Greater Cambridge Integrated Water Management Study

Level 1 Strategic Flood Risk Assessment

On behalf of **Greater Cambridge Shared Planning**

GREATER CAMBRIDGE
SHARED PLANNING

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Abbreviations and Glossary

Term	Definition/Description
Award Drain	Ordinary watercourses that have been assigned (”awarded”) to a public body such as the District Council or an Internal Drainage Board for maintenance
BGS	British Geological Society
CCC	Cambridge City Council
CFMP	Catchment Flood Management Plan: a high-level document presenting the Environment Agency’s long-term policies for flood risk management in the catchment
DCLG	Department of Community and Local Government
Defra	Department of Environment, Flood and Rural Affairs
DTM	Digital Terrain Model
Environment Agency (EA)	Environment Agency, a non-department public body, established in 1995 and with responsibilities relating to the protection and enhancement of the environment in England
Environmental Permitting Regulations	Framework for the regulation of “flood risk activities” by the Environment Agency, which in 2015-2016 replaced the ‘flood defence consent’ process
EU	European Union
FCERM	Flood and Coastal Erosion Risk Management
Flood Zone	Nationally consistent delineation of Zones at ‘high’, ‘medium’, and ‘low’ probability of flooding from fluvial (river) or tidal sources, updated on a quarterly basis by the Environment Agency
Formal Flood Defence	A structure built and maintained specifically for flood defence purposes
FRA	Flood Risk Assessment

Term	Definition/Description
Flood Risk Management Plan	Flood risk management Plans (FRMPs) explain the risk of flooding from rivers, the sea, surface water, groundwater and reservoirs for each river basin district. FRMPs set out how risk management authorities will manage flood risk over the next 6 years. Risk management authorities include the Environment Agency, lead local flood authorities (LLFAs), local councils, internal drainage boards, Highways England and water companies. FRMP are a requirement under the EU Floods Directive 2007.
IDB	Internal Drainage Board, a public body with permissive powers for managing land drainage and flood risk within their local area
Informal Flood Defence	A structure that provides a flood defence function, but was not built and/or maintained for this purpose
LiDAR	Light Detection and Ranging, a surveying method that measures distance to a target using lasers
LLFA	Lead Local Flood Authority, responsible at a local level for managing local flood risk from surface water, ground water and ordinary watercourses, as defined in the Flood & Water Management Act 2010
Main River	These are watercourses designated as “Main River” under the Water Resources Act (1991), as shown on the Main River map. Rights and responsibilities to Main rivers lie with the riparian owner (see owning a watercourse guidance). The Environment Agency have rights to carry out Flood Risk Management works, including maintenance, on Main Rivers. Under the Environmental Permitting Regulations (2016) a permit must be obtained from the Environment Agency for all works in, over, under or adjacent to main rivers.
NPPF	National Planning Policy Framework, the overarching UK planning policy document. NPPF Section 10 ‘Meeting the challenge of climate change, flooding and coastal change’ sets out the specific requirements relating to flood risk
Ordinary Watercourse	Ordinary watercourses are all watercourses which are not part of the Main River network. Rights and responsibilities to ordinary watercourses lie with the riparian owner. Under the Land Drainage Act (1991), consent is required from the Lead Local Flood Authority or Internal Drainage Board for any works that may alter the flow of water. Some ordinary watercourses are classified as “award drains” and maintained by the District Council or Internal Drainage Board.

Term	Definition/Description
Planning Policy Guidance	Planning Policy Guidance (PPG) are written documents that set out the government's policies on different aspects of planning policy. They give guidance to those involved in the operation of the planning system and explained the relationship between planning policies and other policies relating to development and land use. These were replaced by Planning Policy Statements (PPS), written statements published by the government to help explain the statutory provisions of the planning policy. These again are superseded by the NPPF but unless specifically revoked by the framework, existing policies remained effective.
Preliminary Flood Risk Assessment (PFRA)	A high-level summary of significant flood risk required under the Flood Risk Regulations (2009), based on available information and describing both the probability and consequences of past and future flooding
Residual Risk	A measure of the outstanding flood risks and uncertainties that have not been explicitly quantified and/or accounted for as part of the review process. It is the remaining risk after mitigation measures have been considered.
Riparian Owner	A person who owns land bounding a river, lake or other watercourse. Further riparian owner rights and responsibilities is available from the Environment Agency owning a watercourse guidance.
SCDC	South Cambridgeshire District Council
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SPD	Supplementary Planning Document, providing additional guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan.
SWMP	Surface Water Management Plan, which identifies the surface water flood risk and outlines management options and strategy in a particular location
Sustainability Appraisal	Appraisal of plans, strategies and proposals to test them against broad sustainability objectives
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (The World Commission on Environment and Development, 1987)

Term	Definition/Description
Watercourse	Any natural or artificial channel above or below ground through which water flows, such as a river, brook, beck, ditch, mill stream or culvert.
WFD	Water Framework Directive

1 Introduction

1.1 Greater Cambridge Integrated Water Management Study

1.1.1 Stantec UK Ltd were commissioned by Greater Cambridge Shared Planning Service to prepare an Integrated Water Management Study to support the development of the Greater Cambridge Local Plan. The Greater Cambridge area represents South Cambridgeshire District Council (SCDC) and Cambridge City Council (CCC). The combined SCDC and CCC administrative areas will be referred to as “Greater Cambridge” in this report (Figure 1-1).

1.1.2 The Integrated Water Management Study consists of:

- A Strategic Spatial Options Review, to provide a high-level commentary on the opportunities, constraints and uncertainties for water aspects for the strategic spatial options currently being tested by the Greater Cambridge Shared Planning Service.
- A Level 1 Strategic Flood Risk Assessment (SFRA), to support a sequential, risk-based approach to the location of development, required as a standalone document under the National Planning Policy Framework.
- An Outline Water Cycle Study, to identify the baseline / as-existing water situation.
- A Detailed Water Cycle Study, to provide advice on the broad strategy options being considered for the location of growth and the sites coming forward for allocation in the draft Local Plan.

1.1.3 This report comprises the Level 1 Strategic Flood Risk Assessment. Information from this study has been used to inform the Outline Water Cycle Study and vice versa.

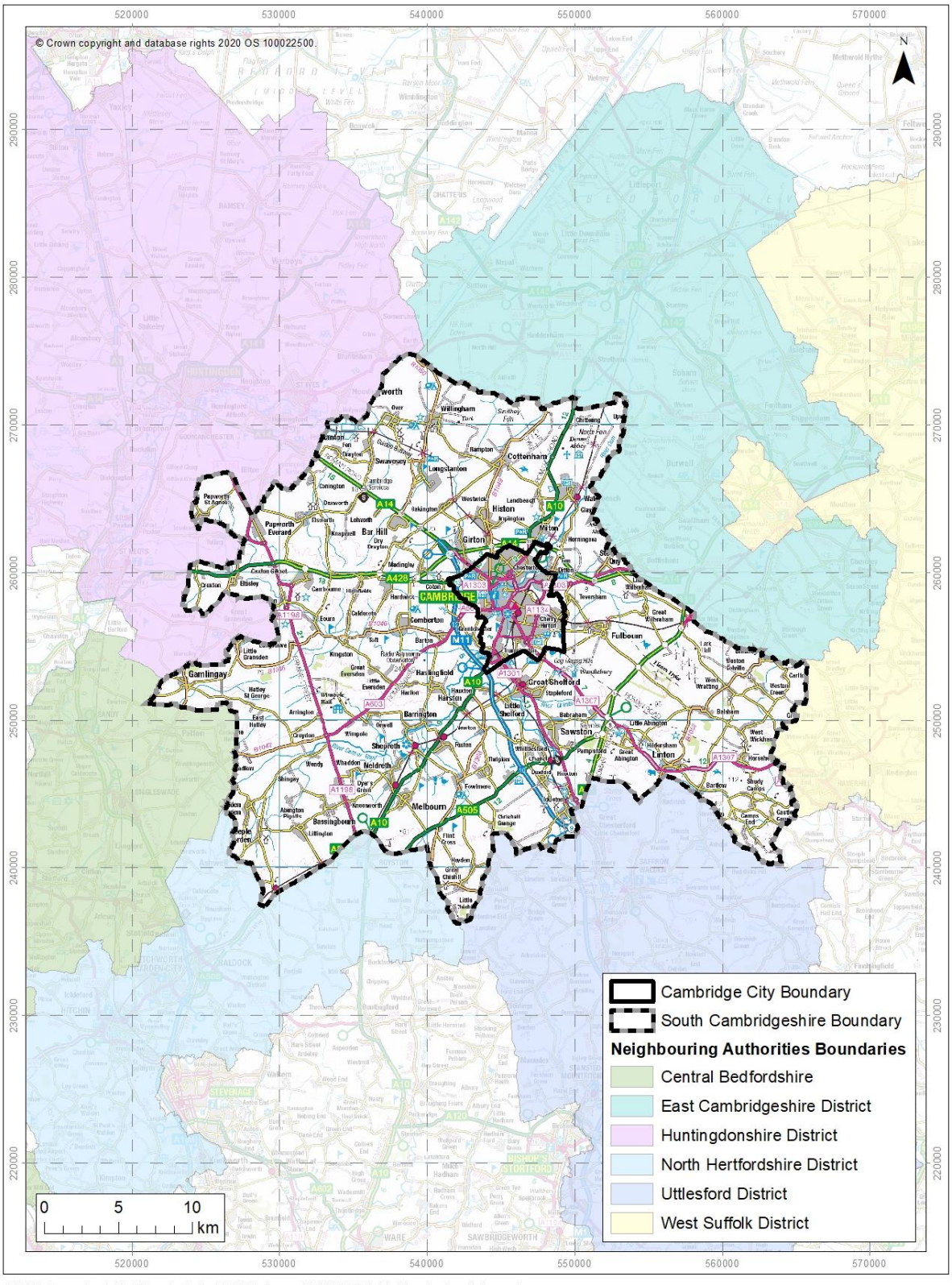


Figure 1-1: Study Area and Neighbouring Authorities

1.2 SFRA Scope and Structure

1.2.1 This Level 1 SFRA replaces the previous Level 1 assessment carried out in 2010. The purpose of this report is to update the previous assessment using the latest flood risk information together with the most current flood risk and planning policy available at the time of writing from the revised National Planning Policy Framework[1] (2019). The councils require this update to inform the evidence base for the new Local Plan.

1.2.2 The SFRA has been prepared based on the Government's requirements[2]. The aims and objectives of this SFRA are:

- To map flood risk from all sources, identifying the extent and severity of flood risk throughout the study area, delineating Flood Zones and the Functional Floodplain.
- To identify the potential effects of climate change and development on future flood risk.
- To identify measures proposed or underway in Greater Cambridge to address flooding issues, and the land required for current and future flood management that should be safeguarded from development.
- To form part of the evidence base and inform the Sustainability Appraisal for the new Local Plan, including recommendations for planning policy relating to flood risk.
- To provide information to support the selection of development sites through the application of the Sequential Test and Exception Test, enabling the councils to meet their obligations under the National Planning Policy Framework.
- To provide advice for site-specific flood risk assessments, including guidance on the application and suitability of mitigation measures, and opportunities to reduce flood risk for existing communities.

1.2.3 To meet these objectives, the following Level 1 SFRA outputs have been prepared:

- Maps, collating current and future flood risk areas, flood risk infrastructure and functional floodplain (where data available)
- This supporting report, which provides supporting information on policy and technical updates, data sources, historic flooding incidents, areas of uncertainty, flood risk management infrastructure, climate change,

[1] National Planning Policy Framework

[2] Local Planning Authorities Strategic Flood Risk Assessment Guidance

surface water management, flood warning and emergency planning, and the Sequential and Exception Test.

- User guidance for applying the Sequential and Exception Test, and for site-specific flood risk assessments, included in this report.

1.2.4 At the time of writing, allocations for future growth are not known, and therefore the Sequential and Exception Test will be applied at a later stage. Following the application of the Sequential Test, the Councils may consider it necessary to develop a Level 2 SFRA should it be shown that proposed site allocations fall within a flood affected area, not within Flood Zone 1. The Level 2 SFRA should provide further evidence to consider the risk of flooding in greater detail, within a local context to provide confidence that the site can be developed in a safe and sustainable manner.

1.2.5 The structure of the SFRA is as follows:

- Chapter 2: Overview of study area geographical context
- Chapters 3 and 4: Legislation, policy and guidance context (national and local)
- Chapter 5: Impacts of climate change
- Chapters 6 and 7: Data collection, quality review and SFRA mapping overview
- Chapter 8: Flood risk opportunities and constraints
- Chapter 9: Overview of Sequential and Exception Tests
- Chapters 10 and 11: Flood risk assessment requirements, surface water drainage and SuDS design advice for new developments
- Chapter 12: Flood warning and emergency plan
- Chapter 13: Summary and recommendations

1.3 Stakeholder Engagement

1.3.1 A stakeholder engagement process was followed to seek information for this study. This engagement process did not constitute a formal consultation process, which will be undertaken as part of the new Local Plan programme. A full list of stakeholders contacted, and responses received, is included in Appendix A, and the data received is summarised in Chapter 6.

1.3.2 There are a number of stakeholders who have responsibility for managing flood risk in the Greater Cambridge area. These Risk Management Authorities and their key responsibilities relevant for this SFRA are outlined in

1.3.3 Table 1-1. The flood risk sources managed by each Risk Management Authority are summarised in Table 1-2.

Cambridgeshire County Council, the Lead Local Flood Authority (LLFA), have established the Cambridgeshire & Peterborough Flood and Water Partnership (CP FloW). This brings together all the organisations and partners across the county who are concerned with managing flooding, including those listed in

1.3.4 Table 1-1, as well as Cambridgeshire Constabulary, Natural England and the Wildlife Trust. This partnership provides a coordinated and collaborative approach to flood risk management across the county.

Risk Management Authority	Overview of Responsibilities
Environment Agency	• Strategic overview of all types of flooding and water management issues • Permissive powers to manage watercourses designated “Main River”, including issuing consents for works • Declaring and communicating Flood Warnings • Enforcement authority for all reservoirs that fall under the Reservoirs Act (1975), and statutory undertaker for its own reservoirs • Enforcement powers to require landowners to take action to minimise flood risk to others • Review risks, flood management strategies and asset schemes
Lead Local Flood Authority (Cambridgeshire County Council)	• Preparation of Local Flood Risk Management Strategy • Investigating and reporting flood incidents • Designating and registering structures and features that affect flood risk • Permissive powers to manage flood risk from surface water, ‘ordinary watercourses’ outside of IDB areas, and groundwater, including issuing consents for works • Enforcement powers to require landowners to take action to minimise flood risk to others
District Councils (South Cambridgeshire District Council and Cambridge City Council)	• Local Planning Authority responsibilities for development and flood risk, including surface water drainage and flood risk • Maintenance of “Awarded Watercourses”
Internal Drainage Boards (Middle Level Commissioners and Ely Group of Drainage Boards)	• Local public drainage authority in areas of special drainage need • Permissive powers to manage flood risk and land drainage to meet local needs, including issuing consents for works • Enforcement powers to require landowners to take action to minimise flood risk to others
Water and wastewater providers (Anglian Water and Cambridge Water)	• Responsibility for surface, foul and combined public sewers (Anglian Water) • Provision of potable water (Cambridge Water)
Highway Authority (Cambridge County Council)	• Highways drainage

Table 1-1: Overview of Risk Management Authorities in Greater Cambridge

Risk from:	**Environment Agency**	**Lead Local Flood Authority**	**District / Borough Council**	**Water Company**	**Highway Authority**	**Internal Drainage Board**
Main River[4]	✓					
The sea	✓					
Surface water		✓				✓
Surface water (from highway)					✓	
Sewer flooding				✓		
Ordinary watercourse		✓	✓			✓
Groundwater		✓				
Reservoirs[3]	✓	✓	✓	✓	✓	✓
Coastal erosion	✓		✓			
Strategic overview of all risk sources	✓					

Table 1-2: Risk management authorities by risk source.

[3] Risk management authorities have different responsibilities for reservoirs, including regulation, asset management and flood incident response.

[4]Excludes any Public Sector Cooperation Agreements for maintenance.

1.4 Updating this SFRA

1.4.1 This document is an update to the original SFRA produced in 2010. Since the publication of the original SFRA, there have been significant changes in national and local planning policy and associated guidance, combined with improvements in the understanding of flood risk within Greater Cambridge. Flood risk is not static and there are continual developments in flood risk management guidance and policy. It is recommended that the SFRA is reviewed by the Local Authorities in consultation with the Environment Agency and the Lead Local Flood Authority on a regular basis, to identify and implement any significant updates necessary. This review could be led by the Greater Cambridgeshire Local Planning Authority.

1.4.2 The following key questions should be used to identify whether a significant update is necessary:

Question 1: Has any significant flooding been observed within Greater Cambridge since the previous review?

- If so, information regarding the date, extents, perceived cause, and probability of the event should be captured as an addendum to the SFRA (for example, through reference to any Flood Investigation Reports prepared by the LLFA, see Chapter 4). Consideration should be given to incorporating the observed extents into the flood extents mapping to inform future planning decision making where appropriate.

Question 2: Have any amendments to the NPPF or associated guidance been implemented?

- If so, a review of the SFRA guidance and mapping should be carried out if:
  - There is a revision to the definition of Flood Zones or Flood Extents (any source)
  - There is a revision to the categorisation of land use vulnerability
  - There is a revision to the application and decision-making process of the Sequential and Exception Tests
  - There is a revision to the SFRA guidance or other technical reports

Question 3: Have there been any amendments to any Risk Management Authorities' flood risk management assets, flood risk mapping and/or standing guidance?

- If so, a review of the SFRA guidance and mapping should be carried out if:
  - New flood defence systems have been constructed or existing assets standard of protection altered
  - New or updated flood modelling and mapping has resulted in a change to flood extents (any source)

- The assessment of the impact of climate change on rainfall and/or river flows over time has altered

- The recommendations provided in this SFRA in anyway contradict emerging advice, for example with respect to emergency access, setting of floor levels and integration of sustainable drainage techniques.

Question 4: Has the implementation of the SFRA within the Local Plan and Development Control functions of the Councils raised any issues or concerns?

- If so, a review of the SFRA guidance and mapping should be undertaken with regards to the issues raised?

1.5 Disclaimer

1.5.1 This SFRA has been compiled using the information and data available at the time of preparation. The mapping of flood risk is not an exact science, and the risk to a specific area can change over time as greater knowledge on localised flooding is obtained.

1.5.2 The SFRA is a strategic-level document intended to support and inform the spatial planning process and it will trigger the requirement for more detailed site-specific Flood Risk Assessments to accompany applications for new development. It is anticipated that such reports will further refine and improve the assessment of flood risk at a localised level with the most up-to-date information at the time.

2 Geographical Context

2.1 Location and Climate

2.1.1 Greater Cambridge comprises an area of 942 km^2 across southern Cambridgeshire. It is bordered by Uttlesford and North Hertfordshire District Councils to the south, Central Bedfordshire and Huntingdonshire District Council to the west and north, and East Cambridgeshire and West Suffolk District Councils to the north and east (Figure 1-1).

2.1.2 The area is centred on the city of Cambridge, which is a highly urbanised area with some notable green spaces that are often linked to the River Cam corridor. The remainder of the area is essentially rural with a network of villages. The total population of the area is approximately 294,320 (Cambridgeshire Insights, 2018), of which almost half reside in Cambridge City.

2.1.3 Greater Cambridge is one of the driest regions in the UK, with an average rainfall of 568 mm per year compared to the UK average of 1154 mm per year. The area tends to have hot summers, and holds the highest temperature record for the UK, 38.7 °C, recorded in July 2019 at Cambridge University Botanic Garden. Rain typically falls evenly through the year, but the rain that falls in summer months is often in the form of intensive convective summer thunderstorms; the LLFA have noted these intense rainfall events have occurred on several occasions. This means that flooding from different sources can and has occurred all year round.

2.2 Geology, Topography and Land Use

2.2.1 The geology of the area is shown in Figure 2-1 (bedrock) and Figure 2-2 (superficial deposits). The bedrock comprises various chalk formations in a band from the south-west of the area to the north-east. These give way to clay formations in the north-west quadrant, interspersed with some smaller areas of sandstone. Superficial deposits include Diamicton, sand and gravel river terrace deposits, alluvium and peat.

2.2.2 The topography of the area is strongly influenced by the bedrock geology. Levels vary from highs of +150 m AOD in southern and eastern parts where the area overlies the East Anglian Chalk ridge, to lows of less than 0 m AOD (below sea level) in northern parts where the area encroaches into the Cambridgeshire Fens (see Figure 2-3).

2.2.3 The study area is currently mostly agricultural land Grade 2, with some areas categorised Grade 3 (see Figure 2-4 and Table 2-1). Where peat deposits are found, the land is classified as agricultural Grade 1. Approximately 7% of the study area is currently classified as urban or non-agricultural land use.

Land Classification	Total Area (km2)	Proportion of Study Area (%)
Grade 1	17.4	1.8
Grade 2	596.7	63.3
Grade 3	248.5	26.4
Grade 4	15.7	1.7
Grade 5	18.7	2.0
Non-Agricultural	45.5	4.8
Urban	17.4	1.9

Table 2-1: Land use classification for Greater Cambridge area

2.3 Watercourses and Catchments

2.3.1 The main watercourse in the area is the River Cam, which flows northwards through Cambridge before entering the River Great Ouse north of the area (Figure 2-5). Key tributaries of the River Cam include the River Granta, the River Rhee, Bourn Brook, and the Cam Lodes. Areas in the north-west of the area lie outside the River Cam catchment and are drained northwards by other tributaries of the River Great Ouse, such as Swavesey Drain.

