union
FEH	Flood Estimation Handbook. Industry-standard method for estimating river flows and site runoff rates in the UK.

Term	Definition
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 Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management. The Flood Risk Regulations were revoked in December 2023, as many parts are duplicated under the duties of the Flood and Water Management Act 2010.
Flood and Water Management Act (FWMA)	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 Main River.
FRA	Flood Risk Assessment - A site-specific assessment of all forms of flood risk to the site now and in the future, and the impact of development of the site to flood risk in the area.
FRMP	Flood Risk Management Plan. River catchment-scale plans created by the Environment Agency which set out how organisations, stakeholders and communities will work together to manage flood risk in England.
GI	Green Infrastructure – a network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and urban fringe.
Greenfield	Undeveloped parcel of land.
Groundwater Flooding	As rain infiltrates through the soil it percolates down into the saturated zone. In areas where the water table is close to the surface, low volumes of rainfall can cause the groundwater level to rise upwards and seep out at the surface, leading to flooding.
Ha	Hectare.
HELAA	Housing and Economic Land Availability Assessment - The Housing and Economic Land Availability Assessment (HELAA) is a technical piece of evidence to support local plans and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing and economic land in Buckinghamshire which is suitable and deliverable.
HFM	Historic Flood Map
IDB	Internal Drainage Board. A public body that manages water levels in an area, known as an internal drainage district, where there is a special need for drainage. The Buckingham and River Ouzel IDB covers part of

Term	Definition
	Buckinghamshire. The IDB has powers under the Land Drainage Act 1991 to regulate flows in rivers within their internal drainage districts.
Indicative Flood Risk Area	Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by Defra.
JBA	Jeremy Benn Associates
LIDAR	Light Detection and Ranging. LIDAR can provide accurate, detailed data on elevation for the creation of sophisticated flood models and maps. A LIDAR system involves the use of aircraft-mounted lasers that send pulses down to the Earth's surface.
LFRMS	Local Food Risk Management Strategy. Local strategies for flood and coastal erosion risk management prepared by Lead Local Flood Authorities in England.
LLFA	Lead Local Flood Authority. A unitary or county council responsible for taking the lead on local flood risk management (flood risk from ordinary watercourses, surface water and groundwater). The LLFA has powers under the Land Drainage Act 1991 to regulate ordinary watercourses (outside internal drainage districts) to maintain flow.
LNRS	Local Nature Recovery Strategy. System of spatial strategies that establishes priorities and maps proposals for actions to drive nature's recovery and provide wider environmental benefits.
LPA	Local Planning Authority. The local government body that is empowered by law to exercise urban planning functions for a particular area and also control development.
mAOD	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. Natural processes used to manage the risk of flooding and coastal erosion.
NPPF	National Planning Policy Framework. Sets out the government's planning policies for England and how these are expected to be applied.
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.
PFRA	Preliminary Flood Risk Assessment. A high-level assessment of flood risk, based on historic and predicted flood risk data, to identify the areas of greatest risk. In England, a national PFRA has been prepared by the Environment Agency and local PFRAs have been prepared by Lead Local Flood Authorities.
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

Term	Definition
	the network is full to capacity.
PPG	Planning Practice Guidance. Provides guidance on the National Planning Policy Framework.
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.
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.
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	Anyone who owns a watercourse by the fact that it crosses their land. Has responsibility for maintaining that part of the watercourse.
RoFSW	Risk of Flooding from Surface Water. National dataset which assesses flooding scenarios as a result of rainfall with a 3.3%, 1% and 0.1% chance of occurring each year.
RTCT	River Thame Conservation Trust.
SBDC	South Buckinghamshire District Council (former district council)
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment - SFRA provides an overview of the risk from all sources across the Council's area.
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations. It includes the public and communities.
SuDS	Sustainable Drainage Systems - Management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff because 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.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions,

Term	Definition
	timescales and responsibilities of each partner. It is the principal output from the SWMP study.
WDC	Wycombe District Council (former district council)
WFD	Water Framework Directive - An EU Directive, transposed into UK law that requires surface waters and groundwater to achieve good status. This is to deliver multiple benefits including reduced pollution and a better environment for biodiversity and people. This led to the introduction of River Basin Management Plans.
WwTW	A wastewater treatment works receives flows from the sewerage system and treats it so it can be discharged back into a river. They may also be called Sewage Treatment Works (STWs) or Water Recycling Centres (WRCs).

Executive Summary

Introduction

This Strategic Flood Risk Assessment (SFRA) Level 1 2023 document replaces the Level 1 SFRAs published by the former Aylesbury Vale, Chiltern, South Bucks and Wycombe District Councils. It forms part of the evidence base for the emerging Local Plan for Buckinghamshire (LP4B), the first Local Plan for Buckinghamshire Council since it became a unitary authority in 2020. The LP4B is currently at the evidence gathering and engagement stage and the forward timetable for consultations, expected examination and adoption in 2027 can be found on the Council website[1],[2]. Once finalised and adopted, the LP4B will replace the existing Local Plans for the former districts of Aylesbury Vale, Chiltern, South Bucks and Wycombe. The new local plan will cover the period up to 2045.

Buckinghamshire is also served by a Minerals and Waste Local Plan which covers the period of 2016-2036, adopted in July 2019. A separate assessment of flood risk was undertaken in 2019 to support this Plan, and an updated SFRA will be required when the Minerals and Waste Local Plan is updated.

The SFRA is a planning tool that will assist the Council in its selection and development of sustainable housing and employment development sites away from vulnerable flood risk areas in accordance with the NPPF and its associated Planning Practice Guidance on Flood Risk and Coastal Change.

The report has been prepared to update the previous SFRAs and to provide appropriate supporting evidence for the emerging LP4B, which will set out a vision and framework for development in Buckinghamshire and identify the location of future housing and employment developments.

SFRA objectives

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 housing, employment, minerals or waste 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 areas at high risk from all flood sources cannot appropriately accommodate all the necessary development, and the potential flood risk vulnerability of the proposed development creates the need to apply

1 Buckinghamshire Council website https://www.buckinghamshire.gov.uk/planning-and-building-control/planning-policy/local-development-plans-and-guidance/local-development-scheme/ accessed 09/02/2024

2 Buckinghamshire Council (2023) Stages to create the Local Plan for Buckinghamshire. Available at: Stages to create the Local Plan for Buckinghamshire.pdf (citizenspace.com)

the NPPF's (National Planning Policy Framework) Exception Test, where appropriate. In these circumstances, the assessment should consider the detailed nature of the flood characteristics and whether development of the site will be safe throughout its lifetime.

At this stage, a Level 1 SFRA has been prepared for Buckinghamshire. This replaces the previous Level 1 SFRAs prepared for the former districts of Buckinghamshire - Aylesbury Vale (2017)[3], Chiltern and South Bucks (2018)[4], and Wycombe (2014)[5] but not the SFRA that informed the Buckinghamshire Minerals and Waste Local Plan (2019).

SFRA outputs

- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, groundwater, canal, reservoir and sewer flooding.
- Updated review of historic flooding incidents.
- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.

At the time of preparing the Level 1 SFRA, the identification of suitable and deliverable allocation sites for the Local Plan, as part of the Housing and Employment Land Availability Assessment (HELAA) was in progress, and therefore site boundaries were not yet available for assessment.

Once sites are available, as part of a Level 2 SFRA, the flood risk to each of these sites, from all sources of flooding, will be assessed by screening the site boundaries against the flood risk mapping from all sources, to determine the proportion of the site at risk. Section 12 recommends the flood risk criteria to be used in the assessment of flood risk to sites.

Summary of flood risk in the study area

The SFRA has considered all sources of flooding including fluvial, surface water, ordinary watercourses, groundwater, sewers and reservoirs within the study area.

3 Aylesbury Vale District Council (2017) Level 1 Strategic Flood Risk Assessment. Available at: JBA Consulting Report Template 2015 (buckinghamshire-gov-uk.s3.amazonaws.com)

4 Chiltern and South Bucks District Councils (2018) Strategic Flood Risk Assessment (Level 1) Available at: B127F002-L1-SFRA-03_CSBDC_Level_1_SFRA_1.pdf (buckinghamshire-gov-uk.s3.amazonaws.com)

5 Wycombe District Council (2014) Strategic Flood Risk Assessment (Level 1) Update. Available at: Microsoft Word - Wycombe DC Level 1 SFRA Update v03.docx (buckinghamshire-gov-uk.s3.amazonaws.com)

- Fluvial flood risk is shown to generally be confined to the Main River floodplains of the Rivers Colne, Great Ouse, Thame, Thames and Ray.
- Surface water flood risk is concentrated in urban areas on the lower slopes of the Chilterns, which receive large volumes of overland flows. Many of the settlements across Buckinghamshire have experienced flooding in the past, with Chesham particularly affected in July 2007.
- The risk of flooding from ordinary watercourses is not explicitly represented within any national mapping dataset. However, the Risk of Flooding from Surface Water mapping provides an indication of the flood risk associated with ordinary watercourses within Buckinghamshire.
- Groundwater flood risk is significant in Buckinghamshire, with the county severely affected by the flood events of Winter 2000/2001 and Winter 2013/2014. Jacobs groundwater emergence modelling and JBA groundwater mapping identify the highest risk areas occurring in the Chiltern Hills and Thames Valley, however elevated groundwater levels are likely to affect all of the major floodplains.
- The greatest number of recorded sewer flooding incidents were recorded in the postcode areas of HP13 (High Wycombe), HP15 (Cryers Hill, Great Kingshill, Hazlemere), HP19 (North west Aylesbury) and SL2 (Farnham Common/Farnham Royal) within the Thames Water region, and within MK17 (Woburn Sands, Newton Longville) and MK18 (Winslow, Steeple Claydon) in the Anglian Water region.
- Climate change is predicted to result in more frequent and extreme rainfall events, increasing the frequency and severity (depth/hazard) of flooding from fluvial, ordinary watercourses and surface water sources. The effect of climate change on the fluvial Flood Zones and surface water flood risk (also used to indicate the fluvial flood risk from ordinary watercourses) has been assessed, with mapping provided in Appendix C.
- There is a potential risk of flooding from 32 reservoirs both within Buckinghamshire and those outside. There are no records of flooding from reservoirs in the study area to date. The level and standard of inspection and maintenance required under the Reservoirs Act 1975 means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach and this risk should be considered in any site-specific Flood Risk Assessments (where relevant).
- There is a potential risk of flooding in Buckinghamshire from canal breach or overtopping from the Grand Union Canal. There are records of historic breach and overtopping events in Aylesbury and Wendover, as well as in neighbouring Leighton Buzzard.

How to use this report

Planners

The SFRA provides recommendations regarding all sources of flood risk in Buckinghamshire, which can be used to inform policy on flood risk within the Local Plan. This includes how the cumulative impact of development should be considered.

It provides the latest flood risk data and guidance to inform the Sequential Test and provides guidance on how to apply the Exception Test. The Council can use this information to apply the Sequential Test to strategic allocations and identify where the Exception Test will also be needed. The SFRA provides guidance for developers, which can be used by development management staff as well to assess whether site specific Flood Risk Assessments meet the required quality standard.

Developers

This SFRA provides guidance for the application of the Sequential and Exception Tests at a site level and for detailed site-specific Flood Risk Assessments. For sites that are not strategic allocations, developers will need to use this SFRA to help apply the Sequential Test. For all sites concerned, whether strategic allocations or windfall sites, developers will need to apply the Exception Test where the Sequential Test has not been passed as per the PPG table 2, and use information in a site-specific Flood Risk Assessment to inform this test at planning application stage. When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as providing evidence to show that they have adequately considered other reasonably available sites.

This is a strategic assessment and does not replace the need for site-specific Flood Risk Assessments where a development is either within Flood Zones 2 or 3, or greater than a hectare in Flood Zone 1. In addition, a surface water drainage strategy will be needed for all major developments in any Flood Zone to satisfy Buckinghamshire Council, as Lead Local Flood Authority (LLFA).

Developers can use the information in this SFRA, alongside site-specific research, to help to scope out what additional work will be needed in a detailed Flood Risk Assessment. To do this, they should refer to Section 9, Appendix C (mapping) and Appendix F (SFRA user guide). At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances, last updated by the Environment Agency in 2022), inform master planning and prove, if required, whether the Exception Test can be passed. As part of the Environment Agency's updated guidance on climate change, which must be considered for all new developments and planning applications, developers will need to undertake a detailed assessment of climate change as part of the planning application process when preparing FRAs, including when considering reasonable alternative sites for the

Sequential Test. Consideration of climate change for the proposed site only will not be acceptable, as it is not consistent with the PPG.

Developers need to ensure that new development does not increase surface water runoff from a site. Section 9 provides information on the surface water drainage requirements of Buckinghamshire Council as LLFA.

Sustainable Drainage Systems should be considered at the earliest stages that a site is developed which will help to minimise costs and overcome any site-specific constraints. Flood Risk Assessments will need to identify how flood risk will be mitigated to ensure the development is safe from flooding and does not increase flood risk elsewhere. In high-risk areas, the Flood Risk Assessment will also need to consider emergency arrangements, including how there will be safe access and egress from the site.

Any developments located within an area protected by flood defences where the standard of protection is not sufficient to mitigate flood risk over the proposed lifetime of the development (either now or in the future), the use of developer contributions should be considered to fund improvements. This would be necessary to ensure that development is feasible and would remain safe throughout its lifetime.

Cumulative impacts

A cumulative impact assessment has been carried out which has identified which catchments in Buckinghamshire are more sensitive to the cumulative impact of development and where more stringent policy regarding flood risk is recommended. Any development in these areas should seek to contribute to work that reduces wider flood risk in those catchments.

Neighbourhood plans

The SFRA provides information on the sources of flooding and the variation in the risk across Buckinghamshire, which organisations are involved in flood risk management and their latest strategic plans, current plans for major flood defences, the requirements for detailed Flood Risk Assessments and to inform the site selection process. Neighbourhood planners can use this information to assess the risk of flooding to sites within their community, using Section 4, the sources of flooding in Buckinghamshire, and the flood mapping in the appendices. The SFRA will also be helpful for developing community level flood risk policies in high flood risk areas.

These maps highlight on a broadscale where flood risk from fluvial, surface water, groundwater and the effects of climate change are most likely. These 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 Buckinghamshire are listed in Section 6.1 and this can be used to supplement local knowledge regarding areas worst hit by flooding. Ongoing and proposed flood alleviation schemes are outlined in Section 7, and Section 9.5 discusses mitigation, resistance and resilience measures, which can be applied to alleviate flood risk to an area.

Use of SFRA data

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 all sources of flooding, and the potential impacts of future climate change.

Information on flood risk is being updated continuously. The SFRA should be periodically updated as appropriate 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 Buckinghamshire Council, Thames Water, Anglian Water, the Environment Agency, the Buckingham and Ouzel IDB and neighbouring authorities. Community engagement, and the sharing of knowledge on local flood events help by communities, may also result in new information coming to light.

Next steps

As the Council move forward with their Local Plan, they will use the most up to date information in the Sequential Test, and developers should be aware of the latest information for use in Flood Risk Assessments. The Council will consider the need for a Level 2 SFRA, once it has completed a review of capacity for future growth and a comprehensive audit of the suitability and deliverability of potential site options for the new Local Plan. The methodology used in this SFRA may be amended for a Level 2 study, for example due to changes in national planning policy and other guidance.

1 Introduction

1.1 Local Plan Context

This Level 1 Strategic Risk Assessment (SFRA) has been prepared to provide comprehensive and supporting evidence for the emerging Local Plan for Buckinghamshire (LP4B). The SFRA study area is shown in Figure 1-1. The LP4B is the first Local Plan for Buckinghamshire Council as a unitary authority, following its establishment in April 2020. It will set the context for new development up to 2045, and will make sure that sufficient housing and employment land, alongside associated infrastructure, will be planned to meet the needs of the area. The Local Plan will also identify what new development should be provided , including building a suitable number and size of homes, allocating land for new jobs, protecting the environment (by supporting wildlife, historic places and managing flood risk) and, contributing to infrastructure to meet needs such as roads, schools and health facilities[6].

An updated Local Transport Plan 5 (LTP 5) is also being developed, to set out long-term ambitions, policies and plans for future investment in all types of local transport in Buckinghamshire up to 2040.

The LP4B is currently at the evidence gathering and engagement stage and the forward timetable for consultations, expected examination and adoption in 2027 can be found on the Council website[7] .Once finalised and adopted, the LP4B will replace the existing Local Plans for the former districts of Aylesbury Vale, Chiltern, South Bucks and Wycombe but not the SFRA that informed the Buckinghamshire Minerals and Waste Local Plan (2019).

1.2 Purpose of the Strategic Flood Risk Assessment

As outlined in paragraph 160 of the National Planning Framework (July 2021)[8], "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".

The key objectives of the 2023 Level 1 SFRA are:

6 Buckinghamshire Council (2023) Consultation on vision and objectives for development and transport in Buckinghamshire. Available at: Have your say on the vision and objectives for development and transport in Buckinghamshire - Your Voice Bucks - Citizen Space

7 Buckinghamshire Council website https://www.buckinghamshire.gov.uk/planning-and-building-control/planning-policy/local-development-plans-and-guidance/local-development-scheme/ accessed 09/02/2024

8 UK Government (2021) National Planning Policy Framework. Available at: National Planning Policy Framework - Guidance - GOV.UK (www.gov.uk)

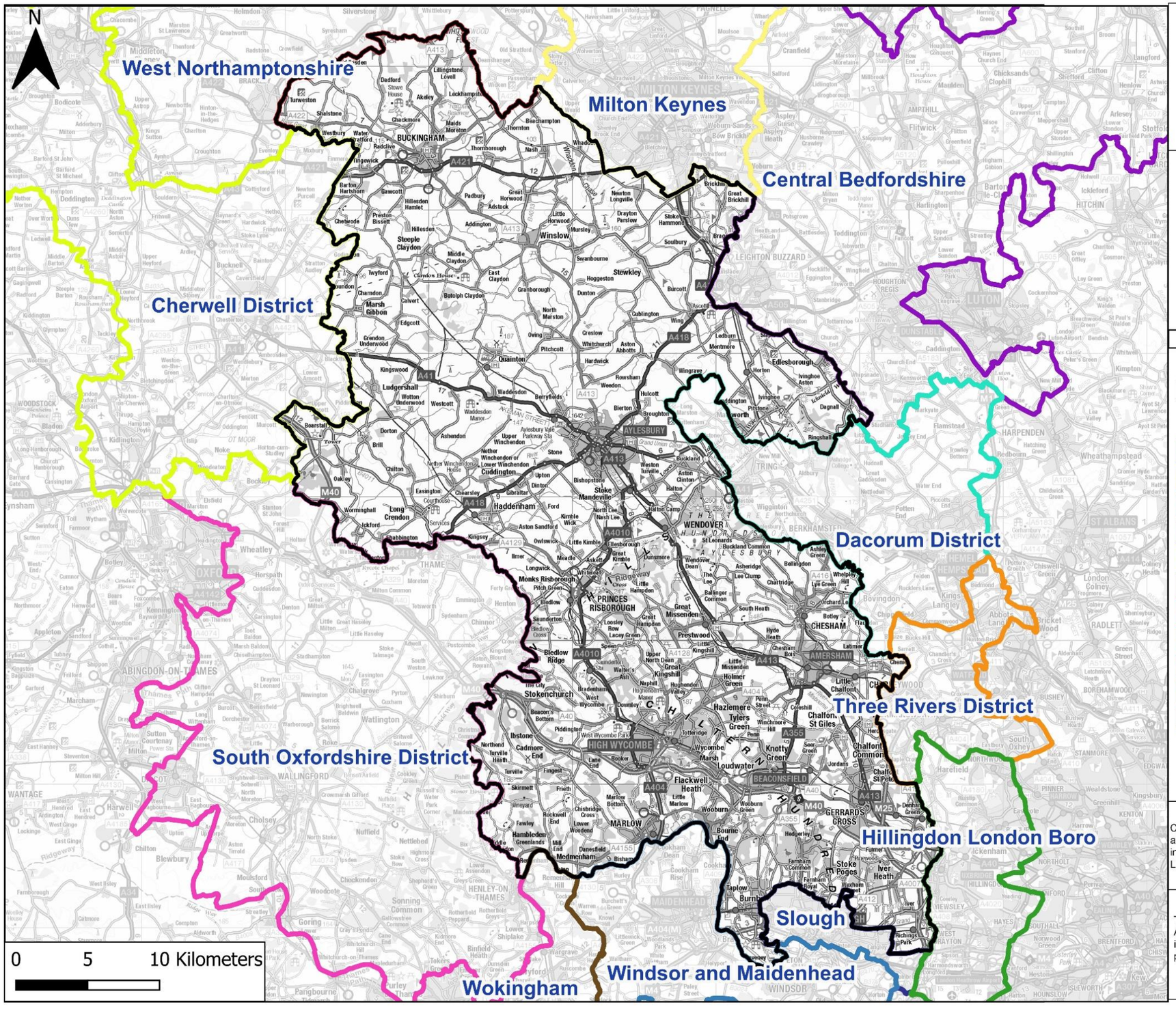
- To provide up to date information and guidance on flood risk for Buckinghamshire Council, considering the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies
- To define all Flood Zones, including Flood Zones 3b, 3a and 2, including an allowance for climate change
- To provide the basis for applying the flood risk Sequential Test, and if necessary the Exception Test
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as part of the evidence base for the Local Plan Review and to support the preparation of Neighbourhood Plans
- Identify the requirements for site-specific Flood Risk Assessments and the application of Sustainable Drainage Systems
- To carry out effective stakeholder consultation on the Level 1 SFRA

This SFRA supersedes the previous Level 1 SFRAs prepared for the former districts of Buckinghamshire - Aylesbury Vale (2017)[9], Chiltern and South Bucks (2018)[10], and Wycombe (2014)[11].

9 Aylesbury Vale District Council (2017) Level 1 Strategic Flood Risk Assessment. Available at: JBA Consulting Report Template 2015 (buckinghamshire-gov-uk.s3.amazonaws.com)

10 Chiltern and South Bucks District Councils (2018) Strategic Flood Risk Assessment (Level 1) Available at: B127F002-L1-SFRA-03_CSBDC_Level_1_SFRA_1.pdf (buckinghamshire-gov-uk.s3.amazonaws.com)

11 Wycombe District Council (2014) Strategic Flood Risk Assessment (Level 1) Update. Available at: Microsoft Word - Wycombe DC Level 1 SFRA Update v03.docx (buckinghamshire-gov-uk.s3.amazonaws.com)



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Legend

- Buckinghamshire boundary

Neighbouring LPAs

- Central Bedfordshire
- Cherwell District
- Dacorum District
- Hillingdon London Boro
- Milton Keynes
- Slough
- South Oxfordshire District
- Three Rivers District
- West Northamptonshire
- Windsor and Maidenhead
- Wokingham

Figure 1-1: Buckinghamshire Council Local Plan area and neighbouring authorities

1.3 Levels of SFRA

The Planning Practice Guidance[12] (PPG) and Environment Agency guidance[13] (2022) advocate a tiered approach to risk assessment and identifies the following two levels of SFRA:

- Level 1: where flooding is not a major issue in relation to potential site allocations and where development pressures are low. The assessment should be of sufficient detail to enable application of the Sequential Test.
- Level 2: where land outside areas at risk of flooding from all sources cannot appropriately accommodate all necessary developments, creating the need to apply the Sequential Test further, and where necessary, the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

The Level 1 assessment will form a key part of the evidence base for the Local Plan and will be compliant with the latest policy and guidance, including the NPPF, August 2022 updates to PPG, and ADEPT SFRA guidance[14], and incorporate the best available data.

1.4 SFRA outputs

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

- Assessment of all potential sources of flooding
  - Section 3 How flood risk is assessed
  - Section 6 Understanding flood risk in Buckinghamshire
  - Appendix C - Flood Risk Mapping
- Assessment of the potential impact of climate change on flood risk
  - Section 5 Impact of climate change
  - Appendix C - Flood Risk Mapping
- A review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc).
  - Section 2 Flood risk policy and strategy
  - Section 3 How flood risk is assessed
  - Appendix C - Flood Risk Mapping
  - Appendix F - Sources of information used in preparing the SFRA
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.

12 Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2022) Flood risk and coastal change. Available at: Flood risk and coastal change - GOV.UK (www.gov.uk)

13 Environment Agency (2022) How to prepare a strategic flood risk assessment. Available at: How to prepare a strategic flood risk assessment - GOV.UK (www.gov.uk)

14 Association of Directors of Environment, Economy, Planning & Transport (2021) Strategic Flood Risk Assessment good practice guide. Available at: Strategic flood risk assessment good practice guide | ADEPT (adeptnet.org.uk)

- Section 4 Planning policy for flood risk management
- Guidance for developers including requirements for site-specific Flood Risk Assessments.
  - Section 9 Flood risk management requirements for developers
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS).
  - Section 10 Surface water management and SuDS
- Mapping of location and extent of functional floodplain.
  - Section 3 How flood risk is assessed
  - Appendix C - Flood Risk Mapping
  - Appendix F - Sources of information used in preparing the SFRA
- Mapping areas at risk from other sources including surface water, sewer, groundwater, reservoir inundation.
  - Section 3 How flood risk is assessed
  - Section 6 Understanding flood risk in Buckinghamshire
  - Appendix C - Flood Risk Mapping
  - Appendix F - Sources of information used in preparing the SFRA
- Mapping areas covered by an existing flood alert / warning.
  - Section 9.6 Manage residual risk
  - Appendix C - Flood Risk Mapping
- Identify opportunities to reduce flood risk.
  - Section 9 Flood risk management requirements for developers
  - Section 10 Surface water management and SuDS
  - Section 11 Strategic flood risk measures
- Flood defence infrastructure.
  - Section 7 Flood alleviation schemes and assets
- Assessment of strategic flood risk solutions that can be implemented to reduce risks.
  - Section 8 Cumulative impact of development and strategic solutions
  - Section 11 Strategic flood risk measures

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 SFRA:

- Buckinghamshire Council (as Local Planning Authority, Lead Local Flood Authority and Emergency Planning Authority)
- Environment Agency
- Thames Water
- Anglian Water
- Affinity Water
- Bedford Group of Drainage Boards
- The Canal and River Trust
- Neighbouring District/Borough/City/Unitary Councils

1.5.1 Engagement

Preparation of this SFRA has been supported by the following engagement to date:

Inception meeting

Engaged Parties	Buckinghamshire Council (LPA)
Details	Scope of works and data collection requirements.
Date	11 January 2023

Stakeholder meeting

Engaged Parties	Buckinghamshire Council (LPA, LLFA)
Details	Scope of works and data collection requirements. Discussion of methodology, particularly around Sequential Test and Critical Drainage Areas.
Date	26 January 2023

Stakeholder meeting

Engaged Parties	Buckinghamshire Council (LPA, LLFA) Bedford Group of Drainage Boards Thames Water Anglian Water Environment Agency - unable to attend, engaged remotely by sharing SFRA Methodology for review
Details	Scope of works and data collection requirements. Discussion of methodology, including Sequential Test
Date	09 February 2023

Stakeholder meeting on draft Level 1 SFRA comments

Engaged Parties	Buckinghamshire Council (LPA, LLFA) Bedford Group of Drainage Boards Thames Water Anglian Water Canal and River Trust Environment Agency - unable to attend
Details	Discussed comments on draft L1 SFRA report.
Date	12 June 2023

Neighbouring authorities

Engaged Parties	Central Bedfordshire Council Cherwell District Council Dacorum Borough Council London Borough of Hillingdon Milton Keynes City Council Slough Borough Council South Oxfordshire District Council Three Rivers District Council West Northamptonshire Council Royal Borough of Windsor and Maidenhead Wokingham Borough Council
Details	Request for housing and employment growth for Cumulative Impacts Assessment. Issue of draft SFRA for review and comment.

Collaboration with other organisations

Engaged Parties	Canal and River Trust
Details	Request of canal breach/overtopping datasets. Issue of draft SFRA for review and comment. Incorporation of comments.

Engaged Parties	Affinity Water
Details	Meeting to introduce the L1 SFRA and Water Cycle Study for Buckinghamshire.
Date	07 March 2023

1.6 Use of SFRA data

Level 1 SFRAs are high-level strategic documents and therefore do not go into detail on individual sites. The SFRA has been developed using the best available information at the time of preparation. This relates to both the current risk of flooding from rivers, surface water and groundwater, and the potential impacts to future climate change.

SFRAs should be a 'living document', and as a result should be updated when new information on flood risk, new planning guidance or legislation becomes available. New information on flood risk may be provided by Buckinghamshire Council, the Environment Agency, the Bedford Group of Drainage Boards, Thames Water and Anglian Water. Such information may be in the form of:

- New hydraulic modelling results (which then update the Flood Map for Planning)
- Flood event information following a flood event
- Policy/legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment.

It is recommended that the latest version of the SFRA is reviewed regularly, 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. The SFRA will be reviewed as part of the preparation for the Local Plan for Buckinghamshire.

When undertaking site-specific Flood Risk Assessments to support Planning Applications, developers will be able to use the information in the SFRA to scope out the sources of flood risk that will need to be explored in more detail at site level. However, developers should check the Flood Map for Planning[15] in the first instance to identify any major changes to the Flood Zones.

1.7 SFRA report structure

Section	Contents	How to use
Executive Summary	Focuses on how the SFRA can be used by planners, developers and neighbourhood planners	Summarises the Level 1 findings and recommendations.
1. Introduction	Provides a background to the study, the Local Plan stage the SFRA informs, the study area, the roles and responsibilities for the organisations involved in flood management and how they were involved in the SFRA. Includes this table of the contents of the SFRA	For general information and context.
2. Flood risk policy and strategy	Sets out the relevant legislation, policy and strategy for flood risk management at a national, regional and local level.	Users should refer to this section for any relevant policy which may underpin strategic or site-specific assessments.
3. How flood risk is assessed	Provides a short introduction to how flood risk is assessed and the importance of considering all sources.	For general information and context.
4. Planning policy for flood risk management	Provides an overview of both national planning policy and existing Local Plan policy on flood risk management.	Users should use this section to understand and follow the steps required for the Sequential and Exception Tests.

15 Environment Agency (2023) Get flood risk information for planning in England. Available at: Flood map for planning - GOV.UK (flood-map-for-planning.service.gov.uk)

Section	Contents	How to use
	This includes the Flood Zones, application of the Sequential Approach and Sequential/Exception Test process. Provides guidance for Buckinghamshire Council and Developers on the application of the Sequential and Exception Test for both allocations and windfall sites, at allocation and planning application stages.	
5. 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 (time periods) and conditions, linked to the vulnerability of a development.
6. Understanding flood risk in Buckinghamshire	Provides an overview of the characteristics of flooding affecting the study area and key risks including historical flooding incidents, flood risk from all sources and flood warning arrangements.	This section should be used to understand all sources of flood risk in the Council area, including where has flooded historically. This section may also help identify any data gaps, in conjunction with Appendix B.
7. Flood alleviation schemes and assets	Provides a summary of current flood defences and asset management and future planned schemes. Introduces actual and residual flood risk.	This section should be used to understand if there are any defences or flood schemes in a particular area, for further detailed assessment at site-specific stage.
8. Cumulative impact of development and strategic solutions	This section introduces the cumulative impact assessment (CIA).	Planners should use this section to help develop policy recommendations for the cumulative impact of development.
9. Flood risk management for developers	Guidance for developers on Flood Risk Assessments, considering flood risk from all sources.	Developers should use this section to understand requirements for FRAs and what conditions/ guidance documents should be followed, as well as mitigation options.

Section	Contents	How to use
10. Surface water management and SuDS	An overview of Sustainable Drainage Systems, Guidance for developers on Surface Water Drainage Strategies, considering any specific local standards and guidance for Sustainable Drainage Systems (SuDS) from the Lead Local Flood Authority.	Developers should use this section to understand what national, regional and local SuDS standards are applicable.
11. Strategic flood risk measures	Overview of possible strategies to manage flood risk in Buckinghamshire.	Planners and developers should use this section to understand the wider flood risk benefits which can be delivered as part of development.
12. Assessment of flood risk in potential development areas	Overview of the methodology to be used in assessing potential Local Plan allocation sites for all sources of flood risk. Sites are not available for assessment at this stage.	Once sites have been screened, planners should use this section to help inform application of the Sequential Test.
13. Summary and recommendations	Summarises sources of flood risk in the study area and outlines planning policy recommendations	Developers and planners should use this as a summary of the SFRA. Developers should refer to the Level 1 SFRA recommendations when considering requirements for site-specific assessments.
Appendices	Appendix A: Flood history table Appendix B: Sewer flooding records Appendix C: Flood Risk Mapping Appendix D: Settlement summary of flood risk Appendix E: Sequential Test Methodology Appendix F: Sources of information used in preparing the SFRA Appendix G: Cumulative Impact Assessment (CIA)	Planners should use these appendices to understand what data has been used in the SFRA, to inform the application of the Sequential and Exception Tests, as relevant, and to use these maps and tabulated summaries of flood risk to understand the nature and location of flood risk.

2 Flood risk policy and strategy

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 SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and considered.

A diagram showing strategic planning links and key documents for flood risk can be found in Figure 2-3.

2.2 Key legislation for flood and water management

2.2.1 Floods Directive (2007) and Flood Risk Regulations (2009)

The **Flood Risk Regulations**[16] translated the **EU Floods Directive**[17] into UK law. The EU required Member States to complete an assessment of flood risk (known as a Preliminary Flood Risk Assessment (PFRA)) and then use this information to identify areas where there is a significant risk of flooding. The threshold for designating significant Flood Risk Areas is defined by Defra. For these Flood Risk Areas, States must then undertake Flood Risk and Hazard Mapping and produce Flood Risk Management Plans.

The Flood Risk Regulations as pertain to English and Welsh legislation direct the Environment Agency to do this work for river, sea and reservoir flooding. LLFAs must do this work for surface water, Ordinary Watercourses and groundwater flooding. This is a six-year cycle of work and the second cycle started in 2017. In the instance of this SFRA, the LLFA is Buckinghamshire Council (BC).

The **Buckinghamshire PFRA (2011)**[18] provided information on significant past and future flood risk from localised flooding in Buckinghamshire.

In 2011 indicative Flood Risk Areas were identified nationally by LLFAs. The exercise was repeated in 2018 and a further national study prepared to identify potential areas of significant flood risk ("Flood Risk Areas") – **'Review of preliminary flood risk assessments (Flood Risk Regulations 2009): guidance for lead local flood authorities in England – 25th Jan 2017'.** There were no indicative Flood Risk Areas identified within Buckinghamshire in 2011. However, when the exercise was repeated in 2017, High Wycombe/Marlow area and Chesham were identified as Flood Risk Areas.

The Flood Risk Regulations were revoked in December 2023, as many parts are duplicated under the duties of the Flood and Water Management Act 2010.

16 UK Government. (2009) Flood Risk Regulations. Available at: https://www.legislation.gov.uk/uksi/2009/3042/contents/made

17 European Commission. (2007) EU Floods Directive. Available at: https://ec.europa.eu/environment/water/flood_risk/

18 Buckinghamshire Council (2011) Preliminary Flood Risk Assessment. Available at: Flood risk strategies, plans and assessments | Buckinghamshire Council

2.2.2 Flood and Water Management Act (2010)

The **Flood and Water Management Act (FWMA)**[19] was passed in April 2010. It aims to improve both flood risk management and the way we manage our water resources.

The FWMA has created clearer roles and responsibilities and helped to define a more risk-based approach to dealing with flooding. This included the creation of a lead role for Local Authorities, as LLFAs, assigned to manage local flood risk (from surface water, groundwater and ordinary watercourses) and to provide a strategic overview role of all flood risk for the EA.

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. The integration and synergy of strategies and plans at national, regional and local scales, is increasingly important to protect vulnerable communities and deliver sustainable regeneration and growth.

Defra has announced its intention to enact Schedule 3 of the FWMA 2010, which will mandate sustainable drainage (SuDS) in new developments in England[20]. Current policy, which has been in place since April 2015, implements SuDS through planning policy. SuDS must be included in all new major developments (over 10 homes), unless there is clear evidence that this would be inappropriate. The enactment of Schedule 3 is expected to come into effect in 2024. Key features of Schedule 3 are as follows:

- SuDS must be incorporated into new developments in England.
- Applications for the approval of SuDS on new developments that meet the criteria will need to be made to a SuDS Approving Body (SAB). SAB approval will be separate from the Local Planning Authority approval. SAB approval could be subject to conditions and may require a non-performance bond.
- Construction works covering an area of under 100 sqm or single properties will be exempt. Nationally Significant Infrastructure Projects will also be exempt.
- The automatic right to connect surface water into the public sewer network will be removed, and instead become conditional upon the drainage system being approved by the SAB, in consultation with the Water and Sewerage Companies.

Schedule 4 of the FWMA also updates the Reservoirs Act 1975 by reducing the threshold for regulation of large, raised reservoirs from a capacity of 25,000m^3 to 10,000m^3 and introducing a 'high risk' designation for reservoirs which pose a risk to life in the event of a breach. Implementation of Schedule 4 has been split into two phases. Phase 1 was implemented in 2013 and required large, raised reservoirs to be registered and designated as 'high risk', where required. Phase 2 involves removing the capacity requirement for reservoirs to be designated under the Reservoir Act, although no timescale is currently specified for implementation of Phase 2.

19 UK Government (2010) Flood and Water Management Act. Available at: https://www.legislation.gov.uk/ukpga/2010/29/contents

20 UK Government (2023) Schedule 3 FWMA Update. Available at: https://www.gov.uk/government/publications/sustainable-drainage-systems-review

2.2.3 The Water Framework Directive (2000) & Water Environment Regulations (2017)

The purpose of the Water Framework Directive[21] (WFD), which was transposed into English Law by The Water Environment Regulations[22] (first published in 2003 and updated in 2017), is to deliver improvements across Europe in the management of water quality and water resources. This is achieved through a series of plans called River Basin Management Plans (RBMP), which were last published in 2015 and are currently being updated. Draft updates were published in 2022, following a series of public consultations between June 2018 and April 2022.

2.2.4 Environmental permitting

The Environmental Permitting Regulations[23] (2016, amended 2018) set out where developers will need to apply for additional permission (as well as Planning Permission) to undertake works to a Main River or pollution related works to an Ordinary Watercourse. This includes flood risk activities, for example:

- on or within 8 metres of a Main River (16 metres if tidal);
- on or within 8 metres of a flood defence structure or culvert (16 metres if tidal);
- on or within 16 metres of a sea defence;
- involving quarrying or excavation within 16 metres of any Main River, flood defence (including a remote defence) or culvert; and
- in a floodplain more than 8 metres from the riverbank, culvert or flood defence structure (16 metres if it is a tidal Main River) and you do not already have planning permission.

Environmental permits may also be required from the Environment Agency to discharge runoff, trade effluent or sewage into a Main River. They may also be required in relation to groundwater activities, where there may be a risk of groundwater contamination.

Land Drainage consent may be required where work is conducted which could affect the flow of water within an Ordinary Watercourse (any watercourse not classified as a Main River. These should be acquired from Buckinghamshire Council.

Any other types of work that involve working on or close to an ordinary watercourse within the Buckingham and River Ouzel IDB area require consent from the Internal Drainage Board prior to any activities. More details on this can be found in Section 2.2.6.

2.2.5 Land Drainage Act (1991)

Under the Land Drainage Act (1991)[24] Internal Drainage Boards were also given the power to implement their own Byelaws. The act also outlines riparian responsibilities to maintain

21 European Commission (2000) Water Framework Directive. Available at: https://ec.europa.eu/environment/water/water-framework/index_en.html

22 UK Government.(2003) Water Environment Regulations. Available at: https://www.legislation.gov.uk/uksi/2003/3242/contents/made

23 UK Government (2016) Environmental Permitting Regulations. Available at: https://www.legislation.gov.uk/uksi/2018/110/contents/made

24 UK Government (1991) Land Drainage Act. Available at: https://www.legislation.gov.uk/ukpga/1991/59/contents

the flow of water and sets out Local Authority powers to regulate works that may alter the flow of water in a watercourse.

2.2.6 Byelaws

Land Drainage Byelaws outline legal obligations and responsibilities when undertaking works on or close to a watercourse, for the purpose of preventing flooding, or mitigating any damage caused by flooding.

The Local Plan area includes the Buckingham and River Ouzel Internal Drainage Board (IDB) Byelaws. These Byelaws have effect on functions relating to land drainage in the Buckingham and River Ouzel IDB area (shown in Figure 2-1).

Byelaws include:

- Control of introduction of water and increase in flow or volume of water in any watercourse in the Internal Drainage District (without prior consent of the Board).
- Maintenance responsibilities of those with control of any sluice, water control structure or appliance.
- Prohibiting of stopping up, diverting, impeding or altering the water level or direction of any watercourse in the Internal Drainage District, without consent from the Board
- Requirements for riparian owners to cut all vegetation growing in or on the bank of a watercourse when instructed.

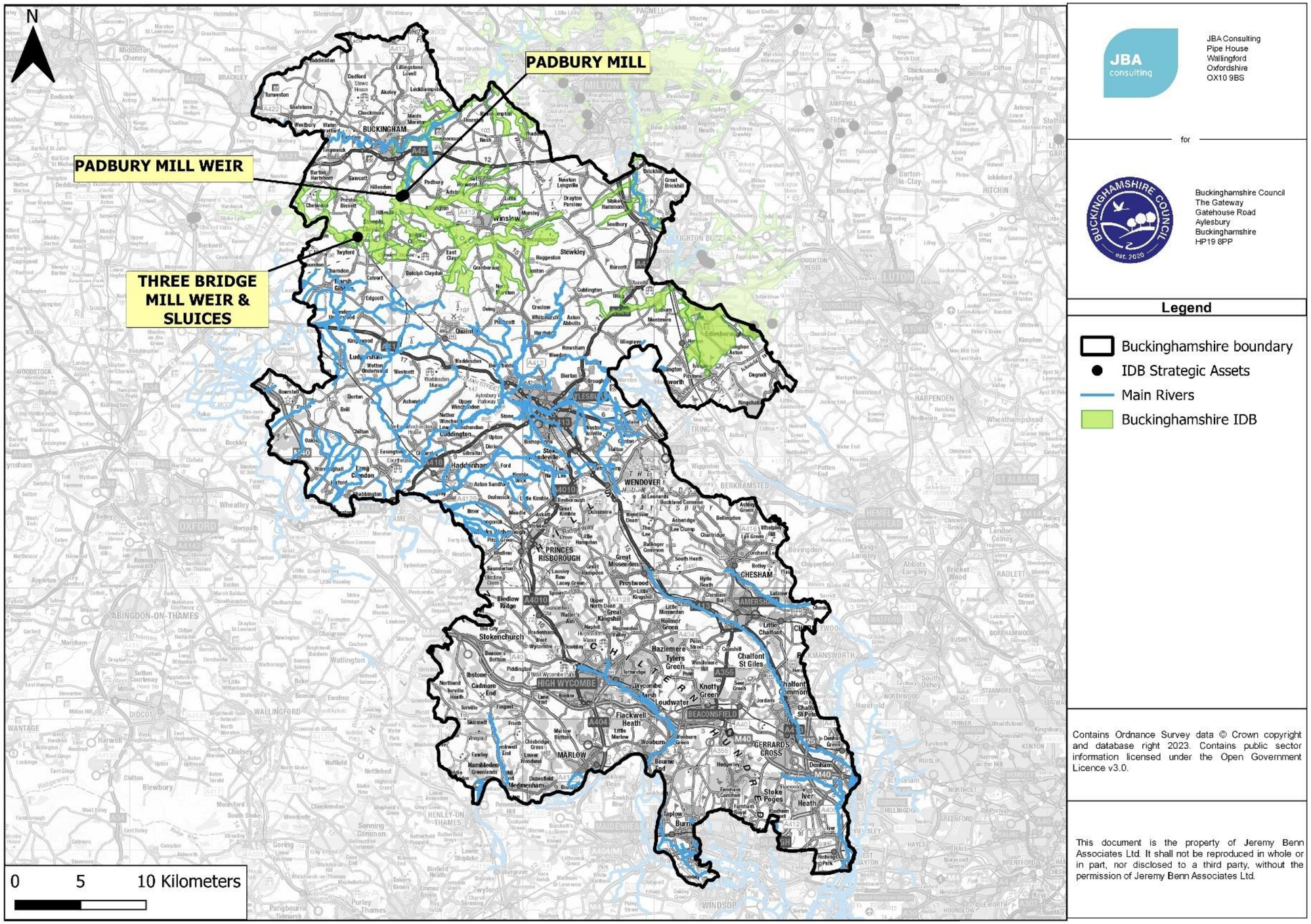


Figure 2-1: Extent of the Buckingham and River Ouzel Internal Drainage Board area within Buckinghamshire and strategic assets

2.2.7 Additional legislation

Additional legislation relevant to development and flood risk in Buckinghamshire include:

- The Town and Country Planning Act (1990) and the Water Industry Act (1991). These set out the roles and responsibilities for organisations that have a role in Flood Risk Management (FRM). The Town and Country Planning Act sets out the role of Buckinghamshire Council (as LLFA) as statutory consultee to the planning system on surface water drainage matters for major development.
- 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.

It should be noted that some of the environmental directives listed are from European Union (EU) legislation. These may be subject to change in the future due to the UK leaving the EU and it is for the user to be aware of any changes in applying this SFRA.

2.3 Relevant national, regional and local policy and strategies

Table 2-2: Summary of policy and strategies

	Document, lead author, and date	Relevant direct legislation	Information	Policy and measures	Development design requirements	Next update due
National	National Flood and Coastal Erosion Risk Management Strategy and Policy Statement (Environment Agency) 2020	Flood and Water Management Act (2010)	No	Yes	No	2026
National	Natural Flood Management Plans (Environment Agency)	N/A	Yes	No	No	-
National	National Planning Policy Framework (MHCLG) 2021	Planning and Compulsory Purchase Act 2004 as amended & The Town and Country Planning (Local Planning) (England) Regulations 2012 as amended	No	Yes	Yes	2023
National	Planning Practice Guidance (MHCLG) 2022	Planning and Compulsory Purchase Act 2004 as amended & The Town and Country Planning (Local Planning) (England) Regulations 2012 as amended	Yes	No	Yes	Updated in August 2022
Regional	Thames River Basin District River Basin Management Plan (Environment Agency) 2022	WFD (Section 2)	No	Yes	No	-
Regional	Anglian River Basin District River Basin Management Plan (Environment Agency, 2018)	WFD (Section 2)	No	Yes	No	-
Regional	Anglian River Basin District Flood Risk Management Plan (Environment Agency) 2022	Flood Risk Regulations (Section 2)	No	Yes	No	-
Regional	Thames River Basin District Flood Risk Management Plan (Environment Agency) 2023	Flood Risk Regulations (Section 2)	No	Yes	No	-
Regional	Thames Catchment Flood Management Plan and Great Ouse Rivers Catchment Flood Management Plan (Environment Agency) 2009	N/A	Yes	Yes	No	
Regional	Climate change guidance for development and flood risk (Environment Agency) 2022	N/A	No	No	Yes	
Regional	Anglian Water Draft Drainage and Wastewater Management Plan (DWMP) (Anglian Water, 2022)	N/A	Yes	Yes	No	2023

	Document, lead author, and date	Relevant direct legislation	Information	Policy and measures	Development design requirements	Next update due
Local Regional	Thames Water Drainage and Wastewater Management Plan (DWMP) (Thames Water, 2023)	N/A	Yes	Yes	No	2023
Local	Buckinghamshire Council Sustainable Drainage Systems (SuDS) guidance for developers (last updated, 2022)	N/A	Yes	No	Yes	-
Local	Buckinghamshire Local Flood Risk Management Strategy (Buckinghamshire Council) 2017 (draft, 2023)	FWMA	Yes	No	Yes	2023

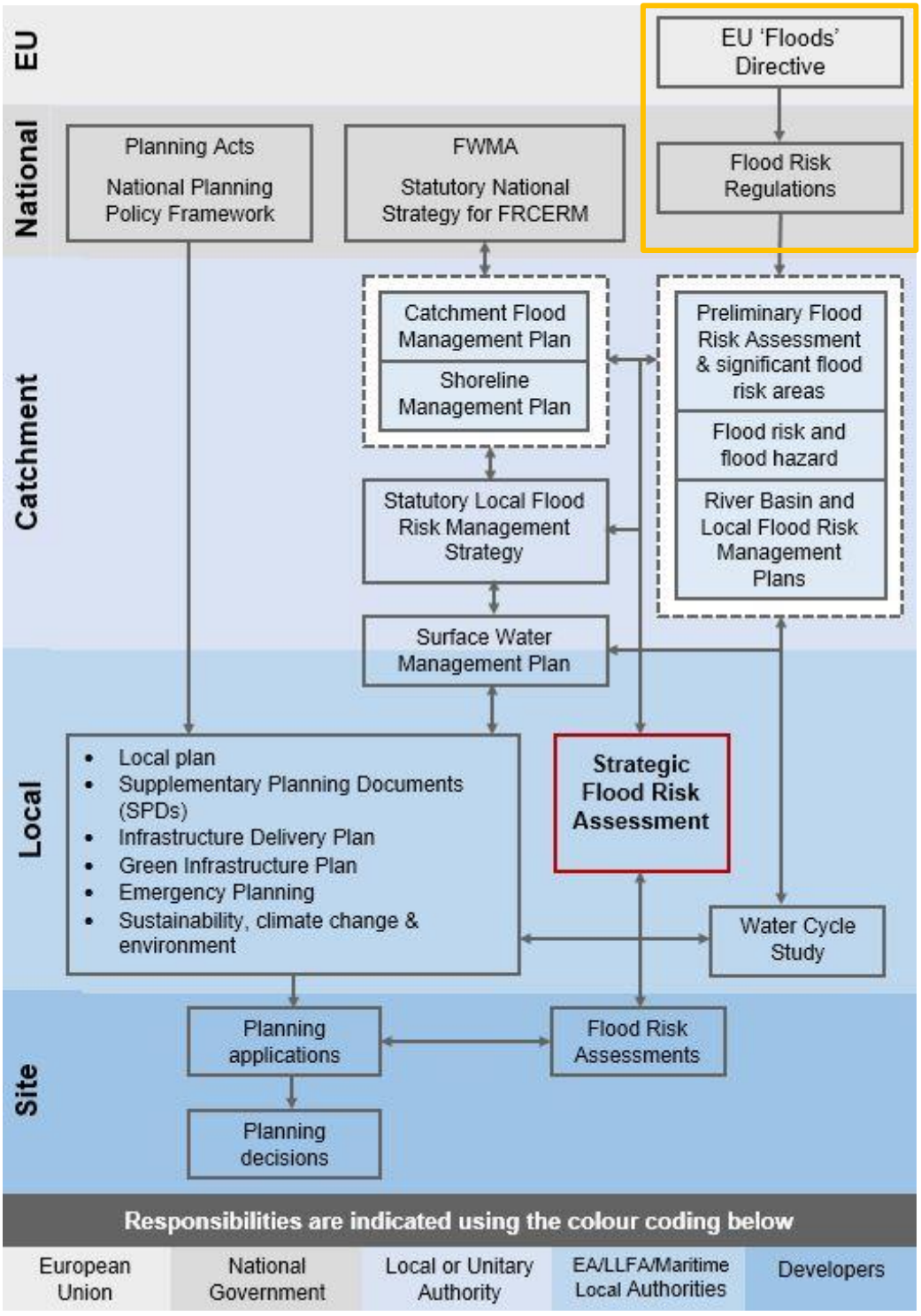


Figure 2-3: Strategic planning links and key documents for flood risk (the Flood Risk Regulations were revoked in the UK in December 2023. References have been retained in this diagram to demonstrate how the legislation informed existing guidance)

† See Table 2-4 for roles and responsibilities for the preparation of information

2.4 Key national, regional and local policy documents and strategies

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

The National Flood and Coastal Erosion Risk Management Strategy (FCERM) for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. 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 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. The strategy outlines strategic objectives relating to these ambitions, with specific measures to achieve these.

The Strategy was laid before parliament in July 2020 for formal adoption and published alongside a new National Policy Statement for Flood and Coastal Erosion Risk Management[25]. 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.

It can be expected that the implementation of the National Strategy will lead to the publication of new guidance and practice that is focused on resilience and adaptation over the coming years. It will be important to adjust the content of the SFRA so that changes in approach are captured in the delivery of the Local Plan.

25 Environment Agency (2020) New National Policy Statement for Flood and Coastal Erosion Risk Management. Available at: https://www.gov.uk/government/publications/flood-and-coastal-erosion-risk-management-policy-statement

2.4.2 Natural Flood Management (NFM)

The Environment Agency has developed Natural Flood Management (NFM) mapping[26] which displays opportunities for NFM. These maps are to be used as a guide and supplemented with local knowledge to provide a starting point for discussions about NFM. NFM aims to protect, restore and emulate the natural functions of catchments, floodplains, rivers and the coast. NFM should be used on a catchment wide scale and is the linking of blue and green infrastructure.

The maps identify NFM opportunities on different catchment scales:

- National River Basin Districts
- River Basin Districts showing Management Catchments
- Management Catchments showing Water Body Catchments
- Water Body Catchments.

These catchments cross boundaries between Buckinghamshire and other neighbouring authorities. As has been the case with NFM projects undertaken to date in Buckinghamshire (River Leck and North Bucks Freshwater Resilience Project), discussions about NFM should be had with catchment stakeholders in combination with local knowledge.

2.4.3 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts.

The plans provide a summary of programmes of measures that help prevent deterioration to protect and improve the beneficial use of the water environment in the river basin districts. An assessment of whether deterioration has occurred from the 2015 classification baseline was carried out in 2021. Updated plans have been prepared for the Anglian and Thames river basin districts.

Measures are presented for each significant water management issue in the river basin district which are:

- Physical modifications
- Managing pollution from wastewater
- Managing pollution from towns, cities and transport
- Changes to natural flow and levels of water
- Managing invasive non-native species

26 Environment Agency (2023) Working with Natural Processes. Available at: wwnp.jbahosting.com

Buckinghamshire Council falls within the Anglian RBMP[27] and the Thames RBMP[28].

2.4.4 Flood Risk Management Plans

Flood Risk Management Plans (FRMPs) are part of the six-year cycle of assessment, mapping and planning required under the Flood Risk Regulations. Under the Regulations, it is a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP) for risk from rivers, reservoirs and the sea. The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive.

More detailed strategic information on proposed strategic measures and approaches can be found in the Anglian[29] (2022) and Thames (2023) River Basin District Flood Risk Management Plan[30] (FRMP) – Parts A,B and C. The FRMPs draw on previous policies and actions identified in the Catchment Flood Management Plans (see section 2.4.5) and also incorporate information from Local Flood Risk Management Strategies (see section 2.4.6).

2.4.5 Catchment Flood Management Plans

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

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

The six national policies are:

- No active intervention (including flood warning and maintenance). Continue to monitor and advise
- Reducing existing flood risk management actions (accepting that flood risk will increase over time)

27 Environment Agency (2018) Anglian river basin district river basin management plan. Available at: Anglian river basin district river basin management plan - GOV.UK (www.gov.uk)

28 Environment Agency (2022) Thames river basin district river basin management plan

Available at: Thames river basin district river basin management plan: updated 2022 - GOV.UK (www.gov.uk)

29 Environment Agency (2022) Anglian River Basin District Flood Risk Management Plan, Available at: Anglian River Basin District Flood Risk Management Plan 2021 to 2027 (publishing.service.gov.uk)

30 Environment Agency (2023). Thames River Basin District Flood Risk Management Plan. Available at: hhttps://www.gov.uk/government/publications/thames-river-basin-district-flood-risk-management-plan

- Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline)
- Take further action to sustain the current level of flood risk (responding to the potential increases in risk from urban development, land use change and climate change)
- Take action to reduce flood risk (now and/or in the future)
- Act with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

Buckinghamshire Council falls within the Thames CFMP[31] and the Great Ouse CFMP[32].

2.4.6 Drainage and Wastewater Management Plans (DWMPs)

The UK Water Industry Research (UKWIR) "21st Century Drainage" programme has brought together water companies, governments, regulators, local authorities, academics and environmental groups to consider how planning can help to address the challenges of managing drainage in the future. These challenges include climate change, population growth, urban creep and meeting the Water Framework Directive.

The group recognised that great progress has been made by the water industry in its drainage and wastewater planning over the last few decades, but that, in the future, there needs to be greater transparency and consistency of long-term planning. The Drainage and Wastewater Management Plan (DWMP) framework[33] sets out how the industry intends to approach these goals, with the objective of the water companies publishing plans by the end of 2022, in order to inform their business plans for the 2024 Price Review.

DWMPs will be prepared for wastewater catchments or groups of catchments and will encompass surface water sewers within those areas which do not drain to a treatment works. The framework defines drainage to include all organisations and all assets which have a role to play in drainage, although, as the plans will be water company led, it does not seek to address broader surface water management within catchments.

31 Environment Agency (2009) Thames Catchment Flood Management Plan. Available at: Thames: Catchment flood management plan - GOV.UK (www.gov.uk)

32 Environment Agency (2009) Great Ouse Catchment Flood Management Plan. Available at: Great Ouse: Catchment flood management plan - GOV.UK (www.gov.uk)

33 UK Water Industry Research (2018) A framework for the production of Drainage and Wastewater Management Plans. Available at:

http://www.water.org.uk/wp-content/uploads/2018/12/Water-UK-DWMP-Framework-Report-Main-Document.pdf on: 08/02/2023.

LPAs and LLFAs are recognised as key stakeholders and will be invited to join, alongside other stakeholders, the Strategic Planning Groups (SPGs) organised broadly along river basin district catchments.

DWMPs will provide more transparent and consistent information on sewer flooding risks and the capacity of sewerage networks and treatment works, and this should be considered in SFRAs, Water Cycle Studies, as well as in site-specific FRAs and Drainage Strategies.

Thames Water[34] and Anglian Water[35] released their updated draft DWMPs in May 2023, which outline plans and proposals which the companies will undertake up to 2050. The DWMPs have been reviewed as part of the Buckinghamshire Scoping Water Cycle Study, with the latest DWMP information available on the relevant water company website.

2.4.7 Buckinghamshire Council Local Flood Risk Management Strategy

Local Flood Risk Management Strategies set out how Lead Local Flood Authorities such as Buckinghamshire Council will manage local flood risk i.e., from surface water runoff, groundwater and ordinary watercourses, for which they have a responsibility as LLFA. It also sets out the work that other Risk Management Authorities are doing to manage flood risk across the unitary authority area.

The Buckinghamshire Local Flood Risk Management Strategy[36] was published in 2017, when the LLFA sat within the County Council, and was updated in 2023. The objectives for the 2023 strategy are:

- Develop and promote better understanding of flood risk from all sources, now and in the future,
- Work in partnership to build the resilience of our communities to flood risk and climate change,
- Support climate-resilient placemaking,
- Manage flood risk through nature-based solutions and adaptive pathways; and
- Improve innovation, skills and resourcing in flood risk management.

2.4.8 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

34 Thames Water (2023) Drainage and Wastewater Management Plan. Available at: https://www.thameswater.co.uk/about-us/regulation/drainage-and-wastewater-management#csplans.

35 Anglian Water (2023) Drainage and Wastewater Management Plan. Available at:

https://www.anglianwater.co.uk/about-us/our-strategies-and-plans/drainage-and-wastewater-management-plan/

36 Buckinghamshire Council (2017) Buckinghamshire Local Flood Risk Management Strategy. Available at: Facsimile (buckinghamshire-gov-uk.s3.amazonaws.com)

LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. They are produced to understand the flood risks that arise from local flooding, which is defined by the Flood and Water Management Act 2010 as flooding from surface runoff, groundwater, and Ordinary Watercourses.

SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments. The action plan from SWMPs should be reviewed and updated as a minimum every six years.

In the Buckinghamshire area, there has been one SWMP produced in 2011 for Chesham and High Wycombe[37] and two Phase 1 SWMPs in 2013 for Buckingham[38] and Marlow[39].

2.4.9 Water Cycle Studies

Future changes in climate and increases in new development can be expected to exert greater pressure on the existing wastewater supply and infrastructure within a settlement. A large number of new homes, for instance, may cause the existing water supply infrastructure to become overwhelmed, which would result in adverse effects on the environment both locally and in wider catchments. Planning for water management therefore needs to take these potential challenges into account.

Water Cycle Studies (WCS) assist local authorities to select and develop growth proposals that minimise impacts on the environment, water quality, water resources, infrastructure and flood risk and help to identify ways of mitigating such impacts.

The Aylesbury Vale Water Cycle Study Phase 1[40] was undertaken in February 2017, to support the former Vale of Aylesbury Local Plan. The WCS identified the former district as an area of 'serious' water stress, and recommended using planning policy to require the 110/person/day water consumption target permitted by National Planning Policy Guidance in water-stressed areas. Water supply and wastewater infrastructure in both Anglian Water and Thames Water regions were identified as requiring upgrading to accommodate for the planned growth during the period 2013-2033.

37 Buckinghamshire Council (2011) Surface Water Management Plan for Chesham and High Wycombe. Available at: (Click to enter Document Title) (buckinghamshire-gov-uk.s3.amazonaws.com)

38 Buckinghamshire Council (2013) Buckingham Surface Water Management Plan. Available at: Buckingham SWMP Rev1 (amazonaws.com)

39 Buckinghamshire Council (2013) Marlow Surface Water Management Plan. Available at: https://buckinghamshire-gov-uk.s3.eu-west-1.amazonaws.com/documents/marlow-phase1-swmp.pdf

40 Aylesbury Vale District Council (2017) Aylesbury Vale Water Cycle Study: Phase 1. Available at: JBA Consulting Report Template 2015 (aylesburyvaledc.gov.uk)

An assessment into Princes Risborough and Little Marlow Wastewater Treatment Works was completed in May 2017, to support preparation of the Wycombe District Local Plan. The assessment concluded that planned future growth in Wycombe District would result in minor (less than 10%) deterioration in water quality downstream of the Wastewater Treatment Works. It also concluded that, with some upgrades, the Princes Risborough works would be able to accommodate the increased sewage from planned growth (it was not necessary to model the permit limits at Little Marlow works). In March 2018, the South Bucks and Chiltern District Council Water Quality Assessment was undertaken for the South Bucks and Chiltern Districts, to support a new joint Local Plan. The main actions identified were for sewerage networks and capacity to be addressed in several locations across the districts, including Beaconsfield, Farnham, Burnham and Denham Green.

A Stage 1 Scoping Water Cycle Study for Buckinghamshire Council has been prepared to inform the emerging LP4B. The Stage 1 Scoping Study assesses whether the water infrastructure capacity could constrain growth in Buckinghamshire and identifies if there are any gaps in the evidence needed to make the assessment. The study considers the issues of water resources demand and supply and wastewater infrastructure and treatment. It also considers water quality and environmental impact, to ensure that the receiving watercourses ecological status can continue to comply with the Water Directive even with additional growth.

2.4.10 Risk Areas for Local Planning Authorities in England

The Association of British Insurers (ABI) and the National Flood Forum have published guidance for Local Authorities with regards to planning in flood risk areas[41]. The guidance aims to assist Local Authorities in England in producing local plans and dealing with planning applications in flood risk areas. The guidance complements the National Planning Policy Framework. The key recommendations from the guidance are:

- Ensure strong relationships with technical experts on flood risk.
- Consider flooding from all sources, taking account of climate change.
- Take potential impacts on drainage infrastructure seriously.
- Ensure that flood risk is mitigated to acceptable levels for proposed developments.
- Make sure Local Plans take account of all relevant costs and are regularly reviewed.

41 Association of British Insurers and National Flood Forum (2012) Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England. Available at: abi-nff-guidance-on-insurance-and-planning-for-local-planning-authorities.pdf

2.4.11 Updated Strategic Flood Risk Assessment guidance

There was an update to the 'How to prepare a Strategic Flood Risk Assessment guidance' in March 2022, which requires further adjustment to the approaches to both Level 1 and Level 2 assessments.

There were also minor updates to the guidance in September 2020 and a substantive adjustment in August 2019. The Level 1 assessment is undertaken in accordance with the latest guidance.

2.4.12 Wider supporting documents in Buckinghamshire

There is a wide range of plans, strategies, guidance and projects within Buckinghamshire which support decision-making on planning applications and inform Local Plan policy. These include (but are not limited to):

- Strategies and plans
  - Local Transport Plan 5 (in progress)
  - Climate Change and Air Quality Strategy (2021)
  - Oxford to Cambridge Growth Arc (2021)
  - Local Nature Recovery Strategy Pilot for Buckinghamshire (2021) and Local Nature Recovery Strategy for Buckinghamshire and Milton Keynes (in progress) (as well as natural capital mapping and Wilder Road Verges Toolkit). Led by the Natural Environment Partnership (NEP) for Buckinghamshire and Milton Keynes.
  - Buckinghamshire Green Infrastructure Strategy (2009) and Delivery Plan (2013)
- Guidance
  - Biodiversity Net Gain (BNG) Supplementary Planning Document (SPD)
  - Buckinghamshire Design Code for developments (in progress)
- Projects
  - Aylesbury Garden Town
  - Transport infrastructure projects e.g. East West Rail and High Speed Rail 2.

2.5 Roles and responsibilities for Flood Risk Management in Buckinghamshire

Flood risk management in England is managed by a range of different Risk Management Authorities (RMAs)[42]. The Flood and Water Management Act places a duty on all flood risk management authorities to co-operate with each other. The roles

42 Defra and Environment Agency (2014) Flood risk management: information for flood risk management authorities, asset owners and local authorities. Available at: Flood risk management: information for flood risk management authorities, asset owners and local authorities - GOV.UK (www.gov.uk)

and responsibilities for different organisations in Buckinghamshire are shown in Table 2-4.

Section 2 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and the Flood and Water Management Act, in conjunction with the Localism Act "duty to cooperate", introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

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 Studies (WCSs).

Table 2-4: Roles and responsibilities of organisations in Buckinghamshire

Organisation	Strategic Level	Operational Level	Planning Role
Environment Agency	Has strategic overview of all sources of flooding; lead the National Strategy and are involved in reporting and general supervision	Responsible for Main Rivers and reservoirs.	Statutory consultee for development in Flood Zones 2 and 3.
Lead Local Flood Authority (LLFA) (Buckinghamshire Council)	Develop and provide the preliminary Flood Risk Assessment and Local Flood Risk Management Strategy.	Responsible for surface water, groundwater, ordinary watercourses (works, consenting and enforcement).	Statutory consultee on surface water drainage matters for major developments.
Local Planning Authority (LPA) (Buckinghamshire Council)	Develop and provide Local Plans as Local Planning Authorities.	Responsible for determining Planning Applications, manage open spaces under the National Park Authority ownership and ordinary watercourses (works).	Responsible for determining Planning Applications, managing open spaces under the National Park Authority ownership and ordinary watercourses (works).
Water and Sewerage Companies (Anglian Water and Thames Water)	Develop and provide Water Resources Management Plans and Asset Management Plans, supported by Periodic Reviews (business cases) and develop Drainage and Wastewater Management Plans.	Responsible for public sewers and wastewater treatment works.	Non-statutory consultee.
Highways Authority (Transport for Buckinghamshire)	Manage highway drainage policy and planning.	Responsible for highway drainage.	Statutory consultee regarding highways design standards and adoptions.
Internal Drainage Boards (Bedford Group of Drainage Boards - Buckingham and River Ouzel IDB)	Work in partnership with other authorities to actively manage and reduce the risk of flooding.	Responsible for water level management in low lying areas.	Non-statutory consultee.
The Canal and Rivers Trust*	Navigation authority owning and operating its own canals and other waterways.	Responsible for inspecting, maintaining and operating water control structures within its ownership.	Statutory obligation to maintain navigation.

*It should be noted that the Canal and River Trust is not a RMA, as defined under the Flood and Water Management Act 2010, and does not have specific statutory responsibilities in relation to flooding. However, its responsibilities are those of an owner and operator of reservoirs, canals and other waterways.

3 How flood risk is assessed

This section describes how flood risk is defined and assessed within the SFRA, including the main sources of information, data and mapping.

Planners and developers should use the evidence and maps presented in this SFRA, along with any other available evidence, to identify any risk of flooding from all sources for a particular site.

3.1 Definitions

3.1.1 Flood

Section 1 (subsection 1) of the Flood and Water Management Act (FWMA) (2010) defines a flood as:

'any case where land not normally covered by water becomes covered by water'.

Section 1 (subsection 2) states that 'it does not matter for the purposes of subsection (1)' whether a flood is caused by:

a. heavy rainfall;

b. a river overflowing or its banks being breached;

c. a dam overflowing or being breached;

d. tidal waters;

e. groundwater; or

f. anything else (including any combination of factors).

Sources of flooding under this definition do not include excess water from any part of a sewerage system (unless caused by an increase in the volume of rainwater entering or affecting the system), or a flood caused by a burst water main.

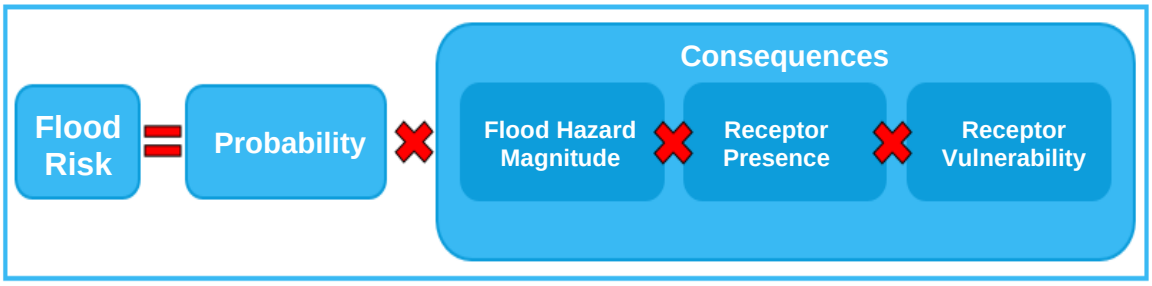
3.1.2 Flood risk

Section 3 (subsection 1) of the FWMA defines the risk of a potentially harmful event (such as flooding) as:

'a risk in respect of an occurrence is assessed and expressed (as for insurance and scientific purposes) as a combination of the probability of the occurrence with its potential consequences.'

Thus, it is possible to summarise flood risk as:

Flood Risk = (Probability of a flood) x (Scale of the consequences)



Using this definition, it can be seen that:

- **Increasing the probability or chance of a flood being experienced increases the flood risk**: In situations where the probability of a flood being experienced increases gradually over time, for example due to the effects of climate change, then the flood risk will increase.
- **The potential scale of the consequences in a given location can increase the flood risk:**
  - **Flood Hazard Magnitude:** If the direct hazard posed by the depth of flooding, velocity of flow, the speed of onset, rate of risk in flood water or duration of inundation is increased, then the consequences of flooding, and therefore risk, is increased.
  - **Receptor Presence**: The consequences of a flood will be increased if there are more receptors affected, for example with an increase in extent or frequency of flooding. Additionally, if there is new development that increases the probability of flooding (for example, increase in volume of runoff due to increased impermeable surfaces) or increased density of infrastructure then consequences will also be increased.
  - **Receptor Vulnerability:** If the vulnerability of the people, property or infrastructure is increased then the consequences are increased. For example, residential/educational facilities are more vulnerable than office facilities in the event of a flood.

3.1.3 Flood Zones

The Flood Zones describe the land that would flood from rivers if there were no defences present. They are based on broad scale modelling that has been refined with detailed hydraulic models in areas of higher risk. Areas Benefiting from Defences can be identified using the accompanying layers. A concept diagram showing the classification of NPPF Flood Zones graphically, is included in Figure 3-1, with definitions of the Flood Zones provided in Table 3-2.

The preference when allocating land is, whenever possible, to place all new development on land in Zone 1. Since the Flood Zones identify locations that are not reliant on flood defences, placing development on Zone 1 land means there is no future commitment to spending money on flood banks or flood alleviation measures. It also does not commit future generations to costly long-term expenditure that would become increasingly unsustainable as the effects of climate change increase.

A fuller discussion of Flood Zones and their relation to planning policy, including descriptions and discussion of appropriate development within each Flood Zone, can be found in the NPPF and the Planning Policy Guidance.

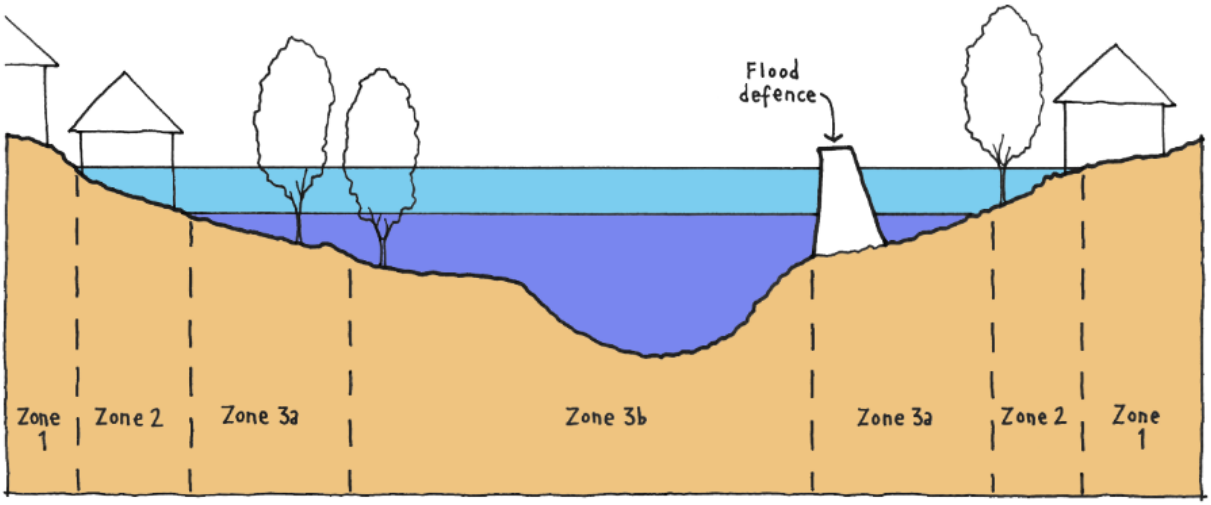


Figure 3-1: Definition of Flood Zones (source: JBA Consulting)

Excluding Flood Zone 3b, 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 Level 1 SFRA assesses all sources of flood risk. However, the Flood Zones do not consider the risk of flooding from ordinary watercourses, surface water, sewers or groundwater, nor the impacts of canal or reservoir failure, or climate change. Hence there could still be a risk of flooding from other sources and the level of flood risk will change over time during the lifetime of a development.

Table 3-2: National Flood Zone descriptions[43]

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%).
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or, in coastal areas, between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year.
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. The updated August 2022 PPG recommends that the 1 in 30 (3.3%) AEP flood extent is the starting point for Flood Zone 3b.

3.2 Surface water

Flooding from surface water runoff (or 'pluvial' flooding) is caused by intense short periods of rainfall and usually affects lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage or drainage blockage by debris, and sewer flooding.

The Risk of Flooding from Surface Water (RoFSW) mapping predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas and upslope of topographic features including railway lines and roads. RoFSW mapping throughout Buckinghamshire is provided in Appendix C.

Paragraph 167 of the NPPF states that the Sequential Test must now "steer new development to areas with the lowest risk of flooding from **any source**. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the information that can be used to support the test. The

43 Department of Communities and Local Government (2023) Paragraph 5 Table 1: Flood Zones. Technical Guidance to the National Planning Policy Framework. Accessed online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf .

sequential approach (as described in Para 161) should be used in areas known to be at risk now or in the future from any form of flooding."

To address the requirement to address flood risk from any source in the Sequential Test a Sequential Test Methodology has been prepared in consultation with Buckinghamshire Council (Local Planning Authority and Lead Local Flood Authority) and the Environment Agency (see Appendix E).

In summary, the Environment Agency's Risk of Flooding from Surface Water flood extent mapping has been used to define a simple zoning scheme that identifies:

- High risk zone - between a 1 in 30 (3.3%) and 1 in 100 (1%) chance of occurring,
- Medium risk zone - between a 1 in 100 (1%) and 1 in 1000 (0.1%) chance of occurring; and
- Low risk zone - greater than a 1 in 1000 (0.1%) chance of occurring.

As in the case of the Flood Zones, sites located within 'high' and 'medium' risk zones meet the threshold for further assessment.

Watercourses with a catchment less than 3km^2 in area are not included within the Environment Agency Flood Map for Planning. However, this does not necessarily mean that there is no flood risk from these smaller watercourses. Within the Sequential Test Methodology, the Risk of Flooding from Surface Water mapping has been used as an estimate of the flood risk from ordinary watercourses.

It should be noted that the Risk of Flooding from Surface Water includes an allowance for drainage (a flood risk management feature), so this is not strictly the same conceptual risk zone as defined for river and sea flooding (even though it is associated with the same probability). However, it does create a product that can accommodate sequential testing, as it facilitates strategic decisions that direct development to land in a "low risk surface water flood zone".