2.3.2 The designated Main River watercourses in the area are:

- River Granta from Linton
- River Cam
- River Rhee and Mill River
- Bourn Brook downstream of Toft
- Bin Brook from Newnham
- Wilbraham Fen Lode
- Cottenham Lode and its upper tributaries in Oakington and Girton
- Willingham Lode (Cam Lodes)
- Swavesey Drain and its upper tributaries

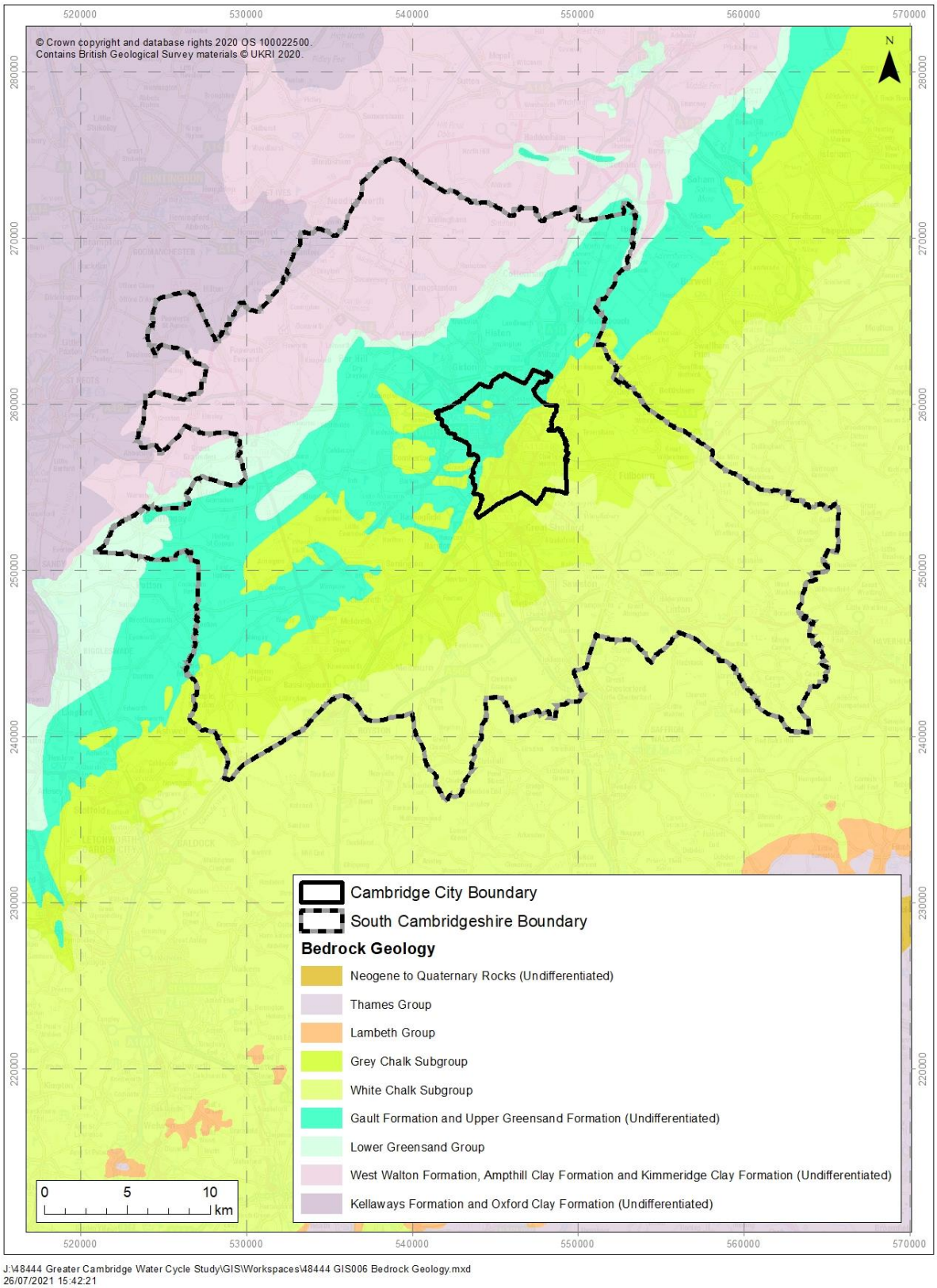


Figure 2-1: Bedrock Geology

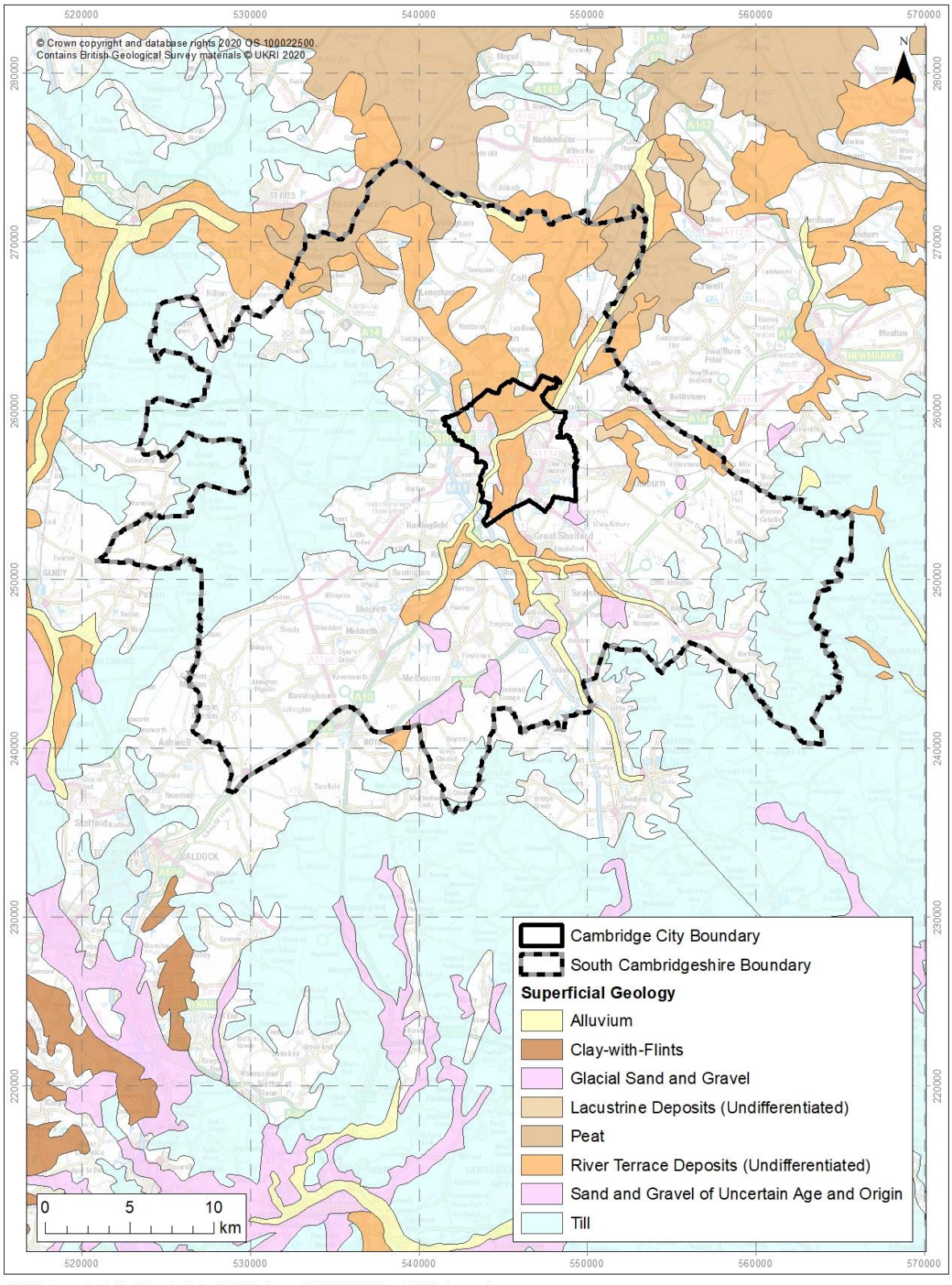


Figure 2-2: Superficial Geology

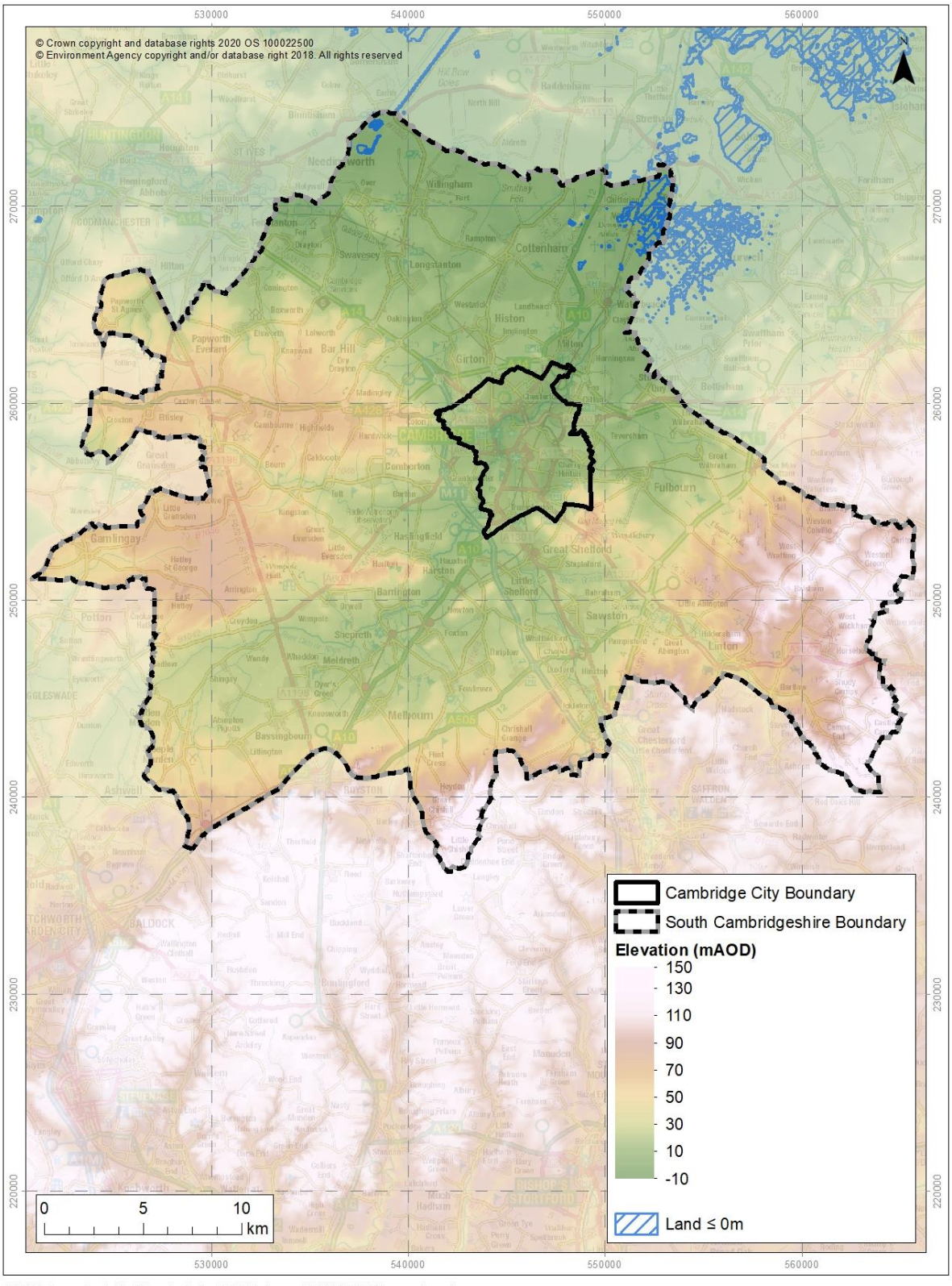


Figure 2-3: Topography

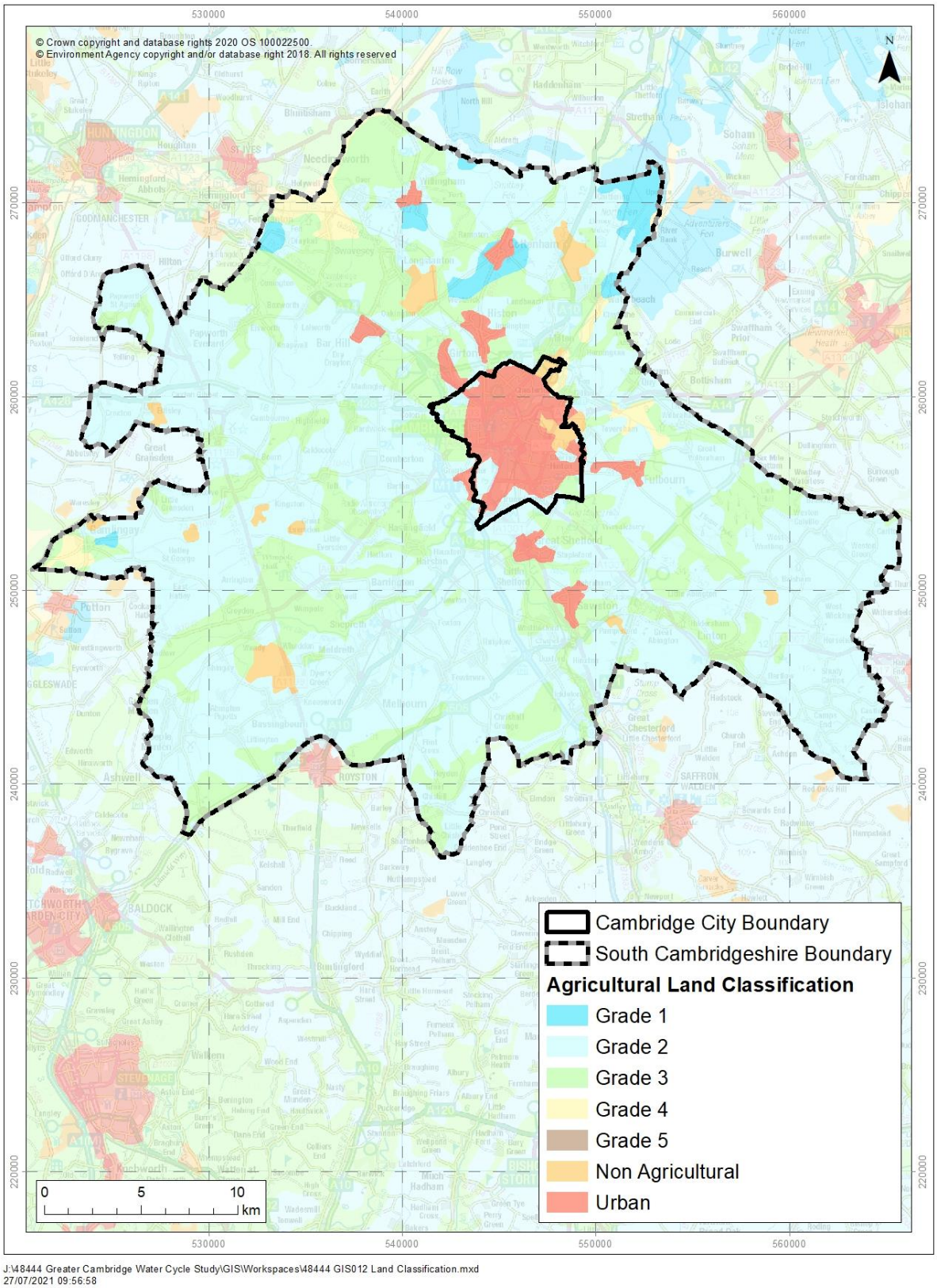


Figure 2-4: Agricultural Land Classification

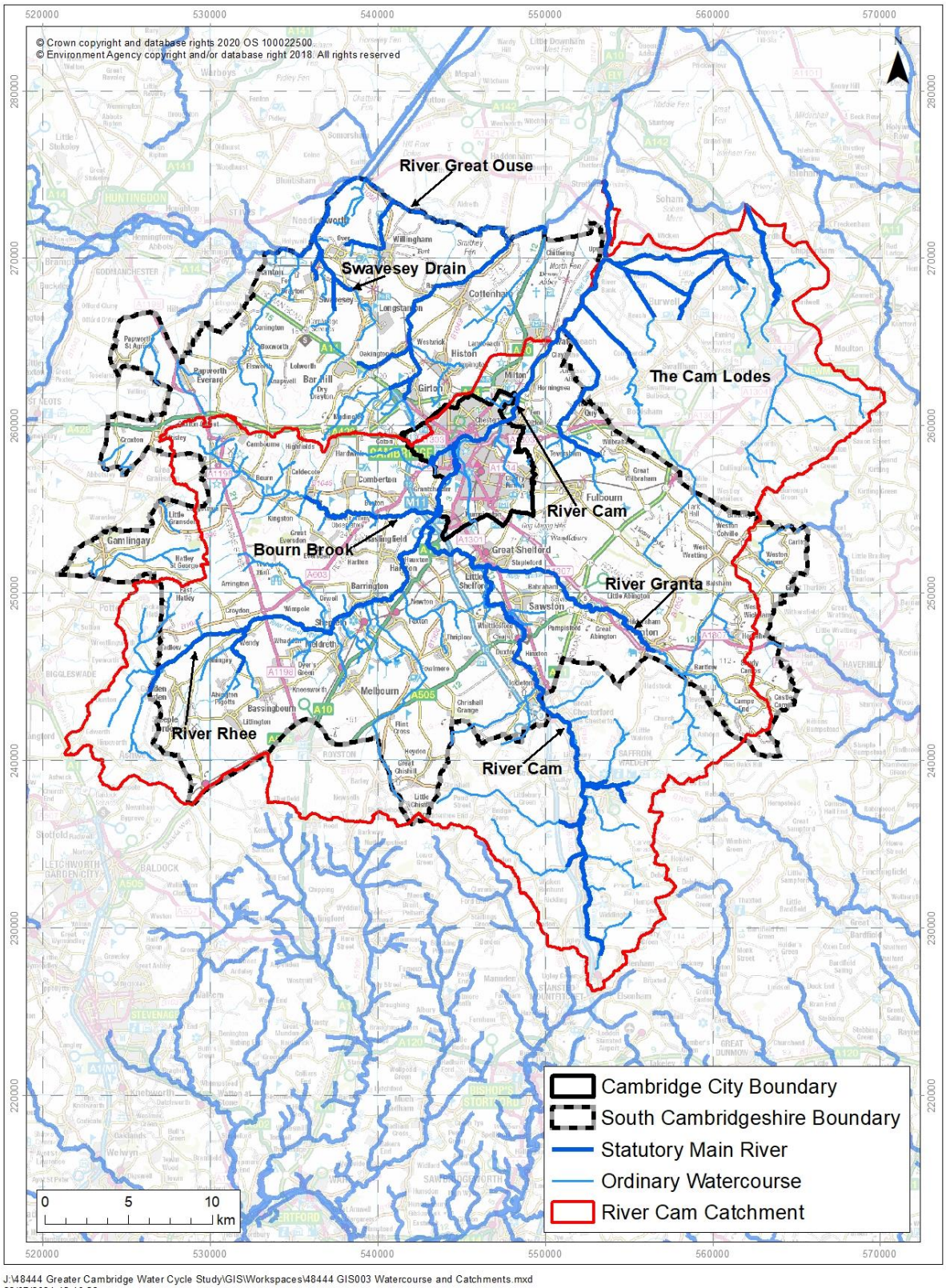


Figure 2-5: Watercourses and River Cam Catchment

2.4 Past and Future Development

2.4.1 Although the total percent of urban land use in the study area is small, the rate of urbanisation in Cambridgeshire as a whole has doubled since the 1950s. The majority of this growth has occurred in the rural South Cambridgeshire district area, partly due to the green belt restrictions around Cambridge itself however growth has also occurred on the edges of Cambridge within the green belt via urban extensions. The past growth has included new settlements such as Bar Hill (begun late 1950s) and Cambourne (begun late 1990s) and the new settlement of Northstowe, as well as infilling and expansion of existing villages.

2.4.2 A further 45,180 homes are currently planned to be constructed from 2018 onwards in the most recent Greater Cambridge Housing Trajectory and Five Year Housing Land Supply[4], published April 2020, based on site allocations in the 2018 Local Plan. This leads to the future projected population shown in Figure 2-6, based on current development plans (excluding additional growth related to the new Local Plan proposals), with a population estimate of over 350,000 by the year 2033.

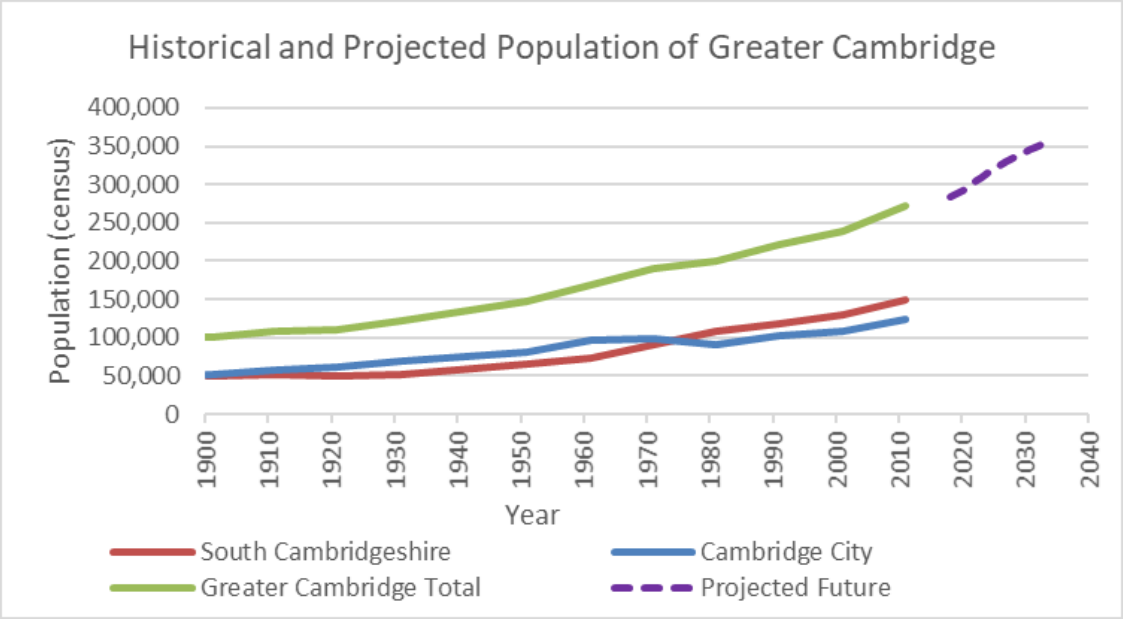


Figure 2-6: Historical population of Greater Cambridge (census data adjusted for boundary changes by Cambridgeshire Insight) and future projected population (based on Greater Cambridge Housing Trajectory April 2020)

2.4.3 As part of the Cambridgeshire and Peterborough devolution deal, the Combined Authority committed to a vision of doubling the total economic output of the area over 25 years. Initial calculations indicate that 2,900 homes a year will need to be built to achieve the jobs growth.