3.3 Reservoirs

3.3.1 Background to existing reservoir modelling and mapping products

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are on a register held by the Environment Agency. The level and standard of inspection and maintenance required by a Supervising Panel of Engineers under the Act means that the risk of flooding from reservoirs is very low.

Flooding from reservoirs occurs following partial or complete failure of the control structure designed to retain water in the artificial storage area. Reservoir flooding is very different from other forms of flooding; it may happen with little, or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult

to estimate but is extremely low compared to flooding from other sources. The probability of a failure event is not included in the Reservoir Flood Mapping and describes the consequences of a “reasonable worst case”. If there was a failure of a reservoir it may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe. The consequences of inundation to Buckinghamshire as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the 2021 Reservoir Flood Mapping (RFM) study.

To prepare Reservoir Mapping outputs the breach locations applied are selected to cover all downstream flow paths expected to form in the event of a breach on the reservoir. For some reservoirs, the mapping includes multiple breach locations, to encompass all likely flow paths. However, the Risk of Flooding from Reservoirs mapping might not describe the extent of flooding from an actual breach, as the mechanics of the failure are likely to be different from those assumed for the purposes of the mapping.

3.3.2 Considerations when using the Risk of Flooding from Reservoirs mapping

The Sequential Test Methodology (Appendix E) outlines how reservoir flooding can be included in the Sequential Test. The latest available Environment Agency Risk of Flooding from Reservoirs mapping now shows “wet day” and “dry day” reservoir inundation extents. The “wet day” being a reservoir breach at the same time as a 1 in 1,000 river flood (as this is a likely time when a reservoir might fail) and the dry day shows the failure just from the water retained by the dam. Neither set of mapping describes a risk-based scenario as they do not provide the probability of a dam failure but are intended to describe a “reasonable worst case”.

The Risk of Flooding from Reservoirs mapping is not conceptually similar to the risks pertaining to river and sea flooding or surface water. If sites selected through a comparative process of assessing the river and surface water flood risk are located in such zones, then the implications should be addressed in the Level 2 SFRA and further consideration given to the identification of alternative locations at lower potential risk at this stage. Risk of Flooding from Reservoirs mapping for the Local Plan area can be found in Appendix C.

A reservoir may also be retained by numerous dams and a breach could occur on any length. The potential effects on a development site will be different depending on the location of the site in relation to the reservoir and the point of breach. For example, a development site located immediately next to a reservoir dam would be at considerably higher risk of flooding than a site further downstream, due to the likelihood of very rapid inundation and high velocities of water.

Detailed results of the depth, velocity and hazard of the predicted flooding from reservoir breaches are outputs of the RFM study, but are not publicly available, due to

the sensitivity of the data. The information therefore cannot be used within the Level 1 SFRA to define 'higher hazard' areas within the Risk of Flooding from Reservoirs mapping. Instead, the hazards associated with flooding from each reservoir should be considered on a case-by-case basis, for each potential development site. For the purpose of preparing the Plan this exercise will be performed in a Level 2 SFRA using the initial sites selected, as described by the use of flood risk information to inform the Sequential Test.

Environment Agency guidance[44] [45] states that the Risk of Flooding from Reservoirs mapping should be used when preparing a SFRA and Local Plan, but that the mapping should not be used in isolation. For planners looking to allocate a site within a Local Plan, Environment Agency guidance and Planning Practice Guidance (PPG) (paragraph 046) recommends consultation with the relevant reservoir owners to establish any constraints on safe development. For those proposing new development at risk of flooding from a reservoir, Environment Agency guidance requires the impact of the development on the reservoir or reservoir owner to be considered, which may involve undertaking a site-specific reservoir breach model to understand the residual flood risk to the development.

Within the Level 1 SFRA, the Risk of Flooding from Reservoirs mapping is used for the purpose of identifying sites with the potential to be at risk of flooding in the event of a reservoir breach. Areas within the 'wet day' Risk of Flooding from Reservoirs mapping flood extent have been identified as a 'higher risk' zone, which provides an indication of where reservoir flooding is predicted to make fluvial flooding worse and where the placement of new development could result in properties being in a location where hazards from flow depth and velocity are potentially severe. However, exclusion of a site from this zone does not indicate that the risk would be insignificant, and it is acknowledged that this zone may not identify locations in the immediate vicinity of a reservoir dam which are at risk of flooding from a breach. Therefore, for potential development sites located either within the Risk of Flooding from Reservoirs mapping or in the vicinity of a reservoir, the impact of the residual flood risk to the site from a reservoir breach needs to be considered in detail within a Level 2 SFRA and a site-specific Flood Risk Assessment.

3.4 Groundwater

Groundwater flooding is the term used to describe flooding caused by unusually high groundwater levels. It occurs as excess water emerges at the ground surface or within manmade underground structures such as basements and the sewer network.

44 Environment Agency (2021) Reservoir flood maps: when and how to use them. Available at: Reservoir flood maps: when and how to use them - GOV.UK (www.gov.uk)

45 Environment Agency (2022) How to prepare a strategic flood risk assessment. Available at: How to prepare a strategic flood risk assessment - GOV.UK (www.gov.uk)

Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and it can result in significant damage to property.

Research by the Environment Agency[67] suggests the following definition for identifying the presence of groundwater flood risk:

- *'if water comes out at the surface then flooding and property flooding will occur.*
- *If groundwater comes to within 3m below surface then it can affect property structure or infrastructure'*.

Groundwater flooding can be caused by:

- High water tables, influenced by the type of bedrock and superficial geology
- Seasonal flows in dry valleys, which are particularly common in areas of chalk geology
- Rebounding groundwater levels, where these have been historically lowered for industrial or mining purposes

In the areas of Hambleden, West Wycombe and Princes Risborough in Buckinghamshire, outputs from previous groundwater emergence modelling studies allow a simple zoning scheme to be applied that identifies high and low risk zones.

Outside the extent of these areas, the JBA groundwater flood map has been used. However, it does not provide the confidence or certainty required to undertake the Sequential Test on its own, as it only shows likely areas of risk of emergence of water at the ground surface and does not show where the groundwater is likely to flow or cause a risk of flooding.

The risk of emergence mapping has been combined with supplementary GIS analysis to understand where the groundwater is likely to flow once it has emerged. This supplementary assessment has been performed using the 1 in 1,000-year Risk of Flooding from Surface Water mapping to provide an indication of the likely flow paths as the generalised modelling is based on the topography of the area, and groundwater and surface water pathways tend to coincide. Where a surface water flow path crosses and is downstream of, a groundwater emergence zone this has been highlighted as an area potentially at-risk from groundwater flooding. If the flow path is also associated with any watercourse (Main River or ordinary watercourse), this would already be considered to be fluvial flooding.

Using GIS techniques, the JBA Groundwater Flood Map high and medium risk areas has been merged with the likely flow paths. This has provided a zone map to show areas which are potentially at higher risk of groundwater flooding than other areas and create a product that can accommodate an appropriate level of sequential testing.

If a site is potentially at risk from groundwater flooding a more detailed assessment should be undertaken within the Level 2 SFRA and will consider local conditions on a site-by-site basis using historic, borehole, geological and LIDAR data.

Further information can be found in Appendix E.

3.5 Canal flooding

Canals are regulated waterbodies and are unlikely to flood unless there is a sudden failure of an embankment or a sudden ingress of water from a river in areas where they interact closely. Embankment failure can be caused by:

- Culvert collapse
- Overtopping
- Animal burrowing
- Subsidence/ sudden failure e.g. collapse of former mine workings
- Utility or development works close or encroaching onto the footings of a canal embankment.

Flooding from a breach of a canal embankment is largely dictated by canal and ground levels, canal embankment construction, breach characteristics and the volume of water within the canal that can discharge into the lower lying areas behind the embankment. The volume of water released during a breach is dependent on the pound length (i.e. the distance between locks) and how quickly the operating authorities can react to prevent further water loss, for example by the fitting of stop boards to restrict the length of the canal that can empty through the breach, or repair of the breach. The Canal and River Trust monitor embankments at the highest risk of failure.

Flood risk mapping associated with canal overtopping or breach is not available within Buckinghamshire. However, the proximity of a site to a section of canal with a raised embankment (e.g. a 100m buffer) can be used to define a high risk zone. A buffer distance of 100m from a canal was used to define areas at risk of flooding from canals within the Aylesbury Vale Level 1 SFRA, and this distance has been retained within the Buckinghamshire Level 1 SFRA. The high risk zone can be used to identify sites with the potential to be at risk of canal flooding, in the event of raised embankment failure.

If a site intersects the high risk zone defined by the buffered canal embankments, a more detailed assessment of local ground levels, historic canal flood risk and site-level mitigation measures should be undertaken within a Level 2 SFRA and a site-specific FRA. Further information can be found in Appendix E.

However sites outside this zone can still be affected by canal flooding, and can impact how canal operators manage their assets. Section 0 provides further guidance on the consideration of canal flood risk within a site-specific FRA, including the mitigation of canal risk in designs, to minimise the impacts of flooding, and to ensure that works do not adversely affect the stability of the canal infrastructure.

3.6 Sewer flooding

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and / or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment (such as pumps) failure occur in the sewerage system. Surface water inundation of manhole openings and entry of groundwater may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines (now replaced by the Design Construction Guidance) have required new surface water sewers to be designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year (3.33% AEP), although until recently this did not apply to smaller private systems.

Consequently, even where sewers are built to current specifications, they can still be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g., a 1 in 100 chance of occurring in any given year (1% AEP)). Existing sewers can also become overloaded as new development adds to their catchment, even with restrictions in place on permitted discharge, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Historic sewer flood data is only available at a postcode level and does not define spatial extent or location of sewer flooding. Sewer flooding is often caused by blockages and hence it can happen at any point in the sewer network.

A key issue surrounding wastewater and drainage in Buckinghamshire is groundwater infiltration into the sewer network, which results in a lack of capacity in the overall network. High groundwater levels and surface water flooding caused by intense rainfall is understood to reduce the hydraulic capacity of the sewers, particularly in Chesham, Hambleden, Little Marlow, Marsh Gibbon and Princes Risborough.

The DWMPs for Anglian and Thames Water will provide more detailed information on the performance of the sewerage network. There is no mapping available to enable execution of a risk-based sequence. On this basis, Flood Zones for sewer flooding have not been prepared and the available information is not appropriate for use in the Sequential Test. Further information can be found in Appendix E.

3.7 Cumulative impacts

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

entering watercourses, increasing the risk of fluvial flooding at locations further downstream that are potentially sensitive to increases in the volume or flow of flood water.

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

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

For windfall sites which have not yet been allocated, the NPPF requires that the cumulative impact of development should be considered at the application stage and the appropriate mitigation measures undertaken to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk.

3.8 Cross boundary considerations

Situations may occur where a development site is situated across Local Authority boundaries, or where the development in one district or borough may impact flood risk elsewhere.

Buckinghamshire shares a border with 11 neighbouring Local Planning Authorities, and therefore cross-boundary flood risk is a key consideration. On a river catchment scale, the topography and routing of watercourses through the county means that Buckinghamshire drains towards, and therefore has the potential to affect flood risk in, all of the neighbouring authorities. With the exception of Cherwell, Milton Keynes and Slough, eight of the neighbouring authorities drain into Buckinghamshire. The catchments considered to be at high risk of cumulative impacts, as well as policy recommendations for managing the cumulative impact of are presented in Section 8.

A high-level overview of potential cross-boundary flood risk considerations is provided in Table 3-3. The assessment is based on the WFD catchments which cross the Buckinghamshire boundary and does not account for groundwater catchments or sewer sub catchments, which may transect the topographic boundaries of the river catchments.

It is recommended that Buckinghamshire Council consults neighbouring authorities on cross-boundary flood risk issues, particularly during the consultation phases of the Local Plan. In situations where cross-boundary developments are proposed, Buckinghamshire Council should work closely with other Local Planning Authorities to satisfy the requirements of policies in their respective Local Plans, in consultation with statutory consultees such as the Environment Agency, Lead Local Flood Authorities and Internal Drainage Board.

Table 3-3: Summary of cross-boundary flood risk considerations in Buckinghamshire and neighbouring authorities

Neighbouring authority	Cross-boundary flood risk considerations leaving Buckinghamshire	Cross-boundary flood risk considerations entering Buckinghamshire
Central Bedfordshire	Potential for flows in eastern Buckinghamshire entering the River Ouzel (Lovat) to impact the southwestern area of Central Bedfordshire.	Potential for flows in southwest Central Bedfordshire entering the headwaters of the entering the River Ouzel (Lovat) to impact eastern areas of Buckinghamshire.
Cherwell	Potential for flows in western catchments in Buckinghamshire (River Ray) to impact Cherwell.	None identified.
Dacorum	Potential for runoff and groundwater flows from the Chilterns entering the River Gade and Bulbourne catchments.	Flows from the headwaters of the Upper Thame entering eastern Buckinghamshire (Aylesbury Vale). Flows from the Rivers Gade and Bulbourne entering the River Colne, which flows along the south eastern boundary of Buckinghamshire
London Borough of Hillingdon	Potential for flows from the River Misbourne and Alder Bourne catchments entering the River Colne and affecting the western boundary of Hillingdon.	Potential for flows from the River Pinn entering the River Colne and affecting the south east of Buckinghamshire.
Milton Keynes City	Potential for flows in northern and eastern Buckinghamshire entering the River Great Ouse and River Ouzel (Lovat) to impact Milton Keynes.	None identified.
Slough	Potential for flows in the south of Buckinghamshire entering the River Thames upstream, and impacting the south of Slough.	None identified.
South Oxfordshire	Potential for flows in central and western catchments in Buckinghamshire (River Ray and Upper Thame) to impact South Oxfordshire.	Potential for flows from South Oxfordshire into the River Thames to impact South Buckinghamshire.
Three Rivers	Potential for flows from southeast Buckinghamshire (River Chess catchment) impacting the west of Three Rivers District.	Potential for flows from Three Rivers District entering the River Colne to impact the south east of Buckinghamshire.
West Northamptonshire	Potential for flows in the upper reaches of the River Great Ouse to impact the south eastern area of West Northamptonshire	Potential for flows entering the headwaters of the River Great Ouse to impact north Buckinghamshire.
Windsor and Maidenhead	Potential for flows from southwest Buckinghamshire (River Wye catchment) entering the River Thames and impacting the north of Windsor and Maidenhead.	Potential for flows in the north and east (The Cut, River Thames) of Windsor and Maidenhead impacting the southern boundary of Buckinghamshire.
Wokingham	Potential for flows from southwest Buckinghamshire (Hamble Brook catchment) to enter the River Thames and impact the northern boundary of Wokingham.	Potential for flows throughout Wokingham (Emm Brook, Rivers Loddon and Thames) to impact the south west of Buckinghamshire.

3.8.1 Water quality considerations

In addition to cross-boundary issues regarding flood risk, there are also cross-boundary issues relating to water quality. Development or changes to land management practises in the upper catchments of watercourses that flow across boundaries into Buckinghamshire can potentially impact the quality of watercourses within the study area. Development should consider the quality of the water that is released from sites and the impact it may have on the water quality on any receiving waterbodies.

Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area. Any impacts identified should then be considered in relation to the WFD Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives. Opportunities to improve the status of watercourses should also be considered. This is particularly important for Buckinghamshire as the majority of watercourses within the area have not achieved a good overall status, with some watercourses including the River Ray and River Wye classified as poor in status, primarily due to diffuse and point sources of pollution, and levels of phosphate, ammonia and dissolved oxygen.

Information can be viewed at the Environment Agency Catchment Data Explorer website[46].

46 Environment Agency (2023) Catchment Data Explorer. Available at: England | Catchment Data Explorer

4 Planning policy for flood risk management

4.1 National Planning Policy Framework and Guidance

The revised National Planning Policy Framework (NPPF)[47] was published in July 2021 and updated in December 2023, replacing the 2019 and 2018 versions. The NPPF sets out Government's planning policies for England. It must be considered 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. Key changes in the revised 2021 NPPF compared to the 2018 NPPF include:

- 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 (para 166).
- It is encouraged to use opportunities provided by improvements in green infrastructure, and to make as much use as possible of natural flood management techniques (para 167c).

Planning Practice Guidance[48] on flood risk was published in March 2014 (and has since been revised / updated - latest in August 2022) 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. Key changes in the revised 2022 PPG compared to the 2021 PPG include:

- Changes to the definition of Flood Zone 3b. The definition of a functional floodplain (Flood Zone 3b) has changed from a 5% AEP event to a 3.3% AEP event.
- Changes to the lifetime of non-residential development. The PPG now states that the lifetime of development is a minimum of 75 years.
- There is now a requirement for the Sequential Test to assess high, medium, and low flood risk both now and in the future. As such, future Flood Zone 2 (0.1% AEP – medium risk) and Flood Zone 3b (3.3% AEP – the functional floodplain) should be assessed to strictly address the requirement.
- Paragraph 162 of the NPPF has been changed such that the Sequential Test must now "steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are

47 UK Government (2023) National Planning Policy Framework. Available at: https://www.gov.uk/government/collections/revised-national-planning-policy-framework

48 UK Government (2022) Planning Practice Guidance. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change

reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach (as described in Para 161) should be used in areas known to be at risk now or in the future from any form of flooding."

- Design flood' includes climate change and surface water risk.

4.2 The sequential risk-based approach

This SFRA has considered the July 2021 NPPF changes to the Sequential Test requiring a sequential approach for all sources of flood risk. In the August 2022 update to the Planning Practice Guidance the definition of the flood zones was not changed, meaning that the term "Flood Zones" still refers to flooding from rivers and the sea where flood defences are not considered. 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.

Figure 4-1 describes the proposed application of the Sequential Test for Local Plan preparation as is shown in the Planning Practice Guidance. Figure 4-2 summarises the Exception Test, and how it should be performed.

This is a stepwise 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. Please refer to the Sequential Test Methodology in Appendix E for further details.

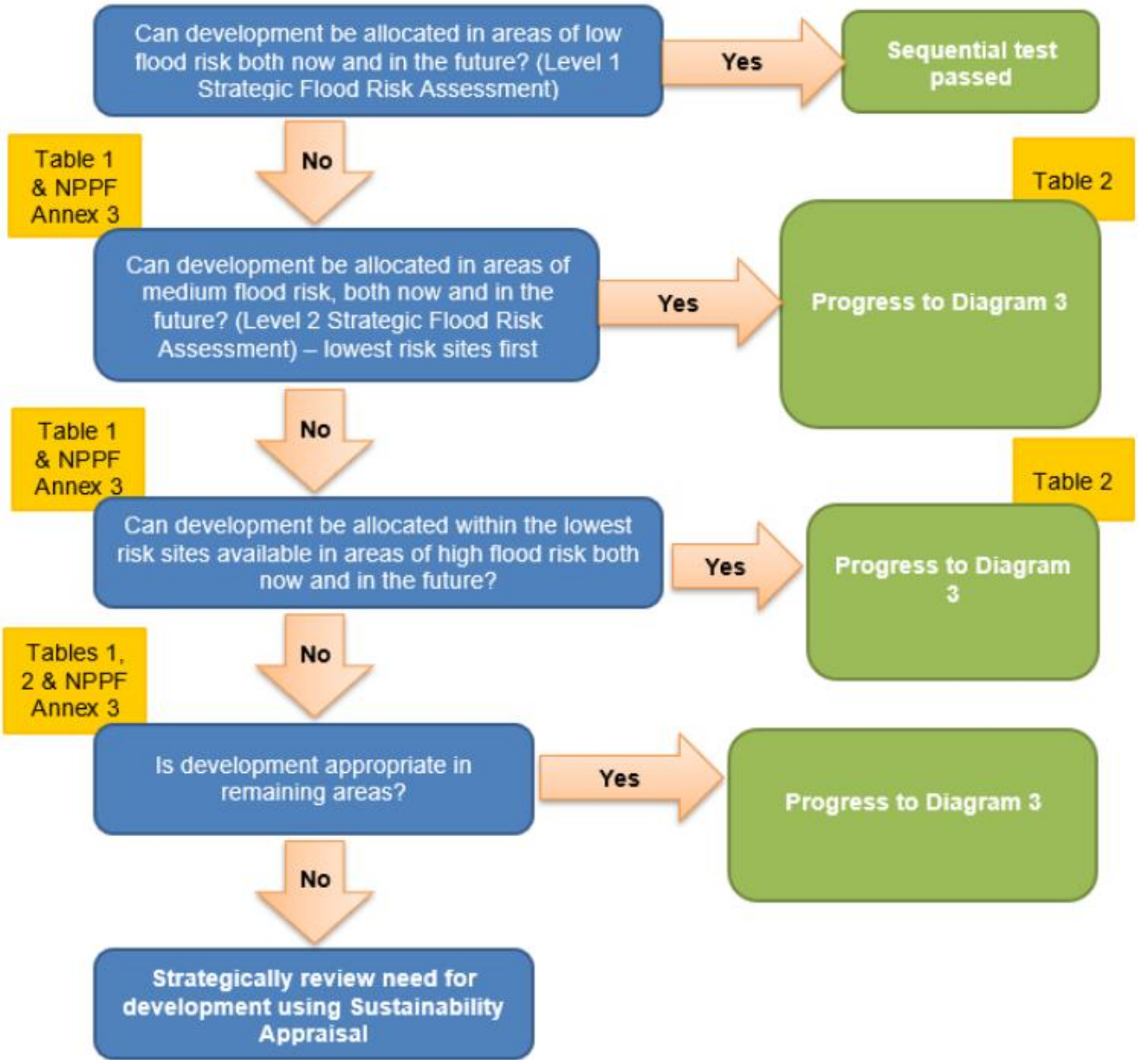


Figure 4-1: Application of the Sequential Test for plan preparation (source: Diagram 2 - PPG, 2022). The definition of low flood risk from all sources is outlined in the Sequential Test Methodology in Appendix E of this L1 SFRA. Diagram 3 of the PPG is reproduced in Figure 4-2. For access to Tables 1 and 2, please refer to the PPG, and for Annex 3 see the NPPF.

4.2.1 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.

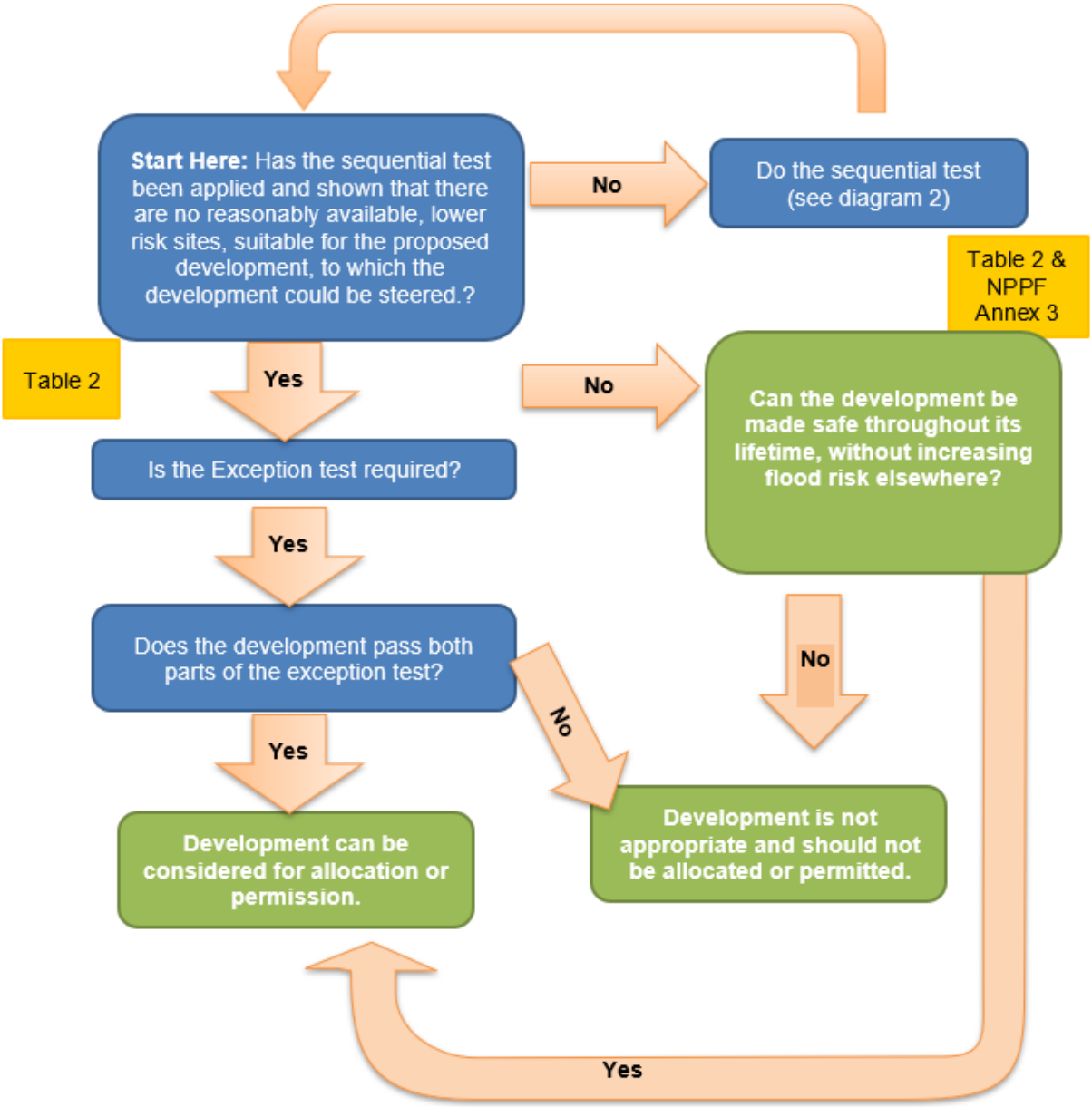


Figure 4-2: Application of the Exception Test to plan preparation (source: Diagram 3 - PPG, 2022). Diagram 2 of the PPG is reproduced in Figure 4-1. For access to Table 2, please refer to the PPG, and for Annex 3 see the NPPF.

The Exception Test should only be applied following the application of the Sequential Test.

Figure 4-2 summarises the Exception Test. An LPA should apply the Exception Test to strategic allocations where required. For all developments, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test. This is because when a site-specific Flood Risk Assessment is done, more information on the exact measures that can manage the risk is available.

There are two parts to demonstrating a development passes the Exception Test:

1. *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.

2. *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 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.

4.2.2 Making a development 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 PPG defines the design standard for new development to consider the suitability of development and any mitigation measures. The 1% fluvial and surface water, and the 0.5% tidal, annual probabilities of flooding with a suitable allowance for climate change should be used as a design standard when assessing the suitability of development and any mitigation measures.
- 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.
- Residual risk is the risk that remains after the effects of flood defences have been considered and / or from a more severe flood event than the design event. The residual risk can be:

- The effects of an extreme 0.1% 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
- Structural failure of any flood defences, such as breaches in embankments or walls.

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.

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.

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

4.3.1 The Sequential Test

Buckinghamshire Council, taking account of views from other relevant parties, is responsible for considering whether the Sequential Test has been passed. The Environment Agency may be invited by Buckinghamshire Council to provide comment in respect of the accuracy of the data the test is based on.

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

- an allocation and the test has already been carried out by the LPA
- a change of use (except to a caravan, camping or chalet site, or to a mobile home or park home site)
- a minor development (householder development, small non-residential extensions with a footprint of less than 250m^2); or
- a development in an area at low risk from all sources of flooding, unless the SFRA or other information, indicates there may be a risk of flooding in the future.

If a site allocated in a local plan or neighbourhood plan is proposed for a use which would increase the vulnerability of users (e.g. allocated for employment but proposed for residential), the Sequential Test should be re-applied at planning application stage.

The SFRA contains information on all sources of flooding and considering 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 now and in the future.

The Local Planning Authority must use local circumstances 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
- Housing and Economic Land Availability Assessments (HELAAs)/ 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 risk.

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

The SFRA guide to using technical data in Appendix F shows where the Sequential and Exception Test may be required for the datasets assessed in the SFRA, and how to interpret different levels of concern with the datasets, recommending what development might be appropriate in what situations.

It should also be noted that for “small catchments” (typically less than 3 square kilometres) or the upper extremity of larger catchments the nationally available fluvial flood mapping might not have been prepared. This potentially gives the incorrect impression that a site is in fluvial Flood Zone 1, when in fact it might be affected by flood risk from an adjacent watercourse. In such circumstances an initial assessment should be performed by the applicant to identify the extent of the flood zones to understand the implications with respect to applying the Sequential Test.

It is recommended that specific guidance on applying the Sequential Test for all sources of flood risk within Buckinghamshire is developed by the LPA, in consultation with the LLFA, to ensure consistent decision-making is applied across the county.

4.3.2 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 Diagram 3 of the PPG). Applicants and developers are required to apply the Exception Test to all applicable sites (including strategic allocations).

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

- *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 sustainability issues the development will address and how these 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.
- *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,
  - access and egress,
  - operation and maintenance,
  - design of the development to manage and reduce flood risk wherever possible,
  - resident awareness,
  - flood warning and evacuation procedures, 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

5 Impact of climate change

Climate change projections show an increased chance of warmer, wetter winters and hotter, drier summers with a higher likelihood of more frequent and intense rainfall. This is likely to make severe flooding happen more often.

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 considered.

5.1 The impact of climate change in the Local Plan Review area

The UKCP18[49] climate projections provide a number of future projections for different variables across the UK. With an increase in global temperature between 2 – 4 degrees, the UKCP18 allowances estimate that within South East England[50]:

- Increased mean summer temperature of between 2° - 7°C by 2099.
- Increased mean winter temperatures of up to 2ºC or a decrease of up to -1ºC by 2099.
- Summer rainfall could decrease by over 80% or it could increase up to 10% by 2099.
- Winter rainfall could decrease by up to 10% or it could increase over 30% by 2099.

Whilst changes in trends and mean values is important, the more influential effect of climate change with respect to flood risk and drought is to increase the chance of occurrence and severity of more extreme wet and dry events.

5.2 Climate change, the NPPF and PPG

The NPPF (updated in July 2021, and subsequently in December 2023) and PPG Climate Change guidance[51] sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and PPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

The 2023 NPPF also states that the 'sequential approach should be used in areas known to be at risk now or in the future from any form of flooding' (para 168). In accordance with the PPG, the SFRA seeks to take account of climate change for 100

49 UKCP18 Climate Projections. Met office (2018). https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

50 UKCP18 Overview Report: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

51 Climate change guidance. Ministry of Housing, Communities, and Local Government. (2014, updated 2019) https://www.gov.uk/guidance/climate-change

years, therefore this shall commence at the beginning of the plan period, which is 2021.

The PPG has been updated alongside the NPPF to incorporate all sources of flooding when assessing flood risk with a greater emphasis on the impacts of climate change. The Sequential Test now seeks to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account both now and in the future (as set out in diagram 2 of the PPG).

5.3 Climate change guidance and allowances

Making an allowance for climate change helps reduce the vulnerability of the development and provides resilience to flooding in the future. 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 used these projections to update their climate change guidance for new developments with regards to updated fluvial and rainfall allowances which were released in July 2021.

The Environment Agency published climate change guidance[52] on 19 February 2016 (further updated in February 2019, December 2019, July 2021 and May 2022), which supports the NPPF and must now be considered in all new developments and planning applications. The document contains guidance on how climate change should be accounted for when considering development, specifically how allowances for climate change should be included with FRAs. The guidance adopts a risk-based approach, considering the vulnerability of the development and considers risk allowances on a management catchment level, rather than a river basin level.

Developers should check the government website for the latest guidance before undertaking a detailed Flood Risk Assessment.

5.4 Peak river flow allowances

The peak river flow allowances[53] provided in the guidance show the anticipated changes to peak flow for the river basin management catchment within which a watercourse is located.

For each management catchment, guidance on uplift in peak flows are provided for three allowance categories, Central, Higher Central and Upper End which are based

52 Environment Agency (May 2022), Flood risk assessments: climate change allowances, (available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

53 Flood Risk Assessments - climate change allowances (2021): https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#Select-the-peak-river-flow-allowances-to-use-for-your-assessment

on the 50th, 70th and 95th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the Flood Zones within which it is located.

Table 5-1: Guidance on the use of peak river flow allowances based on flood zone and vulnerability classification (PPG Table 2)

Vulnerability classification	Flood Zone 2 or Flood Zone 3a	Flood Zone 3b
Essential Infrastructure	Higher Central	Higher Central
Highly Vulnerable	Central (development should not be permitted in FZ3a)	Development should not be permitted
More Vulnerable	Central	Development should not be permitted
Less Vulnerable	Central	Development should not be permitted
Water Compatible	Central	Central

In addition to the guidance provided in Table 5-1, Environment Agency climate change guidance recommends a high impact climate change scenario, the Upper End peak river flow allowance, is also assessed when considering nationally significant infrastructure projects, new settlements and urban extensions. The Upper End scenario is considered a 'sensitivity test', which helps to determine how sensitive the proposal is to climate change under different future scenarios.

An allowance based on the 50th percentile is exceeded by 50% of the projections in the range. At the 70th percentile it is exceeded by 30%. At the 95th percentile it is exceeded by 5%.

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

- The ‘2020s’ (2015 to 2039)
- The ‘2050s’ (2040 to 2069)
- The ‘2080s’ (2070 to 2125)

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years. For non-residential uses a starting point of 75 years should be considered unless there are specific reasons for a different development lifetime to be used. Further information on what is considered to be the lifetime of development is provided in the PPG.

Peak flow climate change allowances for the following management catchments cover Buckinghamshire:

- Upper and Bedford Ouse Management Catchment (Table 5-3)
- Colne Management Catchment (Table 5-4)
- Thames and South Chilterns Management Catchment (Table 5-5)
- Maidenhead and Sunbury Management Catchment (Table 5-6)
- Cherwell and Ray Management Catchment (Table 5-7)

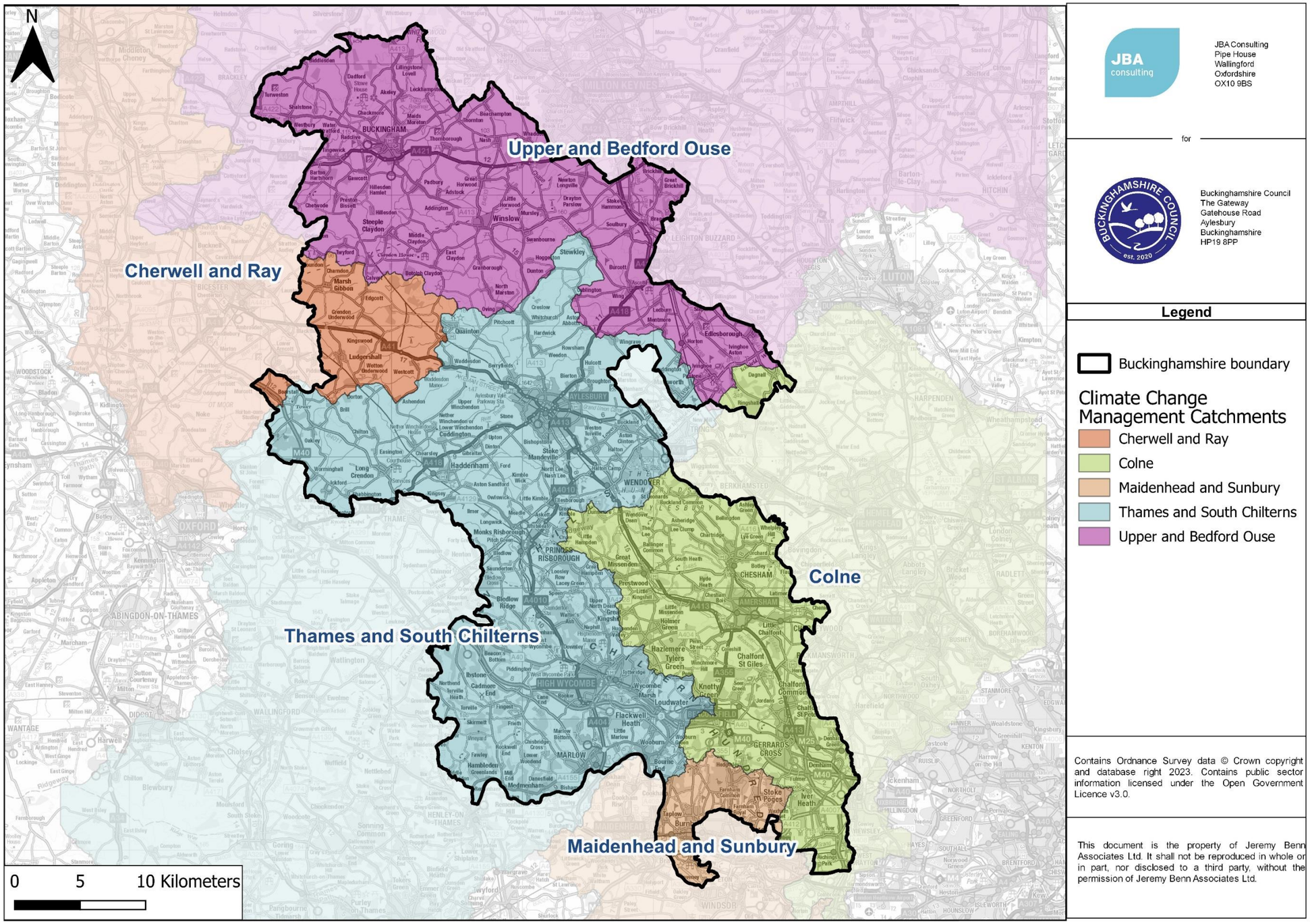


Figure 5-2: Climate change management catchments in Buckinghamshire

Table 5-3: Upper and Bedford Ouse Management Catchment peak river flow allowance

Allowance Category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2125)
Upper end	24%	30%	58%
Higher central	10%	11%	30%
Central	5%	4%	19%

Table 5-4: Colne Management Catchment peak river flow allowance

Allowance Category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2125)
Upper end	30%	38%	72%
Higher central	16%	16%	35%
Central	10%	8%	21%

Table 5-5: Thames and South Chilterns Management Catchment peak river flow allowance

Allowance Category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2125)
Upper end	30%	42%	76%
Higher central	17%	22%	43%
Central	12%	14%	31%

Table 5-6: Maidenhead and Sunbury Management Catchment peak river flow allowance

Allowance Category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2125)
Upper end	32%	45%	81%
Higher central	19%	25%	47%
Central	14%	17%	35%

Table 5-7: Cherwell and Ray Management Catchment peak river flow allowance

Allowance Category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2125)
Upper end	24%	27%	49%
Higher central	11%	10%	25%
Central	6%	4%	15%

5.4.1 Upper End allowance

Current guidance published in May 2022, specifies that Strategic Flood Risk Assessments should use the Central and Higher Central allowances to assess the impacts of climate change on flood risk. The updates for peak river flows place increased emphasis on the Central and Higher Central scenarios, using the Upper End peak river flows only for the following specific types of development:

- Nationally Significant Infrastructure Projects;
- New settlements;
- Significant urban extensions.