2.4.4 In addition, Greater Cambridge lies at one end of the Cambridge – Milton Keynes – Oxford corridor. In 2016, the National Infrastructure Commission was asked to consider how to maximum the potential of this corridor as a single

[4] Greater Cambridge Housing Trajectory and Five Year Housing Supply Report

knowledge-intensive cluster that competes on a global stage, protecting the area's high-quality environment, and securing the homes and jobs that the area needs. The final report was published in 2017 and identifies opportunities to deliver one million new homes and jobs in the area by 2050. Central to achieving this vision is the completion of the strategic transport route East-West Rail.

2.4.5 There is therefore the potential for significant and transformative future development in the Greater Cambridge area and the cumulative impacts of this growth is an important consideration. Specific future growth trajectories and site allocations for the new Local Plan are not considered in detail in this Level 1 SFRA. Following the application of the Sequential Test (see Chapter 9), the Councils may consider it necessary to develop a Level 2 SFRA should any proposed site allocations lie within or near a flood affected area. The Level 2 SFRA would consider the risk of flooding in greater detail within a local context, and give consideration to cumulative impacts, to provide confidence that the site could be developed in a safe and sustainable manner.

2.4.6 The implementation of policies should ensure that there are no impacts, and therefore safeguard against cumulative impacts. Nonetheless, the revised National Planning Policy Framework (see Chapter 3) considers not only the risk of flooding posed to new development, but also seeks to reduce the risk of flooding to existing properties. Therefore, the scale of development in Greater Cambridge may offer new opportunities to improve existing flood risk issues, that would otherwise not have been achievable. These opportunities are discussed further in Chapter 8.

3 National Legislation, Policy and Guidance Context

3.1 Chapter Overview

3.1.1 This SFRA has been prepared with regard to relevant national, regional and local legislation, policy and guidance for flood risk management, as summarised in Table 3-1. This list is not exhaustive but focusses on the most relevant items for this study. This SFRA in turn may be referred to in future local and regional documents and plans. The combined objective of these regulations, documents and plans is to take full account of flood risk when planning at all levels, to deliver appropriate sustainable development in the right places. The aim of policies is to avoid inappropriate development in flood risk areas, assessing risk so that it can be avoided, managed, controlled, and mitigated.

Scale	Regulations, Documents and Plans
National	Reservoirs Act (1975) Highways Act (1980) Building Regulations (1984, 2002, 2010) Water Industry Act (1991) and Water Act (2014) Land Drainage Act (1991) Water Framework Directive (2000) Climate Change Act (2008) Flood Risk Regulations (2009) Flood and Water Management Act (2010) National Strategy for Flood Risk and Coastal Erosion Risk Management (2020) National Planning Policy Framework (2019) and supporting guidance
Regional	Catchment Flood Management Plans (2010) Anglian River Basin District Flood Risk Management Plan (2016) Anglian River Basin Management Plan Anglian Water Asset Management Plan 2020 - 2025
Local	Cambridgeshire Preliminary Flood Risk Assessment (2011) Cambridgeshire Local Flood Risk Management Strategy 2015 - 2020 Cambridgeshire Flood and Water Supplementary Planning Document (2016) Surface Water Management Plans (2011 – 2014) Flood Investigation Reports Internal Drainage Board Byelaws

Table 3-1: Summary of national, regional and local regulations, documents and plans reviewed in this SFRA (not exhaustive)

3.1.2 For ease of reference, national regulations, documents and plans are summarised in this chapter. Regional and local regulations, documents and plans are summarised in the following chapter. These summaries focus on areas relevant to the SFRA, in particular flood risk and development. We recommend the Cambridgeshire Local Flood Risk Management Strategy for a more detailed and broader review of relevant legislation.

3.1.3 The national legislation, policy and guidance provides a context for this SFRA. The legislation sets out the roles and responsibilities of the various Risk Management Authorities. The policy and guidance provide the principles for managing flood risk, allocating development with regards to flood risk considerations, and adapting to the potential impacts of climate change.

3.2 Reservoirs Act (1975)

3.2.1 The **Reservoirs Act (1975)** gives the Environment Agency responsibility for enforcing safety requirements for large raised reservoirs (>25,000 m^3 impounded storage volume). The legislation has since been updated to include the requirement for all reservoir undertakers to prepare Flood Plans for reservoirs where failure could lead to major damage or loss of life. The Environment Agency have also produced reservoir breach inundation maps for all reservoirs.

3.2.2 The Flood and Water Management Act (2010) included provision to reduce the capacity at which reservoirs should be regulated from 25,000 m^3 to 10,000 m^3. This part of the act has not yet been enacted.

3.2.3 The implications of this legislation for the SFRA are:

- The inclusion of reservoir inundation maps to inform site allocations. It is not a requirement that all development must be located outside of the reservoir inundation extents, but instead careful consideration should be given to mitigation of the flood risk through emergency planning (see Chapter 12).

3.3 Highways Act (1980)

3.3.1 The **Highways Act (1980)** covers the management and operation of the road network in England and Wales. The act includes 14 parts, involving aspects such as highway authorities, agreements between authorities and the creation or maintenance of highways; part 6 covers navigational waters and watercourses, offering guidance on the construction of bridges over and tunnels under navigable waters, as well as diversions of watercourses. The act states the highway authority (for the Greater Cambridge region this is Cambridgeshire County Council) may construct drains and take actions to divert surface water into them for the purpose of draining highways. Having the responsibility for ensuring the highways drain fully and take actions to clean drains and watercourse which prevent this.

3.3.2 The implications of this legislation for the SFRA are:

- The rights of the highways authority to construct structures or divert watercourses, influence the existing regime, to adequately drain highways

- The responsibility for the maintenance of highway drains and watercourses

3.4 Building Regulations (1984, 2002, 2010)

3.4.1 The **Building Regulations (1984, 2002, 2010)** cover the requirements for construction and extension of buildings, with the aim of ensuring the health, safety and welfare of people inside or outside the building. The regulations included Part H (Drainage and Waste, 2015 update), which offers guidance on drainage including foul and surface water, and sanitary waste disposal. Requirement H3 relates to the drainage of rainwater (surface water) and sets out a hierarchy for surface water disposal, encouraging a SuDS approach. Minimum design standards are set out for drainage systems, and reference is made to British Standards EN 752-4: 1998 Drain and Sewer Systems Outside Buildings Part 4 for performance requirements. The regulations only relate to the drainage of property and do not consider off-site impacts.

3.4.2 The implications of this legislation for the SFRA are:

- The legal basis for the SuDS hierarchical approach to site drainage (see Chapter 11).

- Specification of the minimum design standards for surface water disposal, including British Standards for performance requirements.

3.5 Water Industry Act (1991) and Water Act (2014)

3.5.1 The **Water Industry Act (1991)** set out the regulatory, competition and consumer representation frameworks for the water sector in England and Wales, following privatisation of the water supply and sewerage networks. The Act places a duty upon the water undertaker to develop and maintain efficient and economical systems of water supply in its area, and a duty upon the sewerage undertaker to provide, improve and extend a system of public sewers to ensure that its area is “effectively drained” and the contents of those sewers effectually dealt with. Under Section 51a and Section 106, developers have the right to connect to the existing supply and sewerage system, respectively. The cost of providing the infrastructure improvements required to supply water and sewerage services are shared between the developer and the undertaker in accordance with the provisions of the legislation.

3.5.2 Investment in water supply and sewerage infrastructure is undertaken through Asset Management Plan cycles. The plans are approved by the water regulator, Ofwat, and include investment programmes to manage the flood risk from sewers.

3.5.3 The Water Act (2014) amended the Water Industry Act (1991). With the aim of reforming the water industry to make it more innovative and responsive to

customers, and to increase the resilience of water suppliers to natural hazards such as drought and floods. The act also made provisions for flood insurance.

3.5.4 The key implications of this legislation for the SFRA are:

- The duty of water companies to “effectively drain” their areas and deal with the contents of sewers. Further discussion of Anglian Water’s Asset Management Plan proposals for managing flood risk from its foul and surface water drainage network is included in Section 4.5.

- The rights of developers to connect to the existing sewerage system for foul and surface water drainage of new developments.

3.6 Land Drainage Act (1991)

3.6.1 The **Land Drainage Act (1991)** outlines the duties and powers to manage land drainage for a number of bodies including the Environment Agency, Internal Drainage Boards, Local Authorities, navigation authorities and riparian landowners, and more recently the LLFA. The Act confers permissive powers for works and bye-laws for Internal Drainage Boards and the LLFA for their areas.

3.6.2 The key implications of this legislation for the SFRA are:

- Consent must be sought by developers from the relevant authority for any works to ordinary watercourses that might affect flow of water, such as construction of a culvert or drainage outfall, or channel realignment.

- Local bye-laws must be adhered to with regards to development control, for example proximity of developments to watercourses, and discharge of surface water run-off.

3.7 Water Framework Directive (2000)

3.7.1 The **Water Framework Directive (EU, 2000)** established a European-wide approach to water quality policy and management. The directive was transposed into UK law by the Water Environment Regulations (updated 2017). The regulations implement a holistic approach to the management, protection and monitoring of the water environment. The aim of the regulations is to prevent any further deterioration in water resources volume and quality, protect and enhance the status of aquatic ecosystems and associated wetlands, promote sustainable water consumption, and contribute to mitigating the effects of floods and droughts.

3.7.2 The key objectives of the regulations are to prevent deterioration in the status of water bodies and aim to achieve good ecological and chemical status or potential (including quantitative status in groundwater bodies) by 2021. Water bodies must also comply with standards and objectives of Protected Areas (i.e. an area designed under another European Directive, such as a Special Area of Conservation), where these apply. In addition, discharges, emissions and losses of priority substances to surface water bodies must be progressively reduced and emissions of priority hazardous substances prevented. Finally,

action must be taken to reverse any identified sustained upward trend in pollution concentrations in groundwater bodies.

3.7.3 The key implications of this legislation for the SFRA are:

- The protection of water bodies against deterioration in status due to development, and the aim to improve to good ecological and chemical status / potential by 2021. The potential impacts of development on water body status are discussed further in the Outline Water Cycle Strategy.

3.8 Climate Change Act (2008)

3.8.1 The **Climate Change Act (2008)** requires the government to regularly assess the risks to the UK of current and predicted impacts of climate change, to set out climate change adaption objectives, and to set out proposals and policies to meet these objectives. The Act was amended in 2019 to commit the UK to achieving a 100% reduction in emissions by 2050 (net zero emissions).

3.8.2 The key implications of this legislation for the SFRA are:

- To support the 2050 net zero emissions target through any proposed flood risk and surface water infrastructure.

- To assess the potential impacts of climate change on flood risk and identify adaptation and mitigation policies and tools for the new Local Plan.

3.9 Flood Risk Regulations (2009)

3.9.1 The **Flood Risk Regulations (2009)** transpose Directive 2007/60/EC of the European Parliament and of the Council on the assessment and management of flood risks for England and Wales. The regulations define the Lead Local Flood Authority (LLFA), which is Cambridgeshire County Council for the Greater Cambridge area. The regulations set out a set of responsibilities and deliverables with an associated timetable, for both the Environment Agency (in relation to flood risk from main rivers, reservoirs and the sea) and the LLFA (for all other sources of flooding):

- Part 2 imposes duties on the Environment Agency and LLFAs to prepare Preliminary Flood Risk Assessment reports of past and potential future flooding in their administrative area;

- Part 3 imposes duties on the Environment Agency and LLFAs to prepare Flood Risk and Flood Hazard Maps;

- Part 4 imposes duties on the Environment Agency and LLFAs to prepare Flood Risk Management Plans;

- Part 6 imposes duties on the Environment Agency and local authorities to co-operate with each other for the purposes of the regulations, and a power to require information reasonably required in connection with functions under these regulations.

3.9.2 The assessments, mapping and planning functions defined by the regulations are reviewed on a six-yearly cycle with the first review due in 2017. This has not yet been published by the LLFA for Greater Cambridge at the time of writing.

3.9.3 The key implications of this legislation for the SFRA are:

- The production of Preliminary Flood Risk Assessment reports, mapping and management plans for the Greater Cambridge area by the LLFA and Environment Agency. These reports are summarised in Chapter 4.

3.10 Flood and Water Management Act (2010)

3.10.1 The **Flood and Water Management Act (2010)** makes provision for the management of flood and coastal erosion risks, including implementing the recommendations of the Pitt Review following flooding in 2007. It introduced powers for local authorities to manage flood risk and allows water companies to restrict water usage during drought periods. The Act further established and confirmed the role of LLFAs as responsible for local flood risk management, including becoming a statutory consultee for surface water on planning applications for major development.

3.10.2 The Act confirms the duty to cooperate between risk management authorities, and the power to request information in connection with functions under the act. The Act included amendments to the Land Drainage Act (1991), the Water Resources Act (1991) and the Water Industry Act (1991) to clarify and enhance the powers of LLFAs and other bodies for managing flood risk.

3.10.3 The Act requires Local Planning Authorities to “aim to make a contribution towards the achievement of sustainable development”. Local Planning Authorities are required to ensure that appropriate Sustainable Drainage Systems (SuDS) are provided for the management of run-off within a development. Local Planning Authorities must also ensure there are clear arrangements in place for the ongoing maintenance of SuDS for the lifetime of the development, through planning conditions or obligations. Should Schedule 3 become enacted, the LLFA may become the SuDS Approving Body (SAB) responsible to approving, adopting and maintaining any SuDS drainage systems that serve more than one property.

3.10.4 The key implications of this legislation for the SFRA are:

- The production of a National Flood and Coastal Erosion Risk Management Strategy by the Environment Agency (see below).

- The preparation of a Local Flood Risk Management Strategy, flood incident reports, and a register of structures or features affecting flood risk in their area, including designation of such features, by the LLFA (see Chapter 4).

3.11 National Strategy for Flood and Coastal Erosion Risk Management (FCERM) (2011 and 2020)

3.11.1 The Environment Agency has a statutory duty to develop, maintain, apply and monitor a national flood and coastal erosion risk management strategy, under Section 7 of the Flood and Water Management Act (2010).

3.11.2 A new National Flood and Coastal Risk management Strategy was issued in July 2020. The strategy offers a new long-term approach to improve resilience to climate change and is closely aligned with the Defra flood and coastal erosion risk management policy statement (2020). The vision of the strategy is "a nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100". The strategy has three long term ambitions:

i. Climate resilient places – working with partners to bolster resilience to flooding and coastal change across the nation, both now and in the face of climate change. Risk management authorities will work with partners to:

- Deliver practical and innovative actions that help to bolster resilience to flood and coastal change in local places.
- Make greater use of nature-based solutions that take a catchment led approach to managing the flow of water to improve resilience to both floods and droughts.
- Maximise opportunities to work with farmers and land managers to help them adapt their businesses and practices to be resilient to flooding and coastal change.
- Develop adaptive pathways in local places that equip practitioners and policy makers to better plan for future flood and coastal change and adapt to future climate hazards.

ii. Today's growth and infrastructure resilience in tomorrow's climate – making the right investment and planning decisions to secure sustainable growth and environmental improvements, as well as infrastructure resilient to flooding and coastal change. Risk management authorities will work with partners to:

- Put greater focus on providing timely and quality planning advice that helps avoid inappropriate development in areas at risk of flooding and coastal change.
- Leave the environment in a better state by contributing to environmental net gain for new development proposals.
- Ensure that spending on flood and coastal resilience contributes to job creation and sustainable growth in local places.

- Mainstream property flood resilience measures and to 'build back better' after flooding to reduce damages and enable faster recovery for local communities.

- Provide expert advice on how infrastructure providers (road, rail, water and power supplies) can ensure their investments are more resilient to future flooding and coastal change avoiding disruption to peoples' lives and livelihoods.

iii. A nation ready to respond and adapt to flooding and coastal change – ensuring local people understand the risks posed by flooding and coastal change, are responsible for managing the impacts and know how to take action. Risk management authorities will work with partners to:

- Support communities to better prepare and respond to flooding and coastal change, including transforming how people receive flood warnings.

- Ensure people and businesses receive the support they need from all those involved in recovery so they can get back to normal quicker after flooding.

- Help support communities with managing the long-term mental health impacts from flooding and coastal change.

- Develop the skills and capabilities needed to better support communities to adapt to future flooding and coastal change.

- Become a world leader in the research and innovation of flood and coastal risk management to better protect current and future generations.

These ambitions inform and are underpinned by continuing development of understanding of risk now and in the future, using this evidence to identify investment needs.

3.11.3 The strategy is ambitious, and the Environment Agency is currently engaging with partners to create a shared set of practical actions for the next 5 years. This SFRA and the wider Greater Cambridge Integrated Water Management Study are in line with the aims and objectives of the strategy.

3.12 Revised National Planning Policy Framework (NPPF, 2019)

3.12.1 The **National Planning Policy Framework (NPPF)** was updated in February 2019 and sets out the government's planning policies for England and how these are expected to be applied. Chapter 14 is entitled 'Meeting the challenge of climate change, flooding and coastal change' and sets out how the planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. The NPPF is supported by planning practice guidance which includes a detailed section on flood risk and coastal change.

3.12.2 The key implications of this legislation for the SFRA are:

- The requirement for a sequential, risk-based approach to the location of development, taking into account the current and future impacts of climate change and managing any residual risk (Chapter 9).
- The requirement to safeguard land from development that is required, or likely to be required, for current or future flood management (Chapter 7).
- The requirement to use opportunities provided by new development to reduce the causes and impacts of flooding (Chapter 8).
- The requirement to relocate development to more sustainable locations, where some existing development may not be sustainable in the long-term due to climate change (Chapter 7).
- The requirement for major developments to incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate (Chapter 11).

4 Regional and Local Regulations, Documents and Plans

4.1 Great Ouse Catchment Flood Management Plan (2010)

4.1.1 The **Great Ouse Catchment Flood Management Plan (CFMP)** was released in 2010 by the Environment Agency. The document provides a high-level overview of the flood risk in the Great Ouse catchment and sets out the Environment Agency's preferred plan for sustainable flood risk management over the next 50 years. Most of the Greater Cambridge study area falls within this catchment. The CFMP aims to develop sustainable policies for managing the increased future flood risk that may result from climate change, urbanisation and land management changes.

4.1.2 The CFMP divides the Great Ouse catchment into 11 distinct sub-areas where each sub-sub area has similar physical characteristics, sources of flooding and level of risk (refer to Map 3 of the CFMP[5]). Of these, sub-areas 3 (Cambridge), 10 (The Fens) and 1 (Eastern Rivers) relate to the Greater Cambridge study area. Each sub-area is allocated one of six flood risk management policies, these and the actions for each sub-area are summarised in Table 4-1 to Table 4-3.

[5] Great Ouse Catchment Flood Management Plan

Policy Unit	10 – The Fens
Location	Low-lying fenland areas in the north of the Greater Cambridge study area
Current and future flood risk	108 properties were estimated as currently at risk of flooding during a 1% annual probability river flood (taking into account current flood defences), increasing to 508 properties in 2110 (for whole sub-area, not Greater Cambridge)
Selected policy	The selected policy for this area is "**Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change**" (Policy P4). Historically, the Fens have been heavily managed to drain the land and reduce the risk of flooding. In the short-term, it is feasible and effective to maintain the existing flood defences. However, it may be difficult to maintain the current level of flood risk into the future for all low-lying areas. Where it is technically, environmentally and economically viable, the policy is to undertake further activities to sustain the current level of flood risk into the future. Within the Fenlands, all risk management authorities and partners must together develop a sustainable, integrated and long-term flood risk management approach. Environmental enhancement projects must also be incorporated to ensure that existing wetlands are maintained and enhanced, and new wetlands created.
Proposed Actions	• In the short term, continue with current levels of flood risk management on all watercourses. • Continue with and implement the recommendations of the Great Ouse Tidal River Strategy. • Ensure any policies within the Local Development Framework or any revisions are in line with the CFMP policy. • Continue with and implement the recommendations of the Earith to Mepal Area Action Plan along with the Cranbrook / Counter Drain flood risk management strategy. • Continue with improvements to the flood warning service by extending the current Flood Warnings Direct service, and by creating community-based flood warnings. • Reduce the consequences of flooding by improving public awareness of flooding and encouraging people to sign up to and respond to flood warnings. • Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links at risk from flooding.

Table 4-1: Catchment Flood Management Plan policy and actions for the Fens policy unit.

Sub-area	**3 – Cambridge**
Location	The city of Cambridge, and surrounding villages Oakington, Histon, Impington, Girton, Milton, Grantchester, Trumpington and Great Shelford.
Current and future flood risk	646 properties were estimated as currently at risk of flooding during a 1% annual probability river flood (taking into account current flood defences), increasing to 942 properties in 2110.
Selected policy	The selected policy for this area is "**Areas of moderate to high flood risk where we can generally take further action to reduce flood risk**" (Policy P5). This policy allows the Environment Agency to further investigate options to reduce the probability of flooding, because the existing flood risk is too high. However, the CFMP notes that large-scale interventions may not be technically, environmentally or economically viable for all communities at risk and therefore action must also be taken to manage the consequences of flooding. The most sustainable way of reducing flood risk will be through floodplain management.
Proposed Actions	• In the short term, continue with current levels of flood risk management on all watercourses. • Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links at risk from flooding. • Continue with improvements to the flood warning service by extending the current Flood Warnings Direct service, and by creating community-based flood warnings. • Develop a flood risk study for Cambridge to investigate options to reduce flooding. This study should focus on the River Cam. • Develop a flood risk study for Vicar's Brook to investigate options to reduce flooding. • Continue with and implement the recommendations of the Surface Water Management Plans. • Ensure any policies within the Local Development Framework or any revisions are in line with the CFMP policy. In areas being developed and redeveloped, policies should be put in place to create green corridors and to incorporate flood resilience measures into the location, lay-out and design of development. Any new development should not increase the risk to existing development. Opportunities should be taken to link flood risk management planning with development and urban regeneration, so that the location, lay-out and design of development can help to manage flood risk.