The Level 1 SFRA assesses climate change for the 3.3%, 1% and 0.1% AEP fluvial event for the '2080s' central, higher central and upper end allowances, with mapped outputs provided in Appendix C. Please note for the Level 1 SFRA the undefended outputs have been assessed for Flood Zone 3a and 2, and the defended outputs have been assessed for Flood Zone 3b (the functional floodplain).

5.4.2 Representing the impact of climate change on fluvial flood risk within the Level 1 SFRA

The following climate change extents have been defined as part of the Level 1 SFRA (with Table 5-8 setting out the data used to represent each of these zones):

- Flood Zone 3b + Climate Change (CC)
- Flood Zone 3a + CC
- Flood Zone 2 + CC

In line with Environment Agency climate change guidance, both the central and higher central allowances have been assessed as part of the Level 1 SFRA. In addition, the upper end allowance was used as a 'sensitivity test' to assess the flood risk from a high impact climate change scenario, to inform any potential future new settlements or significant urban extensions in Buckinghamshire.

Representation of climate change within the Level 1 SFRA was agreed with the EA. The following model outputs were used were used to represent climate change and define Flood Zones 3b, 3a and 2 + CC (with model extents shown in Figure 5-1):

- Chalvey Ditches (2010) - 1.33% (1 in 75-year), 1% and 0.1% AEP events (+32%, +45%, +81% CC allowances)
- Leighton Buzzard (2013)
    - Proxy data sets have been used in some locations of the Leighton Buzzard model, where the modelled flood extents are lesser in extent than the existing Flood Zones 3a and 2. This is further discussed in Appendix F
- Lower Colne (2012) - 2% (1 in 50-year), 1%, 0.1% AEP events (+21%, +35%, +72% CC allowances)
- Misbourne (2016) - 3.3%, 1% and 0.1% AEP events (+21%, +35%, +72% CC allowances)
- Thames (Hurley to Teddington) (2019) - 3.3%, 1% and 0.1% AEP events (+31%, +43%, +76% CC allowances)
- Upper Great Ouse (2011) - 2%, 1% and 0.1% AEP events (+19%, +20%, +58% CC allowances)
- Upper Colne (2010) - 2%, 1%, 0.1% (+21%, +35%, +72% CC allowances)
    - Proxy data sets have been used on the eastern boundary of Buckinghamshire, where the model is 1D-only. This is further discussed in Appendix F.
- Upper Thame and Bear Brook (2018) - 3.3% and 1% AEP events (+31%, +43%, +76% CC allowances)
    - Proxy data sets have been used for Flood Zone 2 + CC, due to model instabilities in running the 0.1% AEP + CC event, which require significant works to the model to resolve. This is further discussed in Appendix F.

- Wye (including Hughenden Stream) (2018) - 3.3%, 1% and 0.1% AEP events (+31%, +43%, +76%)

Two additional models, the Brackley Pre-Feasibility model (2013) and the Buckingham Project Appraisal Report (PAR) (2005) were also supplied. However, mapped model outputs were not provided within the model files, and the models only represented the river channel (i.e. were 1D-only in nature).

It was only possible to generate climate change flood extents where the models were 1D-2D in nature (representing both the river channel and floodplain), and could accommodate the latest climate change uplifts. The existing Flood Zones (Flood Zone 3a and 2) were used as a proxy flood extent where 1D-only models were present, models could not be re-run for the latest climate change allowances, or in areas where there was no detailed model coverage (as explained in Table 5-1).

The Environment Agency (East Anglia area) advised that the Buckingham PAR model was the preferred model to use in Buckingham, rather than the Upper Great Ouse model. As the Buckingham PAR model is 1D-only, Flood Zones 3a and 2 have been used as proxy flood extents within Buckingham.

Appendix F provides further detail on the hydraulic models which have been used to represent the impact of climate change on the fluvial Flood Zones in Buckinghamshire.

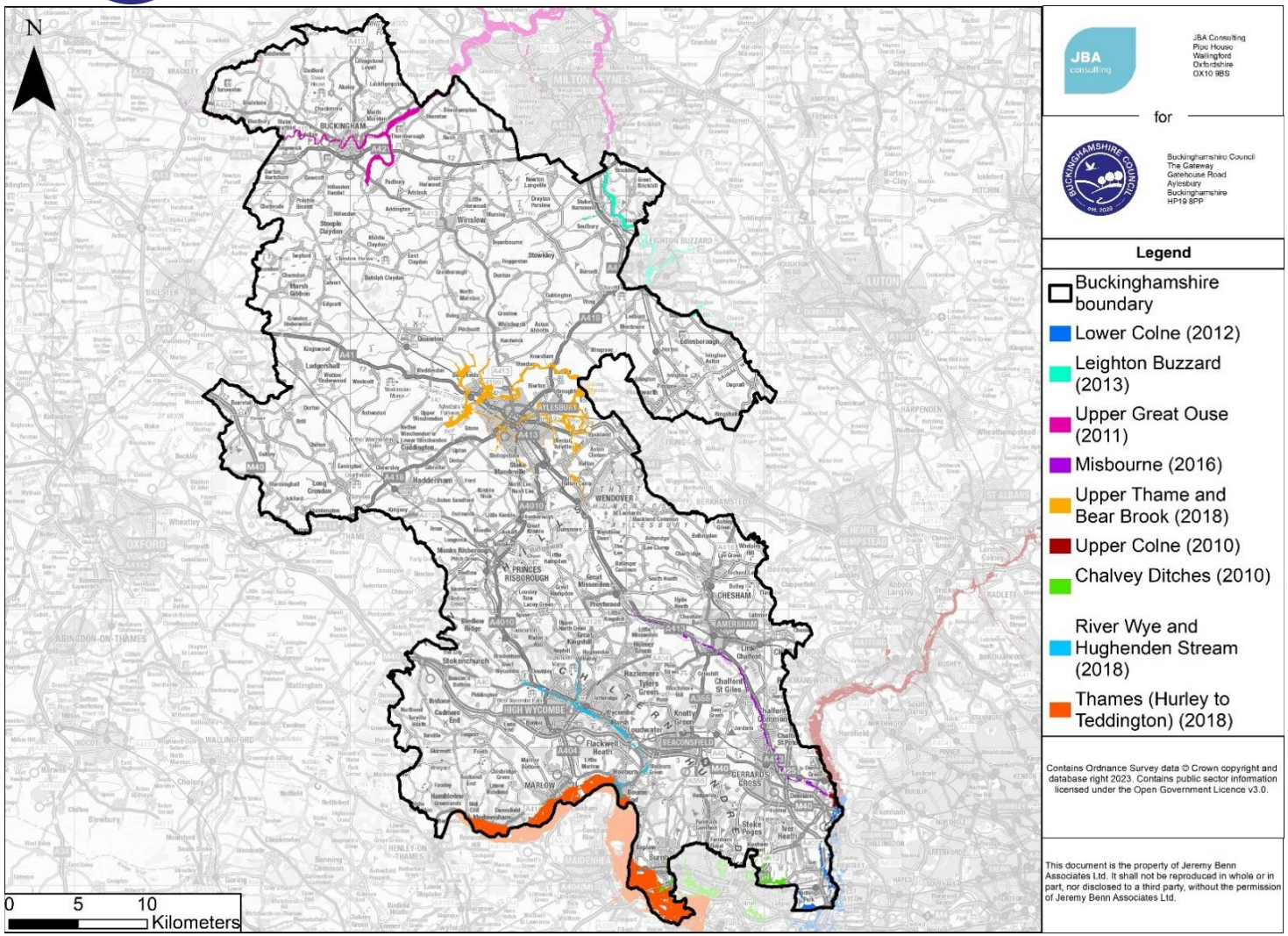


Figure 5-1: Coverage of Environment Agency hydraulic models in Buckinghamshire. Please note the Brackley Pre-Feasibility (2013) and Buckingham PAR (2005) models are not shown as mapped model outputs were not available.

Table 5-8: Data used to represent the impact of climate change on fluvial Flood Zones in Buckinghamshire

Climate Change (CC) extent	AEP / return periods represented	Climate change allowances assessed (for '2080s' epoch)	Approach used where required (return period not available, 1D-only model, model failed, or no model coverage)
Flood Zone 3b + CC	1 in 30-year (3.3% AEP) event.	Central: 19%, 21%, 31%, 32% Higher: 30%, 35%, 43%, 45% Upper: 58%, 72%, 76%, 81% N.B. No model coverage in Cherwell and Ray management catchment	1 in 50-year (0.2% AEP) or 1 in 75-year (1.33% AEP) model extents, where available. Flood Zone 3a (3.3% - 1% AEP) used as a proxy elsewhere.
Flood Zone 3a + CC	1 in 100-year (1% AEP) event.	Central: 19%, 21%, 31%, 32% Higher: 30%, 35%, 43%, 45% Upper: 58%, 72%, 76%, 81% N.B. No model coverage in Cherwell and Ray management catchment	Flood Zone 2 (1% - 0.1% AEP) used as a proxy elsewhere.
Flood Zone 2 + CC	1 in 1,000-year (0.1% AEP) event.	Central: 19%, 21%, 31%, 32% Higher: 30%, 35%, 43%, 45% Upper: 58%, 72%, 76%, 81% N.B. No model coverage in Cherwell and Ray management catchment	Flood Zone 2 (1% -0.1% AEP) used as a proxy elsewhere.

5.5 Peak rainfall intensity allowances

Table 5-9 to Table 5-13 show anticipated changes in extreme rainfall intensity for site-scale applications (for example, drainage design), and for surface water flood mapping in small catchments (less than 5km^2) and urbanised drainage catchments. A drainage catchment is urban if the land use is a town or city.

For development with a lifetime beyond 2100, the EA guidance states that FRAs and SFRAs should assess the upper end allowances. This should be undertaken for both the 1% and 3.3% AEP events for the 2070s epoch (2061 to 2125). In some locations the allowance for the 2050s epoch is higher than that for the 2070s epoch. If so, and development has a lifetime beyond 2061, the Environment Agency guidance outlines that the higher of the two allowances should be used.

As mentioned in Section 5.4, the following peak rainfall climate change allowances for the following management catchments cover Buckinghamshire:

- Upper and Bedford Ouse Management Catchment (Table 5-3)
- Colne Management Catchment (Table 5-10)
- Thames and South Chilterns Management Catchment (Table 5-11)
- Maidenhead and Sunbury Management Catchment (Table 5-12)
- Cherwell and Ray Management Catchment (Table 5-13)

Table 5-9: Upper and Bedford Ouse Management Catchment peak rainfall intensity allowance

Allowance Category	3.3% annual exceedance rainfall event 2050s	3.3% annual exceedance rainfall event 2070s	1% annual exceedance rainfall event 2050s	1% annual exceedance rainfall event 2070s
Upper end	35%	35%	40%	40%
Central	20%	25%	20%	25%

Table 5-10: Colne Management Catchment peak rainfall intensity allowance

Allowance Category	3.3% annual exceedance rainfall event 2050s	3.3% annual exceedance rainfall event 2070s	1% annual exceedance rainfall event 2050s	1% annual exceedance rainfall event 2070s
Upper end	35%	35%	40%	40%
Central	20%	25%	20%	25%

Table 5-11: Thames and South Chilterns Management Catchment peak rainfall intensity allowance

Allowance Category	3.3% annual exceedance rainfall event 2050s	3.3% annual exceedance rainfall event 2070s	1% annual exceedance rainfall event 2050s	1% annual exceedance rainfall event 2070s
Upper end	35%	35%	40%	40%
Central	20%	25%	20%	25%

Table 5-12: Maidenhead and Sunbury Management Catchment peak rainfall intensity allowance

Allowance Category	3.3% annual exceedance rainfall event 2050s	3.3% annual exceedance rainfall event 2070s	1% annual exceedance rainfall event 2050s	1% annual exceedance rainfall event 2070s
Upper end	35%	35%	40%	40%
Central	20%	25%	20%	25%

Table 5-13: Cherwell and Ray Management Catchment peak rainfall intensity allowance

Allowance Category	3.3% annual exceedance rainfall event 2050s	3.3% annual exceedance rainfall event 2070s	1% annual exceedance rainfall event 2050s	1% annual exceedance rainfall event 2070s
Upper end	35%	35%	40%	40%
Central	20%	35%	20%	25%

As part of the SFRA, the following surface water outputs have been prepared based on the Environment Agency guidance (the outputs are mapped in Appendix C):

- 3.3% AEP + 25% and 35% increase in peak rainfall intensity
- 1% AEP + 25% and 40% increase in peak rainfall intensity
- 0.1% AEP + 25% and 40% increase in peak rainfall intensity

5.6 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is much more uncertain, and there is no technical modelling data available to assess the impacts.

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.

As there is substantial uncertainty over the potential effects of climate change on the magnitude of groundwater flows generated by rainfall, there is no competent evidence that can be used to inform a strategic or site-specific assessment. However, as knowledge develops, the latest guidance should be considered at the planning application stage.

5.7 Impact of climate change in Buckinghamshire

5.7.1 Impact of climate change on fluvial flood risk

The areas of Buckinghamshire which are shown to be most sensitive to the impact of climate change on fluvial flood risk are settlements on the floodplains of the River Thames, especially at Dorney, Marlow and Bourne End, and the River Colne, to the east of Iver and Denham Green.

An increase in flood risk on the Upper Thame and Bear Book (and its tributaries) is also seen in central, eastern and south western Aylesbury, as well as on rural land between the Grand Union Canal and Western Turville.

Smaller increases in flood extent are predicted to occur under climate change on the River Misbourne, at Chalfont St Peter, Denham and Higher Denham, as well as on the River Wye at High Wycombe. The upper valleys of these rivers see lesser changes in flood extent, as the floodplain is constrained by steep topography.

5.7.2 Impact of climate change on surface water flood risk

The latest climate change allowances (May 2022) have been applied to the Environment Agency Risk of Flooding from Surface Water dataset and two detailed surface water models covering Aylesbury and Chesham (2020). This provides an indication of the impact of climate change on surface water flood risk, as well as the flood risk from ordinary watercourses.

Settlements in Buckinghamshire which are predicted to be particularly sensitive to the impacts of climate change on surface water flood risk include Amersham, west and south west Aylesbury, Beaconsfield, Burnham, Marlow and Princes Risborough.

The surface water climate change mapping also highlights the significant increase in flood extent on the low-lying floodplains of main rivers and ordinary watercourses within Buckinghamshire, including the River Ouse at Buckingham, the River Ray catchment in the west of the county, and the lower reaches of the River Misbourne.

5.8 Adapting to and mitigating climate change

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

Examples of adapting to and mitigating 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.
- 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, such as at the defence locations mentioned in Section 7.
- Promoting low carbon design approaches to reduce energy consumption in buildings, such as passive solar design.
- Identifying opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems.

It is recommended that the differences in flood extents between present day and future Flood Zone 3b, 3a and 2 are compared by the Council when undertaking the Level 2 SFRA and allocating sites, to understand how much additional risk there could be in the future as a result of climate change. Potential issues will need to be considered such as the extent of the risk, whether the increase is marginal or leads to significantly greater flooding, whether it affects access/ egress and how much land could still be developable overall. Recommendations for development are made for the levels of risk in the SFRA User Guide in Appendix F.

6 Understanding flood risk in Buckinghamshire

This section explores the key sources of flooding in Buckinghamshire and the factors that affect flooding including topography, soils and geology. The main sources of flooding are from watercourses (Main River and ordinary watercourses), surface water, groundwater and sewers.

This is a strategic summary of the risk in Buckinghamshire. Developers should use this section to scope out the flood risk issues they need to consider in greater detail in a site-specific Flood Risk Assessment to support a planning application.

Appendix F contains a list of the sources of data used in the SFRA and the approach to using hydraulic model data to inform the mapping.

6.1 Historical Flooding

The historic flood risk in the Local Plan area has been assessed using information of recorded incidents provided by the British Hydrological Survey, Buckinghamshire Council (as LLFA), the Environment Agency's recorded flood outline dataset, Canal and River Trust archive data, and Anglian and Thames Water's Sewer Incident Report Form (SIRF) dataset. This has been supplemented with other information from Buckinghamshire Council's Section 19 Flood Investigation Reports.

Settlements in Buckinghamshire have experienced a number of severe flood incidents, especially in the catchments of the Rivers Chess, Colne, Great Ouse, Misbourne, Thame, Thames, and Wye. The key historical incidents of flooding identified[54,55,56,57] are summarised in Appendix A, with the source of flooding included, where known. The Environment Agency's historic flood mapping for Buckinghamshire can be found in Appendix C and in Figure 6-1. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendices E and F.

The main flood events recorded in the Historic Flood Map (HFM) are predominantly from Main River, in:

- River Great Ouse - 1947 and 1998;
- River Thame and Bear Brook - 1947, 1990 1992 and 1993;
- River Ouzel (Lovat) - 1947;
- River Thames - 1947, 1974, 1990, 2000, 2003, 2013, and 2014;
- River Misbourne - 1947, 1874, 1981 and 2003;

54 PFRA Preliminary Assessment Report Final (buckinghamshire-gov-uk.s3.amazonaws.com)

55 Buckingham SWMP Rev1 (buckinghamshire-gov-uk.s3.amazonaws.com)

56 https://www.buckinghamshire.gov.uk/environment/flooding-and-flood-risk-management/flood-investigations/

57 Facsimile (buckinghamshire-gov-uk.s3.amazonaws.com)

- River Colne - 1987, 2003 and 2014.

Please note this does not include all recorded flood events, such as those from other sources, which have been recorded by the LLFA. Some of the historic extents may refer to flood events which occurred prior to flood defence improvements.

Notable flood incidents within the county from non-Main River fluvial sources, or from combined sources of flooding are as follows[58]:

- Winter 2000 - 2001
  - Following an exceptionally wet winter, high groundwater levels across the chalk aquifer resulted in high river flows (especially the Misbourne) and widespread flooding in the Chilterns valleys.
- January - March 2003
  - Combined flooding from the River Thames at Marlow, groundwater flooding from the chalk aquifer, and surface water flooding of towns in Aylesbury Vale.
- November - December 2006
  - Heavy rainfall resulted in a series of localised surface water flood incidents in the Chalfonts and parts of Aylesbury.
- July 2007
  - Widespread surface water flooding, as well as flooding from the River Thames in Marlow and the River Great Ouse in Buckingham. Caused by an intense rainfall event falling on a saturated catchment, following many weeks of wet weather.
- February 2009
  - Extensive flooding to the road network in the south of the county (Marlow, Chorleywood, Seer Green and Little Chalfont) following heavy rain and prolonged high groundwater levels.
- December - January 2014
  - Extensive flooding resulting from high groundwater levels, surface water runoff and overtopping of ordinary watercourses.
- January - February 2014
  - Extensive groundwater flooding in Wycombe and Chiltern areas, which exacerbated surface water flooding, due to high river levels and saturated soils. Combined with fluvial flooding from the River Thames at Medmenham.
- September 2014
  - Surface water flooding and increased flow in the River Chess and its tributary the Vale Brook, resulted in flooding in Chesham.
- October 2020

58 Buckinghamshire Council (2017) Buckinghamshire Flood Risk Management Strategy. Available at: Facsimile (buckinghamshire-gov-uk.s3.amazonaws.com)

- Fluvial (Bear Brook and Stocklake Brook) and surface water flooding in the Aylesbury area, following three months' worth of rain within two and a half days .

- December 2020
  - Fluvial and surface water flooding to towns and villages in northern Buckinghamshire (Buckingham, Gawcott, Tingewick, Leckhampstead, Thornton, Thornborough) due to intense rainfall falling on already very saturated ground.

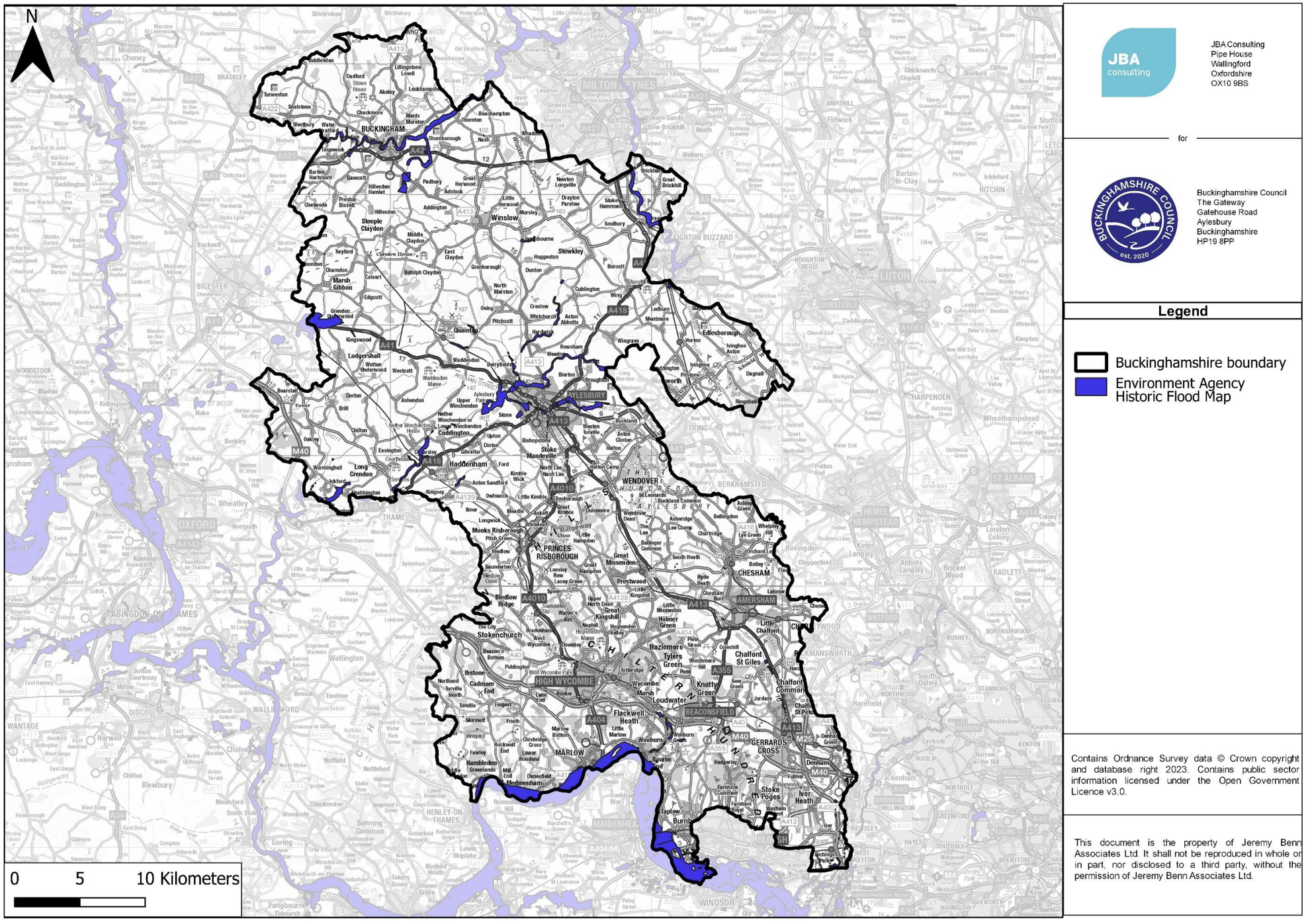


Figure 6-1 - Buckinghamshire historic flood outlines (Environment Agency Historic Flood Map dataset).

6.2 Topography, geology, soils and hydrology

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

6.2.1 Topography

The topography of Buckinghamshire is characterised by the steep chalk uplands of the Chiltern Hills, which form a band through the south of the county, and the low-lying floodplains of the River Great Ouse in the north, the Aylesbury Vale (River Thame) in the centre, the River Thames in the south and the River Colne in the east (as shown in Figure 6-2). Elevations reach a high point of approximately 165m Above Ordnance Datum (m AOD) in the centre of the county, and approximately 20mAOD at the most southern extent of the county, in the Thames Valley.

6.2.2 Geology and soils

Buckinghamshire is dominated by sedimentary bedrock geology, with various formations of sandstones, siltstones, clay and mudstones, as shown in Figure 6-3.

In the north of the county are permeable sandstone and limestone rocks (Great Oolite Group). South of this is the less permeable Kellaways Formation and Oxford Clay Formation made up of mudstone, siltstone and sandstone. The Gault Formation and Upper Greensand Formation (mudstone, sandstone and limestone) make up much of the lower elevations south of Aylesbury, and extend south-west to Monks Risborough.

A large area between the centre and south of the county is made up of the White Chalk Sub Group Formation, which extends from the north east to the south west and forms the Chiltern Hills. The southernmost part of the county is predominantly underlain by clay, silt, sand and gravel deposits from the Woolwich and Reading Beds and the London Clay Group. In addition, aligning north-east to south-west between Aylesbury and Thame, there are mosaics of limestone and calcareous sandstone (Corallian Group, Portland Group, Purbeck Group), as well as mudstone and siltstone (Wealden Group).

The superficial geology (Figure 6-4) comprises of glacial sediment (till) in the north and north-east of the county. Clay with flints overlies the White Chalk Formation bedrock and are found on the higher elevations and in the Chiltern Hills. Sand and gravel river terrace deposits are found in the south of the county. River sediment (alluvium) deposits occupy the valleys of the River Chess, River Great Ouse and River Misbourne and the River Ouzel (also known as the River Lovat).

Mapping from the Cranfield Soil and Agrifood Institute[59] shows the most common soil type in the council area is slowly permeable, seasonally wet slightly acid but base-rich loamy and clayey soils. The west of the catchment comprises lime-rich loamy and clayey soils with impeded drainage. In the centre of the county, where the White Chalk Group is present and in the Chiltern Hills, slightly acid loamy and clayey soils with impeded drainage are found, shallow lime-rich soils over chalk or limestone are also found in this region. The soils in the southern-most part of the county, where the lowest elevations are found, predominantly has freely draining slightly acid loamy soils. The River Great Ouse, River Ouzel and River Thame valleys have a high proportion of loamy and clayey floodplain soils with naturally high groundwater.

6.2.3 Hydrogeology

The bedrock layers and superficial deposits in Buckinghamshire are classified as the following aquifers:

- Principal: layers of rock or drift deposits with high permeability and, therefore, provide a high level of water storage
- Secondary A: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- Secondary B: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- Secondary undifferentiated: rock types which do not fit into either category A or B.
- Unproductive Strata: rock layers and drift deposits with low permeability and, therefore, have a negligible impact on water supply or river base flow.

The bedrock geology in the northern and southern areas of Buckinghamshire, as well as Aylesbury Vale is classified as a mixture of predominantly Principal and Secondary A aquifers, with small areas of Secondary B and Secondary undifferentiated aquifers. The superficial deposits in the south are primarily classified as Principal and Secondary A aquifers, whereas undifferentiated aquifers are located in the centre and north of the county.

59 Cranfield Soil and Agrifood Institute: Soilscapes soil types viewer - National Soil Resources Institute. Cranfield University (landis.org.uk)

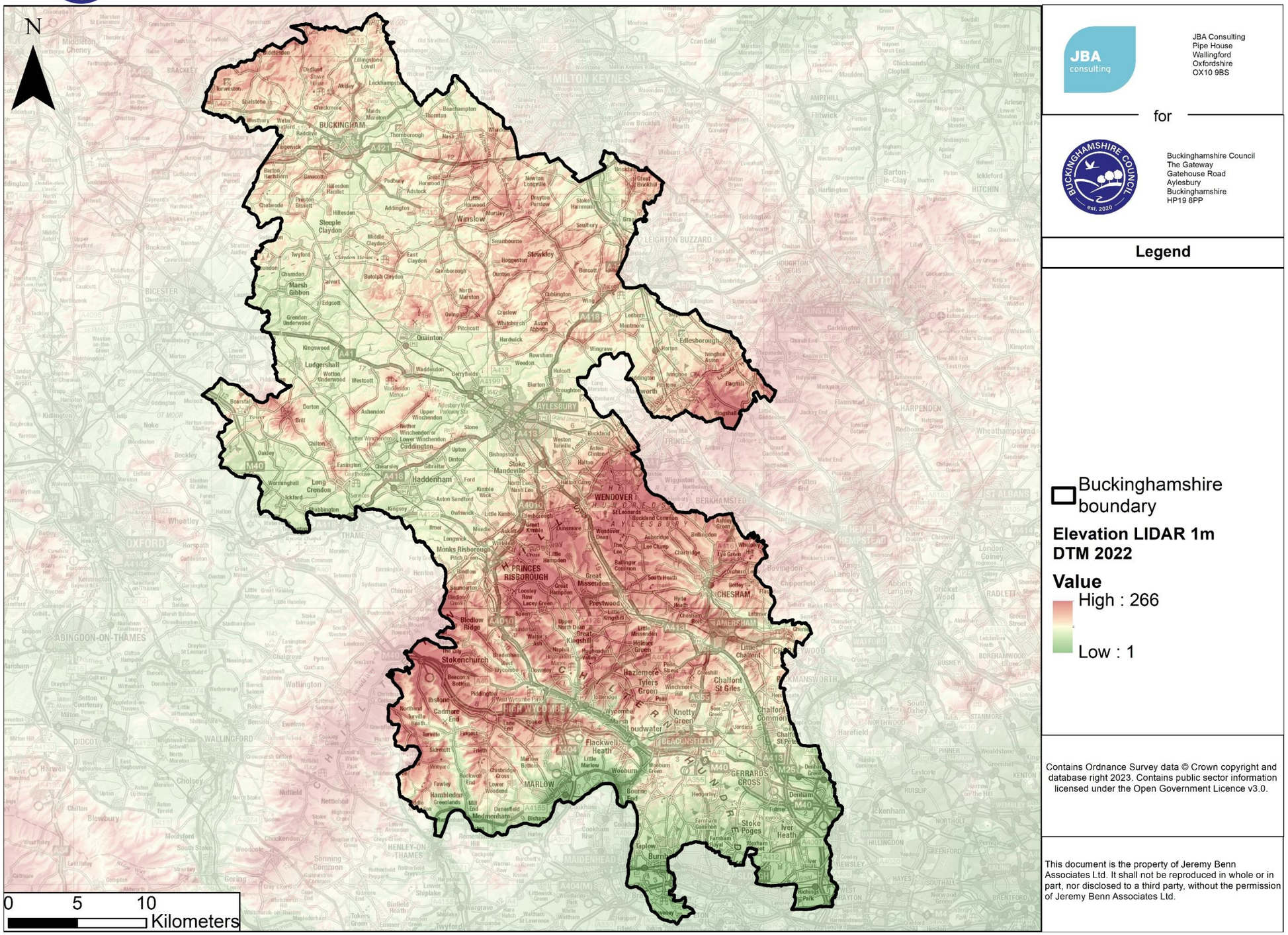


Figure 6-2: Topography of Buckinghamshire

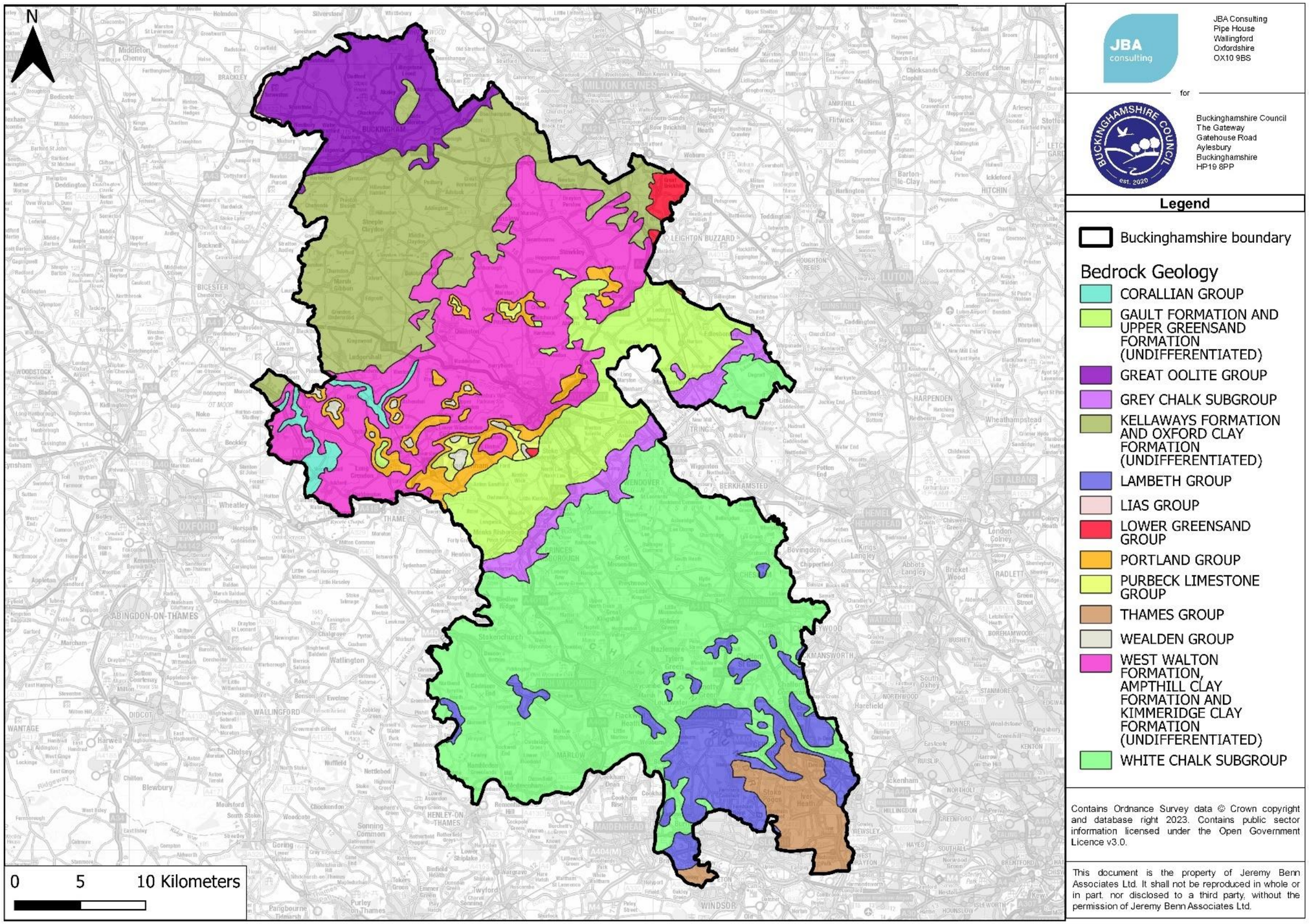


Figure 6-3: Bedrock geology of Buckinghamshire

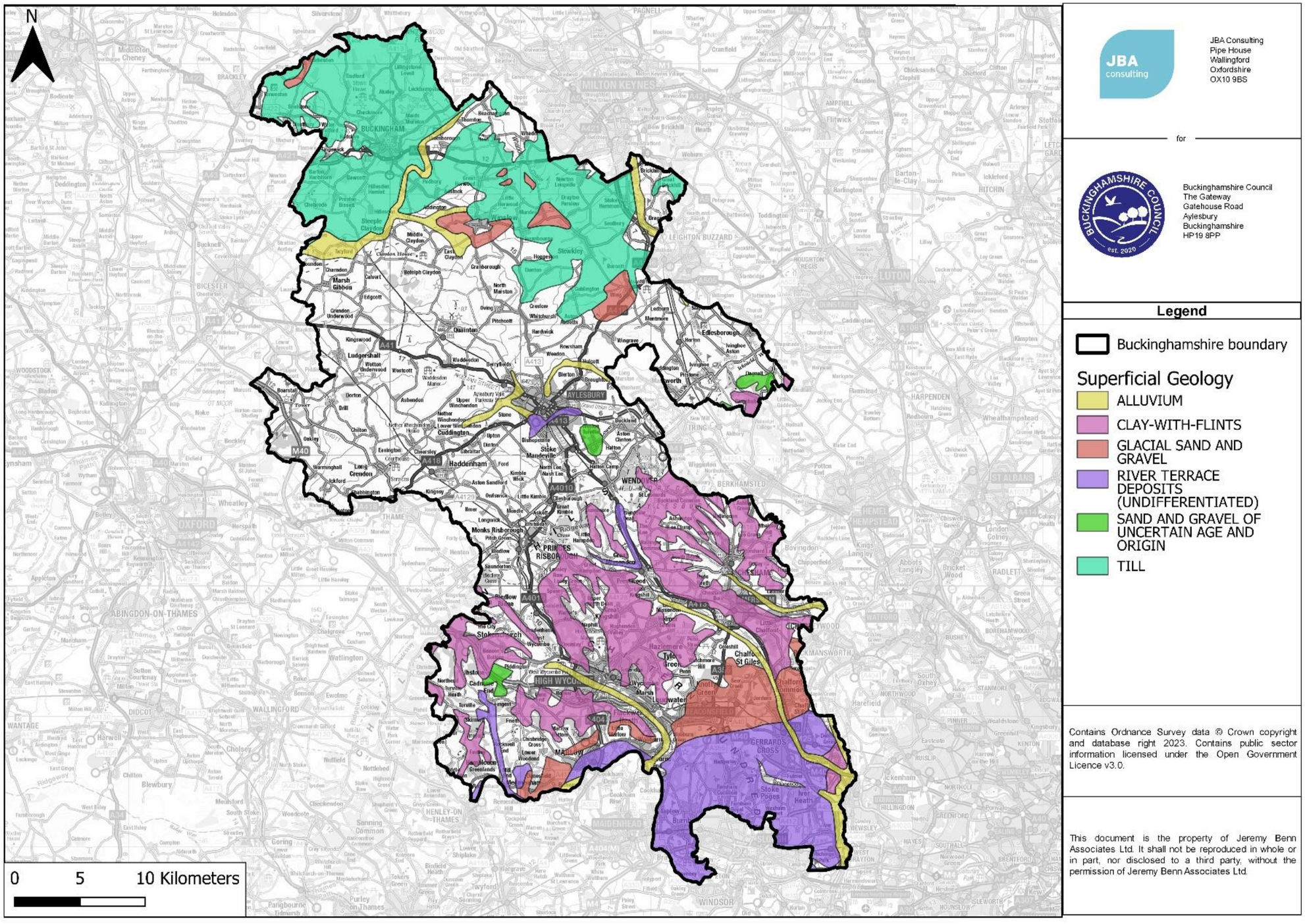


Figure 6-4: Superficial geology of Buckinghamshire

6.2.4 Hydrology

The hydrology of Buckinghamshire is split into two major catchments:

- Upper Great Ouse - smaller catchment in the north
  - Its tributaries:
    - River Ouzel (or Lovat)
    - Padbury Brook.
    - The River Tove, Silverstone Brook and Clipstone Brook also influence the rate of flow in the River Ouse within Buckinghamshire.
- The River Thames - larger catchment in the south
  - Its tributaries:
    - Rivers Ray and Thame - drain westwards to meet the Rivers Cherwell and Thames outside Buckinghamshire
    - Rivers Chess and Misbourne - drain south eastwards to join the River Colne
    - River Wye - flows southwards to form a confluence with the Thames.

The Buckinghamshire administrative area is bounded by rivers, with the River Thames at the southern boundary, the Rivers Colne and Ouzel (Lovat) in the east, and the Rivers Ray and Thame at the west. In addition, rivers flow through the larger settlements in the county; High Wycombe (River Wye), Aylesbury (River Thame), Chesham (River Chess) and Marlow (River Thames).

These rivers are all Environment Agency Main Rivers; tributaries to these rivers include many named watercourses and smaller Ordinary Watercourses. A map of the key watercourses is included in Appendix C.

6.2.5 Groundwater Vulnerability Zones

The Environment Agency published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater to pollution 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 Magic Map.

6.2.6 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones (GSPZs) near groundwater abstraction points. These protect areas of groundwater

used for drinking water. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination. GSPZs can be viewed on Defra's Magic Map.

Due to the presence of an underlying chalk aquifer, the majority of south Buckinghamshire is located within a Groundwater SPZ (Figure 6-5). Areas within a Groundwater SPZ are located along the corridors and tributaries of the Rivers Colne and Lee, specifically:

- Zone 1 SPZ (Inner Protection Zone - most sensitive) covers the River Misbourne as well as areas of the River Chess and Wye. Smaller, isolated areas of Zone 1 also occur in towns and villages, including at Great Missenden, Marlow, Medmenham, Wendover and Wooburn.
- Areas classified as Zone 2 (Outer Protection Zone - also sensitive) are surrounded by Zone 3 (Total Catchment) and can be found in the wider catchments in the south of Buckinghamshire. This covers areas such as Amersham, Bourne End, the Chalfonts, Flackwell Heath, High Wycombe and The Kingshills.

6.2.7 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.

NVZs can be viewed on the Environment Agency's 'Check for Drinking Water Safeguard Zones and NVZs' website. The locations of the Nitrate Vulnerable Zones in Buckinghamshire are shown in Figure 6-6 and predominantly cover the catchments of the Rivers Great Ouse, Ouzel, Ray and Thame, in the centre and north of the county.

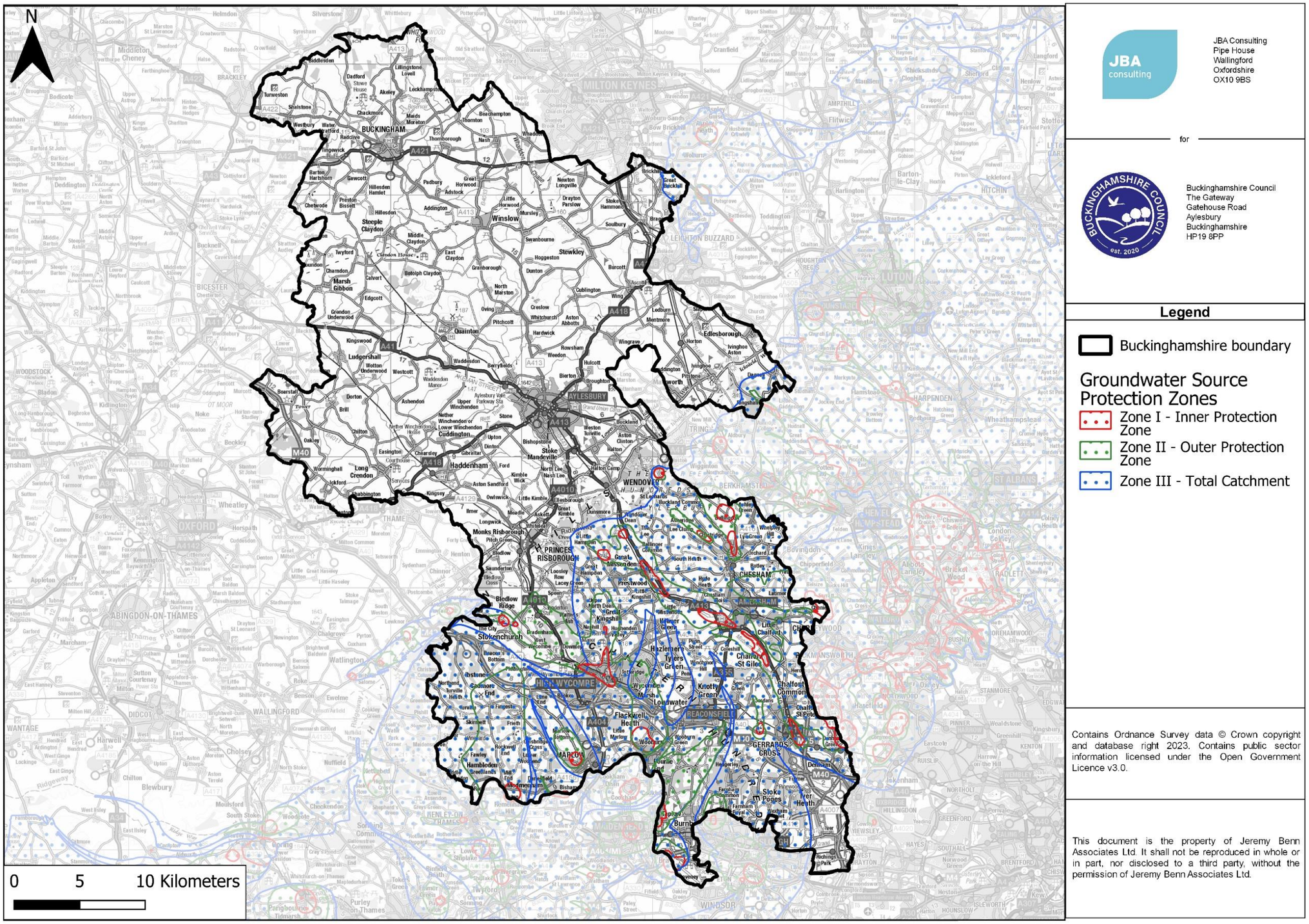


Figure 6-5: Groundwater Source Protection Zones in Buckinghamshire

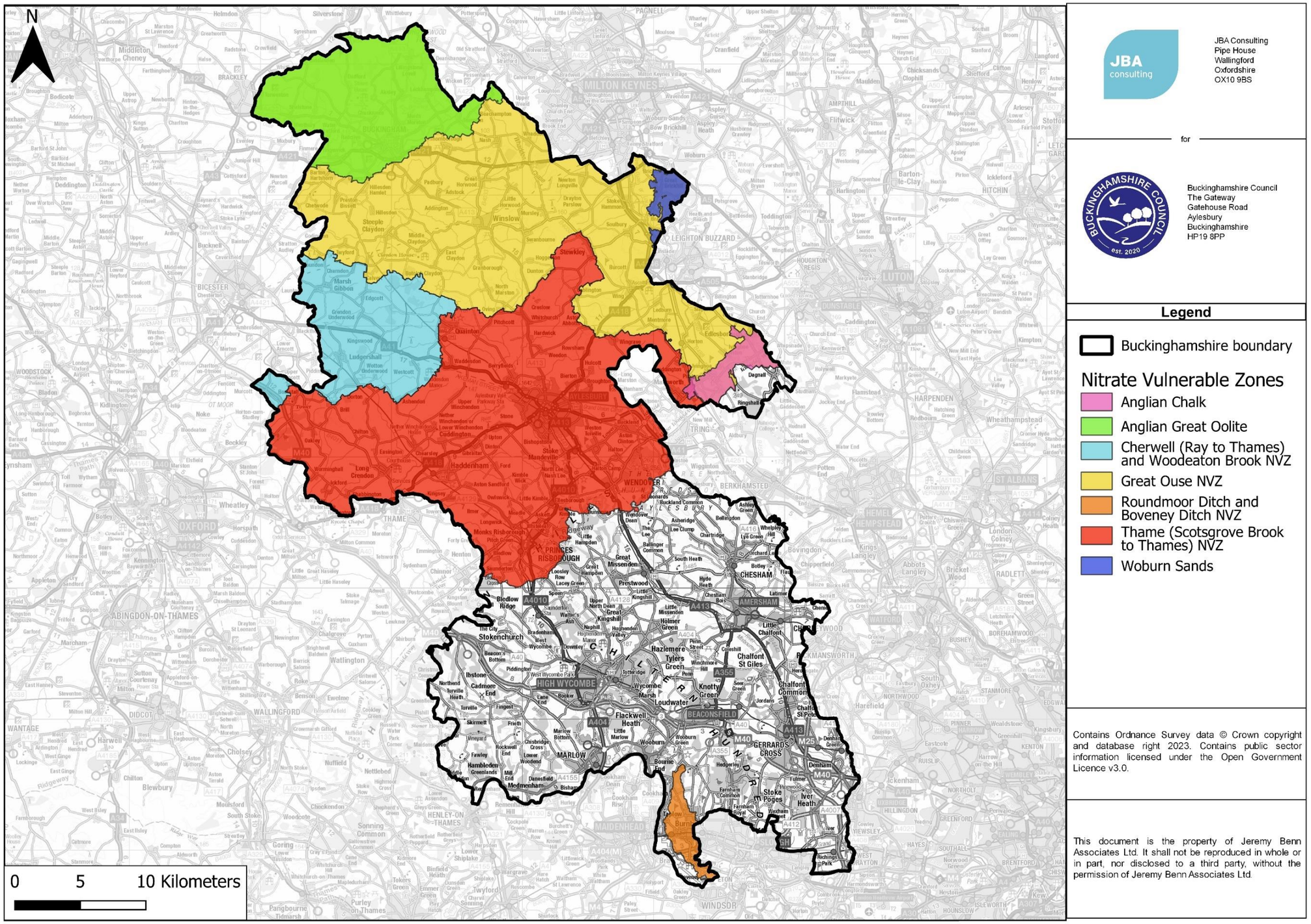


Figure 6-6: Nitrate Vulnerable Zones in Buckinghamshire

Table 6-7: Main Rivers within Buckinghamshire

Watercourse name	Classification	Description
River Chess	Main River	The River Chess is a chalk stream that rises near Chesham in the Chiltern Hills, and flows through Buckinghamshire and Hertfordshire to its confluence with the River Colne in Rickmansworth.
River Great Ouse	Main River	From Syresham in Northamptonshire, the Great Ouse flows through Buckinghamshire, Bedfordshire, Cambridgeshire and Norfolk to drain into the Wash and the North Sea near Kings Lynn.
River Thame	Main River	The River Thame is a tributary of the River Thames. From its source north of Aylesbury in Buckinghamshire, it flows in a general south-westward direction to meet the Thames downstream of Dorchester on Thames, in south east Oxfordshire.
River Thames	Main River	The river rises at Thames Head in Gloucestershire and flows eastwards through Oxford, Reading, Henley-on-Thames and Windsor. From there it flows through Greater London into the North Sea near Tilbury, Essex and Gravesend, Kent, via the Thames Estuary. The lower reaches of the Thames, from Teddington lock onwards, is tidal in nature. The Thames catchment area is fed by at least 50 named tributaries, and covers a large part of south east England, draining the whole of Greater London.
River Misbourne	Main River	The River Misbourne rises in a field on the outskirts of Great Missenden in Buckinghamshire, passing through Little Missenden, Old Amersham, Chalfont St Giles, Chalfont St Peter and under the Chiltern railway line and the M25 motorway to its confluence with the River Colne.
River Ouzel (Lovat)	Main River	The River Ouzel (also known as the River Lovat), is a tributary of the River Great Ouse. It rises in the Chiltern Hills and flows northwards to join the River Ouse at Newport Pagnell.
Gubbinshole and Broadmoor Ditch	Main River	Gubbinshole and Broadmoor Ditch is a small tributary of the River Ray. Rising between Charndon and Calvert, the watercourses flow south westwards, to meet the River Ray just upstream of the A41, at an area locally known as Three Points (downstream of Grendon Underwood).
Bear Brook	Main River	The Bear Brook flows through the centre of Aylesbury, and is one of the most urbanised watercourses in the River Thame catchment. A large number of tributary watercourses join the Bear Brook in Aylesbury, including California Brook, Southcourt Brook and Stoke Brook.
River Wye	Main River	The River Wye rises close to West Wycombe village in the Chiltern Hills and flows through High Wycombe before discharging into the River Thames at Bourne End.
River Ray	Main River	The River Ray is a tributary of the River Cherwell. It rises at Quainton Hill, Buckinghamshire and flows westwards to meet the Cherwell at Islip in Oxfordshire. The River Cherwell then joins the River Thames in south Oxford.
Tetchwick Brook	Main River	The Tetchwick Brook is a small, heavily modified tributary in the headwaters of the River Ray. The Tetchwick joins the Ray just upstream of the A41, at an area locally known as Three Points (downstream of Grendon Underwood), where the Gubbinshole and Broadmoor Ditch system also join the Ray.
River Colne	Main River	The Colne is a tributary of the River Thames, which passes through south Hertfordshire for over half of its course. In its lower reaches, it forms the boundary between Buckinghamshire and the London Borough of Hillingdon. The confluence between the Colne and the River Thames is at Staines-upon-Thames.

NOTE: This table is based on information extracted from the Environment Agency's Statutory (Sealed) Main Rivers database. Ordinary Watercourses within the district are not included within this table.

6.3 Fluvial flood risk

The primary fluvial flood risk in Buckinghamshire is along the main river floodplains of the Rivers Colne, Thame, Thames, Ray and Upper Ouse, and their tributaries. Flood risk by catchment is summarised in Section 6.3.1.

The Flood Zone maps for Buckinghamshire are provided in Appendix A, split into Flood Zones 2, 3a and 3b (including an 'indicative 3b' where FZ3a acts as FZ3b in the absence of detailed model data). The flood risk associated with the major locations in Buckinghamshire are detailed in Appendix D.

6.3.1 Main river fluvial flood risk by catchment

River Colne

The flood risk associated with the River Colne at the eastern boundary of Buckinghamshire largely impacts road infrastructure, including the M25, A40, A412 and A4007. The last recorded flood incident within the EA Recorded Flood Outlines is February 2014. The chalk stream tributaries of the River Colne pose a higher risk to settlements in Buckinghamshire, including the Chalfonts and Little Missenden on the River Misbourne, as well as Chesham and Amersham on the River Chess.

River Ray

The rural villages of Ludgershall, Grendon Underwood and Marsh Gibbon are at high risk of flooding (1% AEP event) from the upper reaches of the River Ray. The confluence of the River Ray's tributaries (including Muswell Hill Brook, Ludgershall Brook and Wotton Brook) between Aylesbury and Bicester is a significant source of fluvial flood risk to the A41 road and the surrounding land. The Environment Agency Recorded Flood Outlines dataset indicates that the last significant flood event took place in October 1993.

River Thame

The floodplains of the Wendover Brook and its tributaries in north Aylesbury, and the Bear Brook and its tributaries (California Brook, Stocklake Brook) in central and southern Aylesbury are tightly constrained through the town, as the watercourses are largely culverted throughout the urban area. In the upper catchment (Hulcott, Weedon, Hardwick) and lower catchment (Cuddington, Chearsley), the floodplain of the River Thame and its tributaries is more extensive, although it remains constrained by topography.

River Thames

The floodplain of the River Thames is extensive along the southern boundary of Buckinghamshire. The towns of Remenham, Mendmedham, Bourne End, Marlow, Little Marlow, Cookham and Taplow are all identified as at high risk of flooding from

river flooding, with February 2014 identified as the most recent incident in the Environment Agency Recorded Flood Outlines dataset. The previous L1 SFRA for Marlow[60] identified that the presence of river terrace gravels on the Thames floodplain can result in groundwater flooding of low-lying areas, when in-channel water levels rise.

Upper Great Ouse

Within the Upper Great Ouse catchment, the primary Main River fluvial flood risks exist around Water Stratford, Radclive and Buckingham where the River Great Ouse passes directly through these settlements. The village of Thornton is also at risk of fluvial flooding once the river has converged with the River Twins. The River Twins itself, and its tributaries, Padbury Brook (ordinary watercourse, although a Main River in its lower course) and Claydon Brook (ordinary watercourse), is a principal source of flooding to the settlements of Twyford, Steeple Claydon and Padbury.

River Ouzel

The River Ouzel is a principal tributary of the Great Ouse, rising north of Dagnell in the Chiltern Hills, and flowing northwards along the boundary between Buckinghamshire and Bedfordshire, through Leighton Buzzard and Milton Keynes, before meeting the Great Ouse at Newport Pagnell. Tributaries of the River Ouzel include the Clipstone Brook, Ouzel Brook, Water Eaton Brook and Whistle Brook. Within Leighton Buzzard, the River Ouzel is hydraulically linked to the Grand Union Canal, via a series of structures which allow the canal to overspill into the river.

River Wye

The heavily urbanised Wye catchment flows south eastwards through the centre of High Wycombe Loudwater, and Wooburn before meeting the River Thames at Bourne End. The tributary of the Hughenden Stream meets the River Wye at a culvert in the town centre in High Wycombe**.** The modelling report for the River Wye identifies a complex interaction between the sewer network and the River Wye, particularly in High Wycombe[61]. This interaction is not represented within the fluvial-only mapping of the Flood Zones, and requires further consideration at site scale within Flood Risk Assessments.

6.3.2 Ordinary watercourses

Ordinary watercourses which have flooded in recent years include the Tonne Brook and Cowerde Brook in Thornborough, the River Leck in Leckhampstead, culverted ordinary watercourses through Tingewick and Gawcott, and an ordinary watercourse through Thornton.

60 Wycombe District Council (2014) Strategic Flood Risk Assessment Level 1 update. Available at: Microsoft Word - Wycombe DC Level 1 SFRA Update v03.docx (buckinghamshire-gov-uk.s3.amazonaws.com)

61 JBA Consulting (2018) River Wye - Final Main River Report.

In addition to flood risk shown by the flood risk mapping, there are a number of small watercourses and field drains which may pose a risk to development. Generalised Flood Zone mapping (where more detailed modelling investigations are not available) is only available for watercourses with a catchment greater than 3km^2. Therefore, whilst these smaller watercourses may not be shown as having flood risk on the flood risk mapping, it does not necessarily mean that there is no flood risk. Within the Level 1 SFRA, the Risk of Flooding from Surface Water mapping has been used as an estimate of flood risk from ordinary watercourses. However, as part of a site-specific flood risk assessment, it will be necessary to assess the risk from these smaller watercourses where these may influence the site.

6.4 Surface water flooding

Surface water flood risk in Buckinghamshire largely follows the valleys of the major rivers in the county, with the most extensive flow paths generated in the low-lying River Thame and Ray catchments in the Vale of Aylesbury, as well as in the steep catchments of the Rivers Chess, Misbourne and Wye in the east and south of the county. The Environment Agency RoFSW mapping for Buckinghamshire is provided in Appendix C.

The updated Preliminary Flood Risk Assessment in 2017 for Buckinghamshire identified four main risk areas identified by the Flood Map for Surface Water (the predecessor to the RoFSW). These areas are Aylesbury, High Wycombe, Amersham/Chesham and Marlow. Chesham and High Wycombe have subsequently been designated as nationally significant Flood Risk Areas for surface water flooding.

Surface Water Management Plans were developed for Chesham and High Wycombe and Marlow, to identify actions to manage the risk. A SWMP was also prepared for Buckingham, based on evidence of past surface water flooding in the town, and in light of uncertainty about future flood risk.

Flood incident records provided by Buckinghamshire Council show locations where surface water flooding has been recorded as the primary source of flooding. The affected areas are predominantly located in the south of Buckinghamshire, as well as in the main settlements identified as at surface water flood risk, Aylesbury, Buckingham, Chesham and High Wycombe.

6.5 Groundwater flooding

Due to the presence of chalk aquifers in the Chiltern Hills, groundwater flood risk is high across many areas of Buckinghamshire. Groundwater flooding in winter months has seriously affected settlements across Buckinghamshire, including Amersham, Chesham, the Chalfonts and Monks Risborough. Groundwater flooding has also been experienced in Marlow, where the floodplain of the River Thames is underlain by

layers of gravel deposits[62]. Rising water levels in the river lead to elevated water levels in the adjacent gravel layers, which can cause flooding to low-lying surrounding areas.

A series of detailed modelling studies have been carried out in at settlements at greatest risk of groundwater flooding (Princes Risborough), to allow the flood depths and extents of groundwater flood risk to be mapped for different probabilities. The outputs are included in Appendix C. Further mapping of groundwater flood risk is planned for nine high risk areas of the Chiltern and Berkshire Downs within Project Groundwater[63], one of 25 Defra-funded Flood and Coastal Resilience Innovation programme (FCRIP) projects. This project aims to raise awareness of groundwater flooding, in addition to improving monitoring of where groundwater emerges.

Where detailed groundwater modelling is not available, the JBA 5m Groundwater Flood Map (see Figure 6-8 and Appendix C) shows the areas in Buckinghamshire that are at risk of groundwater emergence and so are potentially susceptible to flooding. The map indicates that the majority of the risk of groundwater flooding is concentrated in bands in the south (Thames valley), centre (Aylesbury Vale) and north (River Great Ouse valley) of the county, where White Chalk Sub Group or superficial gravel deposits are present. The areas of Buckinghamshire where groundwater levels are either at or very near (within 0.025m of) the ground surface, are mostly located in narrow zones along the base of river valleys, including the Rivers Chess, Misbourne and Wye. In contrast, outside the river valleys, mapping indicates that there is a lower groundwater flood risk.

62 PFRA_Buckinghamshire_County_Council_2017.pdf (publishing.service.gov.uk)

63 Project Groundwater (2023). Available at: Project Groundwater

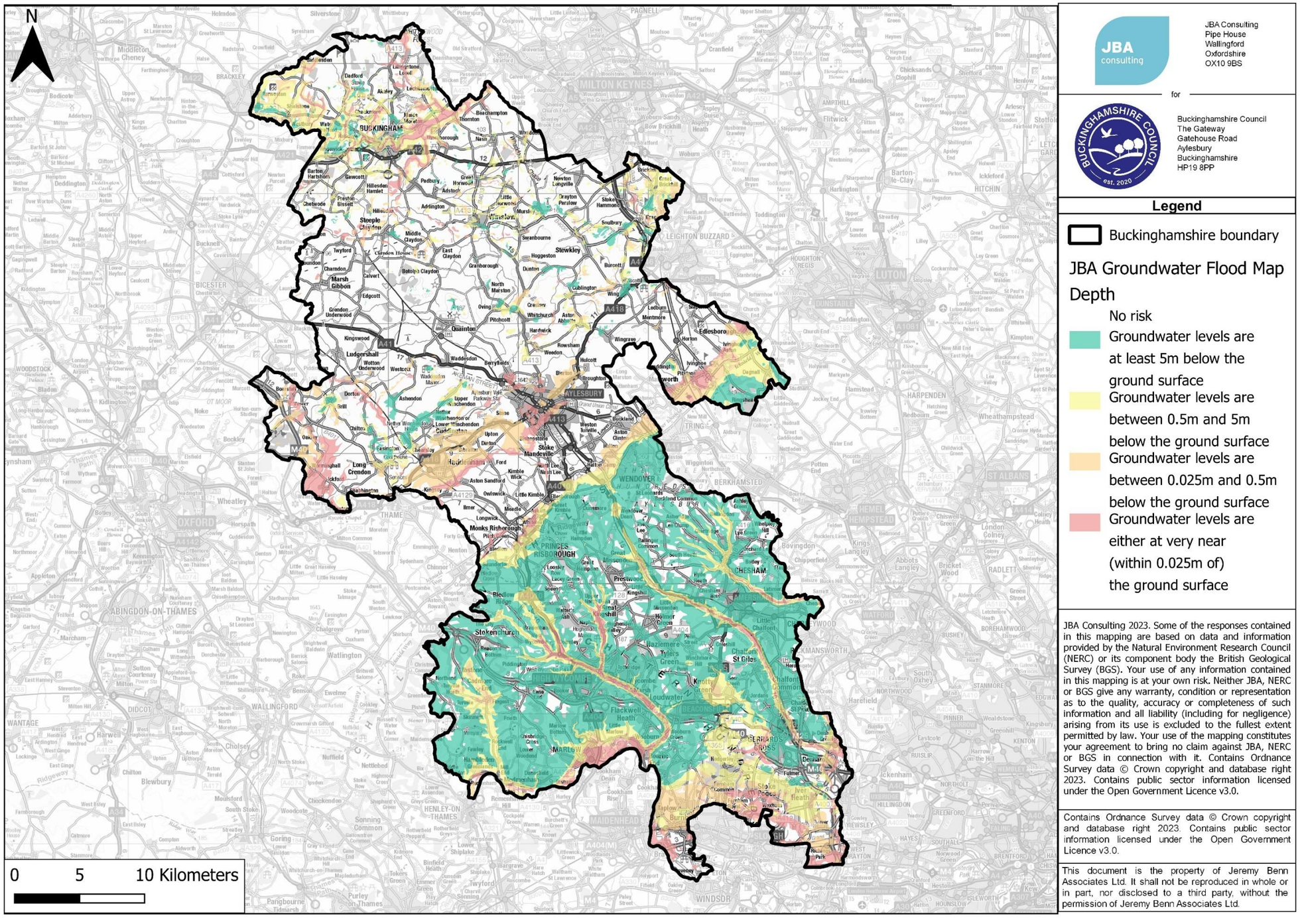


Figure 6-8: Groundwater Flood Map

6.6 Sewer flooding

Buckinghamshire is served by two sewerage undertakers, Anglian Water in the north of the county, and Thames Water in the south (as shown in Figure 6-11). Both companies maintain records of incidents of flooding relating to public foul, combined or surface water sewers and identifies which properties suffered flooding. For confidentiality reasons, this data has been supplied on a postcode basis from the Sewer Incident Report Form (SIRF) hydraulic overload database.

Appendix B shows the number of sewer flooding incidents recorded within each postcode area, with an annual summary provided in Table 6-9 and Figure 6-11. Postcode areas served by Thames Water with the highest number of recorded sewer flooding incidents include:

- HP13 - High Wycombe, Downley, Totteridge
- HP15 - Cryers Hill, Great Kingshill, Hazlemere, Holmer Green, Hughenden Valley
- HP19 - North west Aylesbury
- SL2 - Farnham Common, Farnham Royal, Stoke Poges, Egypt, Hedgerley

Postcode areas served by Anglian Water with the highest number of recorded sewer flooding incidents include:

- MK17 - Woburn Sands, Newton Longville,
- MK18 - Winslow, Steeple Claydon, Padbury (Milton Keynes)

Table 6-9 Hydraulic flood incidents within Buckinghamshire from Thames Water (by year)

Year	Internal property flooding	External property flooding	Other flooding (e.g. highway, agricultural, open space)	Total Number of Incidents
2023	7	14	4	**25**
2022	28	113	47	**188**
2021	108	459	171	**738**
2020	108	528	158	**794**
2019	50	316	138	**504**

Table 6-10 Hydraulic flood incidents within Buckinghamshire from Anglian Water (by year)

Year	Internal flooding	External flooding	Other flooding (e.g. highway, agricultural, open space)	Total Number of Incidents
2023	2	31	10	**43**
2022	3	44	16	**63**
2021	3	39	5	**47**
2020	5	38	9	**52**
2019	1	38	8	**47**

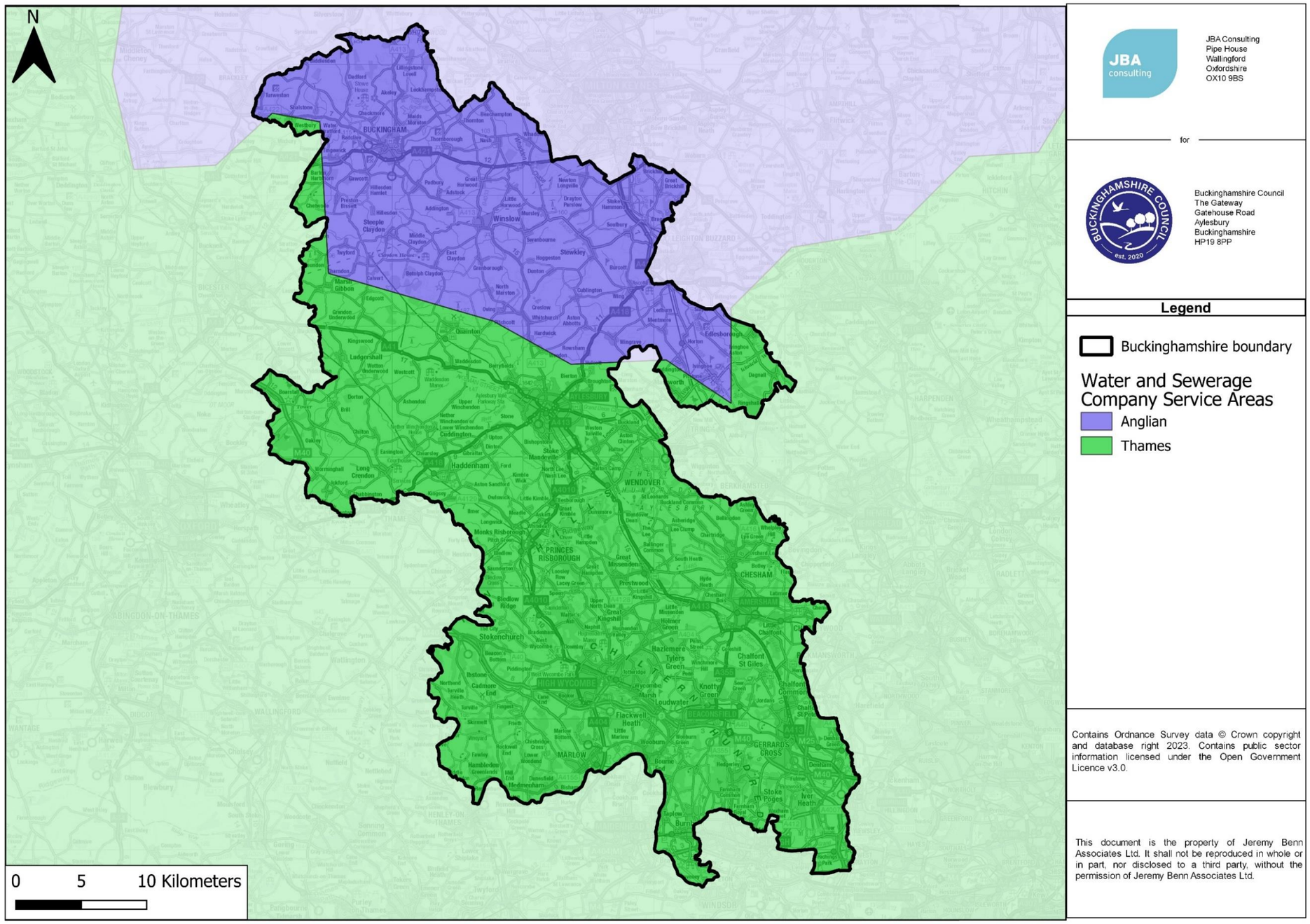


Figure 6-11: Coverage of Water and Sewerage Company Service Areas in Buckinghamshire (excludes water supply-only companies)

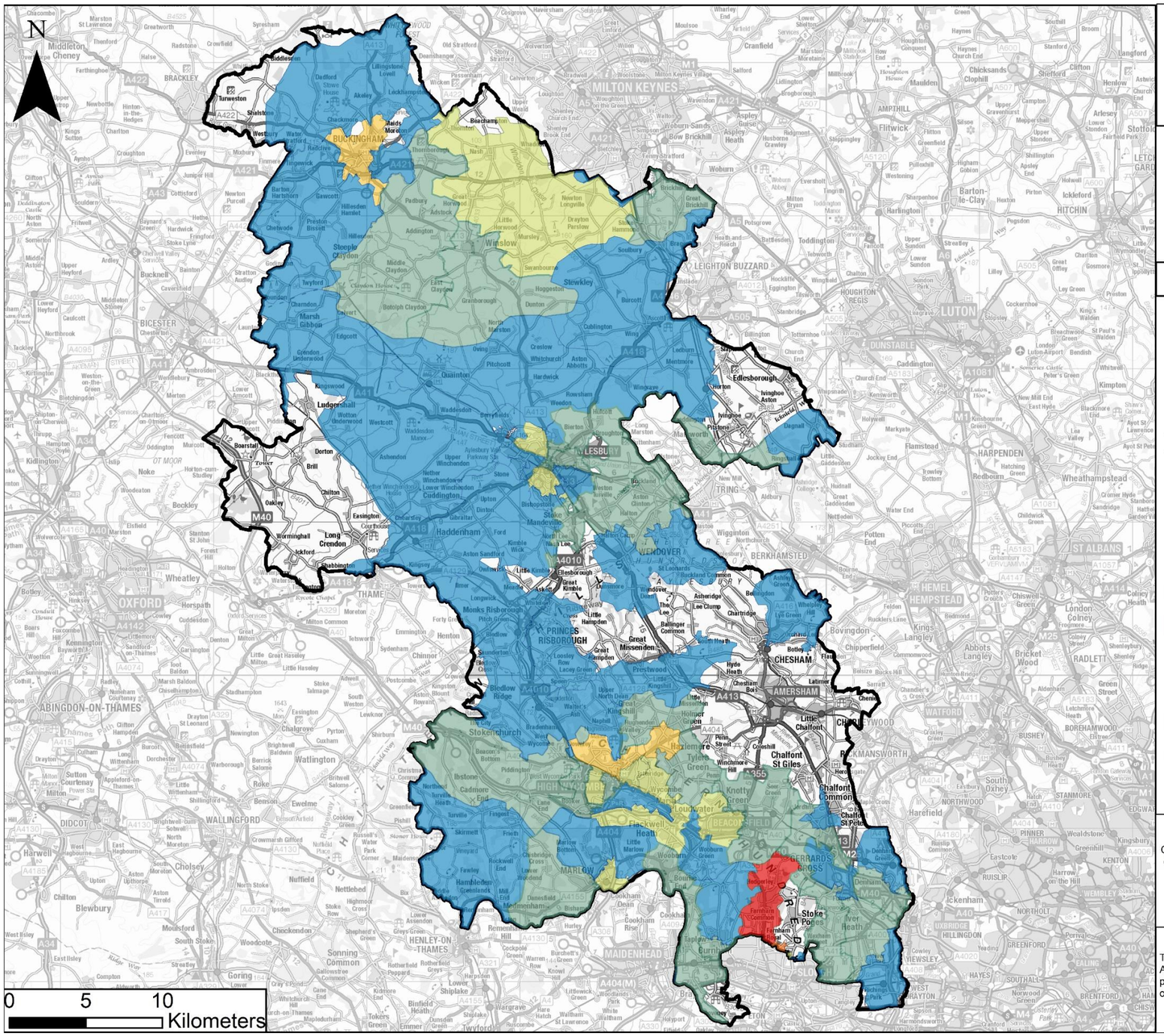


Figure 6-12 Total number of property sewer flooding incidents (internal and external) within Buckinghamshire by postcode area (as recorded by Thames Water and Anglian Water)

Groundwater infiltration into the sewerage system is a key issue in Buckinghamshire. When groundwater levels are high, typically during winter months, water can enter the system through joints and defects in pipes and manholes. This restricts the capacity of the system, which can result in the uncontrolled escape of untreated or partially treated sewage. This can cause flooding, pollution and issues at the receiving Wastewater Treatment Works (WwTW). Thames Water has developed a series of Groundwater Impacted System Management Plans[64] in areas affected by groundwater infiltration, which set out short, medium and long term plans to reduce infiltration. These are currently updated on an annual basis. Within Buckinghamshire, plans have been prepared for Chesham, Hambleden, Little Marlow, Marsh Gibbon and Princes Risborough.

6.7 Flooding from canals

The Grand Union Canal flows through eastern Buckinghamshire, with the Aylesbury Arm branching off at Marsworth and heading westwards to Aylesbury[65]. The Aylesbury Arm is mainly raised above the surrounding ground level, without a natural catchment[66]. The canal ends at Aylesbury town centre, near Walton Street, and contributes flow to the California Brook, through an overflow weir. The canal overflows into the California Brook are represented within the Upper Thame and Bear Brook hydraulic model, which is used to inform the fluvial Flood Map for Planning.

A second arm on the Grand Union Canal, the Wendover Arm, originally linked the town of Wendover to Bulbourne, for water supply to the canal. After becoming unnavigable in 1897, the canal is currently being reconstructed by the Wendover Arm Trust, with Phase 1 completed in 2005[67]. The former Buckingham Arm, which connects Buckingham to Cosgrove, is also currently in the process of restoration. Work is complete at Bourton Meadow (near Buckingham) and continues at Cosgrove, Hyde Lane (near Thornborough) and Little Hill Farm (near Thornton).

Archive data provided by the Canal and River Trust on historic overtopping and breach events is identified in Table 6-13.

64 Thames Water (2023) Groundwater Impacted System Management Plans. Available at: Drainage Plans | Regulation | About us | Thames Water

65 Canal and River Trust (2023) Aylesbury Arm (Grand Union Canal). Available at: Aylesbury Arm (Grand Union Canal) | Canal map, history and information | Canal & River Trust (canalrivertrust.org.uk)

66 Aylesbury Vale District Council (2012) Level 1 Strategic Flood Risk Assessment. Available at: Template : Report (aylesburyvaledc.gov.uk)

67 Canal and River Trust (2023) Wendover Arm (Grand Union Canal). Available at: Wendover Arm (Grand Union Canal) | canal walks | Canal & River Trust (canalrivertrust.org.uk)

Table 6-13: Summary of Canal and River Trust archive data of historic canal overtopping and breach events

Location	Event	Number of events	Description of events
Grand Union Canal - Aylesbury Arm	Overtopping	9	Heavy rainfall, high water levels, a blocked lock bypass, boater misuse 21/03/2008 - Heavy rain, and overwhelmed lock bypass. Repairs carried out. 02/07/2011- Flooding to property caused by boater misuse. 10/01/2014 - Heavy rain on saturated ground brought resulted in high flows into the Aylesbury Arm. Ditch overspill reported to be prevented from being released due to a raised bund on nearby land. Works undertaken to clear ditch on towpath, to allow it to discharge. Nearby lock since fitted with bypass. 09/03/2016 - Heavy rain resulted in overtopping, flooding towpath. Other events - dates unknown.
Grand Union Canal - Aylesbury Arm	Breach	1	28/03/2013 - Lock wall collapse.
Grand Union Canal - Wendover Arm	Overtopping	6	Dates unknown - causes of flooding reported to be heavy rainfall, reed growth in the channel.
Grand Union Canal - Grove, south of Leighton Buzzard	Overtopping	2	21/07/2007 - Water levels in the River Ouzel reached level with the canal. 28/02/2010 - River Ouzel overtopped towpath bank and flowed into canal.
Grand Union Canal - Chelmscote, north west of Leighton Buzzard	Breach	1	2000 - Embankment failure/slip adjacent to the River Ouzel.