Table 4-2: Catchment Flood Management Plan policy and actions for the Cambridge Policy Unit

Sub-area	**1 – Eastern Rivers**
Location	Rural areas east, south and west of Cambridge, including the River Granta, River Rhee and Bourn Brook catchments.
Current and future flood risk	2017 properties were estimated as currently at risk of flooding during a 1% annual probability river flood (taking into account current flood defences), increasing to 2457 properties in 2110 (for whole sub-area, not Greater Cambridge)
Selected policy	The selected policy for this area is "**Areas of low to moderate flood risk where we are generally managing existing flood risk effectively**" (Policy P3). Within this area there are a number of main rivers and ordinary watercourses that are managed by different risk management authorities, and the risk of flooding varies. This policy allows each risk management authority to exercise their powers to continue routine maintenance and carry out essential works on watercourses to benefit local communities. This policy also gives risk management authorities the flexibility to manage flooding through existing or alternative actions. The Environment Agency will look at reducing flood risk maintenance in areas where there is a low risk of flooding and prioritise resources to areas where flood risk is higher.
Proposed Actions	• Investigate opportunities to reduce current levels of flood risk management on the main rivers in this sub-area. • Continue with current levels of flood risk management on all ordinary watercourses (including Award Drains) in this sub-area. • Continue with improvements to the flood warning service by extending the current Flood Warnings Direct service, and by creating community-based flood warnings. • Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links. • Ensure any policies within the Local Development Framework or any revisions are in line with the CFMP policy. • Ensure that opportunities are taken within minerals and waste development / action plans to use mineral extraction sites to store flood water. • Produce land management plans to explore opportunities to change land use and develop sustainable land management practices. • Develop environmental enhancement projects to improve the natural state of the rivers and their habitats.

Table 4-3: Catchment Flood Management Plan policy and actions for the Eastern Rivers policy unit.

4.2 North Essex Catchment Flood Management Plan (2009)

4.2.1 A small part of the Greater Cambridge study area falls within the **North Essex Catchment Flood Management Plan**, specifically the Upper Reaches policy unit. The selected policy and proposed actions for this unit are summarised below.

Policy Unit	**Upper Reaches**
Location	Villages in the far east of the Greater Cambridge study area, including Carlton, Weston Green, Willingham Green, Carlton Green, Castle Camps and Olmstead Green.
Current and future flood risk	83 properties were estimated as currently at risk of flooding during a 1% annual probability river flood (taking into account current flood defences), increasing to 105 properties in 2110 (for whole policy unit area, not Greater Cambridge)
Selected policy	The selected policy for this unit is **"Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions"**. This policy allows risk management authorities to reduce activities to manage flooding in rural reaches, continuing existing actions where flood risk is more concentrated (e.g. towns and villages). Reducing bank and channel maintenance will help naturalise rivers and improve the connectivity between the river and its floodplain.
Proposed Actions	• Investigate options to cease or reduce current bank and channel maintenance and flood defence maintenance. In addition, changes in land use, development of sustainable farming practices and environmental enhancement should be investigated to mitigate an increase in flooding in the future. • Encourage planners to develop policies to prevent inappropriate development in the floodplain. Any new development should be resilient to flooding and provide opportunities to improve river environments. • Continue with the flood warning service including the maintenance of flood warning infrastructure and public awareness plans. • Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links at risk from flooding.

Table 4-4: Catchment Flood Management Plan policy and actions for the North Essex Upper Reaches policy unit.

4.3 Anglian River Basin District Flood Risk Management Plan (2016)

4.3.1 The Environment Agency have prepared a River Basin District Flood Risk Management Plan for the Anglian Region as required under the Flood Risk Regulations (2009). This identifies the risk of flooding from rivers, the sea, surface water, groundwater and reservoirs, and sets out how risk management authorities will manage flood and coastal erosion risk to 2022. The majority of the Greater Cambridge area lies within the Cam and Ely Ouse Management Catchment. Fenland areas in the north of the study area lie within the Fens Strategic Area, while a very small area in the far east of the study area lies within the Combined Essex Management Catchment.

4.3.2 The Flood Risk Management Plan includes objectives for managing flood risk, covering people, the economy and the environment. These are used to plan and prioritise investment programmes to target investment to the most at-risk communities. The actions required to meet these objectives are called 'measures'. For example, across the Cam and Ely Ouse Management Catchment there are 80 measures, and therefore these are not reproduced in full in this report. Particular measures of interest to this study are:

- Investigate the potential for property level protection in suitable locations across Cambridgeshire.
- Reduce flood risk to residential properties in Cambridge.
- Develop detailed Surface Water Management Plans for Histon and Impington.
- Review flood risk and identify mitigation options for Girton.
- Develop a collaborative and strategic approach to flood risk in the Fens.
- Engage with individuals, businesses and communities at risk of flooding to help them be aware of and understand their flood risk, provide advice on how to prepare for and become more resilient to future flooding, and encourage the development of personal and community flood plans.
- Provide a flood warning service for main river, tidal, coastal, and where appropriate groundwater flood risk areas.

4.4 Anglian River Basin Management Plan (2015)

4.4.1 In order to implement the Water Framework Directive (2000) requirements, **River Basin Management Plans** (RBMPs) have been prepared by the Environment Agency for all identified water bodies in the UK. RBMPs include a programme of measures being undertaken for each water body to maintain or reach 'good' status.

4.4.2 RBMPs are focussed on the quality of the water environment, including water quality, ecology and geomorphological indicators. Therefore, the RMBP is reviewed in detail in the accompanying Water Cycle Strategy reports. However, as part of the process of aligning WFD requirements with local planning, all

consents for works to watercourses must show compliance with the WFD objectives, to prevent the deterioration in the overall status of water bodies. Any application that does not properly consider these obligations may be refused.

4.5 Anglian Water Asset Management Plan 2020 – 2025

4.5.1 Anglian Water's **Asset Management Plan (AMP)** sets out how Anglian Water will move closer to achieving its four 25-year Strategic Direction Statement ambitions:

- Make the East of England resilient to the risks of drought and flooding
- Enable sustainable economic and housing growth in the UK's fastest growing region
- Work with others to achieve significant improvement in ecological quality across our catchments
- Be a carbon neutral business by 2050

4.5.2 With regards to flooding, Anglian Water plan to increase investment in sustainable, long term surface water strategies and increased partnership working including a multi-AMP strategy for reducing the volume of surface water that enters the sewers. Community flood risk management will focus on managing storm flows within the wider community, using existing catchment storage with technological solutions, at 643 investment locations and 20 key sewerage catchments.

4.5.3 Anglian Water are currently preparing a Drainage and Wastewater Management Plan, which is a long-term strategic plan to maintain and improve wastewater systems and drainage networks. This plan will be opened for consultation in October 2022, with the final plan published in spring 2023 prior to final determination for funding through Ofwat, expected in January 2024.

4.6 Cambridgeshire Preliminary Flood Risk Assessment (2011)

4.6.1 The Flood Risk Regulations (2009) require the LLFA to produce a **Preliminary Flood Risk Assessment (PFRA)** that shows areas of significant flooding using the government's threshold. This provides a high-level screening of high-risk areas, to facilitate effective management of flood risk at the national scale and was completed in 2011. A review and update to this report is required every six years under the Regulations but was not available at the time of writing.

4.6.2 The study identified that there are no 'Flood Risk Areas of national significance' within Cambridgeshire. There are areas that have high levels of flood risk from a variety of sources, that are most effectively managed at the local scale through the future preparation of local flood risk management strategies such as Surface Water Management Plans (see below).

4.7 Cambridgeshire Local Flood Risk Management Strategy (2015 – 2020)

4.7.1 The Flood and Water Management Act (2010) requires the LLFA to '*develop, maintain, apply and monitor a strategy for local flood risk management in its area'*. This was completed by the LLFA in 2015, developed jointly with members of the Cambridgeshire Flood Risk Management Partnership, and will be updating the Local Flood Risk Management Strategy within the next year. There are 5 objectives within the strategy:

i. Understanding flood risk

ii. Managing the likelihood and impact of flooding

iii. Helping citizens to understand and manage their own risk

iv. Ensuring appropriate development in Cambridgeshire

v. Improving flood prediction, warning and post-flood recovery

4.7.2 The study also sets out the roles and responsibilities of risk management authorities, the various funding avenues for flood risk management activities, and the need for local partnership and contributions in delivering flood management schemes. The study is a comprehensive study of flood risk management in Cambridgeshire, including further details on Risk Management Authorities and other stakeholders' roles and responsibilities, associated plans and documents, and the LLFA's approach to fulfilling its duties in flood risk management, investigation and reporting. It is recommended that this study is referred to for further information beyond the overview provided in this SFRA.

4.7.3 With regards to Objective 4: Ensuring appropriate development in Cambridgeshire, the report explains the roles and responsibilities of the LLFA and other Risk Management Authorities in the planning process. Specific actions to support this objective include:

- Prepare planning guidance document to detail how information from detailed Surface Water Management Plans can be used in planning decisions.
- Provide Flood and Water Supplementary Planning Document to provide greater policy guidance when considering new development.
- Support revisions to SFRAs to ensure evidence in the local plans is up to date, and planning decisions are made in adherence with the National Planning Policy Framework.
- Contribute towards the protection and enhancement of the environmental heritage and unique landscape character of the Fens, by working in partnership with key stakeholders to help grow the economy in the Fens through early consideration of flood and water management needs.

- Share information and data in the development of new Local Plans, demonstrating that Local Plans take account of the relevant information from the Local Flood Risk Management Strategy.

- Ensure developments take account of flood risk and make necessary contributions to the cost of flood defences through Section 106 and Community Infrastructure Levy, and contributions payable to IDBs.

4.8 Cambridgeshire Flood and Water Supplementary Planning Document (2016)

4.8.1 The supplementary planning document (SPD) was prepared with input from all water management authorities across Cambridgeshire, coordinated by the LLFA and is a material planning consideration when determining planning applications. It does not introduce new policy but is consistent with and elaborates on existing policies in the current local plan.

4.8.2 The SPD addresses all the flood and water issues associated with developments within Cambridgeshire. The SPD provides detailed guidance on working together with risk management authorities, site selection and managing flood risk to developments, managing and mitigating risk, surface water and sustainable drainage systems, and the water environment. The SPD has been referred to extensively in the preparation of this report, to ensure consistency of approach with the LLFA.

4.9 Cambridgeshire Surface Water Management Plan (2011 - 2014)

4.9.1 A strategic county-wide surface water management plan (SWMP) was produced in 2011 and updated in 2014 by the Cambridgeshire Flood Risk Management Partnership. The objectives of the SWMP were to:

- Engage with partners and stakeholders.

- Map historical flood incident data.

- Map surface water influenced flooding locations.

- Identify areas at risk of surface water flooding, referred to as ‘wetspots’.

- Assess, compare and prioritise wetspots for detailed assessment.

- Identify measures, assess options and confirm preferred options for the prioritised wetspots.

- Make recommendations for next steps.

4.9.2 The initial 2011 report presented the results of the initial investigations and produced a prioritised list of wetspots for further investigation. Detailed modelling of flood alleviation options, economic appraisal and detailed design was subsequently undertaken for a number of high priority wetspots. Following these studies, instances of surface water flooding, and updated national surface water flood risk mapping, the SWMP was updated in 2014. The resulting

wetspots identified using a variety of multi-criteria analysis methods are listed in Table 4-5.

Cambridge City	South Cambridgeshire
Bin Brook Castle School Cherry Hinton Cherry Hinton village City Centre Coldham's Common King's Hedges Arbury North Chesterton South Chesterton Trumpington Vicar's Brook Hobson's Conduit	Bar Hill Bourn Caxton Comberton Coton Cottenham Elsworth Fen Drayton Fulbourn Gamlingay Girton Great Shelford Haslingfield Histon / Impington Linton Oakington Papworth Everard Sawston Whittlesford

Table 4-5: Priority wetspots identified using all multi-criteria analysis weightings and methods (alphabetical order)

4.9.3 The study recommended that the LLFA:

- Review the historic flooding incident weighting, because this significantly affected ranking of wetspots and prioritisation of resources.
- Continue the collation and review of historic flood incident data in wetspots with high frequencies of historic incidents, particularly blockages, to inform decisions on future maintenance programmes.
- Determine ongoing resilience planning and mitigation measures for third party assets, to inform decisions where critical infrastructure significantly affects ranking of wetspots.
- Prioritise investment in flood resilience planning and flood alleviation using the outputs of the study and taking into account budgetary constraints and local concerns.
- Educate and engage with Parish Councils and the public to demonstrate the LLFAs efforts in flood risk management in the County.

4.9.4 The LLFA have prepared detailed surface water management plans (SWMPs) at the following wetspots in the Greater Cambridge study area, which are reviewed in the following sections:

- Cambridge and Milton
- Girton
- Histon and Impington

4.10 Cambridge and Milton Detailed Surface Water Management Plan (2011)

4.10.1 The Cambridge and Milton SWMP (2011) aimed to produce a long-term action plan for surface water management in Cambridge and Milton. Area-wide hydraulic modelling was used to identify priority wetspots within the study area for detailed investigation. The SWMP also produced flood depth, velocity and hazard mapping across the Cambridge and Milton study area.

4.10.2 The Cherry Hinton and King's Hedges & Arbury wetspots were prioritised. For the remaining wetspots, further monitoring was recommended with a view to using future development in these areas to help mitigate flood risk. The detailed investigations evaluated a range of potential engineering measures and options, including cost-benefit appraisal. The 'Do Minimum' option of continuing current maintenance arrangements was identified as the most cost-effective option for both wetspots. However, it was recognised that this option does not deliver any reduction to the number of properties vulnerable to flooding and will not address increasing flood risk associated with climate change. Therefore, the recommended option was a combination of:

- Increased maintenance of ordinary watercourses and surface water drains in the wetspot.
- A combined engineering option to include installation of attenuation features and swales within the catchment, to be taken forward for detailed design.
- Actions for risk management authorities to assess key assets in the study area, campaign to increase the uptake of water butts and other SuDS in existing residential areas, and improved data management including upkeep of a Flood Incident Register by the LLFA.

4.11 Girton Detailed Surface Water Management Plan (2012)

4.11.1 The Girton SWMP (2012) considered surface water flood risk for the village of Girton. The village is located on a ridge of higher ground, bounded to the north and west by the Washpit Brook and Beck Brook river valleys. Major flooding occurred in May 1978 and October 2001, resulting in internal property flooding. Localised flooding was reported on a further nine events between 2005 and 2010. Detailed hydraulic modelling was used to identify priority wetspots at Thornton Road and the A14 and assess improvement options.

4.11.2 The study did not recommend any options for the A14 wetspot due to the planned (now completed) engineering works to the A14, which were anticipated to improve drainage. Watercourse clearance upstream and downstream of Thornton Road was recommended to reduce flood risk in that area, to be combined with property level mitigation measures. It is not known if these proposed works have been implemented.

4.12 Histon and Impington Detailed Surface Water Management Plan (2014)

4.12.1 The Histon and Impington SWMP (2014) examined surface water flood risk in the two villages, which had a history of flooding. Priority wetspots were identified as the lower extent of South Road and Villa Road, Glebe Road, and Water Lane. Detailed hydraulic modelling was used to assess a short list of options, including upstream attenuation, channel reprofiling and improved maintenance.

4.12.2 The study found that upstream and downstream storage with channel widening was the preferred option, but the low cost-benefit ratio meant that the scheme would not attract FCERM grant funding. Although it has not been possible to implement these recommendations as yet, Highways England funding has been used to replace a dilapidated culvert.

4.13 Cambridge University Hospitals NHS Foundation Trust Surface Water Management Plan (2018)

4.13.1 The Cambridge University Hospitals NHS Foundation Trust SWMP (2018) aimed to produce a long-term action plan for surface water management for the commonly known Addenbrooke's and Rosie Hospitals, as well as its surrounding areas, as this area was previous identified at risk of surface water flooding within the Cambridge and Milton SWMP (2011). Area-wide hydraulic modelling was used to identify priority wetspots within the study area for detailed investigation. The SWMP also produced flood depth, velocity and hazard mapping across the area.

4.13.2 The study found that the risk of flooding to certain infrastructure associated with the hospital campus, and consequential impact on operations across the site, was unacceptable. These certain sites were generally basement departments. General surface water flooding was found primary on the road network and regarded as a moderate hazard.

4.13.3 A long list of mitigation options was created that include introducing SUDS features across the campus, upgrading the existing drainage infrastructure, and relocation of sensitive equipment from high risk areas. It was deemed the most cost effective methods would be improving existing building resilience, though the gradual introduction of adaption measures such as SUDS would help offset possible climate change impacts. As a result, the recommended outcome of the study was to develop a business case, to create a short list of options, in accordance with SWMP guidance, assess the economics of each option, and identify a preferred option.

4.14 Local Flood Investigation Reports

4.14.1 Under Section 19 of the Flood and Water Management Act 2010, the County Council investigates flood incidents that meet the threshold set out in the Cambridgeshire Flood Risk Management Strategy. There are:

- Where there is internal flooding of one property on more than one occasion.
- Where there is internal flooding of five or more properties (in close proximity) in a single event.
- Where flooding significantly affects the external premises of one or more properties.
- Where flooding on public roads significantly disrupts the flow of traffic.
- Where the failure of a significant flood asset has been reported.

4.14.2 Eight flood incidents have been investigated to date, that lie within Greater Cambridge. Of these, five occurred in August 2014. The Flood Investigation Reports are summarised below, with full details available on the LLFA website[6]:

- Meldreth, January 2014: One property was affected by internal flooding, with external flooding affecting the local road network, following heavy rainfall causing surface water runoff (depth 150 to 300 mm). Historic flooding is also reported to have occurred on the local road network in 2011 and 2012. Investigations showed the highways system outfall was blocked and local ditches required maintenance. Some small culverts have been installed on the watercourse in gardens which has also reduced capacity. Some remedial work was undertaken by riparian owners and the Highways Authority renewed pipework and installed an additional gully.
- Waterbeach, February and August 2014: Flooding on Bannold Road on two occasions caused extensive external property flooding. Both events are thought to have been caused by heavy rainfall causing surface water to enter the foul sewer system and cause a ditch to block and surcharge. The local riparian owner was granted permission to improve the drainage on Bannold Road, and Anglian Water have addressed issues with the foul water pumping station.
- Bar Hill, August 2014: Multiple locations in Bar Hill were affected by surface water, local watercourse and drain flooding, following extremely high levels of intense rain falling in a short time period (estimated annual probability of 1 in 330). Flooding affected the primary school and at least 79 properties internally, with a further 30 properties affected externally. Following the event, clearance and maintenance work was undertaken on highways gullies and sewers by the Highways Authority, the Parish

[6] Cambridgeshire Flood Investigations

Council and Anglian Water. A modelling study of Oakington Brook was undertaken which indicates flood risk from the watercourse is sensitive to summer weed growth and blockages. A surface water management plan is now being prepared by the LLFA, to assess potential improvement options for Bar Hill.

- Caldecote: August 2014: 12 properties were affected by internal flooding, and a residential care home evacuated, following an extremely intense short rainfall event (estimated annual probability of 1 in 330). Historic flooding is also reported to have occurred in 2001. Following the event, clearance and maintenance work was undertaken on the highways gullies. The award drains were reviewed and no additional maintenance was required. Anglian Water installed a storm tank to their pumping station at Highfields Caldecote, installed telemetry and uprated pumps.

- Oakington, August 2014: 57 properties were affected by internal flooding, with external flooding to approximately 60 additional properties, following an extremely intense short rainfall event (estimated annual probability of 1 in 330). Historic flooding is also reported to have occurred in 1978 and 2001. The Environment Agency reported depths of 5 to 60 cm in properties.

  Prior to the event, the Environment Agency had investigated options for flood risk management in the village, and a scheme to install property level protection had commenced in 2012. 53 properties had signed up to receive protection, and this was partially installed when the flooding occurred. Training on how to install products was not completed and homeowners had not received individual flood plans explaining how or where to deploy products such as submersible pumps. The timing of the flooding meant that defences were deployed in darkness. A review of the property level protection scheme concluded:

  - A Flood Action Group should be set up to continue to support the community to develop flood action plans throughout the life of the scheme.

  - Individual homeowners should be encouraged to write their own flood action plans so that they know where, when and how to deploy barriers and pumps, and what to do if they are not at home in a flood event.

  - Training should be given to homeowners to operate products as they are installed or delivered, with a community training day also arranged as soon as possible afterwards.

  - The limitations of property level protection should be communicated to homeowners so that they fully understand the change in risk to their property.

- Longstanton, August 2014: 18 properties were affected by internal flooding, and there was extensive external flooding reported, following an

extremely intense short rainfall event (estimated annual probability of 1 in 330). Vegetation, silt and debris washed into the channel during the event blocked a culvert which contributed to the flooding. Completed improvement works (Hatton's Road balancing ponds) as part of the Northstowe development are anticipated to substantially reduce future flood risk.

- Barrington, July 2015: At least three properties were affected by internal flooding from multiple sources, including drains, local ditches and surface water, following an extremely intense short rainfall event (estimated annual probability of 1 in 180). Following the event, clearance and maintenance work was undertaken on the highways gullies. A local landowner of a disused quarry (Cemex) undertook remedial measures and prepared surface water drainage reports for planning applications at the site.

4.15 Internal Drainage Board Plans and Regulations

4.15.1 The Internal Drainage Boards (see Figure 4-1) have power and authority under Section 66 of the Land Drainage Act (1991) to make byelaws considered necessary for the efficient working of the drainage system in their districts. The byelaws are enforced under the Act and cover topics such as:

- Changes to the flow or volume of watercourses in the District.
- Introduction of additional water into the District.
- Use and maintenance of sluices, pumps, and other control structures.
- Diversion or stopping up of watercourses.
- Construction or planting within 9 m of the edge of watercourses.
- Construction of culverts, bridges, inlets and outlets.

4.15.2 The Ely Group of Drainage Boards' byelaws for Old West, Swaffham and Waterbeach IDB are available on their website. The Board have highlighted the following as particularly relevant for developers:

- No building or works in, over, under or within nine metres of an IDB main drain.
- Prior consent required for any infilling of any watercourse, culverting or bridge works, or any new surface or foul water discharge.
- The Board's design greenfield run-off rate is 1.1 l/s/ha. Any discharge over the greenfield rate will require a developer contribution, based on the charging scheme as developed by King's Lynn IDB.
- For large scale developments, a legal agreement between the Board and the developer is required.

- The Board would wish to see environmental net gain as a result of the development.

4.15.3 The Swavesey IDB have commented that the IDB byelaws include a nine metre maintenance strip to be left undeveloped along both banks of designated watercourses. Developments will need to provide sufficient surface water storage for a period of up to 3 weeks while Webb's Hole sluice gate is closed and preventing gravity discharge. The IDB should be contacted by developers at the earliest stage to agree design principles.

4.15.4 Specific comments have not been received from the Middle Level Commissioners for Over & Willingham IDB. Developers should review the Middle Level Commissioners website and consult directly with the relevant drainage board to agree design principles and obtain the necessary permits.

4.15.5 A small area near Gamlingay lies within the Bedford and River Ivel IDB area. Developers should consult directly with this drainage board (the Bedford Group of Drainage Boards) to agree design principles and obtain the necessary permits.