Location	Event	Number of events	Description of events
Grand Union Canal - near Farlows Lakes, Iver	Overtopping	4	Dates unknown - overtopping of the canal following rainfall.
Grand Union Canal - Bloom Park, on boundary with Slough	Overtopping	1	Date unknown - Overtopping of canal into Bloom Park.

Historical records indicate that the Grand Union Canal has flooded in the past, for example, the Aylesbury Arm has been subject to overtopping and seepage, particularly between College Road and Broughton Road, and Broughton Lane and Oakfield Road[68]. Flooding has also been observed in Aston Clinton from both the Aylesbury and Wendover Arms of the GUC. The BC building at Green Park, Aston Clinton is noted to have experienced groundwater flooding in February 2001, however the water was thought to originate from the Aylesbury Arm[64]. Similarly, heavy rainfall in 2002 also caused seepage and flooding to the lower section of the Wendover Arm[64].

In addition to the incidents recorded within Buckinghamshire, there is a risk of flooding from the Grand Union Canal at Leighton Buzzard, close to the eastern Buckinghamshire boundary. The Grand Union Canal and River Ouzel appear to connect at various junctions, and high flows have previously contributed to overtopping of the canal. In Winter 2020/2021 widespread flooding occurred in the River Ouzel catchment from the Grand Union Canal, River Ouzel and Clipstone Brook. Further details of canal flooding incidents in Leighton Buzzard are included within the Central Bedfordshire Level 1 SFRA[69]:

The interactions between the Grand Union Canal and adjacent watercourses may not be represented in full within the Flood Map for Planning. Therefore, the risk of canal breach or overtopping should be assessed in detail within site-specific Flood Risk Assessments. Further details for requirements of assessing canal flood risk within a Flood Risk Assessment are provided in Section 0.

To address a future shortfall in water resources, Affinity Water (in collaboration with multiple stakeholders, including the Canal and River Trust) is currently investigating

68 Aylesbury Vale District Council (2012) Level 1 Strategic Flood Risk Assessment.

69 Central Bedfordshire Council (2017) Central Bedfordshire Council Level 1 Strategic Flood Risk Assessment. Available at: Microsoft Word - Cover Report Template (oc2.uk)

plans to transfer water from the Midlands to the South via the Grand Union Canal network. This will require raising of the canal banks, new pipelines and pumps, as well as a new water recycling plant at Minworth to treat water. The project is also expected to provide flood alleviation, as well as biodiversity and public access enhancements. The project is currently at the investigation and planning stages, with construction due to start in 2026 - 2027, and completion by late 2032.

6.8 Flooding from reservoirs

The Environment Agency provide two flooding scenarios for the reservoir flood maps: a ‘dry-day’ and a ‘wet-day’. The ‘dry-day’ scenario shows the predicted flooding which would occur if the dam or reservoir fails when rivers are at normal levels. The ‘wet-day’ scenario shows the predicted worsening of the flooding which would be expected if a river is already experiencing an extreme natural flood.

The current mapping shows that there are 19 reservoirs located within Buckinghamshire, and 13 located outside the county, that affect Buckinghamshire within the 'dry-day' scenario (shown in Table 6-15). A further nine reservoirs located outside of the county affect Buckinghamshire during the 'wet-day' scenario. The reservoirs inundation extents provided by the Environment Agency can be found on the Environment Agency’s Long term flood risk map for England. Developers and planners should check the online mapping before using the reservoir data shown in this SFRA to make sure they are using the most up to date mapping.

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

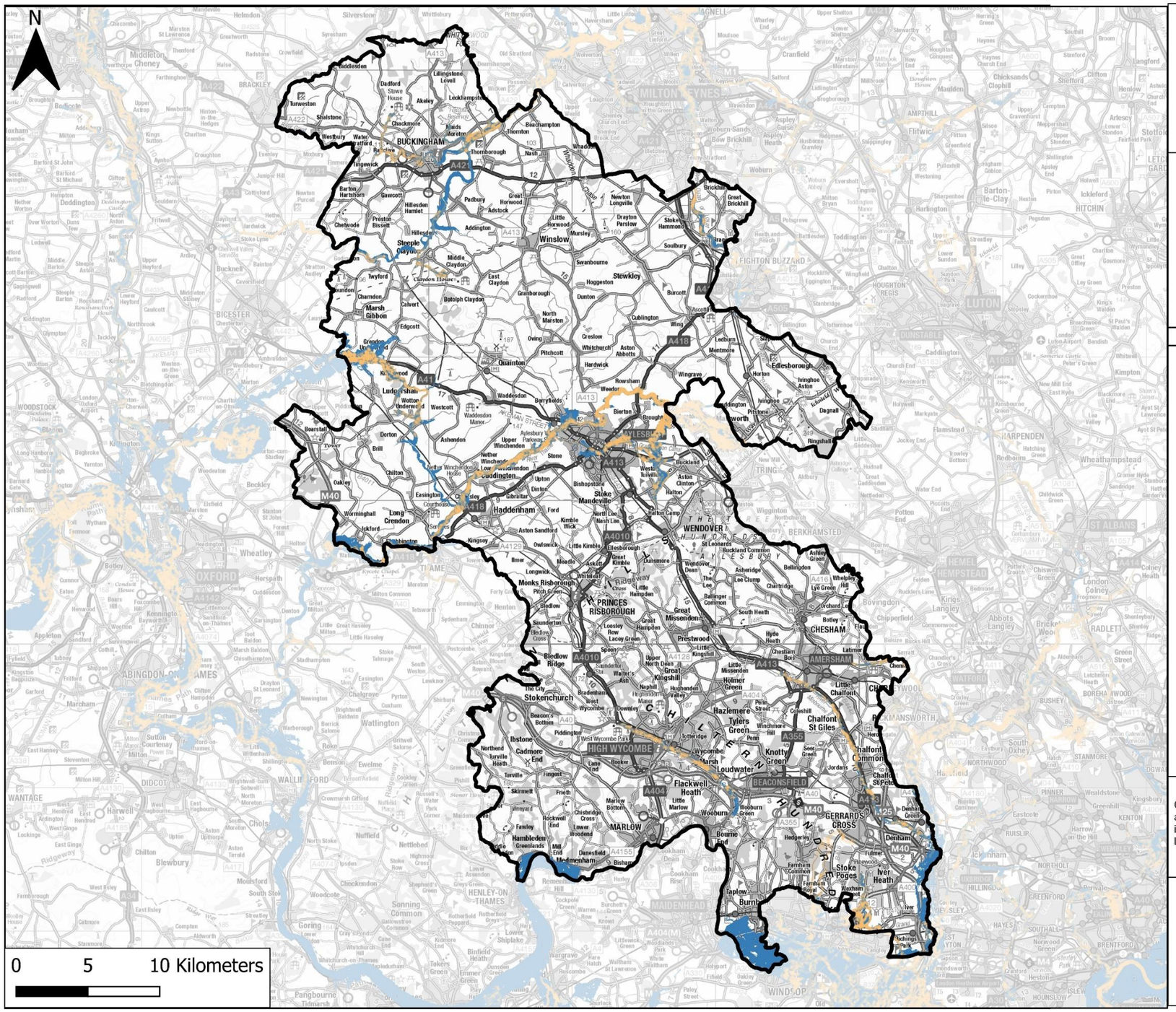


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Figure 6-14: Reservoir flood extents in Buckinghamshire showing 'wet-day' and 'dry-day' scenarios

Table 6-15: Reservoirs within Buckinghamshire with a risk of impacting flood risk in Buckinghamshire in the event of a breach

Reservoir	Location (grid reference)	Reservoir owner[70]	Environment Agency area	Local authority
Stowe Landscape	Stowe Landscape	Stowe Landscape	Stowe Landscape	Buckinghamshire Council
Stowe Park Eleven Acre	SP 67300 36800	National Trust	Lincolnshire and Northamptonshire	Buckinghamshire Council
Claydon Park Lower Lake	SP 71706 25433	Claydon Estate LLP	Thames	Buckinghamshire Council
The Warrells	SP 67847 16780	Private owner	Thames	Buckinghamshire Council
Wotton Park Lake	SP 67900 16800	Private owner	Thames	Buckinghamshire Council
Foscott Reservoir	SP72500 35200	Anglian Water Services	Lincolnshire and Northamptonshire	Buckinghamshire Council
Foxcote Reservoir	SP 71200 36400	Anglian Water Services	Thames	Buckinghamshire Council
West Wycombe Lake	SU 83142 94469	National Trust	Thames	Buckinghamshire Council
Eythrope Park Lake	SP 77040 14168	The Waddesdon Estate	Thames	Buckinghamshire Council
Shardeloes	SU 94230 98022	Private owner	Thames	Buckinghamshire Council
Latimer Lakes (Great Water)	SU 99720 98712	Restore Hope	Hertfordshire and North London	Buckinghamshire Council
Bear Brook Flood Storage Reservoir	SP 83833 14100	Environment Agency		Buckinghamshire Council
Weston Turville Reservoir	SP 86228 09650	Canal and Rivers Trust	Thames	Buckinghamshire Council
Black Park Lake	TQ 00720 83131	Buckinghamshire Council	Hertfordshire and North London	Buckinghamshire Council
Biddlesden Upper Park Lake	SP 63118 39875	Private owner	Lincolnshire and Northamptonshire	Buckinghamshire Council
Fulmer Wood Lake	TQ 00100 8000	Private Owner	Hertfordshire and North London	Buckinghamshire Council
Stoke Park Lower Lake	SU 97000 82300	Slough Borough Council	Hertfordshire and North London	Buckinghamshire Council
Stoke Park Upper Lake	SU 97396 82763	Stoke Park Ltd	Hertfordshire and North London	Buckinghamshire Council
Stocklake Flood Storage	SP 83565 14699	Environment Agency	Thames	Buckinghamshire Council

70 Data from Defra data services Check your long term flood risk https://check-long-term-flood-risk.service.gov.uk/postcode

Table 6-16: Reservoirs outside Buckinghamshire with a risk of impacting flood risk in Buckinghamshire in the event of a breach

Reservoir	Location (grid reference)	Reservoir owner[71]	Environment Agency area	Local authority
Lark Hill Reservoir	SP 55678 29952	Tusmore Park Farms Ltd	Thames	Oxfordshire County Council
Queen Mother Reservoir	TQ00900 76800	Thames Water Ltd	Hertfordshire and North London	Royal Borough of Windsor and Maidenhead
Marsworth Reservoir	SP 92156 13752	Canal and Rivers Trust	Thames	Hertfordshire County Council
Startopsend Reservoir	SP 91869 13757	Canal and Rivers Trust	Thames	Hertfordshire County Council
Tringford Reservoir	SP 91869 13322	Canal and Rivers Trust	Thames	Hertfordshire County Council
Rusislip Lido	TQ 08617 89057	Hillingdon Council	Hertfordshire and North London	Hillingdon Council
Wilstone	SP 90600 13100	Canal and Rivers Trust	Thames	Hertfordshire County Council
Fish Pond (Battlesden Park Lake)	SP 95728 28685	Bedford Estates Nominees Ltd	Thames	Central Bedfordshire Council
Haymill Balancing Pond	SU 9425 781467	Environment Agency	Hertfordshire and North London	Slough Borough Council
Hilfield Park Reservoir	TQ 15221 96074	Affinity Water Ltd	Hertfordshire and North London	Hertfordshire County Council
Rycote Lake	SP 66986 04883	Private owner	Thames	South Oxfordshire District Council
Thame Park Lake	SP 71700 03600	Thame Park Estate	Thames	Oxfordshire County Council
Wraysbury Reservoir	TQ02500 74500	Thames Water Ltd	Hertfordshire and North London	Surrey County Council
Farmoor Reservoir No. 1	SP 44458 06154	Thames Water Ltd	Thames	Oxfordshire County Council
Farmoor Reservoir No. 2	SP 44500 06000	Thames Water Ltd	Thames	Oxfordshire County Council
Bourne Ditch	SU 95900 75355	Environment Agency	Hertfordshire and North London	Windsor and Maidenhead
George V Flood Storage Area	TQ 12800 90400	Environment Agency	Hertfordshire and North London	Harrow Council
King George VI	TQ 04100 73200	Thames Water Ltd	Hertfordshire and North London	Surrey Borough Council
Hartsbourne Flood Storage Area	TQ 13000 93200	Environment Agency	Hertfordshire and North London	Hertfordshire County Council
Otmoor Phase 1	SP 56100 13900	RSPB	Thames	Oxfordshire County Council

71 Data from Defra data services Check your long term flood risk https://check-long-term-flood-risk.service.gov.uk/postcode

Reservoir	Location (grid reference)	Reservoir owner[71]	Environment Agency area	Local authority
Otmoor Phase 2	SP 56100 13600	RSPB	Thames	Oxfordshire County Council
Tusmore Park Lake	SP 56300 30600	Tusmore Park Farms Ltd	Thames	Oxfordshire County Council

6.9 Summary of flood risk in Buckinghamshire

A table summarising all sources of flood risk to key settlements in Buckinghamshire can be found in Appendix D.

7 Flood alleviation schemes and assets

7.1 Introduction

A high-level review of flood defences was carried out for this SFRA, involving an interrogation of existing information on asset condition and standard of protection. An assessment of the Environment Agency Spatial Flood Defence dataset has been carried out, with all defences within the dataset considered. The dataset includes manmade and natural defences which may arise for instance due to the presence of naturally high ground adjacent to a settlement have been considered. The defences and their locations are summarised in the following sections.

Developers should collect the available asset information and undertake further survey as necessary to present an understanding of current flood risk and the existing drainage network in a site-specific Flood Risk Assessment.

7.2 Defence standard of protection and residual risk

One of the principal aims of this SFRA is to outline the present risk of flooding across the Buckinghamshire Local Plan area including consideration of the effect of flood risk management measures (including flood banks and defences).

The modelling that informs the understanding of flood risk within the Local Plan area is typically of a catchment wide nature, suitable for preparing evidence on possible site options for development. In cases where a specific site risk assessment is required, detailed studies should seek to refine the results used to provide a strategic understanding of flood risk from all sources. Developers should consider the standard of protection provided by defences when preparing detailed Flood Risk Assessments.

7.2.1 Standard of Protection

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

Although flood defences are designed to a standard of protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to the increased magnitude of the flood hazard caused by climate change effects (e.g. rise in frequency and intensity of extreme weather over time).

For the purpose of this study, the standard of protection has been derived from the Environment Agency Spatial Flood Defence Dataset.

7.3 Defence condition

Formal structural defences are given a rating by the Environment Agency based on a grading system for their condition[72]. A summary of the grading system used by the Environment Agency for condition is provided in Table 7-1.

Table 7-1 Grading system used by the Environment Agency to assess flood defence condition

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

7.4 Maintenance

The Environment Agency and local authorities have permissive powers to maintain and improve Main Rivers and Ordinary Watercourses, respectively. There is no legal duty to maintain watercourses, defences or assets and maintenance and improvements are prioritised based on flood risk. The ultimate responsibility for maintaining watercourses rests with the landowner.

There is potential for the risk of flooding to increase in areas where flood alleviation measures are not maintained regularly. Breaches in raised flood defences are most likely to occur where the condition of a flood defence has degraded over time. Drainage networks in urban areas can also frequently become blocked with debris and this can lead to blockages at culverts or bridges.

Developers should not assume that any defence, asset or watercourse is being or will continue to be maintained throughout the lifetime of a development. They should contact the relevant RMA about current and likely future maintenance arrangements and ensure future users of the development are aware of their obligations to maintain watercourses.

7.5 Major flood risk management assets in Buckinghamshire

The Environment Agency defines 'Reduction in Risk of Flooding from Rivers and Sea due to Defences' mapping (which supersedes the ‘Areas Benefiting from Defences’ dataset). This shows areas that benefit from the defences that provide a SoP of at

72 Condition Assessment Manual, Environment Agency (2012)

least a 1 in 100-year river flood event. It does not show areas that benefit from protection for more frequent events.

There are a number of formal flood defences within Buckinghamshire, which provide varying levels of protection. The condition and design standards of these defences are displayed in Appendix C, with further details provided in Table 7-3.

Elsewhere, naturally higher ground provides more informal flood defences, such as raised channel banks and railway embankments. These have been removed from the overview of defences in Appendix C, as they are not designated flood defence assets.

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

7.5.1 Aylesbury

Within the town, a series of raised flood embankments at Coldharbour Way, Aylesbury Railway Station and Station Way, and Hilda Wharf are designed to provide a low standard of protection (1 in 5-year event) to fluvial flooding from the Bear Brook. In the west, a flood wall is constructed on the western bank of Southcourt Brook is designed to provide a 1 in 25-year standard of protection to the adjacent residential areas.

Upstream of the town, clay embankments on the Bear Brook (and its tributary, Bedgrove Brook) and Stocklake Brook form two Flood Storage Areas (FSA), which are part of the Aylesbury Vale Flood Alleviation Scheme (AVFAS). Constructed in the mid-1990s to facilitate development in Aylesbury, the FSAs are maintained by the Environment Agency and have a 1 in 100-year standard of protection. As noted in the previous Level 1 SFRAs for Aylesbury Vale, the standard of protection provided by the AVFAS is reliant on the management of surface water runoff rates and volumes in new developments, to prevent loss of the designed flood storage and channel capacity. Works are also likely to be required to ensure the defences keep pace with the impact of climate change on increasing river flows.

The current condition scores for flood defence assets In Aylesbury is not available in the EA Spatial Defences dataset.

7.5.2 Buckingham

The Marsh Edge flood embankment, located on the left bank of the River Great Ouse, is the only formal flood defence in Buckingham. Constructed as part of the Linden Village housing development, it is privately owned and maintained (, and runs from Wittmills Oak to Akister Close, providing a 1 in 50-year standard of protection. The current condition score for the asset (evaluated by the Environment Agency) is not available in the EA Spatial Defences dataset.

A wider flood alleviation scheme in Buckingham, including an upstream storage area and raised defences, was considered by the Environment Agency between 2005 - 2008. However, the scheme was found not to be viable for funding[73].

7.5.3 Chesham

Two formal raised flood defences are identified in Chesham, which comprise of engineered high ground on the left and right banks of the River Chess at Water Lane and Germain Street. Downstream, a flood wall and embankment are constructed on the River Chess alongside Waterside road provide a 1 in 5-year standard of protection to the Waterside and Chessmount residential areas. The current condition score for the asset is not available in the EA Spatial Defences dataset.

Following significant flooding to Chesham in 2001, 2006, 2008 and 2014, works are proposed to replace a 40m section of the culverted Vale Brook which was in risk of immediate collapse. Culverted through much of its length, the Vale Brook responds rapidly to rainfall, yet the culverted sections fall under riparian ownership and significant sections remain in 'poor condition'[74]. An Environment Agency report for Chesham identified that 100m of temporary flood defences are also deployed on Broad Street when required[75].

7.5.4 Marlow

Southern areas of Marlow also benefit from defence from the River Thames, via the Marlow Flood Alleviation Scheme. Constructed in 2018, the scheme was designed to manage the risk of flooding to 287 properties in a 1 in 75-year event from fluvial

73 Buckinghamshire Council (2022) Buckingham S19 Flood Investigation. Available at: JBA Consulting Report Template 2015 (buckinghamshire-gov-uk.s3.amazonaws.com)

74 Environment Agency (2017) Chesham Vale Brook Flood Alleviation Scheme. Consultation response document. Available at: Document template: green report (environment-agency.gov.uk)

75 Environment Agency (2016) Chesham Flood Resilience Update. January 2016.

flooding, as well as indirect flooding from groundwater emergence through river gravels and surcharged surface water drainage systems[76].

It includes a series of flood embankments (on Mill Road, Pound Lane, Goossmore Park and Pergola Field, flood walls with flood gates (Mill Road, Millbank, Pound Lane), raised flood kerbs (Mill Road) and a demountable defence (Millbank), as well as floodplain compensation storage at Lower Pound Lane. EA data indicates that the assets are currently in Fair (3) or Good (2) condition.

7.5.5 Jubilee River - Taplow and southern Buckinghamshire boundary

The Jubilee River is an engineered watercourse forming part of the Maidenhead, Windsor and Eaton Flood Alleviation Scheme, which runs parallel to the River Thames, diverting water from upstream of Maidenhead and reducing river levels in the Thames at Maidenhead, Eton and Cookham[77].

A series of raised flood embankments and walls line the banks of the Jubilee River, providing defence benefits to Taplow, and settlements at the southern boundary of Buckinghamshire, including Dorney Reach. The flood embankments provide a 1 in 100-year standard of protection, and are maintained by the Environment Agency, with an asset condition ranging from Poor (4) to Good (2). The flood walls provide a 1 in 25-year standard of protection, with some managed by the Environment Agency and others by private individuals or organisations. Asset condition ratings exist for the walls managed by the Environment Agency and are Fair (3) to Good (2).

7.5.6 New Denham

The area of Willowbank in New Denham lies between the western and eastern channels of the River Colne. As part of a 2003 flood alleviation scheme, a series of five embankments were constructed to provide a 1 in 100-year standard of protection for properties in this location. EA asset data shows the embankments to be in Fair (3) condition, with the exception of Bund 2 which was scored as Very Poor (5) when last inspected in October 2022, suggesting severe defects which could result performance failure.

76 Environment Agency (2017) Marlow Flood Alleviation Scheme. Available at: Marlow flood alleviation scheme - GOV.UK (www.gov.uk)

77 Environment Agency (2021) Jubilee River Flood Alleviation Scheme. Available at: Jubilee River flood alleviation scheme - GOV.UK (www.gov.uk)

7.5.7 Buckingham and River Ouzel IDB

Strategic assets within the Buckingham and River Ouzel IDB in Buckinghamshire are shown in Table 7-2 and shown in Figure 2-1. The three IDB assets located within Buckinghamshire are weirs and sluices with a water level management function, located on the Padbury Brook, a tributary of the River Great Ouse. Two of the assets are owned by private mill owners, and ownership of the third asset is under dispute. A total of 11 culverts are also recorded on ordinary watercourses within the IDB, the majority of which are identified as being under riparian ownership. Recent condition scores for the assets were not present in the available datasets, although there were details of works being required to the Padbury Brook weirs and sluices in 2006.

Table 7-2 Internal Drainage Board Strategic Assets

Asset Name	Function	Owner
Padbury Mill	Water level management	Mill owner
Padbury Mill Weir	Water level management	Under dispute
Three Bridge Mill weir and sluices	Water level management	Mill owner

Table 7-3 Flood defences in Buckinghamshire

Defence	Location	Authority Area	Standard of Protection (years)	Current condition
Stop Log Defence	Marlow FAS Millbank 17 Marlow Mill	Buckinghamshire	Not specified	2
Flood Gate	Marlow FAS Millbank	Buckinghamshire	Not specified	2
Embankment Bund	Marlow FAS Mill Road	Buckinghamshire	Not specified	2
Embankment Bund	Marlow FAS Gossmore Park - north-east and west boundary	Buckinghamshire	Not specified	Not specified
Embankment	Marlow FAS Pergola Field - Embankment 1 and 2	Buckinghamshire	Not specified	Not specified
Flood Wall	Marlow FAS Pergola Field	Buckinghamshire	Not specified	2
Flood Wall	Marlow FAS Mill Road	Buckinghamshire	Not specified	2
Raised Flood Kerb	Marlow FAS Mill Road	Buckinghamshire	Not specified	2
Flood Wall	Marlow FAS Millbank - East boundary	Buckinghamshire	Not specified	2
Flood Wall	Marlow FAS Pound Lane	Buckinghamshire	Not specified	2
Embankment	Marlow FAS Pound Lane	Buckinghamshire	Not specified	3
Spillway	Bigley Ditch, near to West Drayton, South East Buckinghamshire	Buckinghamshire	Not specified	5
Flood Storage Reservoir Spillway	Bear Brook, Aylesbury	Buckinghamshire	Not specified	Not specified
Flood Storage Reservoir Overspill	Stocklake Flood Storage Reservoir, Aylesbury	Buckinghamshire	Not specified	Not specified
Embankment	R/B of Jubilee River downstream of Mill Lane Bridge, Taplow, South West Buckinghamshire	Buckinghamshire	1 in 100	4
Embankment Bund	Willowbank Bunds 1, 2, 3, 4 and 5, New Denham, East Buckinghamshire	Buckinghamshire	1 in 100	Not specified, 3,5,3, 3
Embankment	Bear Brook, Aylesbury	Buckinghamshire	1 in 2	Not specified
Embankment	Bear Brook, Aylesbury	Buckinghamshire	1 in 5	Not specified
Embankment	Bear Brook, South and south west side, Aylesbury	Buckinghamshire	1 in 100	Not specified
Embankment bund	Stocklake Brook, Aylesbury	Buckinghamshire	1 in 100	Not specified
Bund	Stocklake Brook - north, Aylesbury	Buckinghamshire	1 in 100	Not specified
Embankment	Thorney Weir, Coinbrook (South wall), near to West Drayton, South East Buckinghamshire	Buckinghamshire	Not specified	3

7.6 Existing and future flood alleviation schemes

7.6.1 Natural flood management (NFM)

NFM is used to protect, restore and re-naturalise the function of catchments and rivers to reduce flood risk. A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes in order to store or slow down flood waters before they can damage flood risk receptors (e.g. people, property, infrastructure, etc.). Techniques and measures which could be applied in Buckinghamshire include:

- Creation of offline storage areas
- Re-meandering streams (creation of new meandering courses or reconnecting cut-off meanders to slow the flow of the river)
- Targeted woodland planting
- Reconnection and restoration of functional floodplains
- Restoration of rivers and removal of redundant structures i.e. weirs and sluices no longer used or needed
- Installation or retainment of large woody material in river channels known as leaky dams
- Improvements in management of soil and land use
- Creation of rural and urban SuDS

NFM projects have been successfully implemented in Buckinghamshire, particularly in the Upper Great Ouse catchment. These include:

- River Leck, north of Buckingham - 25 leaky dams were built in the headwaters of the Leck in 2019 as part of a pilot project between Buckinghamshire Council and Freshwater Habitats Trust to help build evidence of the effectiveness of such measures. Further NFM features such as storage bunds and small scrapes have since been implemented. The measures were designed to hold back water and slow the flow during heavy rain, to help reduce the risk of flooding in downstream communities, such as Leckhampstead.
- North Bucks Freshwater Resilience Project) - starting in 2020, the overarching aim of the project is to help to reduce surface water flood risk and provide habitat enhancements across multiple North Buckinghamshire river catchments, close to the East West Railway line. Baseline flood modelling, monitoring of the freshwater environment and landowner engagement was undertaken in 2021 to identify the best locations for works to be implemented. The Freshwater Habitats Trust and LLFA, Ecology and Archaeology teams at Buckinghamshire Council worked together to create innovative designs for a range of NFM measures and

habitat enhancements. Local landowners and subcontractors will construct leaky dams, debris dams, flood storage areas, clear and create ponds and reintroduce species in 2023, and the effectiveness of the measures will be monitored until 2025.

- Upper Great Ouse Natural Flood Management - Project was funded through Section 106 (S106) planning obligations (see Section 9.4.2), to investigate the feasibility of NFM options to mitigate flood severity in the upper catchment of the River Great Ouse to Buckingham town. The funding was obtained as a contribution from a housing development in Aylesbury Vale in 2019 under the Aylesbury Vale District Council. The catchment has a long history of flooding, stretching from 1823 to the most recent June 2023[78], with flooding from rivers and catchment runoff as the main contributors to fleshy flooding. The project is being delivered in partnership between Buckinghamshire Council and the River Thame Conservation Trust (RTCT).

7.6.2 Other Schemes

The EA's Asset Management map provides an updated indication of schemes that are under construction or have a forecast start date. There are currently no schemes in Buckinghamshire under construction or in the pipeline.

Based on information published by Thames Regional Flood and Coastal Committee[79] and provided by the LLFA, there are five allocated schemes for 2023/2024 which are being led by Buckinghamshire Council. These include:

- Hughenden and High Wycombe Flood Alleviation Scheme
  - Following delivery of the River Wye Catchment Surface Water Management Plan (SWMP) in July 2020, various flood alleviation options have been considered and a preferred option been identified, which has the potential to benefit 228 residential properties in the Hughenden Area. The preferred option being considered comprises of a flood bund/ storage area, located in a dry valley to the north of Coates Lane, High Wycombe.
  - Surface water flooding in the River Wye catchment is primarily driven by rainfall but interactions with river levels, high groundwater levels and piped drainage networks also occur to influence where flooding happens. The principal areas of flood risk, include areas of significant flooding along the River Wye and Hughenden Stream corridors which arise from a combination of surface water and fluvial flooding.

78 Buckinghamshire Council (2016, 2022) Buckingham Section 19 Investigations. Available at: Flood investigations | Buckinghamshire Council

79 Thames Regional Flood and Coastal Committee - main committee meeting, 25 January 2023 (publishing.service.gov.uk)

- Pednormead End, Chesham Flood Resilience Scheme
    - Over 100 homes in Pednormead End, an area of Chesham in South East Buckinghamshire, are at risk of flooding from surface water, groundwater and overtopping of the River Chess. Buckinghamshire Council is undertaking a scheme to replace a culvert and provide Property Flood Resilience measures to homes at risk.
- Newt Ditch Flood Alleviation Scheme, Marlow
    - The Newt Ditch is a watercourse in eastern Marlow which poses a high risk of flooding to the surrounding areas, due to blockages and a lack of capacity in culverted sections of the watercourse. The scheme focuses on improvements to the culverted section of watercourse, through cleansing, diverting pipe crossings through the culvert and replacing the culvert with an open channel in some locations. It is expected to help manage flood risk to 125 residential and non-residential properties.
- West Marlow OBC Project
    - The aim of the West Marlow OBC Project is to investigate if there are any feasible methods to reduce surface water flood risk in the area.

7.7 Actual and residual flood risk

A Level 2 SFRA (for strategic allocations) or developer site-specific Flood Risk Assessment will need to consider the actual and residual flood risk due to the presence of any flood risk management and drainage assets in greater detail.

As outlined in Section 7.5, there are several locations in Buckinghamshire which benefit from flood defences, and where there is a difference between actual and residual flood risk, notably in Aylesbury, south Marlow and New Denham, which benefit from flood alleviation schemes.

7.7.1 Actual Flood Risk

Understanding the implications of development is accomplished by considering information on the “actual risk” of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It also accounts for hydraulic modelling, topographic surveys of the site in question and any historic flooding information. It should be noted that the use of flood defences is not always the most appropriate way of protecting new residential development against flooding. Other options should also be considered such as natural flood risk management (e.g. the creation of floodplain storage areas). It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- Residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) considering climate change in any year.

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

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated,
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed,
- The standard of safety must be maintained for the intended lifetime of the development (assumed to be 100 years for residential development). Over time the effects of climate change will erode the present-day standard of protection afforded by defences. Commitment is needed to invest in the maintenance and upgrade of defences, if the present-day levels of protection are to be maintained, and where necessary land secured for affordable future flood risk management measures; and
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater, it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.
- The proposed development must not negatively impact on the integrity of any flood defence structure, and appropriate maintenance access must be retained.

For information on defences reference should be made to the Environment Agency's Asset Information Management System (AIMS) which contains details on the standard of protection of defences.

7.7.2 Residual risk

The residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding. It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the ‘design flood’). This can result in overtopping of flood banks, failure of flood gates to cope with

the level of flow or failure of pumping systems to cope with the incoming discharges; or

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

The assessment of residual risk demands that attention be given to the vulnerability of the receptors (including those who are less mobile or have a physical impairment) and the response to managing the resultant flood emergency. In this instance, attention should be paid to the characteristics of flood emergencies and the roles and responsibilities during such events. Additionally, in the cases of breach or overtopping events, consideration should be given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

It is the responsibility of the developer to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed.

This SFRA does not assess the probability of failure other than noting that such events are very rare. However, in accordance with NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. Developers should be aware that any site that is at or below defence level, may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail, and this should be considered in a detailed Flood Risk Assessment.

The assessment of residual risk should consider:

- The flood hazard, depth and velocity that would result from overtopping or breach of defences. Flood gate or pumping station failure and/ or culvert blockage (as appropriate). The Environment Agency can provide advice at site-specific development level for advice on breach/ overtopping parameters for flood models.
- The design of the development to take account of the highest risk parts of the site e.g. allowing for flood storage on parts of the site and considering the design of the development to keep people safe e.g. sleeping accommodation above the flood level.
- A system of warning and a safe means of access and egress from the site in the event of a flood for users of the site and emergency services.
- Climate change and/ or policy-dependent residual risks (such as those that may be created if necessary, future defence improvements are required, or those associated with any managed adaptive strategies).

8 Cumulative impact of development and strategic solutions

Under the NPPF, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para.166), rather than just to or from individual development sites.

When allocating land for development, consideration should be given to the potential cumulative impact of the loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe. Similarly, the effect of the loss of surface water flow paths, surface ponding and infiltration can also give rise to cumulative effects and potentially exacerbate surface water flood risk.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments comply with the latest guidance and legislation relating to flood risk and sustainable drainage, and appropriate consideration is given to surface water flow paths and storage, proposals, they should normally not increase flood risk downstream.

Catchments within the study area that have the potential to influence existing flood risk issues in neighbouring Local Authorities were identified, as well as catchments in the study area that may be influenced by development in catchments in neighbouring Local Authorities. Historic flood incidents, the current and predicted increase in surface water flood risk to properties and cross boundary issues in each catchment were assessed to identify the catchments at greatest risk.

Local planning policies can also be used to identify areas where the potential for development to increase flood risk is highest and identify opportunities for such new development to positively contribute to decreases in flood risk within a catchment.

8.1 Approach and methodology

The approach is based on providing an assessment of catchments where the allocation of more than one site could result in effects that increase the flood risk elsewhere. At a strategic level this involves comparison of catchments, to assess the quantum of proposed development and the sensitivity of the catchment to changes in flood risk. Historic flooding incidents are also included in the assessment, as these are an indicator of the actual sensitivity of locations within a catchment to flood events.

The methodology deploys a range of metrics to assess the potential for cumulative impacts to be experienced, which provide a balance between predicted and observed flooding data recorded by Buckinghamshire Council and the Environment Agency.

Further details of the approach are provided in Appendix G.

8.2 Ranking of catchments

To identify which catchments are more sensitive to cumulative impacts, each catchment was given a ranking for each of the three metrics (potential level of growth, historic flood risk and properties sensitive to growth). To understand which catchments within Buckinghamshire area are likely to experience the greatest pressure for future growth, all housing and economic sites which were either committed for development at the time of assessment, or preferred for allocation within the Local Plans of neighbouring authorities were analysed. Site commitment data was not available for Dacorum Borough or Three Rivers District.

In the case of Buckinghamshire itself, spatial data on the pattern of growth is not yet available, as the Local Plan is in its early stages. Instead, committed developments and site allocations from adopted local plans of the legacy Local Planning Authority areas have been used to represent a potential growth scenario in this assessment. It is recommended that this assessment is updated as part of a Level 2 SFRA, once potential site allocations for the emerging Local Plan for Buckinghamshire (LP4B) are available. As the Local Plan is likely to allocate further growth on top of what is committed, the cumulative impacts analysis will be crucial advice to the drafting of the LP4B.

These rankings were then combined to give an overall ranking which was divided into three categories - high, medium, and low according to how sensitive each catchment is to cumulative impacts relative to one another.

Further details of the approach are provided in Appendix G.

8.3 Conclusions of the Cumulative Impact Assessment

A summary of the Cumulative Impacts Assessment results is shown in Figure 8-1. The Cumulative Impact Assessment highlights areas where there is a high risk of encountering negative cumulative effects from planned development. In these catchments this should be considered by developers and specifically addressed within FRAs for proposed development. The five catchments with the highest combined sensitivity to flood risk and development within Buckinghamshire were identified as:

- Bear Brook and Wendover Brook
- Clipstone Brook
- Stoke Brook Aylesbury

- Ouzel US Caldecote Mill
- Maidenhead Ditch

Policy recommendations for development within catchments at different levels of risk are provided in Appendix G, with a summary of considerations for catchments identified as at medium rand high risk provided in Section 8.4. This includes recommendations for Chesham and High Wycombe specifically, which reflect their designation as nationally significant 'Flood Risk Areas' for surface water flood risk within the 2018 Environment Agency Preliminary Flood Risk Assessment.

In addition, development proposals within catchments draining into the River Ouzel and Upper Great Ouse should also consider the requirements of the Marston Vale Surface Waters Plan[80], which sets further policies for surface water runoff draining towards the area of the Forest of Marston Vale, to the south and west of Bedford.

In considering cumulative effects FRAs should also be required to assess:

- The location and sensitivity of receptors to cumulative effects and the mechanisms that potentially result in flooding (e.g. locations that are reliant on the performance of pumped drainage systems to manage flood risk, locations where existing flooding is experienced and can be exacerbated by relatively small changes in flood flow magnitude, volume or flood duration, etc).
- The potential quantum of proposed cumulative development within a River Basin and assessment of the effect on sensitive receptors of the cumulative benefit afforded by piecemeal mitigation at the respective allocation sites.
- The requirement for measures to address potential cumulative effects (these can be both ‘on-site’ measures and contributions to strategic ‘off-site’ measures).
- The opportunity to integrate site mitigation measures with strategic flood risk management measures planned in the River Basin.
- The long-term commitments to management and maintenance.

8.4 Policy considerations from Cumulative Impact Assessment

The policy considerations for catchments identified as at medium risk (Section 8.4.1) and high risk (Section 8.4.2) are summarised below. Full details, including policy recommendations for all developments in Buckinghamshire (regardless of catchment risk classification), are provided in Appendix G.

76 The Marston Vale Surface Waters Group (2001) The Marston Vale Surface Waters Plan: Executive Summary. Available at: 1 (idbs.org.uk)

8.4.1 Planning considerations for medium sensitivity catchments

All new development (other than minor extensions) in these catchments should:

- Incorporate SuDS and provide details of adoption, ongoing maintenance and management, in line with the Buckinghamshire SuDS Guidance.
- Developments in these areas should be incentivised to provide wider betterment by demonstrating in site specific Flood Risk Assessments and Surface Water Drainage Strategies what measures can be put in place to contribute to a reduction in flood risk downstream. This may either be through provision of additional storage on site and/or by providing a Partnership Funding contribution towards a wider community scheme.
- Both greenfield and brownfield developments are to achieve greenfield runoff (for peak flow and volume) post-development. Where it is not reasonably practicable for a brownfield development to achieve greenfield runoff, post development runoff (for peak flow[81] and volume[82]) should achieve a minimum of 50% betterment over pre-development runoff.
- Surface Water Management Plans should be developed as required.

8.4.2 Planning considerations for higher sensitivity catchments

For all new development (other than minor extensions) in this catchment:

- National and local flood risk planning policy must be stringently applied within these areas, with flood risk from all sources given the appropriate priority, particularly when applying the Sequential and Exception Tests.
- Once preferred allocation sites have been identified, consider undertaking a Level 2 SFRA to assess further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on receiving watercourses. Such studies could provide further justification for greater restrictions through local planning policy with regards peak flow and volume control of surface water runoff from development sites that are over and above those required by national policy and guidance. They could also identify where there are opportunities for allocated sites to provide on-site / off-site betterment.
- Both greenfield and brownfield developments to achieve 50% betterment over greenfield runoff (for peak flow[83] and volume[84]) post-development to counter cumulative impacts.

81 For the 1 in 1 year rainfall event and the 1 in 100 year rainfall event

82 For the 1 in 100 year, 6 hour rainfall event

83 For the 1 in 1 year rainfall event and the 1 in 100 year rainfall event

84 For the 1 in 100 year, 6 hour rainfall event

- A Surface Water Drainage Strategy should be required for all developments in these catchments, regardless of development size. This would mean that a site specific Flood Risk Assessment would be required for all developments, regardless of their size.
- The Environment Agency may designate higher sensitivity catchments as critical drainage areas as required. If a critical drainage area is identified by the Environment Agency, the LPA (supported by the LLFA) should draft a policy within their Local Plan to manage flood risk from local sources in catchments with critical drainage problems.
- For larger sites and strategic developments:
    - The LLFA, Environment Agency and LPA should be consulted at pre-application stage.
    - The FRA should examine the cumulative impacts of potential peak rates and volumes of water from across the site on peak flows, duration of flooding and timing of flood peaks in receiving watercourses. This should include the impact of other developments within the WFD catchment as advised by the LPA/LLFA if appropriate.
    - A Surface Water Drainage approach should develop and implement appropriate drainage sub-catchments and specific runoff rate and volume requirements for each sub-catchment, based on the SuDS management train. This approach will inform the site masterplanning.
    - Particular attention should be given to limiting runoff volumes to greenfield volume, with long-term storage to be provided where required. The timing of runoff released from the development site will need to be assessed against peak flow timings on the receiving watercourse, to ensure that discharges do not have a detrimental impact on downstream flood risk.
    - The timing of flows released from the development site will need to be assessed in the context of peak flows on the receiving watercourse.
    - Every opportunity should be taken to infiltrate and/or store water at a plot level.
    - Longer-term measures to managing flood risk should be considered, including river restoration and contributions to pipeline flood alleviation schemes.
- Where development sites receive runoff, or drain towards, neighbouring authorities:
    - Work closely with neighbouring Local Authorities and the LLFA to develop complementary Local Planning Policies on cumulative flood risk and sustainable drainage.

8.4.3 Additional considerations for Chesham and High Wycombe

- Chesham and High Wycombe have been designated as a nationally significant 'Flood Risk Areas' for surface water flood risk within the 2018 Environment Agency Preliminary Flood Risk Assessment.
- A Surface Water Drainage Strategy should be required for all developments in Chesham and High Wycombe, regardless of development size.
- Developers should seek to reduce existing flood risk in Chesham and High Wycombe, which may include making a developer contribution towards wider flood alleviation works, as appropriate.
- Ensure that all developments in Chesham and High Wycombe have considered the rapid response nature of the catchments to surface water flooding when designing safe access and escape routes. The availability of flood alerts and flood warnings, as well as the time people would have to respond should also be considered as part of an agreed emergency flood plan, to ensure no additional burden is placed on emergency services.

8.5 Next steps

The Cumulative Impact Assessment is used in the following ways:

- The assessment highlights the catchments in Buckinghamshire where the cumulative impacts of development on flood risk could potentially be greatest. The policy recommendations in this section, and in Appendix G can be used to inform stronger policies for higher and medium risk catchments. Developers and Buckinghamshire Council should also take the assessment into consideration when identifying appropriate sites for development.
- For sites in catchments identified as being at high or medium risk of cumulative impacts FRAs should contain an assessment of the potential cumulative impacts of development further.
- If sites are taken forward to a Level 2 SFRA, the cumulative impacts of relevant development will be considered in further detail.

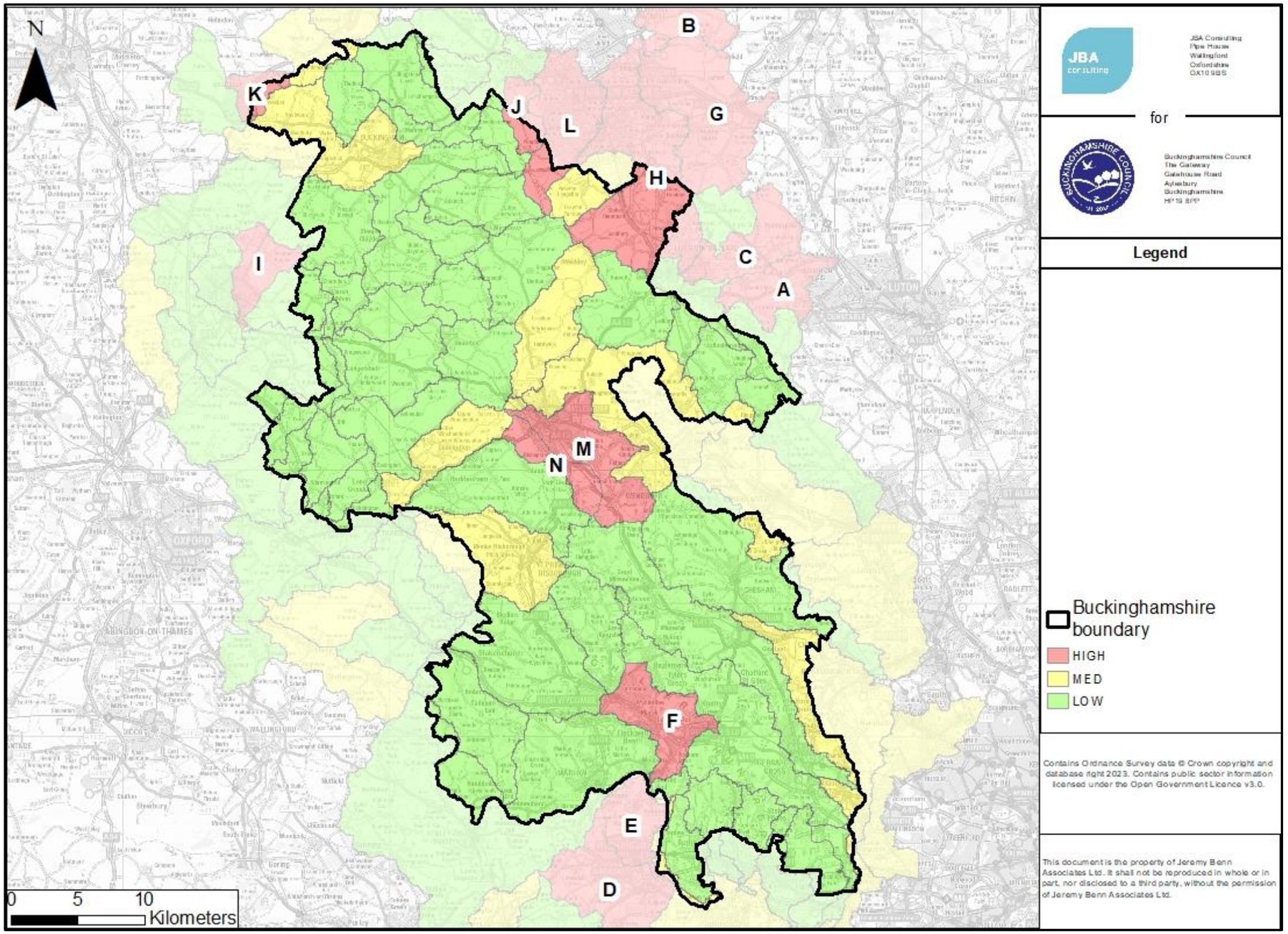


Figure 8-1 Cumulative Impact Assessment overall catchment ranking (references for high-risk catchments shown in Table 8-2)

Table 8-2: References of high risk catchments identified in Figure 8-1

Reference	Catchment
A	Ouzel Brook
B	Chicheley Brook
C	Clipstone Brook
D	Cut (Binfield to River Thames confluence) and Maidenhead Ditch
E	Maidenhead Ditch
F	Wye (High Wycombe fire station to Thames)
G	Broughton Brook
H	Ouzel US Caldecote Mill
I	Langford Brook (source to downstream A41)
J	Weald Brook
K	Ouse US Brackley
L	Loughton Brook
M	Bear Brook and Wendover Brook
N	Stoke Brook Aylesbury

9 Flood risk management requirements for developers

This section 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 within Buckinghamshire. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk and the actual and residual risk and standard of protection and safety at a site are considered in more detail.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of watercourses to verify flood extents (including latest climate change allowances), to inform the sequential approach within the site and prove, if required, whether the Exception Test can be satisfied.

The PPG sets out the process to be used in plan and decision-making, where flood risk is a consideration (paragraph 004), and the guidance within this section is structured around these themes. These are:

- Assess flood risk
  - Within a site-specific FRA, to accompany applications for planning permission.
- Avoid
  - Through application of the Sequential Test and Exception Test, substituting lower vulnerability uses in areas of risk, and using the site layout to locate the most vulnerable areas of the development in the areas of lowest risk.
- Control
  - Investigating measures to control the risk of flooding affecting the site, and considering opportunities for flood alleviation schemes.
- Mitigate
  - Using flood resistance and resilience measures to address any residual risks after the use of avoidance and control measures.
- Manage residual risk
  - Considering further management measures required to manage any residual risk, after avoidance, control and mitigation approaches have been used. Includes safe access and escape routes, and whether adequate flood warning would be available to people using the development.

The guidance in this sections applies to all sources of flood risk, unless stated otherwise.

9.1 Principles of new developments

9.1.1 Consider the risk from all sources of flooding and use 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 Assessment that they are using the latest available datasets.

Developers should apply the most up-to-date Environment Agency climate change guidance (last updated in May 2022) and ensure the development has considered climate change adaptation measures. For more detail, see Section 5.

9.1.2 Consult with statutory consultees at an early stage to understand their requirements

Developers should consult with the Environment Agency, Buckinghamshire Council (as LPA and LLFA), Buckingham and River Ouzel IDB (where applicable), Thames Water and Anglian Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling and drainage assessment and design.

9.1.3 Applying the Sequential and Exception Test

Developers should refer to Section 4.2 for more information on how to consider the Sequential and Exception Tests. For allocated sites, Buckinghamshire Council should use the information in this SFRA and future Level 2 SFRA to apply the Sequential Test.

For windfall sites, a developer must undertake the Sequential Test, which includes considering reasonable alternative sites at lower flood risk now and in the future. Therefore, the impact of climate change on flood risk not only needs to be considered for the chosen site, but also within the assessment of reasonable alternative sites. Only if it passes the Sequential Test should the Exception Test then be applied if required. A detailed FRA may show that a site, windfall or other, is not appropriate for development of a particular vulnerability or even at all.

The Sequential and Exception Tests in the NPPF apply to 'major' and 'non-major' development (as defined in paragraph 051 of the PPG) proposed in areas at risk of flooding. An FRA should not be seen as an alternative to proving these tests have

been met. The PPG (paragraph 027) identifies scenarios where application of the Sequential Test is not required, with development types which are exempt from the test specified in footnote 59 of the NPPF (also summarised in Section 4.3.1).

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?
- Can the site layout be varied to reduce the number of people, the flood risk vulnerability or the building units located in higher risk parts of the site?

9.1.4 Ensure that the development does not increase flood risk elsewhere

Section 10 sets out the requirements for taking a sustainable approach to surface water management. Developers should ensure that the development itself, as well as any mitigation measures, do not increase flood risk elsewhere and that floodplain compensation is provided where necessary.

9.1.5 Enhance the natural river corridor and floodplain environment through new development

Developments should realise opportunities to create, enhance and link green and blue infrastructure. This can provide multiple benefits including flood risk management and biodiversity/ ecology improvements, and may provide opportunities to use the land for an amenity and recreational purposes.

Where possible, developers should identify and work with partners to explore all avenues for improving the wider river corridor environment.

In line with Buckinghamshire Council culvert policy[85], developers should open up existing culverts and should not construct new culverts on site except for short lengths to allow essential infrastructure crossings.

85 Buckinghamshire Council (2022) Buckinghamshire Council Culvert Policy. Available at: Buckinghamshire Council Culvert Policy | Buckinghamshire Council

9.1.6 Consider and contribute to wider flood mitigation strategy and measures in the council area and apply the relevant local planning policy

Wherever possible, developments should 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 (NFM) or by contributing in kind by mitigating wider flood risk on a development site.

More information on the contribution developers are expected to make towards achieving the wider vision for flood risk management and sustainable drainage in the council area can be found in Section 10. Developers must demonstrate in an FRA how they are contributing towards this vision.

9.1.7 Ensure the development is safe for future uses

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, as discussed in Section 7.7.

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.

9.2 Assess flood risk

9.2.1 Requirements for site-specific Flood Risk Assessments

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.
- At locations where it is proposed to locate development in a high-risk surface water flood zone.

- Proposals of less than one hectare in Flood Zone 1 where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water)

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)
- Where evidence of historical or recent flood events have been passed to the LPA
- Land identified in an SFRA as being at increased risk in the future.
- In former Wycombe District, where a 'Wycombe Critical Drainage Area' has been defined (see below).

As part of Wycombe District Level 1 SFRA[86], 'Wycombe Critical Drainage Areas' (WCDAs) were defined using the medium risk (1 in 100-year) surface water flood extent, to identify areas at risk of groundwater or surface water flooding. They were defined in High Wycombe, Marlow, Princes Risborough, Hambledon Stream and along the River Thames. The Wycombe Local Plan (Policy DM39) requires a FRA to be prepared for developments located within WCDAs or areas of high or medium surface water flood risk.

The option to define further CDAs was discussed with Buckinghamshire Council LPA and LLFA teams during preparation of this SFRA. It was agreed that the requirements of the updated Sequential Test (NPPF, 2023) now cover the function of requiring FRAs to identify areas of high groundwater and surface water flood risk. Therefore, no further CDAs have been defined as part of the SFRA.

Requirements for site-specific FRAs

The aim of a FRA is to demonstrate that the development remains safe during the design flood event, the 1 in 100-year (1% AEP) plus climate change event. This includes an assessment of mitigation measures required to safely manage flood risk.

Where appropriate, the following aspects of all sources of flood risks should be addressed in all planning applications in areas at risk of flooding:

- The area liable to flooding,
- The probability of flooding occurring now and over time,
- The extent and standard of existing flood defences and their effectiveness over time,
- The likely depth of flooding,
- The rates of flow likely to be involved,

86 Wycombe District Council (2014) Strategic Flood Risk Assessment (SFRA) Update. Available at: Microsoft Word - Wycombe DC Level 1 SFRA Update v03.docx (buckinghamshire-gov-uk.s3.amazonaws.com)

- The likelihood of impacts to other areas, properties, habitats and protected species,
- The effects of climate change,
- The nature and currently expected lifetime of the development proposed and the extent to which it is designed to deal with flood risk; and
- Any opportunities to increase areas of Natural Flood Management to provide connectivity for the movement of flood water, habitats and protected species.

Development proposals requiring FRAs should therefore:

- Be performed in accordance with the requirements of the Sequential and, when necessary, the Exception Tests;
- Not increase flood risk, either upstream or downstream of the site, taking into account the impacts of climate change;
- Seek to not increase surface water volumes or peak flow rates that would result in increased flood risk to the receiving catchments;
- Use opportunities provided by new development to, where practicable, reduce flood risk within the site and elsewhere;
- Ensure that where development is necessary in areas of flood risk (after application of the Sequential and Exception Tests), it is made safe from flooding for the lifetime of the development, taking into account the impact of climate change;
- Consider all sources of flood risk (including fluvial, ordinary watercourses, surface water, groundwater, sewers and drainage, reservoirs and canals); and
- Seek to use Natural Flood Management solutions in the first instance.

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Buckinghamshire 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); and
- Site-specific Flood Risk Assessment: CHECKLIST (NPPF PPG, Defra)

Guidance for local planning authorities for reviewing Flood Risk Assessments submitted as part of planning applications was published by Defra in 2015 – Flood Risk Assessment: Local Planning Authorities.

In circumstances where FRAs are prepared for windfall sites, then they should include evidence that demonstrates that the proposals are in accordance with the policies described in the Local Plan.

Assessing risk from watercourses

The risk of flooding from watercourses of all sizes should be considered within a FRA, including both Main Rivers and ordinary watercourses.

Flood Zone mapping is only available where hydraulic modelling has been undertaken, and therefore there are some areas (typically watercourses with a catchment area of less than 3km^2) where the fluvial flood risk has not been mapped, and so are shown to be in Flood Zone 1.

In these areas detailed modelling may be required to accurately define the Flood Zones and determine the flood risk to the site. The Environment Agency (for Main Rivers), Buckinghamshire Council as LLFA (for ordinary watercourses) and the Buckingham and River Ouzel IDB (for watercourses within the IDB area) should be consulted to confirm the modelling requirements for a site. Further information on the Flood Zone mapping can be found in Appendix F.

The FRA should consider the flood depths, velocities and water levels predicted to occur on the site, as well as the expected duration of flooding and the likely hazard to people. Both the pre- and post-development scenarios should be assessed, and the impacts of climate change also needs to be considered, in line with the latest Environment Agency guidance. Detailed information on the fluvial flood risk from Main Rivers can be requested from the Environment Agency, and advice is available on which type of information to request, based on the size of the development[87].

The FRA should also explain the residual risks which exist to the site, from both proposed and existing flood risk management measures, such as the risk of blockage to culverts or overtopping of defences.

Assessing risk from surface water

To assess the existing surface water flood risk within a site, a FRA should consider the existing flow paths and areas of ponding within a site, as identified in the RoFSW mapping and historic records. The flood depth, velocity and hazard information available within the RoFSW should be used as a starting point, and the scale at which the RoFSW mapping is appropriate to use should be reviewed[88]. Where the mapping is less suitable to be used at a small scale, it may be necessary to undertake more detailed surface water modelling of the site, to better represent risk to the site.

87 Environment Agency (2017) Flood risk assessments if you're applying for planning permission. Available at: Flood risk assessments if you're applying for planning permission - GOV.UK (www.gov.uk)

88 Environment Agency (2021) Risk of Flooding from Surface Water Suitability. Available at: Risk of Flooding from Surface Water Suitability - data.gov.uk

Buckinghamshire Council as LLFA and the Buckingham and River Ouzel IDB (within the IDB area) should be consulted at the earliest opportunity to confirm surface water modelling requirements.

Surface water flood risk needs to be assessed in both the pre- and post-development scenarios, including the impacts of any proposed changes in ground level on existing flow paths and areas of predicted or recorded risk. The impact of climate change on surface water flood risk needs to be considered, in line with the latest Environment Agency guidance.

Key to managing the risk of surface water on site is the design of Sustainable Drainage Systems (SuDS). SuDS on all new development must adhere to industry standards and to the applicable runoff discharge rate and storage volume allowances stated by Buckinghamshire Council, the LLFA. Site-specific FRAs should always consider surface water flood risk management and options for onsite flood storage through appropriate SuDS. A Sustainable Drainage Strategy should always be submitted, which clearly takes account of the findings of the site-specific FRA and specify the proposed design, constructions, adoption and management and maintenance arrangements of the proposed SuDS components. The LPA and LLFA must always be consulted during this process, as should the Water Companies, IDB and the EA, if required.

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

Assessing risk from groundwater

Following the update to the NPPF in 2021, groundwater flood risk must be considered within the Sequential Test, to steer development to areas of lowest flood risk. The mapping of flood risk is key to spatial planning, and groundwater flood risk maps included in Appendix C can be used to inform application of the Sequential Test within the Local Plan and individual planning applications. Where sites are identified as at high risk of groundwater flooding, more detailed assessment will be required within a Level 2 SFRA or site-specific FRA.

Where groundwater flood risks are not considered at planning stage, potential mitigation and management opportunities will be missed, and the onus often falls to the developer to resolve issues after construction[89].

89 Environment Agency (2021) Rapid evidence assessment and overview of groundwater flood risk management in England. FRS19217. Available at: Microsoft Word - Groundwater flood risk management in England - report (publishing.service.gov.uk)

The following information should be considered in assessing groundwater flood risk:

- Both the geological and hydrogeological setting, including bedrock and superficial geology, and the presence of aquifers.
- Local and historic data, including flood records. In particular, historic mapping may indicate former indicators of high groundwater levels (such as the presence of historic watercourses or ponds), which have subsequently been built over.
- Local borehole information (both new boreholes sunk as part of the Site Investigations, and historic borehole records available on the BGS website), and local knowledge from the landowner, neighbouring residents etc.
- Consider risk of below ground flooding, as well as the potential above ground flood risk if groundwater emergence is to occur.
- Where mapping indicates that there is a high risk of groundwater emergence occurring during extreme groundwater events, consideration should be given as to the likely areas where water will flow and pond on the site. LIDAR data, the EA Surface Water Flood Map, and existing groundwater emergence modelling held by Buckinghamshire Council, have been used to inform this assessment at the Level 1 SFRA stage. Site-specific FRAs should also use site walkovers and topographic surveys to assess the impacts of groundwater emergence.
- Where sites are at high risk of groundwater flooding, groundwater monitoring will be requested at planning application stage, to determine the impact of seasonal fluctuations in groundwater levels on flood risk to the site and to below ground structures (such as building foundations and drainage assets). Monitoring should be undertaken during winter months (November until the end of April) and the duration of monitoring may be specified by Buckinghamshire Council as LLFA.
- Any known groundwater flow routes should be safeguarded, to ensure that groundwater flood risk is not increased on site or elsewhere.
- Where sub-surface structures (including basements), cut-off walls, pipes or other features which may block or transmit groundwater flow are proposed in areas of high groundwater flood risk, they should be supported by evidence that it will not raise groundwater levels either upstream or downstream of the development.

In addition, careful planning and design of infiltration SuDS is required in sites with high groundwater levels or Groundwater SPZs. Designs must demonstrate that infiltration techniques do not increase flood risk on or off site, and do not allow pollutants to enter groundwater.

Assessing risk from reservoirs

As discussed in Section 6.8, there is a risk of reservoir flooding in several areas of Buckinghamshire during a 'wet-day' and 'dry-day' scenario. 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 risk classification of the reservoir (to be based on the latest industry guidance)
- 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 online Risk of Flooding from Reservoirs mapping contains 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 currently governed by the Reservoir Act 1975). Consideration should be given to the extent, depths and velocities shown in these online maps. The Risk of Flooding from Reservoirs mapping assumes a 'worst-case' flood extent, in which a void forms through the highest point on the reservoir embankment[90]. However, the potential flood risk impacts to a development located near to a reservoir may be different, depending on the location at which the breach occurs on the embankment. As a result, Environment Agency guidance specifies that the Risk of Flooding from Reservoirs mapping should not be used in isolation, and the residual risk from reservoirs needs to be assessed on a case-by-case basis. Section 3.3 provides further detail on the use of reservoir flood mapping within assessments.

The GOV.UK website on Reservoirs: owner and operator requirements provides information on how to register reservoirs, appoint a panel engineer, produce a flood plan and report an incident.

In addition, developers should consult the Thames Valley Local Resilience Forum about emergency plans.

Developers should use the above information to:

- Apply 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. The

90 Environment Agency (2021) Reservoir flood maps: when and how to use them. Available at: Reservoir flood maps: when and how to use them - GOV.UK (www.gov.uk)

potential risk should be assessed in both the pre- and post-development scenarios, to determine any increase in risk to the site.

- 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. However, as reservoirs can fail with little or no warning, Emergency Plans should not be considered a primary measure to manage flood risk from a reservoir.

Consideration should also be given to the potential implications of proposed development on the risk evaluation of a reservoir. Where development downstream of a reservoir increases the risk, the reservoir owner has a duty to undertake proportionate actions to rebalance the risk, for example by considering the hydraulic capacity and safety of the reservoir embankment and spillway. The implications of such potential obligations should be identified and understood so that it can be confirmed that these can be met if proposed new development is permitted. The developer is required to cover the cost of any actions undertaken by the reservoir owner to manage the increased risk (PPG paragraph 46), as well as any pre-planning breach modelling and risk assessment.

Assessing risk from canals

Where sites are located near to a canal, the residual risk of canal breach or overtopping must be considered.

Within this SFRA, a buffer distance of 100m around raised canal embankments has been used as an indication of areas where the impact of canal breach may be greatest, in line with the approach used in the Vale of Aylesbury Level 1 and 2 SFRAs. However, the Canal and River Trust considers canal flood risk on an individual site basis, and therefore the Trust should be consulted at the earliest opportunity, where a site is located near to a canal.

As in the case of reservoir flood risk, it will be necessary to assess the potential risk that canal breach or overtopping poses to a development site in both the pre- and post-development scenarios, to determine any increase in risk. Additional assessments, such as hydraulic modelling of breach or overtopping events, may be required, and advice on assessment requirements should be sought from the Canal and River Trust.

Where property cannot be located in areas of lower risk within the site boundary, and the risk cannot be controlled, the assessment should then inform proportionate flood risk mitigation measures, in order to manage flood risk to property (examples are provided in 9.5). This may include elevated floor levels, landscaping or positioning roads and paths close to the canal, to act as buffers which minimise the impacts of canal flooding, and manage potential flows away from properties. There can be a direct link between land stability and canal flood risk, and therefore it must also be ensured that any works do not adversely affect the stability of the canal infrastructure, in accordance with the NPPF (Paragraphs 180e, 189 - 190).

9.3 Avoid

9.3.1 Site layout and design

The flood risk assessment should be completed at an early stage to influence the layout and design of a site, and provide the greatest opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to locate more vulnerable land use within the areas at lowest risk of flooding, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas.

Whether parking in floodplains is appropriate will be based on the likely flood depths and hazard, evacuation procedures and availability of flood warning systems.

Waterside areas, or areas along known flow routes, can act as green infrastructure, being used for recreation, amenity and environmental purposes. These land uses allow for the preservation of flow routes and flood storage, and at the same time provide valuable social and environmental benefits, contributing to other sustainability objectives.

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

9.3.2 Phasing of development

Large, strategic, multiple phase development sites should also consider the management of flood risk across the overall site boundary, when planning the phasing of the development. This can best ensure delivery of a joined-up approach to flood risk management across the site, and helps to manage the cumulative impacts of development on flood risk, both within the site and off-site, during each phase of the development.

9.4 Control

9.4.1 Modification of ground levels

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment. It should only be considered in areas of flood risk where development has passed the Exception Test, and mitigation is required to permit construction in an area at risk of flooding.

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken as raising land above the floodplain could reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land. Raising ground levels can also deflect flood flows, so analysis should be performed to demonstrate that there are no adverse effects on third party land or property.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication Development and flood risk - guidance for the construction industry (C624). Consultation and approval of the floodplain compensation approach should be sought from the Environment Agency for Main Rivers and Buckinghamshire Council as LLFA for ordinary watercourses.

Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment.

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

9.4.2 Developer contributions

In some cases, and following the application of the Sequential Test, it may be necessary for the developer to contribute to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS).

Developer contributions can be provided[91]:

- Through planning obligations within section 106 agreements (under Section 106 of the Town and Country Planning Act 1990, as amended) – where it is not possible to address unacceptable impacts through a planning condition; or
- Through the Community Infrastructure Levy (CIL) – a fixed charge levied on new development to fund infrastructure.

Defra's Flood and Coastal Risk Management Grant in Aid (FCRMGiA) can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion.

Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

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

Where Buckinghamshire Council, in consultation with reservoir owners and operators, considers that new development located downstream of a reservoir has implications for reservoir safety, for example due to the increased risks associated with a breach, the PPG (paragraph 46) specifies that the site developer should cover any additional costs which reservoir owners or operators incur in mitigating the increased risks.

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

The appropriate route for the consideration of strategic measures to address flood risk issues is the Local Flood Risk Management Strategy (LFRMS) prepared by the Lead Local Flood Authority. The LFRMS will describe the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in

91 Buckinghamshire Council (2020) Infrastructure Funding Statement 1 April 2019 to 31 March 2020. Available at: Infrastructure Funding Statement 1 April 2019 to 31 March 2020.pdf (moderngov.co.uk)

accordance with the LFRMS, can be funded and delivered, and have an appropriate priority.

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

9.5 Mitigate

9.5.1 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood. However, it should only be considered in areas of flood risk where development has passed the Exception Test, and mitigation is required to permit construction in an area at risk of flooding.

According to the government's guidance on 'Preparing a flood risk assessment: standing advice' minimum finished floor levels for vulnerable development should normally be above whichever is higher of the following:

- a minimum of 300mm above average ground level of the site,
- a minimum of 300mm above the adjacent road level to the building,
- 300mm above estimated river or sea flood level.

Construction materials that have low permeability up to at least the same height as finished floor levels should be used. If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

The above guidelines should also apply to replacement dwellings not solely the construction of new properties and in line with the August 2022 changes to the PPG. Thresholds should be set to provide appropriate freeboard above flooding from surface water and groundwater and not just river flooding.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels. Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided. Habitable use of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Access should be situated 300mm above the design flood level and waterproof construction techniques used.

9.5.2 Resistance and resilience measures

The consideration of resistance and resilience measures should not be used to justify development in inappropriate locations. Having applied planning policy, there will be instances where developments, such as those that are water compatible and essential infrastructure are permitted in high flood risk areas. Avoiding areas of higher flood risk through appropriate site layout and design should be considered before resistance and resilience measures are relied on.

The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system and the use of back up pumping to evacuate water from a property as quickly as possible. The proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate. Available resistance and resilience measures are shown in Table 9-1.

Table 9-1: Examples of resistance and resilience measures

Measures	Description
Permanent barriers	Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers
Temporary barriers	Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.
Community resistance measures	These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

Measures	Description
Flood resilience measures	These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier. Interior design measures to reduce damage caused by flooding can include electrical circuitry installed at a higher level and water-resistant materials for floors, walls and fixtures.

9.5.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain if they are overtopped or breached. It should only be considered in areas of flood risk where development has passed the Exception Test, and mitigation is required to permit construction in an area at risk of flooding.

Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution. Where it is not possible to achieve the required level and volume of floodplain compensation, it may be suitable to provide floodwater storage in voids below the proposed habitable floors of a building, as a mitigation measure. However, this will be subject to consultation and agreement with the Environment Agency for Main Rivers, and Buckinghamshire Council as LLFA for ordinary watercourses.

Temporary or demountable defences are not acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe.

In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate.

9.5.4 Groundwater flood risk mitigation

Groundwater flooding has a very different flood mechanism to any other, and so many conventional flood mitigation methods are not suitable. Raising finished floor levels 300mm above the surrounding ground level is recommended in areas where groundwater emergence risk is indicated. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream. Obstruction of sub-surface flows by buried services and basements should be avoided.

Infiltration drainage may not be suitable on sites with high groundwater. However, the likely frequency of groundwater reaching within 3m of the ground surface would need to be considered. On some sites, infiltration potential may be good for most of the time, but impeded during high groundwater events. Here a combination of infiltration and surface storage and conveyance techniques may be required to drain the site without increasing flood risk downstream.

High groundwater levels can also cause infiltration into SuDS and piped drainage systems, preventing them from operating to their design capacity. Developers should provide evidence that the risk of groundwater ingress and floatation to below ground assets has been considered in the design and ensure that this will not be a significant risk. The depth of the proposed SuDS must be kept to a minimum and developers should make allowance for wide shallow SuDS such as wetlands and detention basins.

The presence of shallow groundwater should also be taken into consideration when designing below-ground services, particularly foul and surface water sewers, where groundwater infiltration through the fabric of pipes and manholes can lead to system overloading, increasing the risk of pollution incidents and sewer flooding.

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

9.5.5 Sewer flood risk mitigation

Developers should discuss foul and surface water public sewerage capacity with the water utility company at the earliest possible stage. As part of the development, improvements may be required to the existing drainage infrastructure, to reduce flood risk on site and within the sewer catchment.

Where surface water drainage from a development is proposed to discharge into the public sewer network, it is important that a Surface Water Drainage Strategy (often prepared as part of a Flood Risk Assessment) demonstrates that flood risk will not be

increased elsewhere within the sewer catchment. This includes confirming that the receiving sewer network has sufficient capacity, and is in a suitable condition, to accommodate drainage from the site, and that LLFA, IDB and Water Company requirements for runoff rates and volumes from the development have been met. Guidance on surface water and foul drainage strategies for new developments are provided in Section 10.

When redeveloping existing buildings, the installation of some permanent or temporary floodproofing and resilience measures could protect against both surface water and sewer flooding.

Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained.

Consideration must also be given to attenuation and flow ensuring that flows during the 1 in 100-year / 1% AEP plus climate change storm event are retained within the site if any flap valves shut. This should be demonstrated with suitable modelling techniques.

9.6 Manage residual risk

9.6.1 Emergency planning and development

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

Flood warning and emergency planning is a last resort to managing flood risk at a site, and developers must first demonstrate that assessment, avoidance, control and mitigation of flood risk to a development has been considered. However, safety is a key consideration for any new development and includes residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.

Figure 9-2 and Appendix C show the coverage of Environment Agency Flood Warning and Flood Alert Areas in Buckinghamshire. There are currently 17 Flood Alert Areas and 29 Flood Warning Areas covering Buckinghamshire. The coverage of the Flood Alerts and Flood Warnings includes the fluvial corridors and tributaries of the River Thames to the south, the River Colne to the east, and the Great Ouse in the north.

The Environment Agency can provide flood warnings for homes or businesses within these areas. In selected areas, the Environment Agency can provide a groundwater alert / warning. These tend to be for communities located on chalk bedrock or known have a history of groundwater flooding. The Environment Agency groundwater alert service for the 'Henley and Assendon, High Wycombe and Chesham' area covers Buckinghamshire.

The Association of Directors of Environment, Economy, Planning and Transport (ADEPT) and the Environment Agency have published a Flood Risk Emergency Plans for New Development[92] document which provides guidance for Local Planning Authorities regarding their decisions over planning applications.

The NPPF Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test. The depth, velocity and hazard mapping from hydraulic modelling should help inform the provision of safe access and egress routes. As part of an FRA, the developer should review the acceptability of the proposed access in consultation with the LPA and the Environment Agency.

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

- It is a requirement under the 2021 NPPF that safe access and escape routes are included in an FRA where appropriate, as part of an agreed emergency plan.
- The Environment Agency and Defra's standing advice[93] for undertaking flood risk assessments for planning applications states that details of emergency escape plans will be required for any parts of the building that are below the estimated flood level.

It is recommended that Emergency Planners at Buckinghamshire Council are consulted prior to the production of any emergency flood plan.

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

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a breach.

92 Flood Risk Emergency Plans for New Development. ADEPT, Environment Agency. (2019). https://www.adeptnet.org.uk/system/files/documents/ADEPT%20%26%20EA%20Flood%20risk%20emergency%20plans%20for%20new%20development%20September%202019....pdf

93 Flood Risk Assessment Standing Advice. Environment Agency. (2021) https://www.gov.uk/guidance/flood-risk-assessment-standing-advice

- Proposed new development that places additional burden on the existing response capacity of the Council will not normally be considered to be appropriate.
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive these warnings. This applies even if the development is defended to a high standard. Developers should also acknowledge that some flood risks, such as reservoir failure, can occur with little or no warning.
- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g., prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop emergency plans.

More local advice and support for emergency planning can be gained through the Thames Valley Local Resilience Forum. Local Resilience Forums (LRFs) have been set up across England to increase interoperability and develop unified emergency preparedness, response and recovery arrangements.