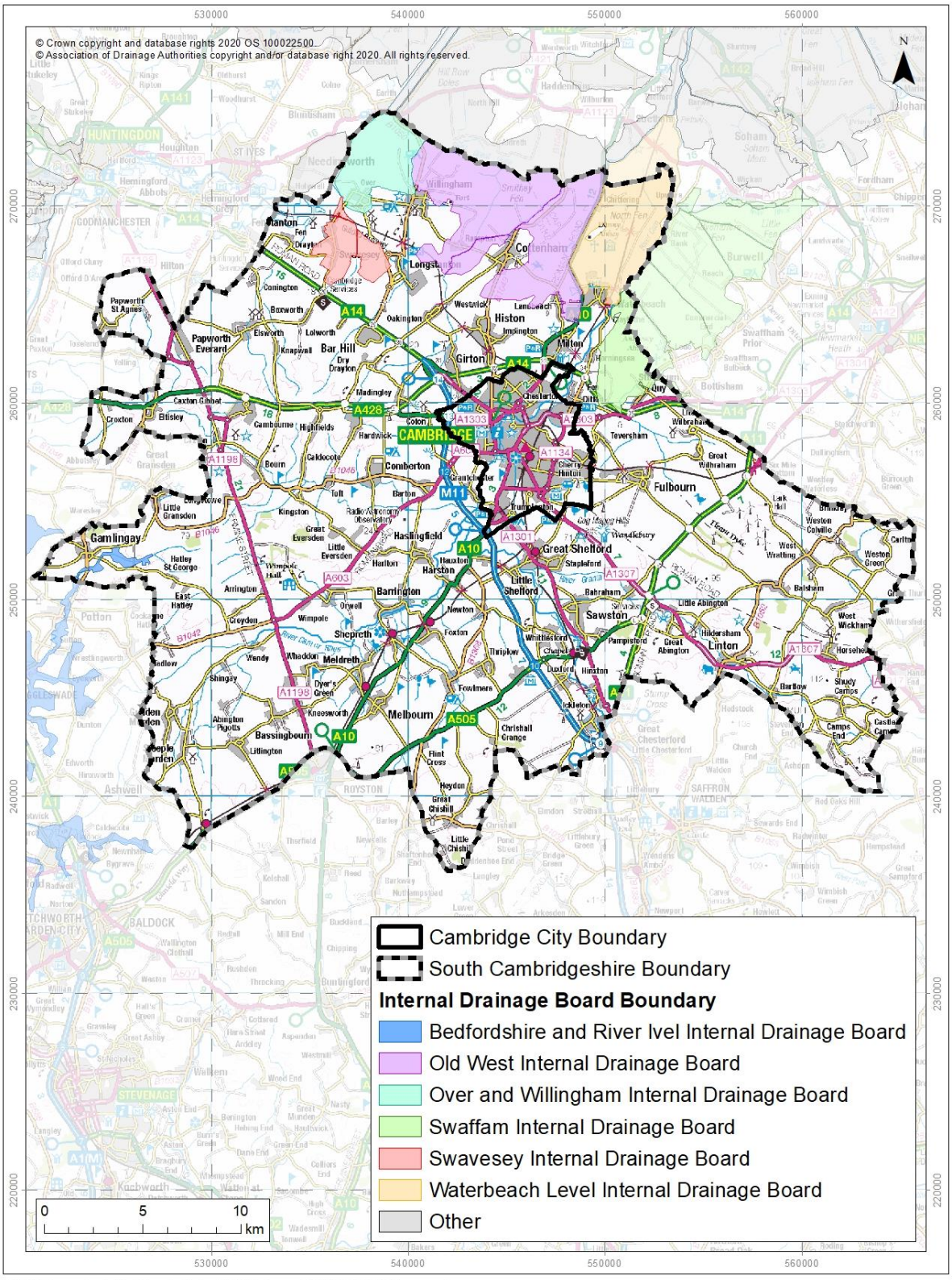


Figure 4-1: Internal Drainage Board Areas within Greater Cambridge

5 Impacts of Climate Change

5.1 Climate Change Impacts

5.1.1 It is now widely accepted that human activities are leading to climate change of a scale and pace that could significantly impact our lives and those of future generations. Burning of fossil fuels since the 1800s has led to a 40% increase in the level of carbon dioxide in the atmosphere[7]. Evidence has shown that the high levels of carbon dioxide and other greenhouse gases in the atmosphere is a leading cause of increasing global temperatures. The average global temperature is now approximately 1°C higher than the 1850 – 1900 average.

5.1.2 The UK Climate Projections (UKCP) provides the most up-to-date assessment of how the climate of the UK may change in the future. UKCP is a climate analysis tool within the government funded Met Office Hadley Centre Climate Programme. The most recent climate projections were released in 2018 (UKCP18), replacing the previous 2009 release (UKCP09).

5.1.3 The UKCP18 observations of current climate show evidence consistent with the expected effects of a warming climate, alongside considerable natural annual to multi-decadal variability. All of the top ten warmest years for the UK, in a series from 1884, have occurred since 2002. The 21st century so far has been warmer than the previous three centuries. Alongside warmer temperatures, winters and summers have also been wetter, although these patterns are potentially within long-term historic natural variability bounds.

5.1.4 The UKCP18 future climate projections indicate warming across all areas of the UK, especially during summer. The temperature and duration of hot spells during summer months will increase. Rainfall patterns will remain variable, but there will be future increases in the intensity of heavy summer rainfall events despite drier summers overall. All future projections also indicate an increase in winter rainfall, although varying between simulation details.

5.1.5 Therefore, it is anticipated that climate change will lead to an increase in the intensity and frequency of extreme weather events, including both summer and winter floods.

5.2 Policy Requirements

5.2.1 The Climate Change Act (2008, see Chapter 3) requires the Local Plan to support the government's 2050 net zero emissions target, to assess the potential impacts of climate change on flood risk, and to identify adaptation and mitigation policies and tools for the new Local Plan.

5.2.2 Local council policy and strategies are also working towards meeting the Climate Change Act requirements:

[7] Met Office – What is Climate Change?

- Cambridgeshire County Council undertook consultation on a Climate Change and Environment Strategy and Action Plan in early 2020. This strategy includes efforts to reduce or prevent emissions, actions to adapt to the effects of climate change, and enhancement of natural capital benefits. By 2023, the Council aims for all of its strategies to include policies that tackle climate change and provide natural capital enhancement.

- South Cambridgeshire District Council adopted their Zero Carbon Strategy in May 2020, which outlines how they will support the district to halve carbon emissions by 2030 and reduce to zero by 2050.

- Cambridge City Council have adopted a Climate Change Strategy (2016 – 2021) which includes objectives to reduce emissions and energy consumption, reduce consumption of resources, and support adaptation to the impacts of climate change. This is currently being updated for 2021-2026.

5.3 Climate Change Guidance

5.3.1 The Environment Agency specify what allowances should be made for climate change in strategic and site-specific flood risk assessments[8]. The guidance is updated periodically and should be referred to directly when preparing site-specific flood risk assessments. The information presented here was correct at time of writing, referencing the guidance last updated in July 2020.

5.3.2 The guidance includes allowances for the impacts of climate change on peak river flows, peak rainfall intensity, sea level rise, offshore wind speed and extreme wave height. As Greater Cambridge is not affected by tidal flooding, this report considers impacts on peak river flows and peak rainfall intensity only.

5.3.3 The guidance for peak river flows and peak rainfall intensity is currently (July 2020) based on the UKCP09 climate projections. It is anticipated that updated allowances will be issued by the Environment Agency within 2021. It is expected that following publication, there will be a short transition period during which use of the UKCP09 allowances will still be permitted, after which all flood risk assessments will need to use the updated UKCP18 allowances. It is expected that the updated UKCP18 allowances will have greater variability at the local scale.

5.4 Peak River Flows

5.4.1 The climate change allowances for peak river flows are provided for the following categories:

- A central allowance, based on the 50th percentile (the point at which half of the possible future scenarios predictions fall below this value, and half fall above)

[8] Flood Risk Assessments: Climate Change Allowances Guidance

- A higher central allowance, based on the 70th percentile
- An upper end allowance, based on the 90th percentile
- A H++ allowance, representing an extreme climate change scenario.

5.4.2 The climate change allowances are also provided over different future periods of time: 2015 to 2039, 2040 to 2069 and 2070 to 2115.

5.4.3 The specific climate change allowance to be used is dependent on the flood risk vulnerability classification for the type of development, Flood Zone, and the lifetime of the proposed development.

5.4.4 Greater Cambridge lies fully within the Anglian river basin district. The peak river flow allowances for the Anglian river basin district are summarised in Table 5-1.

Allowance Category	Total potential change anticipated for the 2020s (2015 to 2039)	Total potential change anticipated for the 2050s (2040 to 2069)	Total potential change anticipated for the 2080s (2070 to 2115)
H++	+25%	+40%	+80%
Upper End	+25%	+35%	+65%
Higher Central	+15%	+20%	+35%
Central	+10%	+15%	+25%

Table 5-1: Peak river flow allowances (correct July 2020)

5.5 Peak Rainfall Intensity Allowances

5.5.1 The climate change allowances for peak rainfall intensity are provided for the following categories:

- A central allowance, based on the 50th percentile (the point at which half of the possible future scenarios predictions fall below this value, and half fall above).
- An upper end allowance based on the 90th percentile.

5.5.2 The climate change allowances are also provided over different future periods of time: 2015 to 2039, 2040 to 2069 and 2070 to 2115. One set of allowances is provided for the whole of England (Table 5-2).

Allowance Category	Total potential change anticipated for the 2020s (2015 to 2039)	Total potential change anticipated for the 2050s (2040 to 2069)	Total potential change anticipated for the 2080s (2070 to 2115)

Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 5-2: Peak rainfall intensity allowances (correct July 2020)

5.6 Impacts of Climate Change on Groundwater Flood Risk

5.6.1 The relationship between climate change and groundwater flood risk is complicated and poorly understood. The Environment Agency do not currently provide guidance on what allowances should be adopted. Much of the research on the impacts of climate change on groundwater levels has focussed on groundwater recharge for water resources purposes, rather than flood risk assessment.

5.6.2 The Future Flows and Groundwater Levels project was carried out in 2010 – 2012, to assess the impact of climate change on water availability, river flows and groundwater levels, based on UKCP09 climate projections. The outputs included an 11-scenario plausible ensemble projection of monthly groundwater levels at 24 borehole locations. Considering all 11 ensemble members (all plausible scenarios) together accounts for some climate change uncertainty.

5.6.3 The simulations indicated that the groundwater recharge season (typically September to April) could be reduced to 3 – 4 months, during which more recharge could occur over a shorter period, leading to flashy responses in groundwater levels. Higher winter river levels could also increase groundwater levels in adjacent river gravel aquifer systems. Although the potential for higher peaks in groundwater level increases under many of the scenarios, results are not uniform and show a wide range of potential outcomes (e.g. see Figure 5-1 for projections for the Therfield Rectory borehole, near Royston, which is the nearest modelled location to Greater Cambridge).

5.6.4 Due to this uncertainty, it is not possible to provide absolute climate change allowances for groundwater flood risk at present.

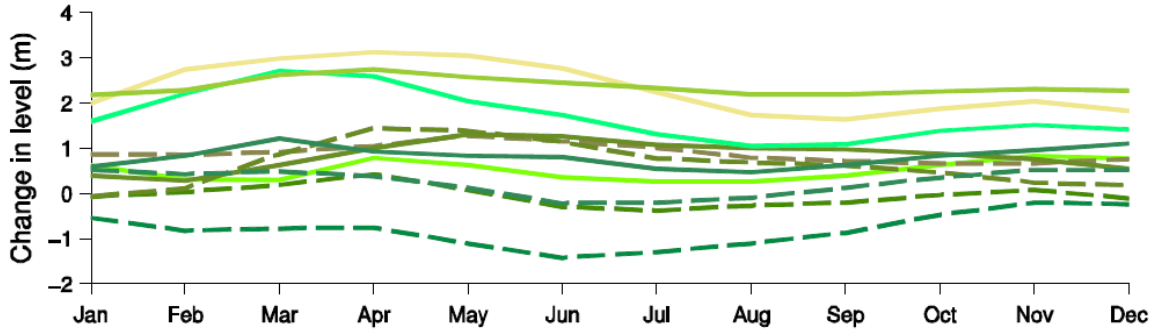


Figure 5-1: Climate change impacts on groundwater levels. Each green line represents the change in level between future (2041 – 2070) and control (1961 – 1990) simulated levels at Therfield Rectory, for a climate change scenario.

5.7 Impacts of Climate Change on Reservoir Flood Risk

5.7.1 Dams and reservoirs that impound more than 25,000 m^3 of water are managed under the Reservoirs Act 1975. The Environment Agency have produced reservoir breach inundation maps for all these reservoirs, for the most extreme flood scenarios which reservoirs are designed to withstand (for example, the 0.01% (1 in 10,000) annual probability flood event, and/or the probable maximum flood event; the theoretical largest flood that could occur resulting from a combination of the most severe meteorological and hydrologic conditions that could conceivably occur in a given area).

5.7.2 Although a warmer climate is expected to result in increased winter rainfall, research on the impact of climate change on the most extreme probable maximum precipitation and flood events used for reservoir safety design is limited. It is widely acknowledged that current methods for estimating these events are outdated and, in some locations, recent rainfall observations have exceeded the theoretical probable maximum precipitation. Defra is currently commissioning research to update these methods and include consideration of climate change. Due to this uncertainty, it is not possible to provide absolute climate change allowances for reservoir flood risk at present.

5.7.3 The potential impacts of climate change on reservoirs' physical structure and functionality were investigated in 2013[9], based on the UKCP09 projections. Overall, it was found that dam form (the physical makeup of the dam and ancillaries) was relatively resilient to the direct effects of climate change, with periodic review of surveillance and maintenance requirements that is generally suited to climate change adaptation. However, some reservoirs functions (the operational uses of the reservoir) may be vulnerable to climate change. The report includes guidance and recommendations for planning, designing, and constructing new reservoirs, and for vulnerability assessments, monitoring and adaptation measures for existing reservoirs.

5.8 Using Climate Change Allowances to support Planning Decisions

5.8.1 The Environment Agency provide detailed guidance on what flood allowances should be applied in which circumstances[10]. The Environment Agency have also provided local guidance on application of the climate change allowances in East Anglia, including Greater Cambridge (available to developers on request). This is summarised below (correct July 2020).

5.8.2 If the development is potentially affected by flooding from a watercourse with a catchment area greater than 5 km^2, the peak river flow allowances in Table 5-1 should be used to estimate future flood levels. This includes sites which are currently not at risk of flooding from any source but may be affected in the future. The peak river flow allowance to be used should be identified according to the most vulnerable land use classification being proposed at the site (Table 5-3)

[9] FD2628 Impact of Climate Change on Dams & Reservoirs

[10] Flood Risk Assessments: Climate Change Allowances Guidance

and the Flood Zone classification for the site (Table 5-4, see Chapter 6 for definition of Flood Zones).

5.8.3 If the development is potentially affected by flooding from watercourses or surface water run-off in a catchment with an area less than 5 km^2, the peak rainfall intensity allowances in Table 5-2 should be used to estimate future run-off and flood levels. This includes sites which are currently not at risk of flooding from any source but may be affected in the future. The peak rainfall allowances to be used are listed in Table 5-5. Drainage systems should be designed so that there is no increase in the rate of runoff discharged from the site for the upper end allowance. Where on-site flooding presents a significant flood hazard, further measures will be necessary. At minimum, there should be no significant flood hazard to people from on-site flooding for the central allowance. Further guidance on flood risk management and drainage system design is given in Chapters 10 and 11.

5.8.4 If development in a flood risk area could have a detrimental impact on offsite areas due to displacement of water, this must be assessed, and suitable floodplain storage compensation provided. The climate change allowances to use for this assessment are listed in Table 5-6.

5.8.5 If the guidance specifies that a range of allowances should be tested, including the H++ high impact scenario, the developer should select the most appropriate value in agreement with the Environment Agency based on:

- The likely depth, extent, speed of onset, velocity and duration of flooding for each allowance of climate change over time.
- The vulnerability of the proposed development types or land use allocations to flooding.
- Any ‘built in’ measures used to address flood risk, for example, raised floor levels, and
- The capacity or space in the development to include measures to manage flood risk in the future, using an adaptive approach (e.g. allowing space for flood defences to be improved in the future).

5.8.6 The Environment Agency have provided local guidance on application of the climate change allowances in East Anglia, including Greater Cambridge. This indicates the level of technical assessment that may be required for new developments:

- Basic: An allowance can be added to the design flood (1% annual probability) peak water levels to account for potential climate change impacts. Allowances for the relevant watercourse can be obtained from the Environment Agency, and their use will only be accepted after discussion.
- Intermediate: Existing modelled flow and level data can be used to construct a stage-discharge rating curve, from which a flood level can be

interpolated for the design flood flow including the required climate change peak flow allowance.

- Detailed: Detailed hydraulic modelling should be used to estimate the flood level, using existing Environment Agency models (if available) or construction of new models by the developer. In exceptional circumstances, if development is proposed in locations marked “not appropriate development” a detailed approach should be used.

5.8.7 Table 5-7 provides an indicative guide to the assessment approach for development depending on their scale and location. Minor development is considered 1 to 9 dwellings or less than 0.5 ha residential sites, or under 1 ha for office, industrial or retail sites, or a traveller site of up to 9 pitches. Small-Major development is considered 10 to 30 residential dwellings, or 1 to 5 ha for office, industrial or retail sites, or a traveller site of 10 to 30 pitches. Large-Major development is considered 30+ residential dwellings, or 5ha+ office, industrial or retail sites, or a traveller site over 30 pitches, or any other development that creates a non-residential building or development over 1000 square metres.

5.8.8 In all cases, it is recommended that the Environment Agency are consulted for a free preliminary opinion, before and outside of the statutory planning consultation process, which will include advice on what allowances to apply and the appropriate approach to incorporating the allowances into assessments. More detailed pre-application planning advice and review of calculations is also available on a charged basis.

Vulnerability Classification	Description
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as ‘Essential Infrastructure’).
More vulnerable	• Hospitals • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill* and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Vulnerability Classification	Description
Less vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water compatible	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas, and wharves. • Navigation facilities. • Ministry of Defence: defence installations. • Ship building, repairing, and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 5-3: Flood risk vulnerability classification (correct July 2020)

Vulnerability Classification	Flood Zone 1	Flood Zones 2 or 3a	Flood Zone 3b
Essential Infrastructure	Apply Flood Zone 2 or 3a allowances for locations that are currently in Flood Zone 1 but might be in Flood Zone 2 or 3 in the future	Upper end	Upper end
Highly vulnerable		Higher central and upper end (development not permitted in Flood Zone 3a)	Development should not be permitted (if appropriate, upper end)
More vulnerable		Higher central and upper end	Development should not be permitted (if appropriate, upper end)
Less vulnerable		Central and higher central. Use the higher central to design safe access, escape routes and places of refuge.	Development should not be permitted (if appropriate, upper end)
Water compatible		Central	Central
Nationally significant infrastructure projects, new settlements or urban extensions	In addition to the above, use the H++ allowance as a sensitivity test to ensure development can be adapted to large-scale climate change over its lifetime		

Table 5-4: Peak river flow allowances to be used according to the site flood risk vulnerability classification and Flood Zone classification

Site characteristics	Peak Rainfall Intensity Allowance
Small catchments (< 5 km^2)	Central and Upper End
Urbanised drainage catchments	Central and Upper End

Table 5-5: Peak rainfall intensity allowances to be used to assess climate change impacts on small catchments or urbanised drainage catchments.

Scenario	Peak River Flow or Rainfall Intensity Allowance
Affected areas contain essential infrastructure, highly vulnerable or more vulnerable uses, and/or catchment is particularly sensitive to small changes in volume which could cause significant increases in flood depth or hazard	Upper End
Affected areas contain only low vulnerability or water compatible uses (including future land uses)	Central

Table 5-6: Peak river flow allowances to be used to assess off-site impacts and calculate floodplain storage compensation, according to the characteristics of the affected off-site area.

Vulnerability Classification	Flood Zone	Minor Development	Small – Major Development	Large – Major Development
Essential Infrastructure	All Zones	Detailed		
Highly vulnerable	Zone 2	Intermediate / Basic	Intermediate / Basic	Detailed
	Zone 3	Not appropriate development		
More vulnerable	Zone 2	Basic	Basic	Intermediate / Basic
	Zone 3a	Intermediate / Basic	Detailed	Detailed
	Zone 3b	Not appropriate development		
Less vulnerable	Zone 2	Basic	Basic	Intermediate / Basic
	Zone 3a	Basic	Basic	Detailed
	Zone 3b	Not appropriate development		
Water compatible	Zone 2	None		
	Zone 3a	Intermediate / Basic		
	Zone 3b	Detailed		

Table 5-7: Environment Agency indicative guide to climate change assessment approach for developments in East Anglia.

6 Data Collection and Quality Review

6.1 Data Collection

6.1.1 The purpose of a Level 1 SFRA is to collate and review available information with respect to flooding from the Risk Management Authorities and other stakeholders in the area. Data was requested from and provided by the following stakeholders and data providers:

- Environment Agency
- Cambridgeshire County Council (LLFA)
- South Cambridgeshire District Council
- Cambridge City Council
- Anglian Water
- Ely Group of Drainage Boards
- Middle Level Commissioners
- British Geological Society

6.1.2 In addition, a general request for information was sent by Greater Cambridge Planning to a wider group of stakeholders including parish councils and residents' associations. A full list of stakeholders contacted is included in Appendix A.

6.2 Environment Agency

Topographical Data

6.2.1 The topography of the area has been mapped using LiDAR data. LiDAR has a typical vertical accuracy of ±0.05m to ±0.15m, with spatial resolution ranging from 0.25m to 2.0m. The data is collected by the Environment Agency and filtered to produce a "bare earth" model (i.e. excluding building footprints, trees, etc). The data is freely available and is of suitable accuracy and resolution for this study. LiDAR data is not suitable to support planning applications, for which detailed site-specific topographical survey must be obtained.

Main River Network

6.2.2 GIS shapefiles showing the Environment Agency's Main River network are freely available under the Open Government Licence and were accessed in May 2020.

Flood Map for Planning (Flood Zone Maps)

6.2.3 The Environment Agency's Flood Map for Planning (Rivers and Sea) was obtained to identify Flood Zones as defined under NPPF (Table 6-1). The GIS dataset is freely available under the Open Government Licence and was accessed in June 2021.