Guidance for preparation of flood response plans:

- Buckinghamshire emergency planning and response website page
- Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups
- Environment Agency (2014) Community Flood Plan template
- Environment Agency Personal flood plans
- ADEPT and the Environment Agency (2019) - Flood Risk Emergency Plans for New Development

Further emergency planning information links:

- 2004 Civil Contingencies Act[94]
- DEFRA (2014) National Flood Emergency Framework for England[95]
- Sign up for Flood Warnings with the Environment Agency[96]
- National Flood Forum[97]

94 UK Government. (2004) Civil Contingencies Act. Available at: https://www.legislation.gov.uk/ukpga/2004/36/contents

95 Environment Agency, Public Health England (2014) National Flood Emergency framework for England. Available at: https://www.gov.uk/government/publications/the-national-flood-emergency-framework-for-england

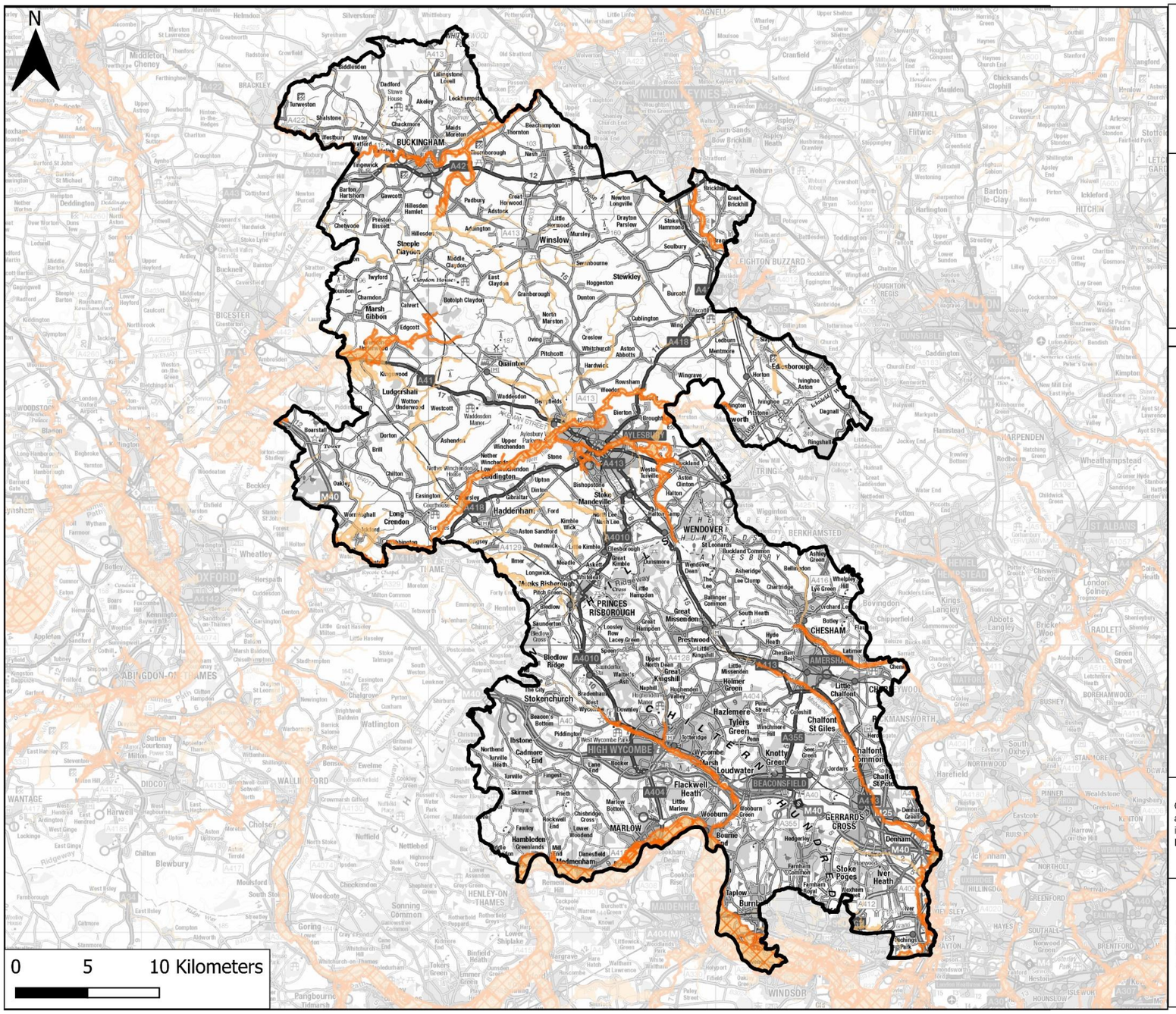
96 Environment Agency (2023) Sign up for Flood Warnings. Available at: https://www.gov.uk/sign-up-for-flood-warnings

97 National Flood Forum website. Available at: https://nationalfloodforum.org.uk/

- GOV.UK Make a Flood Plan guidance and templates[98]
- FloodRe[99]
- GOV.UK - UK Emergency Alerts

98 UK Government (2023) Prepare for flooding. Available at: https://www.gov.uk/prepare-for-flooding/future-flooding

99 FloodRe website. Available at: https://www.floodre.co.uk/



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Legend

- Buckinghamshire boundary
- Flood Warning Areas
- Flood Alert Areas

Figure 9-2 Flood Warning and Flood Alert Areas in Buckinghamshire

10 Surface water management and SuDS

10.1 Introduction

SuDS are drainage features which attempt to replicate natural drainage patterns, through capturing rainwater at source, and releasing it slowly into the ground or a water body. They can help to manage flooding through controlling the quantity of surface water generated by a development and improve water quality by treating urban runoff. SuDS can also deliver multiple benefits, through creating habitats for wildlife and green spaces for the community. SuDS also have the advantage of providing effective Blue and Green infrastructure and ecological and public amenity benefits when designed and maintained properly.

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

Since April 2015[100], management of the rate and volume of surface water has been a requirement for all major development sites, through the use of Sustainable Drainage Systems (SuDS).

Lead Local Flood Authorities (LLFAs) are the statutory consultees to the planning system for surface water management within major development, which covers the following development scenarios:

- 10 or more dwellings
- a site larger than 0.5 hectares, where the number of dwellings is unknown
- a building greater than 1,000 square metres
- a site larger than 1 hectare

However, the UK Government is in the process of implementing Schedule 3 of the Flood and Water Act. In January 2023, the UK Government released their report setting out the findings of a review into the implementation of Schedule 3 to The Flood and Water Management Act 2010 which outlined the possibility of LLFAs becoming SuDS Approving Body (SAB). This would create a new process for the approval and adoption of SuDS, separate to the planning system.

100 House of Commons: Written Statement (HCWS161) Written Statement made by: The Secretary of State for Communities and Local Government (Mr Eric Pickles) on 18 Dec 2014. Accessed online at: https://www.parliament.uk/documents/commons-vote-office/December%202014/18%20December/6.%20DCLG-sustainable-drainage-systems.pdf on: 10/02/2023.

Enactment of Schedule 3 would also remove the automatic right to connect surface water into the public sewer network. Instead, the right to connect would become conditional upon the drainage system being approved by the SAB, in consultation with the Water and Sewerage Companies before construction can commence.

10.3 SuDS design guidance

10.3.1 National guidance

National standards on the management of surface water are outlined within the Defra Non-statutory Standards for Sustainable Drainage Systems[101]. The CIRIA C753 SuDS Manual[102] and Guidance for the Construction of SuDS[103] provide the industry best practice guidance for design and management of SuDS.

10.3.2 Local guidance

Requirements and design standards for managing surface water runoff and drainage in the council area are detailed within the Buckinghamshire SuDS guidance[104]. The guidance also includes advice on what to provide for different levels of planning application, including outline and full planning, reserved matters, permission in principle and change of use.

Anglian Water and Thames Water advocate the use of SuDS in development, to limit the rate and volume of surface water as far as possible, and restrict surface water from entering the foul and combined sewer networks. SuDS are considered to be key in ensuring future capacity of the sewerage system, in response to the pressures of

101 Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems, DEFRA (2015). Accessed online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf on: 10/02/2023.

102 CIRIA Report C753 The SuDS Manual, CIRIA (2015). Accessed online at:

https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx on: 10/02/2023.

103 Guidance on the Construction of SuDS (C768), CIRIA (2017), Accessed online at:

https://www.ciria.org/ItemDetail?iProductcode=C768&Category=BOOK on: 10/02/2023.

104 Buckinghamshire Council (2022) Sustainable Drainage Systems (SuDS): guidance for developers. Available at: Sustainable drainage systems (SuDS) | Buckinghamshire Council

population growth and climate change. Guidance on designing SuDS for adoption by Anglian Water[105] or Thames Water[106] is available on their websites.

10.3.3 Drainage hierarchy

In line with Planning Practice Guidance (para 080), Buckinghamshire Council requires surface water from development sites to be discharged using the following hierarchy of drainage options:

- into the ground (infiltration)
- to a surface water body
- to a surface water sewer, highway drain, or another drainage system
- to a combined sewer

Although rainwater harvesting is not included within the PPG, the Council considers water re-use to be at the top of the drainage hierarchy. Evidence must be submitted to demonstrate why the most favourable drainage discharge option cannot be met.

It should be noted that there are few combined sewer networks within Buckinghamshire, and discharge of surface water to the foul sewer network will not be accepted by Anglian Water or Thames Water.

10.3.4 Delivering multiple benefits

In Buckinghamshire, above ground, vegetated SuDS features which provide multiple benefits will be favoured over more engineered solutions, which solely deliver control of water quantity. SuDS designs should aim to meet the 'four pillars of SuDS design' (shown in Figure 10-1) - water quantity, water quality, amenity and biodiversity. Multifunctional SuDS also provide an opportunity to meet several planning requirements within one feature, such as Biodiversity Net Gain.

105 Anglian Water. SuDS Design and Construction Guidance. Available at: SuDS Design and Construction Guidance (anglianwater.co.uk)

106 Thames Water Outline Guidance Sustainable Drainage Systems (SuDS) Available at: suds-outline-guidance.pdf (southernwater.co.uk)

106 The Marston Vale Surface Waters Group (2001) The Marston Vale Surface Waters Plan: Executive Summary. Available at: 1 (idbs.org.uk)

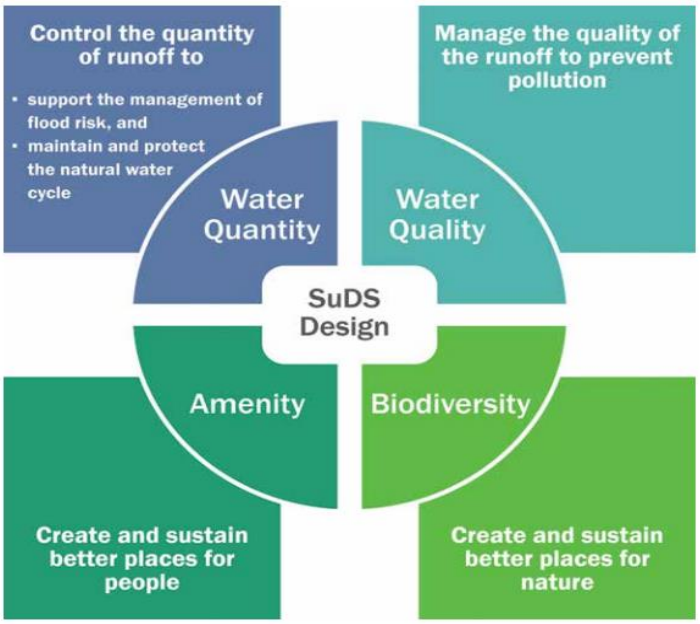

Figure 10-1: Four pillars of SuDS design (The SuDS Manual C753, 2015)

Table 10-2 includes examples of SuDS features which can provide multiple benefits. The suitability of the techniques will be dictated in part by the development proposal and site conditions. Further guidance on SuDS design can be found in the CIRIA SuDS Manual C753 (2015).

Table 10-2: Examples of SuDS techniques and potential benefits.

SuDS Technique	Flood risk management	Water quality treatment & enhancement	Landscape and wildlife benefit
Living roofs	✓	✓	✓
Basins and ponds	✓	✓	✓
Construction wetlands	✓	✓	✓
Balancing ponds	✓	✓	✓
Detention basins	✓	✓	✓
Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices	✓	✓	✓
Soakaways	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	

SuDS Technique	Flood risk management	Water quality treatment & enhancement	Landscape and wildlife benefit
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements			
Tanked systems	✓		
Oversized pipes / tanks	✓		
Storm cells	✓		

10.3.5 Overcoming site constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints, which should be considered during the conceptual, outline and detailed stages of SuDS design. However, as shown in

Table 10-3, all sites will be able to accommodate SuDS in some form, with proper consideration of the site constraints.

Table 10-3: Common site constraints for SuDS and potential solutions

Considerations	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example, features such as permeable paving and green roofs can be used in urban areas where space may be limited.
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable line or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table. If below ground features are proposed, floatation calculations are likely to be required.
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek not to reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Conditions after a flood event, such as siltation, should also be considered during the design phase.
Future adoption and maintenance	Local Planning Authority should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

10.3.6 Design standards for SuDS components

National standards on the management of surface water are outlined within the Defra Non-statutory Standards for Sustainable Drainage Systems[107]. The CIRIA C753 SuDS Manual[108] and Guidance for the Construction of SuDS[109] provide the industry best practice guidance for design and management of SuDS.

Buckinghamshire Council SuDS guidance[110] provides specific design standards which particular SuDS components must meet.

10.4 Sources of SuDS guidance

Further general guidance on SuDS can be found in the documents and websites below:

- Buckinghamshire Council: Sustainable Drainage Guidance Systems (SuDS) guidance for developers
- CIRIA guides - several relating to SuDS, most notably CIRIA SuDS Manual[111], Using SuDS to reduce phosphorus in surface water runoff (C808F)[112], and Using SuDS to reduce nitrogen in surface water runoff (C815F)[113].
- Defra Non-statutory Technical Standards for Sustainable Drainage Systems[114] (and recommendations for updating the standards[115])

107 Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems, DEFRA (2015). Accessed online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf on: 10/02/2023.

108 CIRIA Report C753 The SuDS Manual, CIRIA (2015). Accessed online at:

https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx on: 10/02/2023.

109 Guidance on the Construction of SuDS (C768), CIRIA (2017), Accessed online at:

https://www.ciria.org/ItemDetail?iProductcode=C768&Category=BOOK on: 10/02/2023.

110 Buckinghamshire Council (2022) Sustainable Drainage Systems (SuDS): guidance for developers. Design Standards for SuDS Components. Available at: Design Standards for SuDS Components | Buckinghamshire Council

111 CIRIA (2015) The SuDS Manual (C753). http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

112 CIRIA (2022) Using SuDS to reduce phosphorus in surface water runoff (C808F). Available at: Using SuDS to reduce phosphorus in surface water runoff (ciria.org).

113 CIRIA (2023) Using SuDS to reduce nitrogen in surface water runoff (C815F). Available at: New guidance for Using SuDS to reduce nitrogen in surface water runoff (ciria.org).

114 Defra (March 2015) Non-statutory technical standards for sustainable drainage systems

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

115 Defra (2021) Recommendations to Update Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS) - WT15122. Available at: Science Search (defra.gov.uk)

- Susdrain website[116] - online community for delivering sustainable drainage.
- Local Authority SuDS Officer Organisation - Non-Statutory Technical Standards for Sustainable Drainage: Best Practice Guidance[117]
- BSI Standards Publication - BS8582 Code of practice for surface water management for development sites[118]
- Institute of Civil Engineers - SuDS Route Maps: Guide to Effective Surface Water Management[119]
- Water UK – Sewerage Sector Guidance Appendix C: Design and Construction Guidance[120]

10.5 Wastewater

Developers should discuss public sewerage capacity with the water utility company (Anglian Water or Thames Water) at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and within the wider wastewater catchment.

Major developments and those upstream of areas where sewer flooding is known to be a problem must carry out wastewater capacity checks and should liaise with the sewerage undertaker at an early stage. This is to prevent an increase in sewer flooding and/or spills from combined sewer overflows (CSOs) further down the wastewater system, as a result of the development.

The impact of an increased volume of foul water discharge on watercourses should also be considered for large sites, or where several sites are likely to be developed in the same Sewage Treatment Works (STW) catchment, particularly where the receiving STW discharges into the same watercourse as the surface water runoff from the site.

A Phase 1 Water Cycle Study is currently being undertaken in Buckinghamshire, to provide information on wastewater capacity and the potential impacts of increased discharges of treated effluent on downstream flood risk, and aid the development of the emerging Local Plan.

116 Susdrain website http://www.susdrain.org/

117 Local Authority SuDS Officer Organisation - Non-Statutory Technical Standards for Sustainable Drainage: Best Practice Guidance http://www.lasoo.org.uk/?publications=non-statutory-technical-standards-for-sustainable-drainage

118 BSI Standards Publication (2013) Code of practice for surface water management for development sites. Available at: http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030253266

119 ICE (2018) SuDS Route Maps: Guide to Effective Surface Water Management. Available at: ICE-ACO-SuDS-Route-Map-Booklet-Feb2018.pdf.aspx

120 Water UK (2019) Sewerage Sector Guidance Appendix C. Available at: SSG-App-C-Des-Con-Guide-v-1.0-251019.pdf (water.org.uk)

11 Strategic flood risk measures

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the Local Plan area. The following sections outline different options which could be considered for strategic flood risk solutions. Any strategic solutions should ensure they are consistent with wider catchment policy and the local policies.

It is important that the ability to deliver strategic solutions in the future is not compromised by the location of proposed development. When assessing the extent and location of proposed development, consideration should be given to the requirement to secure land for flood risk management measures that provide wider benefits.

In line with the objectives of the updated Buckinghamshire LFRMS (draft, 2023), strategic flood risk measures should seek to deliver multiple benefits in terms of biodiversity, water quality, climate change adaptation and carbon reduction. The national Flood and Coastal Risk Management (FCERM) appraisal guidance provides further guidance on achieving a carbon reduction within flood risk management projects. Further information is also provided in the updated Buckinghamshire LFRMS.

11.1 Safeguarding land for flood storage

Where possible, the LPA may look to allocate land designed for flood storage functions. Such land can be explored through the site allocation process where an assessment is made, using this SFRA, of the flood risk at assessed sites and what benefit could be gained by leaving the site undeveloped. In some instances, the storage of flood water can help to alleviate flooding elsewhere, such as downstream developments. Where there is a large area of a site at risk that is considered large enough to hinder development, it may be appropriate to safeguard this land for the storage of floodwater.

Section 14; Paragraph 167 of the NPPF states that, to avoid where possible, flood risk to people and property, the LPAs should manage any residual risk by, '*safeguarding land from development that is required, or likely to be required, for current or future flood management'*.

Applicable sites assessed through this SFRA may include any current greenfield sites:

- That are considered to be large enough (>1 hectare) to store floodwater to achieve effective mitigation,
- With large areas of their footprint at high or medium surface water flood risk (based on the RoFSW),

- That is within the functional floodplain (Flood Zone 3b),
- With large areas of their footprint at risk from Flood Zone 3a; and
- That are large enough and within a suitable distance to receive floodwater from a nearby development site using appropriate SuDS techniques which may involve pumping, piping or swales/drains.

Brownfield sites could also be considered, though this would entail site clearance of existing buildings, conversion to greenspace and contaminated land assessments. By using the sequential approach to site layout, the LPA and developers should be able to avoid the areas at risk and leave clear for potential flood storage. See the maps in Appendix C to spatially assess the areas of the sites at risk.

11.2 Flood storage schemes

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

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

The construction of new upstream storage schemes in upper catchments within Buckinghamshire would provide one potential solution to flood risk. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream. This is demonstrated in the Stocklake Brook and Bear Brook Flood Storage Areas in Aylesbury.

There may also be opportunities to collaborate with neighbouring Local Planning Authorities to deliver flood storage schemes rural areas of Buckinghamshire which provide cross-boundary benefits to downstream communities, for example in the River Ouzel catchment, which passes into Central Bedfordshire, and in the River Ray, which passes into Cherwell and South Oxfordshire Districts.

11.3 Natural Flood Management (NFM)

Developments provide opportunities to work with natural processes to reduce flood and erosion risk, and to benefit the natural environment. Local Plan policy can

promote the use of natural flood management techniques, identify and safeguard land needed for NFM, and set out expectations for NFM contributions from developments.

Natural flood management requires integrated catchment management and involvement from those who use the land. It also requires partnership working with neighbouring authorities, organisations and water management bodies. For example, the role of NFM in holding back water needs to be balanced against the role of organisations such as the Buckingham and River Ouzel IDB to keep water flowing through their drainage district.

Conventional flood prevention schemes may be preferred, but consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example.

In 2017, the Environment Agency published an online evidence base to support the implementation of NFM and maps showing locations with the potential for NFM measures. These maps are intended to be used alongside the evidence directory to help practitioners think about the types of measure that may work in a catchment and the best places in which to locate them.

The following areas of potential are identified within Buckinghamshire:

- Additional floodplain woodland
    - River Ray (throughout), River Thame (throughout), River Great Ouse (upstream and downstream of Buckingham), River Thames (at Little Marlow, Bourne End and Taplow)
- Additional riparian woodland
    - Adjacent to watercourses throughout Buckinghamshire (although lesser opportunities in the Chiltern Hills)
- Additional catchment woodland
    - North of Buckinghamshire (Aylesbury Vale, catchments of Rivers Great Ouse, Ouzel and Ray), smaller opportunity area in South East Buckinghamshire (Gerrards Cross to Iver).
- Enhanced floodplain reconnection (removal of existing defences or structures without causing risk to properties)
    - River Thame (immediately upstream and downstream of Aylesbury), River Misbourne (south of Chalfont St Peter and west of Denham).
- Runoff attenuation features (to reduce 1 in 30-year and 1 in 100-year flows)
    - Localised flow paths in all areas of Buckinghamshire, with a greater concentration of opportunity areas in the north of the county.

Detailed mapping of NFM opportunity areas can be found online and in Appendix C.

With flood management schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

11.4 Catchment and floodplain restoration

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

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

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain, to introduce a more natural morphology
- Apply the Sequential Approach to ensure no new development within the floodplain

For those sites considered within the new Local Plan for Buckinghamshire, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. Loss of floodplain connectivity could potentially increase flooding. Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response of a watercourse to any proposed channel modification.

For the former Aylesbury Vale area, a watercourse advice note[121] for planners, developers and designers has been developed, to inform planning applications near watercourses and their associated corridors. It sets out the key principles for development, which include maintaining an ecological buffer zone, preventing pollution, obtaining the relevant permits and consents, and seeking opportunities to re-naturalise river channels, for example through de-culverting.

121 Buckinghamshire Council (2022) Watercourse advice note (Aylesbury Vale area). Available at: Watercourse advice note (Aylesbury Vale area) | Buckinghamshire Council.

As of 2020, the River Thames Conservation Trust is working closely with the Freshwater Habitats Trust and carrying out major projects to enhance the river, including new wetland sites, fish passes, bank and stream enhancements and re-naturalisation. More information on this progress can be found on the River Thame Conservation Trust site. Partnership projects between the Environment Agency, Affinity Water and other stakeholders are currently underway to 'Revitalise Chalk Rivers', including the River Misbourne, to a more natural state, so they are less susceptible to low flows and can support a variety of habitats.

11.4.1 Habitat Creation

There are an array of areas across Buckinghamshire which are focused on the management, restoration, and creation of habitats across wetlands and grasslands. The Natural Environment Partnership outline the habitats of these Biodiversity Opportunity Areas, which include:

- Ashridge & Ivinghoe Beacon
- Brill & Muswell Hill
- Central Chilterns Chalk Rivers
- Chess Valley
- Chiltern Escarpment
- Colne Valley
- Gomm Valley
- Hambleden & Wormsley Valley
- Medmenham
- Ouse Valley
- Radnage Valley
- South Bucks Heaths & Parklands
- South Western Commons
- Thame Valley
- Upper Ray

Strategic flood risk management solutions can provide both onsite and offsite opportunities to fulfil Biodiversity Net Gain (BNG) requirements for new development sites. Although guidance on implementing BNG within new developments in Buckinghamshire has been available since July 2022[122] , BNG will become mandatory for new developments nationwide in November 2023.

122 Buckinghamshire Council (2022) Supplementary Planning Document: Biodiversity Net Gain. Available at: 1. About the biodiversity net gain SPD | Buckinghamshire Council

The Freshwater Habitats Trust and River Thame Conservation Trust work with landowners to create a network of new freshwater and wetland habitats on the floodplains of the River Thame, including on the Waddesdon Estate and at an organic farm in Chearsley, between Aylesbury and Haddenham. The aim is to allow freshwater plants and animals to move easily across the landscape and become more resilient to climate change and other environmental pressures.

The Environment Agency's Regional Habitat Creation Programme also provides opportunities to receive funding to create habitats, which could help to facilitate nature-based flood risk management schemes.

11.4.2 Green Infrastructure and buffer strips

Buffer strips

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

It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. A buffer strip of 8m is required from any Main River[123], and no obstructions are permitted within 9m of the edge of a watercourse within the Buckingham and River Ouzel IDB[124]. The Council will ensure a buffer width is retained alongside ordinary watercourses, to allow sufficient space for access and maintenance. Where flood defences are present, these distances should be taken from the toe of the defence. A map of 8m buffer strips around watercourses in Buckinghamshire is included in Appendix C.

Any development in these areas will likely require a Flood Risk Permit from the Environment Agency, or Ordinary Watercourse Consent from the LLFA or IDB in addition to any planning permission. It should be noted that the requirement for Ordinary Watercourse Consent from the LLFA is independent of the need for planning permission (from the Local Planning Authority) and the granting of planning permission does not imply or guarantee that Land Drainage Consent will be granted.

There should be no built development within these distances from Main Rivers / flood defences (where present).

123 Environment Agency (2022) Flood Risk Activities: environmental permits. Available at: Flood risk activities: environmental permits - GOV.UK (www.gov.uk)

124 Bedford Group of Drainage Boards (2018) BYELAWS MADE BY THE BUCKINGHAM AND RIVER OUZEL INTERNAL DRAINAGE BOARD. Available at: bo_byelaws_final_sealed-defra-approved.pdf (idbs.org.uk)

Green Infrastructure

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

- Open spaces – parks, woodland, nature reserves, lakes
- Linkages – river corridors and canals, and pathways, cycle routes and greenways
- Networks of “urban green” – private gardens, street trees, verges and green roofs.

The identification and planning of GI is critical to sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. GI is also central to climate change action and is a recurring theme in planning policy.

With regards to flood risk, green spaces can be used to manage storm flows and free up water storage capacity in existing infrastructure to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. GI can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity.

Developers are encouraged to contribute to the network of green and blue-green infrastructure for Buckinghamshire within sites of all scales. Detailed GI action plans for the following six priority areas are available in the Buckinghamshire GI Delivery Plan 2013[125]:

- Amersham and Chesham
- Aylesbury
- Burnham and Farnham
- Gerrards Cross
- Whaddon Chase
- Wycombe

In addition, locations of opportunity areas for green infrastructure across in Buckinghamshire can be found in the Green Infrastructure Opportunities mapping[126].

Further priority areas for green infrastructure and nature recovery will be identified in the Buckinghamshire Local Nature Recovery Strategy, which will form part of a national Nature Recovery Network. Consisting of a Statement of Biodiversity Priorities

125 Buckinghamshire Council (2013) Buckinghamshire Green Infrastructure Delivery Plan.

126 Buckinghamshire and Milton Keynes NEP (2018) Green Infrastructure Opportunity Mapping. Available at: Green Infrastructure Opportunities Mapping – Buckinghamshire & Milton Keynes Natural Environment Partnership (bucksmknep.co.uk)

and a Local Habitat Map, the LNRS follows on from a 2021 pilot study, and aims to identify areas important for biodiversity, where recovery could contribute to other environmental benefits (such as managing flood risk and access to green spaces).

There may also be future opportunities to contribute to the green and blue-green infrastructure network associated with the Bedford & Milton Keynes (B&MK) Waterway Park, a strategic project linking the main UK waterway network with the Fens waterways of East Anglia. The scheme proposes to link Bedford to Milton Keynes with a new waterway, set within a multi-functional green corridor connecting east and west, opening up the Marston Vale region.

11.5 Engaging with key stakeholders

Flood risk to an area or development can often be attributed to a number of sources such as fluvial, surface water and/or groundwater. In rural areas the definition between each type of flood risk is more distinguished. However, within urban areas flooding from multiple sources can become intertwined.

Where complex flood risk issues are highlighted it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions.

Engagement with riparian owners is also important to ensure they understand their rights and responsibilities including:

- maintaining river bed and banks;
- allowing the flow of water to pass without obstruction; and
- controlling invasive alien species e.g. Japanese knotweed.

More information about riparian owner responsibilities can be found on the Buckinghamshire Council website and in the Environment Agency's guidance on Owning a Watercourse (2018).

12 Assessment of flood risk in potential development areas

12.1 Introduction

As part of a Level 1 SFRA, all sites and development areas considered for allocation within the Local Plan are assessed for suitability, based on flood risk. This ensures that all potential sites are assessed equally, regardless of their suitability on other planning grounds, and provides a solid evidence base to allow application of the Sequential Test.

At the time of preparing the Level 1 SFRA, the identification of suitable and deliverable allocation sites for the Local Plan, as part of the Housing and Employment Land Availability Assessment (HELAA) was in progress, and therefore site boundaries were not yet available for assessment.

Once sites are available, and as part of a Level 2 SFRA, the flood risk to each of these sites, from all sources of flooding, will be assessed by screening the site boundaries against the flood risk mapping from all sources, to determine the proportion of the site at risk.

The following flood risk information will be used in the assessment for each potential development area:

- % of site within each Flood Zone (3b, 3a, 2, and with an allowance for climate change).
- % of site within Risk of Flooding from Surface Water (3.3%, 1%, 0.1% probabilities, and with an allowance for climate change).
- Historic flooding (based on the Environment Agency's Historic Flood Map).
- % within Risk of Flooding from Reservoirs maximum extent.
- % of site within groundwater emergence mapping available for Buckinghamshire.
- % of site within JBA Groundwater flood map categories 3 (between 0.025m and 0.5m of ground surface) or 4 (within 0.025m of ground surface).
- Presence of watercourse mapped in Detailed River Network layer (watercourses under 3km² may not have Flood Zones).
- Presence of a raised canal embankment within 100m of the site.
- Presence of a large, raised reservoir within 500m of the site.

12.2 Sequential Testing

The SFRA will not include the Sequential Test of sites screened for flood risk. However, it will summarise the flood risk to the sites and provide evidence for use in the completion of the Sequential Test.

NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in preparation of a Local Plan Review. The assessments undertaken for the SFRA will assist Buckinghamshire Council in the preparation of the Sequential Test.

13 Summary

13.1 Overview

This Level 1 SFRA delivers a strategic assessment of all sources of flooding in the Local Plan area. It also provides an overview of policy and provides guidance for planners and developers. The study area comprises the administrative area of Buckinghamshire.

13.2 Sources of flood risk

The following section outlines the sources of flood risk which have been identified in Buckinghamshire.

13.2.1 Historic flooding

Buckinghamshire has a history of documented flood events from multiple sources of flood risk, including rivers, surface water, groundwater, sewers and canals. Flood records indicate that the main source of risk is from fluvial sources. However, this often coincides with high groundwater levels in the Chiltern Hills and gravel deposits of the floodplains, as well as ponding and runoff of surface water.

Recent significant flood events affected Buckinghamshire in occurred in Winter 2000/2001, July 2007, December 2013/2014, December 2020 which included notable flooding from a range of sources, including fluvial, surface water and groundwater.

13.2.2 Fluvial flood risk

The main watercourses flowing through Buckinghamshire are the Rivers Colne (including the Rivers Chess and Misbourne), Great Ouse (including the Ouzel), Thame (including the Bear Brook and Stocklake Brook), Thames (including the River Wye), and Ray. The most extensive fluvial flood risk is associated with the Rivers Thames and Great Ouse, the largest watercourses with the most densely populated floodplains. Flood Zone mapping of the fluvial flood risk in the Local Plan area has been prepared as part of the Level 1 SFRA and can be found in Appendix C.

13.2.3 Surface water flood risk

Flooding from surface water runoff (or ‘pluvial’ flooding) is caused by intense short periods of rainfall and usually affects lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage or drainage blockage by debris, and sewer flooding.

The Risk of Flooding from Surface Water dataset shows a number of surface water flow paths which predominantly follow topographical flow paths along existing watercourses or dry valleys with ponding located in low lying areas. The affected areas are predominantly located in steeper catchments in the south of Buckinghamshire, including Chesham, High Wycombe and Marlow, as well as in Aylesbury and Buckingham. Chesham and High Wycombe are identified as indicative nationally significant Flood Risk Areas for surface water flooding.

13.2.4 Groundwater flood risk

Due to the presence of chalk aquifers in the Chiltern Hills, groundwater flood risk is high across many areas of Buckinghamshire, including Amersham, Chesham, the Chalfonts and Monks Risborough. Groundwater flooding also occurs on river floodplains underlain by gravel deposits, such as the River Thames at Marlow, where rising water levels in the river can elevate water levels in the gravels, and cause flooding to low-lying areas.

Detailed groundwater emergence modelling studies have been carried out in key settlements Hambleden, Princes Risborough, West Wycombe, with further mapping in Buckinghamshire planned as part of Project Groundwater. Elsewhere, the JBA Groundwater Flood Map indicates that the majority of the risk of groundwater flooding is concentrated in bands in the south (Thames valley), centre (Aylesbury Vale) and north (River Great Ouse valley) of the county. The areas of Buckinghamshire where groundwater levels are either at or very near (within 0.025m of) the ground surface, are mostly located in narrow zones along the base of river valleys, including in the Rivers Chess, Misbourne and Wye.

13.2.5 Sewer flood risk

Sewer flooding incident data supplied by Anglian Water and Thames Water indicates a total of 2,250 recorded flood incidents within Buckinghamshire between 2019 and 2023. The more frequently flooded postcodes are HP13, HP15, HP19 and SL2 in the Thames Water area, and MK17 and MK18 in the Anglian Water area. However, it is important to recognise that the information does not present whether flooding incidences were caused by general exceedance of the design sewer system, or by operational issues such as blockages.

13.2.6 Flooding from reservoirs

In relation to artificial sources of flooding, there are no records of flooding from reservoirs impacting properties within Buckinghamshire. The Environment Agency's Risk of Flooding from Reservoir's flood extent mapping indicates that reservoirs in or

outside of the county could affect properties in the event of a breach (a full list of the reservoirs is provided in Table 6-15).

13.3 Flood defences

A high-level review of formal flood defences was carried out using existing information to provide an indication of their condition and standard of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment.

When considering proposed development consideration must be given to the status and timing of FRM measures and schemes to provide evidence on whether a proposed development may benefit from, hinder, adjust or facilitate delivery and implementation.

13.4 Key policies

Many relevant regional and local key policies have been considered within the SFRA (Section 2), such as the Anglian and Thames Rivers Catchment Flood Management Plans, the Anglian and Thames River Basin District Flood Risk Management Plans and the Buckinghamshire Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

13.5 Technical recommendations

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

13.5.1 Climate change modelling

This SFRA is based on the best available data at the time of publication. However, please refer to the latest Environment Agency guidance when preparing site-specific FRAs.

13.5.2 Updates to SFRA

SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. This SFRA has been developed using the best available information, supplied at the time of preparation. This relates both to the current risk of flooding from a range of sources, and the potential impacts of future climate change. Other datasets used to inform this SFRA may also be periodically updated and following the publication of this SFRA, new information on flood risk may be available

from Risk Management Authorities. It is recommended that the SFRA is reviewed internally, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking for any new information available from RMAs, including the Environment Agency, The Bedford Group of Drainage Boards and Buckinghamshire Council as LLFA.

A Appendix A - Flood history table

Date	Location affected	Source of flooding
March 1947	Buckingham	Fluvial
1954	Aylesbury	Fluvial
1962	Aylesbury	Fluvial
1968	Aylesbury	Fluvial
December 1979	Buckingham	Unknown source
1980	Aylesbury	Fluvial
1990	Aylesbury	Fluvial
April 1998	Buckingham	Fluvial and surface water
1999	Buckingham	Fluvial
August 1999	High Wycombe	Surface water
January 2001	Chiltern Hills, South Buckinghamshire and Wycombe District	Groundwater
January - March 2003	Buckingham and Aylesbury	Fluvial, surface water and groundwater
December 2006	Chalfonts and Aylesbury	Surface water
July 2007	Buckingham and Marlow	Fluvial and surface water
February 2009	Marlow, Chorleywood, Seer Green and Little Chalfont	Groundwater
November 2012	Buckingham	Fluvial
February 2013	Buckingham A421 bypass	Surface water
December 2013	Beaconsfield	Sewer flooding
December 2013	Wexham	Surface water
December 2013 - February 2014	Aylesbury	Surface water
December - January 2014	Bishopstone	Fluvial and groundwater
March - April 2014	Chalfont St Giles	Groundwater flooding
March 2014	Chalfont St Peter	Sewer flooding
January - February 2014	Bourne End	Fluvial
January - February 2014	Windsor Hill, Wooburn Green	Fluvial
January - February 2014	Medmenham	Surface water
January - February 2014	New Denham	Fluvial, surface water

Date	Location affected	Source of flooding
		and sewer flooding
January - February 2014	Marlow	Fluvial, surface water and groundwater
February 2014	Aylesbury, Willows	Fluvial
February 2014	Stoke Mandeville	Surface water
February 2014	Old Amersham	Groundwater, fluvial and surface water
February 2014	Monks Risborough	Groundwater flooding, sewer flooding and surface water
February 2014	Gerrards Cross	Surface water
September 2014	Chesham	Fluvial and Surface water
October 2014	Old Amersham	Fluvial
February 2015	Monks Risborough	Groundwater and surface water
March 2016	Buckingham	Fluvial
March 2016	Leckhampstead	Fluvial and surface water
June 2016	Amersham	Surface water
July 2017	High Wycombe	Surface water
May 2018	Great Missenden	Surface water
September 2019	Chalfont St Peter	Sewer flooding
December 2020	Aylesbury	Fluvial
December 2020	Buckingham	Fluvial
December 2020	Ickford	Fluvial
December 2020	Gawcott	Fluvial and surface water
December 2020	Thornborough	Fluvial
December 2020	Thornton	Fluvial
December 2020	Tingewick	Surface water and sewer flooding

B Appendix B - Sewer flooding records

Table 13-1 Hydraulic flooding incidents in areas of Buckinghamshire by postcode (combined records from Thames Water and Anglian Water from 2019 - 2023).

Postcode	Number of incidents
HP10 0	14
HP10 8	23
HP10 9	42
HP11 1	17
HP11 2	37
HP12 3	46
HP12 4	24
HP13 5	65
HP13 6	42
HP13 7	47
HP14 3	34
HP14 4	15
HP15 6	29
HP15 7	70
HP16 0	2
HP17 8	16
HP18 0	10
HP19 0	2
HP19 7	9
HP19 8	8
HP19 9	50
HP20 1	21
HP20 2	35
HP21 7	15
HP21 8	45
HP21 9	19
HP22 4	18
HP22 5	35
HP22 6	13
HP23 4	22
HP23 5	23

Postcode	Number of incidents
HP23 6	3
HP27 0	17
HP27 9	7
HP4 1	1
HP4 2	7
HP5 3	1
HP9 1	44
HP9 2	30
LU7 0	9
MK17 0	45
MK17 9	31
MK18 1	62
MK18 2	34
MK18 3	21
MK18 4	12
MK18 5	1
MK18 7	1
MK3 5	1
OX25 1	3
OX27 0	2
OX27 9	2
OX9 3	2
RG9 3	3
RG9 6	4
SL0 0	40
SL0 9	18
SL1 3	48
SL1 6	18
SL1 7	40
SL1 8	12
SL2 1	98
SL2 2	26
SL2 3	166
SL2 5	20

Postcode	Number of incidents
SL3 6	22
SL6 0	28
SL6 1	4
SL6 5	2
SL7 1	45
SL7 2	21
SL7 3	12
SL8 5	21
SL9 7	18
SL9 8	22
SL9 9	2
UB9 4	26
UB9 5	8
UB9 6	2

C Appendix C - Flood Risk Mapping

D Appendix D - Settlement summary of flood risk

E Appendix E - Sequential Test Methodology

F Appendix F - Sources of information used in preparing the SFRA

G Appendix G - Cumulative Impacts Assessment and recommendations

Offices at

Bristol
Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Leeds
Limerick
Newcastle upon Tyne
Newport
Peterborough
Portsmouth
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
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