Flood Zone	Definition
Zone 1 – Low Probability	Land having a less than 1 in 1,000 (0.1%) annual probability of river or sea flooding
Zone 2- Medium Probability	Land having a between 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding or land having between a 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability of sea flooding
Zone 3a – High Probability	Land having a 1 in 100 (1%) or greater annual probability of river flooding; or Land having a 1 in 200 (0.5%) or greater annual probability of sea flooding.
Zone 3b – The Functional Floodplain	Land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

Table 6-1: Definition of Flood Zones

6.2.4 The information provided in these flood maps is largely based on modelled data (national scale generalised modelling, or more detailed hydraulic modelling where available, combined with 'worst historic' flood outlines), and therefore is indicative rather than specific. The data is not considered sufficiently detailed to show whether an individual property is at risk of flooding. The maps do not include information on flood depth, speed, or volume of flow.

6.2.5 The maps ignore the presence of flood defences. Areas that benefit from flood defences are identified and mapped separately.

6.2.6 The Flood Zones have typically not been mapped for smaller catchments (for example, less than 3 km^2 catchment area). The absence of mapped Flood Zones should not be assumed to indicate there is no fluvial flood risk.

6.2.7 The Environment Agency's knowledge of the floodplain and extent of Flood Zones is continuously being improved through ongoing studies, river flow gauging and level monitoring, and the impacts of observed floods. The Flood Map for Planning is updated on a quarterly basis to include any revisions made. External requests to change the Flood Zones can be made through the "Evidence-Based Review" process, in which suitable evidence must be submitted to the Environment Agency to support the proposed revisions.

Fluvial Flood Extents: Detailed Hydraulic Modelling

6.2.8 The Environment Agency have provided detailed hydraulic modelling outputs from relevant studies in the Greater Cambridge area as summarised in Table 6-2 and Figure 6-1.

6.2.9 The detailed models assume 'typical' conditions within the river channels, with regards to surface roughness, structure blockage, antecedent wetness, etc. The predicted water levels would change if these conditions were altered.

6.2.10 The Environment Agency have confirmed that they are not currently updating any of the detailed hydraulic models within the Greater Cambridge area, however an update the River Cam model is expected in 2022. The Environment Agency has a programme for modelling but this does not include routine updates of models like in previous years, though such updates would help to ensure reliable information is available for future Local Plans. It may be possible to facilitate model updates through site-specific flood risk assessments, although the scope of model update should be proportional to the scale of the development.

Model	Date	Type	Climate Change
Cottenham Lode PFS model	2003	ISIS	None
St Ives and Hemingford FAS model	2005	Mike 11 - 1D	None
Longstanton Brook Existing Situation	2006	Infoworks 1D	None
Vicars Brook Flood Zone improvements	2009	2D only JFLOW	None
Cam Phase 2 (Cam Lodes and Cam Urban)	2012	ISIS-TUFLOW 1D-2D	20% allowance
Coldhams Brook/Cherry Hinton Model	2013	ISIS-TUFLOW - 1D-2D	20% allowance for 0.1% probability event only
Cam Rural (Granta, Bourn Brook, Rhee, Ickleton, Cam and Non-Main Rivers)	2014	ISIS-TUFLOW 1D-2D	20% allowance
Lower Ouse Model	2015	ISIS/ESTRY-TUFLOW 1D-2D	20% allowance (25%, 35% and 65% allowance simulations are unstable)
Hauxton	2016	Third party (not available)	Not available
Gough Way Model	2017	1D-2D	20%, 25%, 35%, 65% allowances

Table 6-2: Detailed hydraulic model availability (Environment Agency)

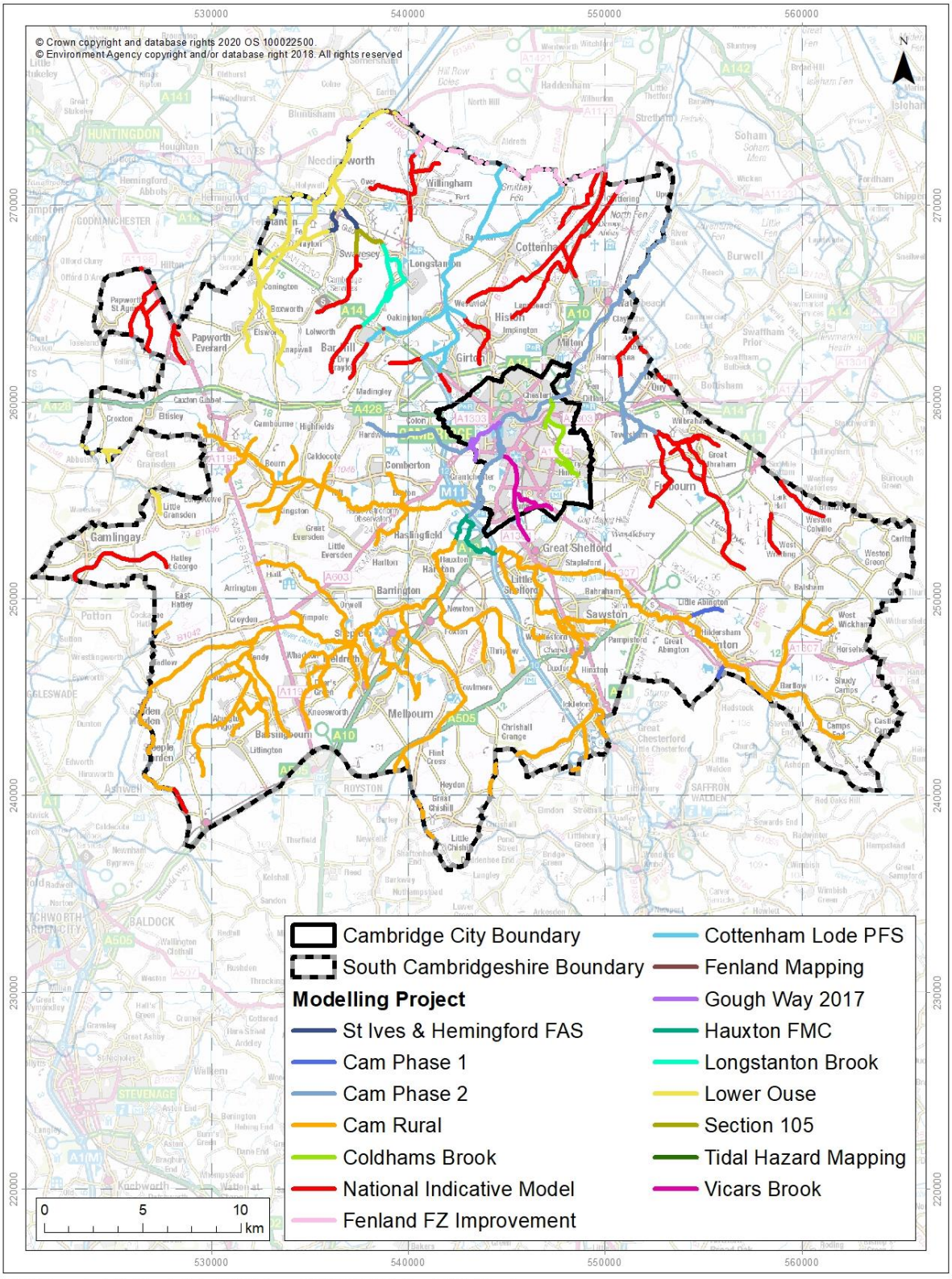


Figure 6-1: Environment Agency Model Extents

Risk of Flooding from Surface Water Maps

6.2.11 The Environment Agency's updated Flood Map for Surface Water was obtained to identify areas potentially at risk of surface water flooding. The dataset is freely available under the Open Government Licence and was accessed in June 2021.

6.2.12 The information provided in these flood maps is based largely on a national scale surface water modelling exercise undertaken by the Environment Agency in 2013. Whilst the management responsibility for flood risk from surface water lies with the LLFA (Cambridgeshire County Council), the mapping work forms part of the Environment Agency's strategic overview role.

6.2.13 The surface water maps are limited by the methods used to generate them. The maps are generated using 25 km^2 tiles, onto which rainfall is applied. The tiles are overlapped to remove edge effects, but flows are not routed from one tile to another and therefore flows do not accumulate in larger catchments. This means that although the maps provide a good indicator of flood risk in smaller catchments for which Flood Zones may not be available, the maps should not be used to assess flood risk in larger catchments, for which the Flood Map for Planning is preferable. The LLFA contribute to the modelling by providing three local surface water models for Cambridge that are integrated into the flood map for surface water, focussing on Cherry Hinton, Girton and Impington, and around Kings Hedges and Arbury. It should be noted that the LLFA are the only ones able to submit an update to the surface water modelling, making it very difficult to challenge the surface water flood map.

National Inundation Reservoir Maps

6.2.14 The Environment Agency have provided Reservoir Flood Risk Maps showing the potential extent of flooding in the event of a breach from large raised reservoirs (with the capability to impound over 25,000 cubic metres of water). This mapping assumes a worst-case scenario: that a breach occurs for the full height and width of the impounding structure when the water level is near the crest. These maps do not provide an assessment of the probability of such an event occurring, or the structural integrity of the embankment.

Historic Flood Maps

6.2.15 The Environment Agency's Historic Flood Map is freely available under the Open Government Licence and was accessed in June 2021. The map shows the maximum extent of individual recorded flood outlines from rivers, the sea and groundwater springs that meet a set criteria. It excludes flooding from surface water, except in areas where it is impossible to determine whether the source is fluvial or surface water, but the dominant source is fluvial. The majority of records begin in 1946. The maps take into account the presence of defences, structures, and other infrastructure present at the time of the recorded flooding. Flood extents may have been affected by overtopping, breaches or blockage. If an area is not covered by the Historic Flood Map, it does not mean that the area has never flooded, only that the Environment Agency do not hold records of flooding in the area that meet the criteria for inclusion. Additionally, not all historic flood events are included within the Historic Flood Map due to uncertainties of the evidence sources, though reports for each watercourse catchment are available from the Environment Agency.

6.2.16 The following recorded flood outlines are available: October 2001, Easter 1998, October 1993, May 1981, May 1978, September 1968, March 1947.

Flood Defence Assets

6.2.17 Flood defence asset information can be viewed as Open Data via this Environment Agency asset management website. The website provides information on main rivers, embankments, flood storage reservoirs, walls, outfalls, bridges, culverts, control gates, and other structures. The information was also provided in GIS shapefile format for this study.

Areas Benefiting from Defences

6.2.18 Information on Areas Benefiting from Defences is freely available under the Open Government Licence and was accessed in June 2021. The dataset shows those areas that benefit from the presence of defences in a 1% chance of flooding each year from rivers, or a 0.5% chance of flooding each year from the sea (including tidal rivers). If defences were not there, these areas would flood in those or larger events. The maps assume that flood defences and other operating structures act perfectly and give the same level of protection as when the Environment Agency's assessment of the area was made.

6.2.19 The layer does not show all areas that benefit from all defences. Some defences are designed to protect against a smaller flood with a higher chance of occurring in any year, for example a flood defence which protects against a 1 in 30 chance of flooding in any year. Such a defence may be overtopped in a flood with a 1% / 0.5% chance of occurring in any year, but the defence may still reduce the affected area or delay (rather than prevent) a flood, giving people more time to act and therefore reduce the consequences of flooding.

6.2.20 The Environment Agency do not always map areas that benefit from defences that offer a lower standard of protection. Other defences, that are designed with higher standards of protection, can withstand more extreme flooding events, though these have a smaller chance of occurring in any year. In this case, the maps show only the area that would have been affected in a flood with a 1% / 0.5% chance of occurring in any year, even though further areas would benefit in the event of more severe flooding for example in a 0.1% flood.

Flood Warning Areas and Flood Information Service

6.2.21 The Environment Agency's Flood Warning Areas show geographical areas where flooding is expected to occur and where the Environment Agency provide a Flood Warning Service. The GIS dataset is freely available under the Open Government Licence and was accessed in June 2021. The Flood Warning Areas represent discrete communities at risk of flooding from rivers or the sea or, in some areas, from groundwater.

Ongoing and Future Studies and Projects

6.2.22 The Environment Agency were consulted to identify if there are any recent, ongoing or future flood studies or projects being undertaken by themselves in the area. The Environment Agency responded (June 2020):

- There are no major updates currently planned for Flood Zone, Historic Flood Map or Areas Benefiting from Defences maps in the next 12 months. However, it should be noted the River Cam model is due to be updated in 2022 with the flood map for planning updates programmed in after this.

- There are no ongoing or anticipated flood modelling and mapping studies currently being undertaken in the area.

- There are no completed, in progress or future flood improvements schemes (since the last SFRA in 2010).

6.2.23 The Environment Agency have commissioned a Great Ouse Storage and Conveyance study, the inception report for which was made available in June 2020. The study will assess how flood risk within the catchment can be managed now and into the future, giving a high-level evaluation of the costs and benefits of providing very large flood storage volumes in the catchment. The inception phase reviewed existing modelling tools and datasets, identified gaps and made methodology recommendations. The next phases of the study will involve strategic screening of options followed by detailed assessment and will include improvements to existing hydraulic models. The outcomes of the study will not be available for several years, however, may require revision to this SFRA to include updated modelling results and any proposed strategic flood storage sites.

6.3 Cambridgeshire County Council (LLFA)

Designated Flood Risk Assets

6.3.1 The LLFA confirmed that they have not formally designated any assets under the Floods and Water Management Act (2010).

6.3.2 The County Highways Authority have a GIS layer showing assets such as ditches, bridges, culverts and gullies that are maintained by the highways authority. It was not possible to obtain this dataset.

Flood Incident Register

6.3.3 A Flood Incident Register was developed as part of the Cambridgeshire Countywide SWMP (2014). This information was provided by Cambridgeshire County Council as a GIS layer. This SFRA has mapped these incidents that date from February 2021 back to 2011.

Surface Water Management Plan Mapping

6.3.4 The LLFA have undertaken a number of SWMP studies in recent years, which included detailed surface water flood risk modelling and mapping.

6.3.5 It has not been possible to confirm if the SWMP mapping has been incorporated into the Environment Agency mapping.

Ongoing and Future Studies and Projects

6.3.6 The LLFA are currently undertaking investigative work in Bar Hill. A study is being undertaken to assess the risk of flooding from surface water, following flooding in August 2014, and consider potential options for reducing economic damages. It is anticipated that this study will be completed in 2021.

6.4 South Cambridgeshire District Council and Cambridge City Council

Awarded Watercourse Network

6.4.1 Awarded watercourses are a network of drainage ditches throughout the district for which the council is responsible for the maintenance of.

6.4.2 The Awarded Watercourse network for Cambridge City Council was provided in georeferenced CAD format and converted to GIS shapefile format for mapping. The watercourses that the City Council currently maintain include: Barnwell East LNR Ditch, Bin Brook, Birdwood Road Ditch, Coldham's Brook, Cherry Hinton Brook, Cherry Hinton Hall Ditches (Blockages only), Clare Field Ditch, Daws Lane Ditch, Derwent Close Ditch, East Cambridge Main Drain, Fulbrooke, First Public Drain East - Milton to Science Park, First Public Drain West, Gunhild Way Ditch, Hobson's Brook, Howards Road Ditch, Jesus Ditch, Kelvin Close Ditch, Lime Tree Close Ditch, Long Road Ditches, Madingley Road Ditch, Marsh Road Ditch, Queens Ditch, Second Public Drain, St Bedes Ditch, Thorpe Way Ditch, and Vicars Brook.

6.4.3 It was not possible to obtain the Awarded Watercourse network in GIS shapefile format for South Cambridgeshire District. However, the network can be viewed on the South Cambridgeshire District Council website. The website allows an awarded watercourse to be selected and original maps and data relating to that watercourse to be viewed.

6.5 Anglian Water

6.5.1 Anglian Water provided records of sewer flooding in the Greater Cambridge area (DG5 Register). The DG5 register records incidents of internal and external flooding relating to public foul, combined or surface water sewers. The register is anonymised to the first three or four digits of the postcode location.

6.5.2 The register indicates a large number of properties flooded in February 2013 (Comberton, Hauxton, Hardwick) and March 2015 (Foxton, Bourn, Comberton, Hardwick, Girton). These do not correlate with any events for which Flood Incident Reports are available, and therefore no further information is known on the severity or causes of the flooding.

Date	Number of reported sewer flooding incidents	
	Internal	External
Not recorded	2	2
2001	4	1

2005	0	1
2006	0	1
2008	0	3
2009	3	3
2010	0	4
2012	1	2
2013	0	17
2014	0	6
2015	4	16
2016	1	0
2017	0	1
2018	0	1

Table 6-3: Number of internal and external sewer flooding incidents per year (Anglian Water records of sewer flooding)

6.6 Internal Drainage Boards

Ely Group of Drainage Boards

6.6.1 The Ely Group of Drainage Boards provided the following information for this study:

- GIS shapefiles showing drainage board districts, managed drains and flood management assets
- Flood history (none recorded)
- Recent improvement works (Cam Pumping Station refurbishment in 2010)
- Future improvement works (none currently planned)
- IDB Byelaws.

Middle Level Commissioners

6.6.2 The Middle Level Commissioners have reported that the Over & Willingham IDB are redeveloping the system of watercourses around Needingworth Quarry, draining to Over pump station.

6.6.3 Swavesey IDB, who fall within the Middle Level Commissioners administrative governance, provided information on the flood risk and surface water drainage constraints in their area.

6.7 British Geological Society

6.7.1 Geological mapping has been obtained from publicly available data provided by the British Geological Society (BGS). This data is of suitable accuracy and resolution for this study. The data is not suitable to support planning applications, for which detailed site-specific ground investigations must be undertaken.

6.7.2 The Areas Susceptible to Groundwater Flooding data has been obtained from the BGS. This is a strategic scale map showing groundwater flood probability areas on a 1km square grid. The data is annotated to show what percentage of the 1km area *could* be susceptible to groundwater flooding, thus providing an indication of the degree of probability of groundwater flooding that is present within a broad area. The accompanying guidance specifies that “these data show likelihood of groundwater flooding occurring and is therefore a hazard not risk-based dataset”.

6.7.3 The Environment Agency are currently undertaking research into current practices for groundwater flood risk management in England (project FRS19217_LT). The project will synthesise current practices for governance arrangements, recording groundwater incidents, risk assessment, forecast and warning, and mitigation. The information will support the Environment Agency and other Risk Management Authorities in managing groundwater flood risk.

6.8 Other Information Provided

6.8.1 A general request for information was sent to all Parish Councils and a range of non-statutory bodies and groups. The responses received are summarised in Appendix A and included in Chapter 8 where relevant.

7 Level 1 SFRA Mapping

7.1 Fluvial Flood Risk

7.1.1 Fluvial flooding is defined as river flooding that occurs when a watercourse cannot convey the water draining into it from surrounding land.

7.1.2 The fluvial flood risk maps are based on the Environment Agency's datasets. Please see Chapter 6 for a review of the data quality and limitations of these maps. The following maps have been produced:

- Flood Map for Planning (Rivers and Sea) (refer to map D1 in Appendix D). This shows the Flood Zones as defined in NPPF and PPG (Table 6-1). The Flood Zones indicate the probability of river and sea flooding (Flood Zone 3 covers land with a ≥1% annual probability event, Flood Zone 2 covers land between Zone 3 and the extent of flooding from a 0.1% annual probability event), ignoring the presence of flood defences.

- Modelled Fluvial Flood Extents Map (Defended or Undefended) (refer to map D3 in Appendix D). This shows modelled 1% and 0.1% annual probability event modelled flood extents, where these are available.

- Historic Fluvial Flood Map (refer to map D7 in Appendix D). This shows historic flood outlines, where these are available.

- Areas Benefiting from Defences Map (refer to map D5 in Appendix D). This shows the location of flood defences and areas benefiting from flood defences, where these are available.

- Functional Floodplain Map (see below) (refer to map D6 in Appendix D).

- Impacts of Climate Change on Fluvial Flood Extents Map (see below) (refer to map D4 in Appendix D).

- Flood Warning Areas (refer to map D12 in Appendix D). This shows areas within Greater Cambridgeshire that received flood warnings from the Environment Agency.

Functional Floodplain

7.1.3 The functional floodplain is defined as land where water has to flow or be stored in times of flood. This is a subcategory of Flood Zone 3, referred to as Flood Zone 3b. The identification of functional floodplain should take into account local circumstances (including the effects of defences and other flood risk management infrastructure) and not be defined solely on rigid probability parameters. However, land which would naturally flood with an annual probability of 1 in 20 (5%) or greater than in any year or is designed to flood (such as a flood attenuation scheme) in an extreme flood, should be used to provide an initial consideration of functional floodplain extents.

7.1.4 For the purposes of this study, making use of available data, the following approach has been taken:

- Where flood extents are available for the 1 in 20 (5%) event, these have been used as a first indication of functional floodplain extents.
- Available information has been reviewed to identify flood attenuation schemes or other flood risk management projects where land has been designed to flood. Only the Hatton's Road, Longstanton balancing ponds have been identified.
- For all other areas, the 1 in 30 (3.3%) surface water flood risk maps have been used as an indicator of potential functional floodplain extents.

7.1.5 The functional floodplain mapping contained in this SFRA should be used as a first indicator of potential extents only. Although generally development should be directed away from these areas, there may be opportunities for development sites that overlap functional floodplain areas to modify the floodplain to provide improved flood risk and other benefits. In these cases, the Local Planning Authority should require there is a net gain in floodplain storage, a betterment to flood risk within and outside the site, and a quantifiable improvement to the existing riparian environment (physical, chemical and/or biological measures). Detailed modelling and site surveys should be undertaken to evidence these impacts in site-specific flood risk assessments.

Impacts of Climate Change

7.1.6 There are a range of potential impacts of climate change on fluvial flood risk (Chapter 5), and flood extents are not available for all scenarios and locations. Therefore, the following approach has been taken to map the impacts of climate change on the 1% (1 in 100) probability event:

- Where hydraulic model flood extents are available, these have been mapped and the applicable scenario noted on the map.
- Where hydraulic model flood extents are not available, the maximum of the 0.1% (1 in 1000) Flood Zone 2 extents and 0.1% surface water flood risk maps should be used as a conservative estimate.

7.1.7 It may be necessary to undertake further climate change modelling to support the allocation of sites, under a Level 2 SFRA, if necessary, following the application of the Sequential Test (Chapter 9).

7.1.8 Environment Agency recommendations for appropriate assessment of climate change for planning applications are included in Chapter 5. The Environment Agency should always be consulted to agree the most appropriate method for the site being assessed, dependent on location, size and proposed land use vulnerability.

7.2 Surface Water Flood Risk

7.2.1 The surface water flood risk maps are based on the Environment Agency's datasets. Please see Chapter 6 for a review of the data quality and limitations of these maps. The following maps have been produced:

- Surface Water Flood Risk Map (refer to map D8 in Appendix D). This shows the 3.3% (1 in 30), 1% (1 in 100) and 0.1% (1 in 1000) event extents. Further detail on depths and velocities for each of these events can be obtained from the online Long-Term Flood Risk Maps[11].

7.2.2 The impact of climate change on surface water flood risk has not been modelled at this stage. It may be necessary to undertake further climate change modelling to support the allocation of sites, under a Level 2 SFRA, if necessary, following the application of the Sequential Test (Chapter 9). As a precautionary approach, the 0.1% (1 in 1000) event extents should be used as a conservative estimate for the 1% (1 in 100) event plus climate change extents. It is recommended that site-specific hydraulic modelling is undertaken to assess the impacts of climate change on surface water flood risk for the relevant scenario, at the planning application stage.

7.3 Sewer Flood Risk

7.3.1 Information from the Anglian Water DG5 register (Chapter 6) has been used to map incidents of sewer flood risk by postcode (refer to map D11 in Appendix D).

7.4 Groundwater Flood Risk

7.4.1 The groundwater flood risk map (refer to map D10 in Appendix D) is based on the British Geological Survey Areas Susceptible to Groundwater Flooding dataset (Chapter 6). The maps indicate susceptibility to groundwater flooding and do not illustrate hazard or risk or include allowance for climate change. The impacts of climate change on groundwater flood risk are uncertain (Chapter 5) and have not been mapped at this stage.

7.5 Reservoir Breach Flood Risk

7.5.1 The reservoir breach flood risk map (refer to map D9 in Appendix D) is based on the Environment Agency's Reservoir Flood Risk Maps (Chapter 6), which show the potential extent of flooding in the event of a breach from large, raised reservoirs (with capability to impound over 25,000 m^3 of water). These maps do not provide an assessment of the probability of such an event occurring, or the structural integrity of the embankment. The impacts of climate change on reservoir breach flood risk are uncertain (Chapter 5) and have not been mapped at this stage.

[11] Long Term Flood Risk Map

7.6 Flood Defences

7.6.1 The flood defences maps are based on the Environment Agency's datasets (Chapter 6) (refer to map D5 in Appendix D).

7.6.2 Further description of key flood risk management structures and features is included in Chapter 8.

7.6.3 Available information was reviewed to identify any areas that should be safeguarded from development, e.g. for future flood management schemes. No such schemes were identified by the Environment Agency, the LLFA or other stakeholders. No capital schemes are listed in the current Defra 6-year capital programme (2015 – 2021). Although land may be sought to provide large scale flood storage, under the River Great Ouse Conveyance and Storage project (Chapter 6), the results of that study are not yet available; as the outputs of the study become available, developers have regard to the outputs when considering mitigation

7.7 Sustainability of Existing Development

7.7.1 The government guidance for Strategic Flood Risk Assessments includes the requirement to identify where existing development may not be sustainable in the long-term due to climate change and may need to be relocated to more sustainable locations.

7.7.2 The indicative functional floodplain map (model outlines only) was used to identify existing development that may already be at a very high risk of flooding, that may not be sustainable to support in the long-term due to climate change. No settlements were identified as potentially at such risk. There were a number of isolated rural properties and farms potentially at very high risk in the low-lying fenland floodplains associated with the River Great Ouse and lower River Cam. These properties may currently need to be located in these higher risk areas for agricultural purposes. It is recommended that the Environment Agency and Lead Local Flood Authority give further consideration to supporting these properties in adapting to climate change, including improved flood warning provision, flood evacuation planning, and property level flood resilience and resistance adaptation. Nevertheless, some properties may be benefitting from unsustainable legacy defences that create significantly higher levels of risk to larger communities. Where the agricultural justification for such properties is no longer significant, there may be an opportunity to assess the suitability of applications to replace or relocate.

8 Flood Risk Opportunities and Constraints

8.1 Introduction

8.1.1 In line with the current SFRA guidance[12], this chapter considers opportunities to reduce the causes and impacts of all types of flooding. These opportunities have been identified in outline only, based on information received from stakeholders and previous studies available. These may not be solely the responsibility Local Planning Authority but other stakeholders such as the EA and LLFA as well and are subject to further feasibility testing and funding. Opportunities could include:

- Building new or improved flood defences
- Funding for new or improved defences
- Area-wide, and retrofitting, sustainable drainage systems to remove surface water from combined sewers providing integrated blue-green solutions within the public realm
- Natural flood management
- Changes to land management
- Surface water capture, re-use, or storage areas
- Fluvial water capture for recharge, irrigation or habitat creation
- Removal of culverts or other restrictions to flow
- River restoration, such as removing canalisation and re-introducing meanders
- Removing permitted development rights in sensitive areas.

8.1.2 The Greater Cambridge area includes a variety of landscapes and flood characteristics, that present differing opportunities and constraints for managing flood risk and development, including future flood management plans and areas to be safeguarded from development. These are discussed in detail for the spatial groupings presented in Table 8-1 in Appendix E. For ease of reference in this chapter, a summary of key opportunities and constrains for each group is presented in Section 8.2.

8.1.3 The Greater Cambridge area lies in the headwaters of the River Cam. Nevertheless, cross-boundary affects require consideration and are discussed further in the relevant sections below:

[12] Local Planning Authorities Strategic Flood Risk Assessment Guidance

- In the south, flows in the upper tributaries of the River Cam may be affected by land use changes in North Hertfordshire (Royston area) and Uttlesford (Elsenham to Great Chesterford, including Saffron Walden).

- In the north-west, flood risk from the River Great Ouse will be affected by land use changes and flood defence schemes in the large upstream catchment, which includes Huntingdon, St Neots, Biggleswade, Bedford, Milton Keynes, Leighton Buzzard, Buckingham and Brackley. Flood levels are also affected by the downstream management of the River Great Ouse, in the Ouse Washes.

- Changes in flows from the Greater Cambridge area may affect flood risk in downstream areas, including the Ouse Washes and the South Level fens. This includes designated sites such as Wicken Fen and the Ouse Washes SSSI.

8.1.4 Box 8-1 to Box 8-8 below highlight initiatives within the region that have or plan to improve flood risk, water quality, the local environment and/or help alleviate pressures on water resources.

Flood Risk Group	Locations Included
Rural Upper Cam	River Cam, Rhee and Granta south of Cambridge
Bourn Brook and Bin Brook	Bourn Brook and Bin Brook catchments west of Cambridge
Urban Cambridge	River Cam and its tributaries within Cambridge
Lower River Cam	River Cam areas downstream of Cambridge, including Cam Lodes and Waterbeach IDB
River Great Ouse and tributaries	North-west areas that drain to the River Great Ouse, including Bar Hill, Northstowe, Girton, Histon, Impington, Swavesey and Cottenham
Edge of District	Areas outside the Cam catchment draining westward (Gamlingay and Croxton), and eastwards (Castle Camps, Weston Green)

Table 8-1: Groupings of locations for discussion in this chapter

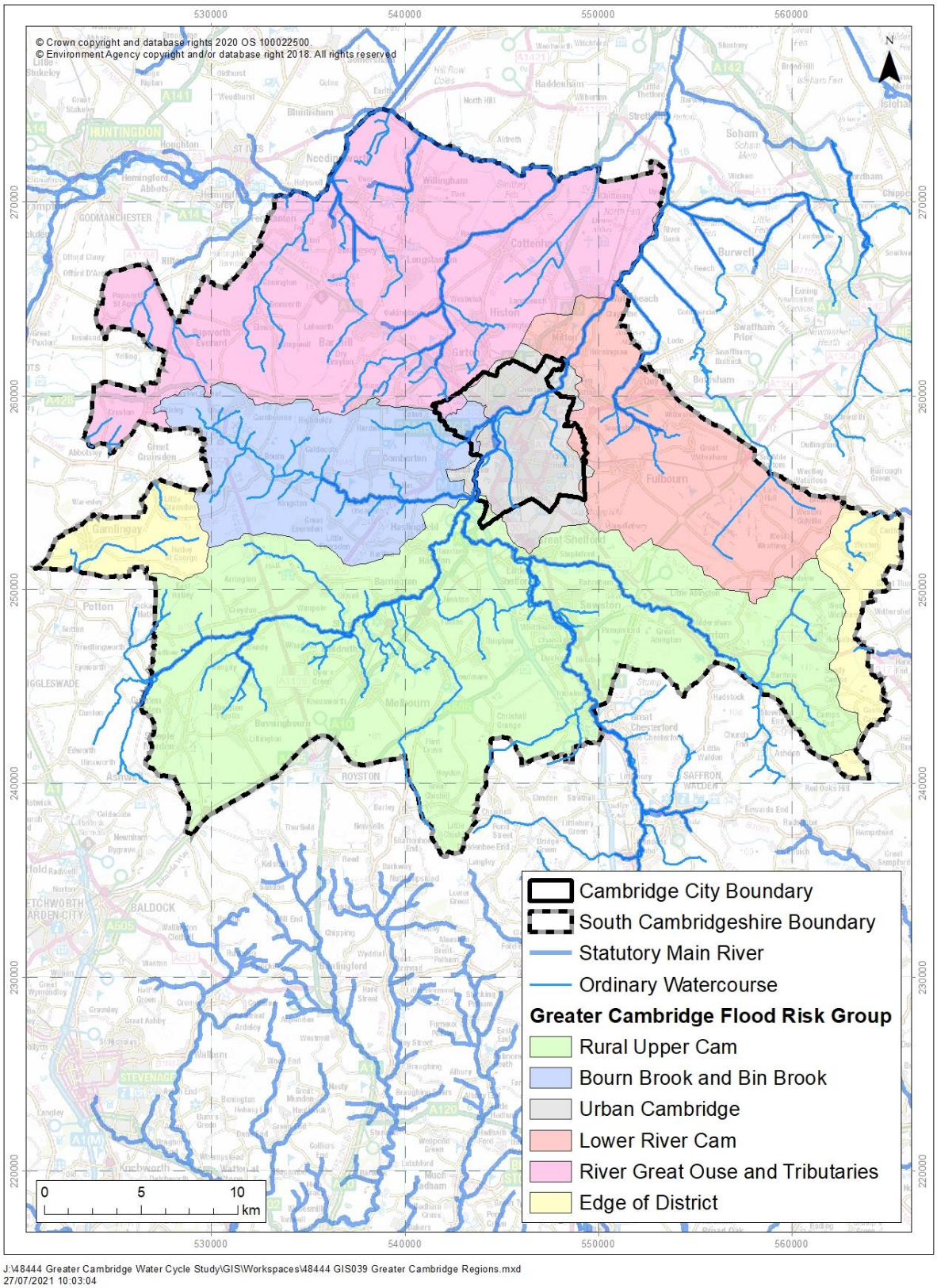


Figure 8-1: Groupings of locations for discussion in Chapter 8

Granta Groundwater Recharge Land Management Project (WRE)

Water Resources East are undertaking trials to support the proposed Environmental Land Management Scheme. This agricultural funding scheme administered by Defra will be rolled out by the end of 2024, to replace environmental management schemes currently available under the EU's Common Agricultural Policy. Under the scheme, farmers will be paid for work that enhances the environment, such as river management to mitigate flooding, or creating and restoring habitats for wildlife. In the trial, WRE are working with a landowner in the headwaters of the Granta to use land close to watercourses for flood relief and groundwater recharge ponds. This pilot project will focus on water level management, whilst recognising the multifunctional benefits the scheme may have for ecology and water quality. The results of the study will be used to develop a model for natural flood risk management and groundwater recharge projects for the Chalk streams in East Anglia.

Box 8-1: Granta Groundwater Recharge Land Management Project (Water Resources East)

River Mel Enhancement Project (River Mel Restoration Group)

Narrowed section, showing marginal vegetation colonisation

Enhancement works were undertaken to the River Mel at Meldreth, to return the watercourse to a more natural width with in-channel variation and improved habitat quality. Over time, the removal of woody debris and silt had led to an over-wide and deep channel that suffered from sluggish flows and poor habitat quality. Supported by the Environment Agency and the River Restoration Centre, the local community group the River Mel Restoration Group undertook works to install willow brashings, channel narrowing using faggot bundles, vegetation clearing to reduce shade and increase natural light, and a v-groyne deflector to create flow variation and encourage scour and deposition. This project is an example of what can be achieved by working with the community with a limited budget and was awarded winners of the Amateur category at the Wild Trout Trust Awards in 2009.

Box 8-2: River Mel Enhancement Project (River Mel Restoration Group)

Bin Brook Wetland and Natural Flood Management (Cambridge Past, Present & Future)

The charity CPPF is a significant landowner in the Bin Brook catchment, through their Coton Countryside Reserve. They are currently undertaking a feasibility study to consider options to improve water quality and reduce flood risk downstream. The proposed works being assessed comprise:

(1) Creation of a new integrated water treatment wetland, to filter outflow from Coton Water Recycling Centre, reduce diffuse pollution from agriculture, improve downstream water quality, create new wetland habitat and public amenity.
(2) Targeted natural flood management interventions to reduce the rate of runoff from agricultural drainage systems, at locations where these ditches enter Bin Brook.

The feasibility study is anticipated to be completed in 2020, after which CPPF will be seeking funding to implement the proposals.

Box 8-3: Bin Brook Wetland and Natural Flood Management Project (CPPF)

Bourn Free Project (Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire)

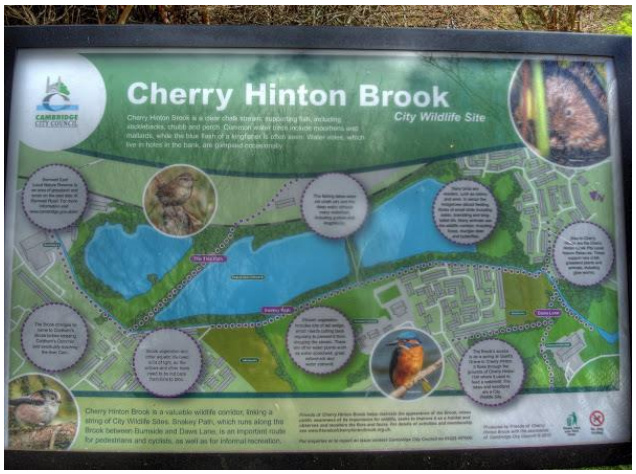
The Bourn Brook is a valuable habitat for water voles, one of the UK's fastest declining mammals due to loss of habitat and predation by mink. The Wildlife Trust has been leading efforts to improve ecology since 2011, in partnership with the Countryside Restoration Trust and the Environment Agency, and with funding from Anglian Water's Pebble Fund. As well as efforts to control mink populations, volunteers have focussed efforts on reducing invasive species including Giant Hogweed and Himalayan Balsam. Regular ecological surveys have been undertaken to track the impacts of interventions, showing significant improvements since 2011, although there was some vulnerability of vole and otter populations to drought conditions in 2019. While continuing with existing work, the project has now begun to look at flood flows and water quality, with the aim of producing a map of potential projects to discuss with landowners and seek funding.

Box 8-4: Bourn Free Project (Wildlife Trust and Countryside Restoration Trust)

Cherry Hinton Brook Improvements (Friends of Cherry Hinton Brook)

Cherry Hinton Brook is a chalk stream that provides habitat for many species and acts as a wildlife corridor in the city. The channel has been straightened over time, leaving a slow-flowing stream with reduced habitat diversity.

The Friends of Cherry Hinton Brook volunteer group received funding to improve the stream habitat by adding flow deflectors and gravel riffles along a 1.7km stretch of the stream. The group also undertake community engagement and involvement in the stream, producing publicity materials and arranging litter picking days. The work has been supported by the City Council, who have also undertaken scrub clearance and tree maintenance, and local landowners.



Gravel bed improvements City Council Information Board

Box 8-5: Cherry Hinton Brook Improvements (Friends of Cherry Hinton Brook)

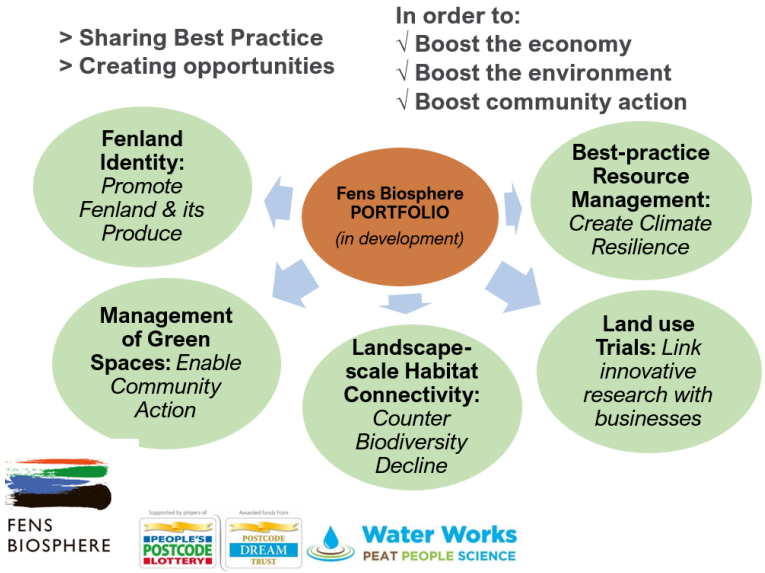
Wilbraham River Protection Society

The society was founded in 1997 by local residents, to work to safeguard the river and its flora and fauna. The society aims to identify the main causes of decline in wildlife and take action to restore the watercourse and plan co-ordinated maintenance. The society supported a river corridor survey, undertaken in 2015 by the Wildlife Trusts, which identified potential habitat improvements including channel narrowing, coppicing, in-channel vegetation cutting, bank re-profiling and bankside vegetation maintenance. The watercourse is groundwater fed and heavily dependent on flow augmentation schemes to maintain flows during summer or drought periods.

Box 8-6: The Wilbraham River Protection Society

The Fens Biosphere Vision

The Fens Biosphere project is a multi-sector partnership, coordinated by Cambridgeshire ACRE, working to achieve UNESCO Biosphere status for the Fens. A Biosphere is a status awarded by UNESCO to a unique and valuable landscape, within which stated activities are managed by a constituted partnership drawn from local organisations and community members. Biospheres aim to inspire a positive future by connecting people, economies and nature today. Once an area has achieved Biosphere status it is known as a Biosphere Reserve, but this does not grant any statutory environmental protections or designations. The primary purpose of the Fens Biosphere will be to add value to existing key initiatives and partnerships, by developing relationships across sectors to promote innovative and sustainable development and environmental management.



Within the proposed Biosphere area (Figure 8-2), the Greater Cambridge area overlaps the Transition Zone (an outer zone where activities will focus on ensuring that resident needs are sustainable and if possible benefit wildlife and the environment), and the Buffer Zone (areas where activities will focus on linking people, science and conservation to support the Core Zones).

Box 8-7: The Fens Biosphere Vision (Cambridgeshire ACRE)

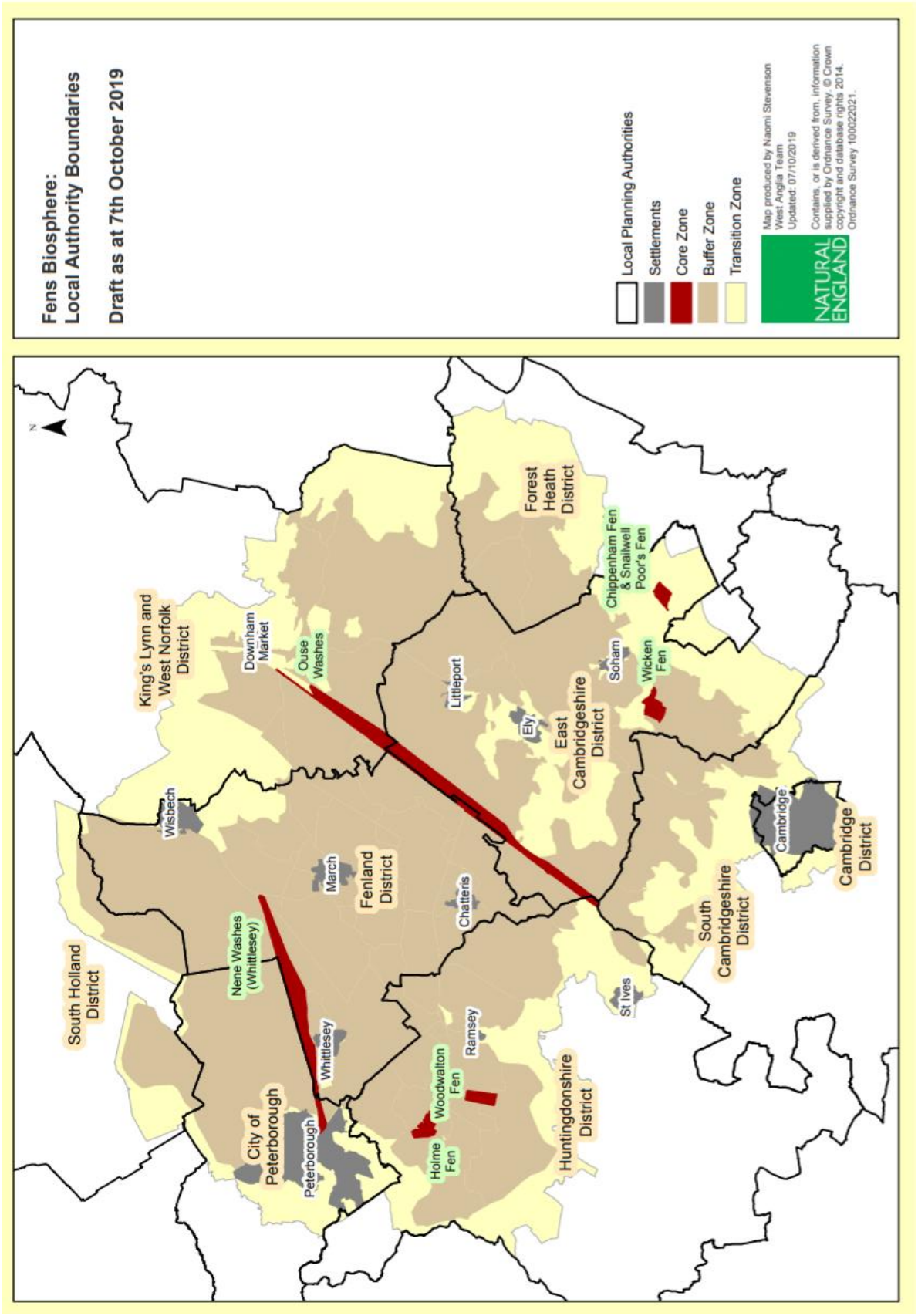
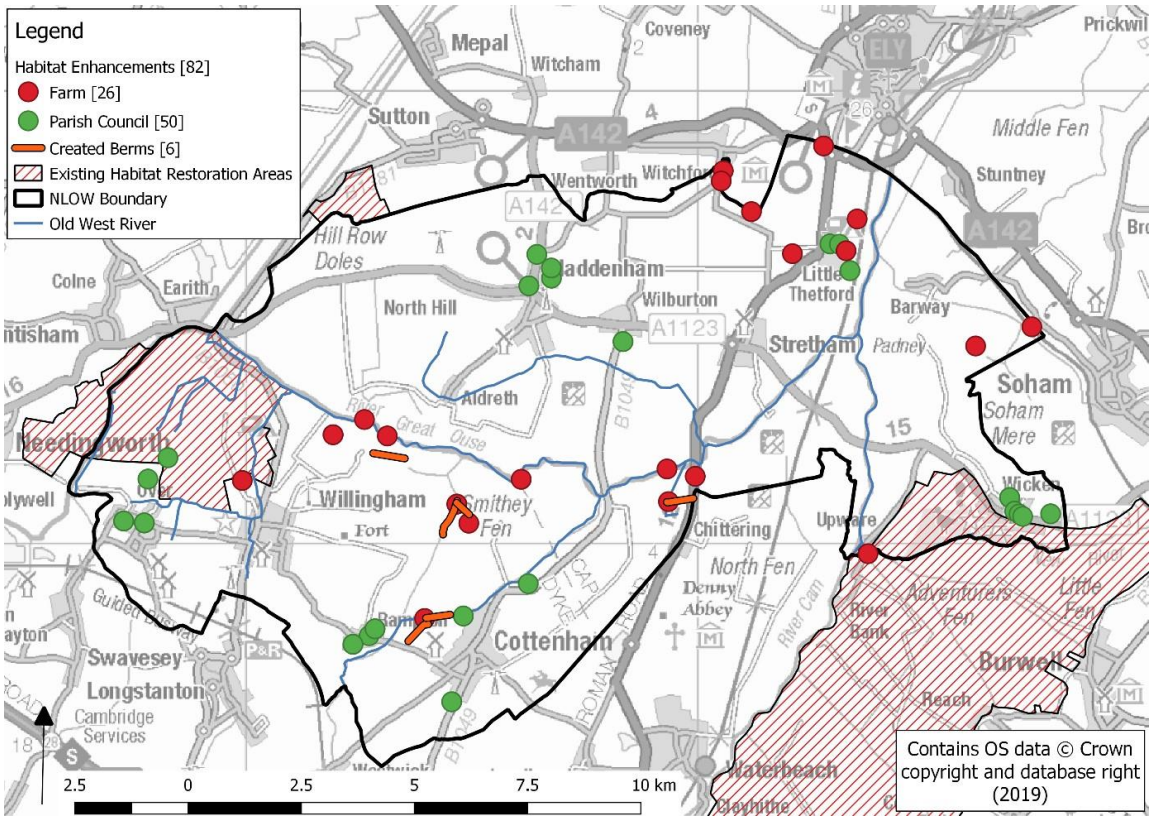


Figure 8-2: Fens Biosphere Zones and Local Authority Boundaries (Cambridgeshire ACRE)

New Life on the Old West (Cambridgeshire ACRE)

This project, developed by Cambridgeshire ACRE, recently received National Lottery funding to implement landscape-scale conservation efforts on and around the Old West river. The project will deliver 88 wildlife habitat enhancements to green spaces and surrounding countryside areas, aiming to increase connectivity and resilience along the ecological corridor between Wicken Fen and the Ouse Washes. The enhancements will include berm creation in drains, new ponds and wetlands, reintroduction of priority and wildflower species, and habitat piles which are deliberately constructed piles of small trees, limbs, and boughs, often with materials that are a by-product of land management activities or storm-related debris.



Box 8-8: New Life on the Old West (Cambridgeshire ACRE)

8.2 Summary of Opportunities and Constraints

Flood Risk Group	Opportunities for development[13]	Constraints to development
Rural Upper Cam	• Many opportunities for development to support local flood improvement works and small-scale flood attenuation schemes along watercourses, using natural flood management techniques, with multiple benefits (e.g. groundwater recharge and river restoration). • Specific opportunity for flood risk betterment at Hinxton Mill.	• Fluvial flood risk from Main River and Ordinary Watercourses • Surface water flood risk in existing villages and small catchments
Bourn Brook and Bin Brook	• Many opportunities for development to support local flood improvement works and small-scale flood attenuation schemes along watercourses, using natural flood management techniques, with multiple benefits (e.g. water quality improvements and river restoration). • Potential for development to support a larger flood storage scheme on Bin Brook, to mitigate existing flood risk to Gough Way estate.	• Fluvial flood risk from Main River and Ordinary Watercourses • Surface water flood risk in existing villages and small catchments, with history of flooding in some villages
Urban Cambridge	• Opportunities for development to support local flood improvement works and small-scale schemes along watercourses, improving maintenance and re-naturalisation of urban channels. • Opportunities for development to reduce surface water flood risk to adjacent sites through reduced run-off rates and oversized attenuation or infiltration storage, at both brownfield and greenfield rates. • Opportunities for development to support the preservation and enhancement of chalk streams (e.g. at Nine-Wells/Hobson's Brook and the mitigation measures for Great Kneighton)	• Fluvial flood risk from Main River and Ordinary Watercourses • Surface water flood risk across many locations
Lower River Cam	• Opportunity for specific flood improvement works through the Cambridge Sport Lakes development (pending planning permission). • Opportunities for development to support local flood improvement works and small-scale flood attenuation schemes along watercourses, using natural flood management techniques, with multiple benefits (e.g. water quality improvements and river restoration). An example being the flood risk mitigation measures related to the Waterbeach New Town development. • Opportunities for development to support future Fen Biosphere aspirations through sustainability improvements. • Opportunity to capture flood water via flood retention basins which can provide a supply of water for agricultural irrigation.	• Risk of flooding due to breach or overtopping of Main River defences • Risk of flooding due to pump station capacity constraints in IDB districts
River Great Ouse and tributaries	• Opportunities for development to reduce surface water flood risk in upper urbanised parts, through reduced run-off rates and oversized attenuation or infiltration storage, at both brownfield and greenfield rates. • Many opportunities for development to support local flood improvement works and small-scale flood attenuation schemes along watercourses, using natural flood management techniques, with multiple benefits (e.g. water quality improvements and river restoration).	• Risk of flooding from Main River and Ordinary Watercourses • Main rivers and tributaries 'tide-locked' by flood levels in the River Great Ouse. • Surface water flood risk in existing villages and small catchments, with history of flooding in some villages • Cross-boundary constraints for the River Great Ouse system downstream, including the Ouse Washes SSSI

[13] Opportunities and schemes outlined in this table are only recommendations to the relevant stakeholders or flood risk management authorities, who may only consider these suggests and not take them forward due to external constraints

Flood Risk Group	Opportunities for development[13]	Constraints to development
Edge of District	• May be opportunities for development to support local flood improvement works and small-scale flood attenuation schemes along watercourses, using natural flood management techniques, with multiple benefits (e.g. water quality improvements and river restoration).	• Risk of flooding from Ordinary Watercourses and surface water

9 The Sequential and Exception Tests

9.1 The Sequential Approach

9.1.1 The NPPF aims to ensure that new development is planned to appropriately manage the risk of flooding (paragraphs 155 to 165). A key element of this is the Sequential Approach, which aims to ensure that, where possible, development is located in areas of lowest flood risk. 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. For example, a site considered to be at low fluvial flood risk in Flood Zone 1 should be considered before a site in Flood Zone 2 or 3 wherever possible, taking account of climate change.

9.1.2 All plans and proposals should follow the Sequential Approach to flood risk. Development should be directed to the areas at the lowest risk of flooding at all stages of the planning process and all scales of development:

- At the strategic scale, to compare a number of sites and select the site with lowest flood risk for development.
- At the site scale, to develop the site layout with development located at the areas of lowest flood risk within the site boundary and the lowest vulnerability uses considered first.
- At the building scale, to orientate the building footprint and layout so that the most vulnerable parts are in the areas of lowest flood risk.

9.1.3 The Sequential Approach should be applied for all sources of flood risk; as well as the fluvial flood risk indicated by the Flood Zone maps, the Sequential Approach must also consider flood risk from smaller unmapped watercourses, surface water (pluvial), groundwater, sewers, and the sea (tidal). It is not a requirement that all development must be located outside of the reservoir breach inundation extents, but instead careful consideration should be given to mitigation of the flood risk through emergency planning.

9.2 The Sequential and Exception Test

9.2.1 The Sequential and Exception Tests are methods for assessing whether a site is suitable for development with regards to flood risk. The Sequential Test (NPPF paragraphs 158 to 159 and Cambridgeshire Flood and Water SPD[14] Chapters 4 and 5) requires demonstration that where possible, all new development is located in areas of lowest flood risk (Flood Zone 1 for fluvial flooding and equivalent risk for other sources of flooding). Where there are no reasonably available sites in these areas, available sites in medium flood risk (Flood Zone 2 or equivalent) should be considered, taking into account the flood risk vulnerability of the proposed land use (Table 5-3) and requirements for the Exception Test to also be passed. Only where there are no reasonably available

[14] Cambridgeshire Flood and Water Supplementary Planning Document

sites in low and medium flood risk areas should the suitability of sites in high-risk areas (Flood Zone 3 or equivalent) be considered, applying the Exception Test if required. Table 9-1 summarises under what circumstances the Exception Test is required and where development should not be permitted.

9.2.2 The presence of existing defences should not be taken into consideration when undertaking the Sequential Test. The maintenance of the defences may change over time and climate change will have an impact on the level of protection that they offer, particularly in low-lying areas noted for their organic sub-strata (peat), which are prone to desiccation and shrinkage.

9.2.3 Development proposals must ensure that flood risk is considered over the lifetime of the development, taking climate change into account. Planning Practice Guidance states that the potential impacts of climate change on flood risk need to be taken into consideration in the Sequential Test. Further guidance on the impacts of climate change is included in Chapter 5.

	Essential Infrastructure	**Highly vulnerable**	**More vulnerable**	**Less vulnerable**	**Water compatible**
Low risk (Zone 1)	✓	✓	✓	✓	✓
Medium risk (Zone 2)	✓	ET	✓	✓	✓
High risk (Zone 3a)	ET[15]	×	ET	✓	✓
Functional floodplain (Zone 3b)	ET[16]	×	×	×	✓[17]

Table 9-1: Flood risk vulnerability and risk category compatibility[18]. Key: ✓ Development is appropriate; × Development should not be permitted; ET Exception Test required.

9.2.4 The Exception Test (NPPF paragraphs 160 - 161) is a method to demonstrate that flood risk to people and property will be managed satisfactorily, allowing

[15] In high risk areas (Flood Zone 3a), essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

[16] In functional floodplain areas (Flood Zone 3b), essential infrastructure should be designed and constructed to remain operational and safe in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere.

[17] In functional floodplain areas (Flood Zone 3b), water compatible uses should be designed and constructed to remain operational and safe in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere.

[18] Flood Risk Vulnerability and Flood Zone Compatibility Table

necessary development in situations where suitable sites at lower risk of flooding are not available. Both parts of the Exception Test must be passed:

- The development must provide wider sustainability benefits to the community that outweigh the flood risk.
- The development must be safe for its lifetime, taking into account the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

9.2.5 The Sequential and Exception Tests do not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site. Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

9.3 Applying the Sequential and Exception Tests in the Local Plan

9.3.1 This Strategic Flood Risk Assessment should be used as part of the evidence base for the Local Plan and to support the application of the Sequential Test. All 'reasonably available' sites will need to be sequentially tested, including sites suggested through the 'Call for Sites' process, current records and sites in council ownership. Local Planning Authorities should then promote sites accordingly, based on those at least risk of flooding and appropriate land uses. Figure 9-1 shows how the Sequential Test should be applied in the preparation of a Local Plan, and Figure 9-2 shows how the Exception Test should be applied.

9.3.2 The Sequential Test will take into account the potential impacts of climate change, ignoring the presence of any existing flood defences. If it has not been possible for all future development or be located in Flood Zone 1, or areas of low flood risk from all sources, then a more detailed site-specific assessment may be required in a Level 2 SFRA to understand the implications of locating proposed development in Flood Zones 2 or 3. The assessment of 'actual risk' of flooding takes into account the presence of formal flood defences and provides an assessment of the safety of the existing and proposed development in terms of flood risk. The assessment of actual risk should also consider the level of protection afforded by the defences with consideration of climate change and management/maintenance policies for the defences.

9.3.3 Cambridgeshire relies heavily on flood defences, particularly in the Fens, and along main rivers and therefore residual risk needs to be considered in determining the viability of land for planning. Residual risk refers to the risks that remain after mitigation measures have been taken to alleviate flooding to make a development appropriate (e.g. flood defences). It applies to fluvial and all other sources of flooding.

9.3.4 The scope for a Level 2 Strategic Flood Risk Assessment would include consideration of residual risks for short-listed sites following the application of the Sequential Test. The Level 2 SFRA should consider the rate and depth of

flooding in the event that flood defences fail, including breach modelling if necessary. The requirement for a Level 2 SFRA to support the Greater Cambridge Local Plan will be assessed following the completion of the Sequential Test.

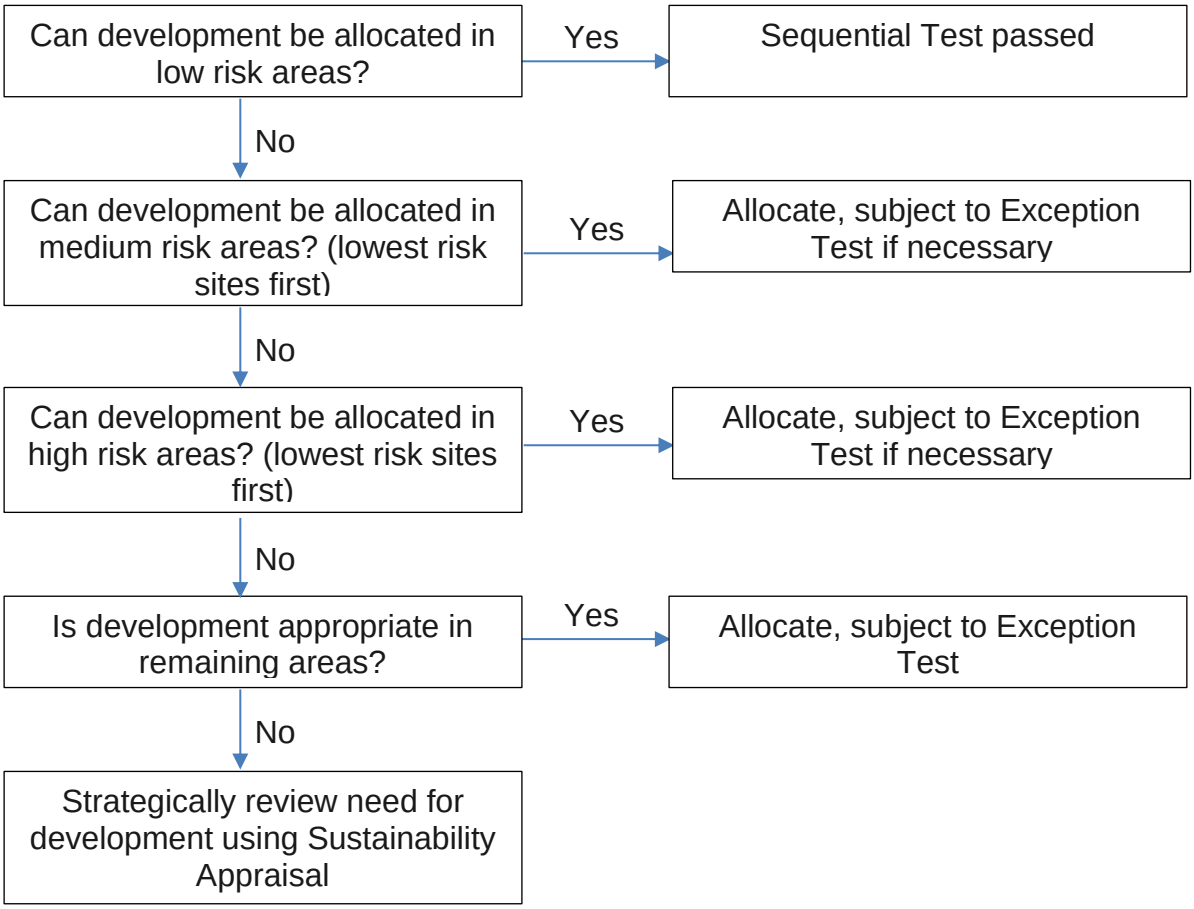


Figure 9-1: Application of the Sequential Test for Local Plan preparation[19]

[19] Application of the Sequential Test for Local Plan Preparation Diagram

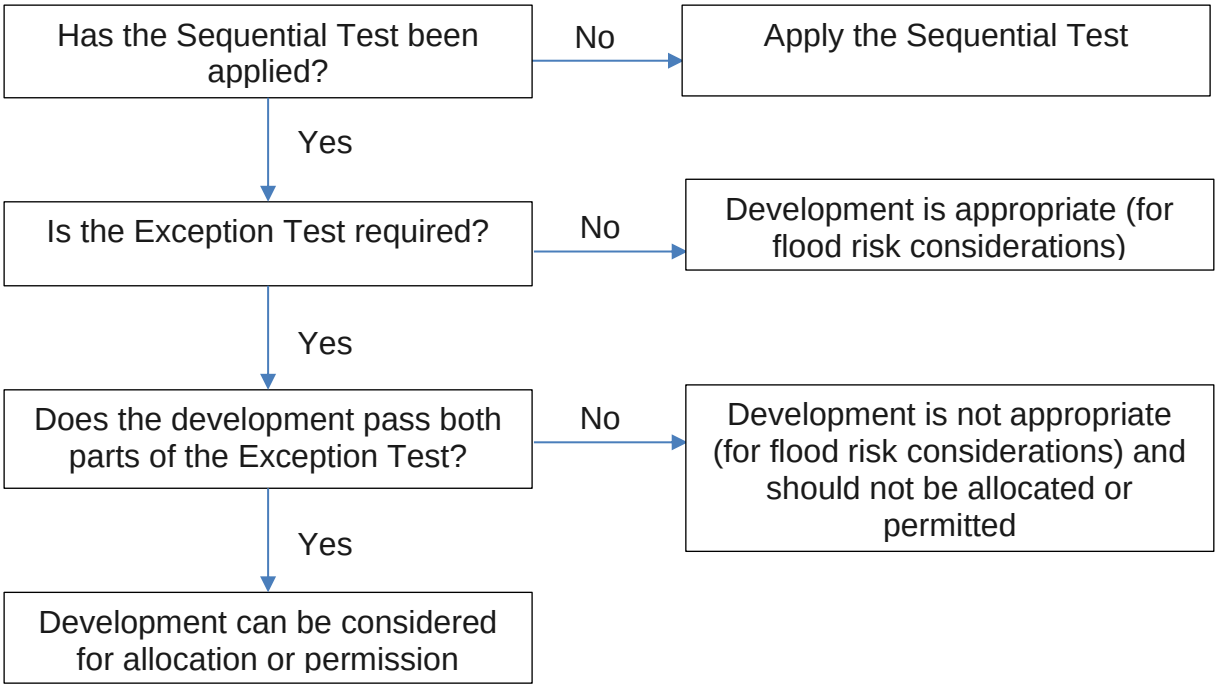


Figure 9-2: Application of the Exception Test for Local Plan preparation[20]

9.4 Applying the Sequential and Exception Tests for Planning Applications

9.4.1 The Sequential Test does not need to be applied to support planning applications for individual developments on sites which have been allocated in the Local Plan through the Sequential Test, provided the planning application is for the same land use vulnerability classification as that assessed in the Local Plan Sequential Test, and there has been no change in flood risk at the site.

9.4.2 The Cambridgeshire Flood and Water Supplementary Planning Document (Chapter 4) provides detailed guidance on how to identify if the Sequential and Exception Tests are required, and how to apply the tests. It requires the following questions to both be answered "yes" if the Sequential Test is not to be necessary for an individual planning application:

- Can it be demonstrated by the developer that the type and location of the proposed development has been allocated in the relevant Local Plan / development plan?
- Can it be demonstrated that the flood risk information contained within the SFRA and associated Sequential Test assessment accompanying the Local Plan / development plan (where applicable) is still appropriate for use?

9.4.3 If the answer to either of these questions is "no", the planning application will need to undertake the Sequential and Exception Tests.

[20] Application of the Exception Test to Local Plan Preparation Diagram

9.4.4 The developer should then consider the potential flood risk at the site. The developer must undertake the Sequential Test if the answer to any of these questions is yes:

- Is the site in Flood Zone 2 or 3?
- Is the site in Flood Zone 1 and within an area that has been identified in the relevant SFRA (or any updated available information) as having flooding issues now or in the future (including climate change)?
- Is the site in an area of significant flood risk from sources other than fluvial or tidal, such as surface water, groundwater, reservoirs, sewers, etc.

9.4.5 The developer should follow Sections 4.3, 4.4 and 4.5 of the Cambridgeshire Flood and Water SPD to undertake the Sequential Test, and, if necessary, the Exception Test. The Exception Test must not be completed until the Sequential Test has been applied.

9.4.6 The presence of existing defences should not be taken into consideration when undertaking the Sequential Test. Proposed site mitigation measures should also not be taken into consideration when undertaking the Sequential Test. If required, these should be assessed through the Exception Test and the site-specific flood risk assessment.

9.4.7 Any development proposals where the Exception Test is required must demonstrate the sustainability issues that the proposal is seeking to address. The general provision of housing by itself would not normally be considered as a wider sustainability benefit to the community which would outweigh flood risk, however confirmation should be sought from the Local Planning Authority. Examples of wider sustainability benefit to the community that would be considered could include regeneration of an area, or the provision of new community facilities such as green infrastructure, woodland community centres, cycle ways/footways or other infrastructure which allow the community to function in a sustainable way.

9.4.8 Development proposals must ensure that flood risk is considered over the lifetime of the development (typically a minimum of 100 years for residential development), taking climate change into account. Planning Practice Guidance states that the potential impacts of climate change on flood risk need to be taken into consideration in the Sequential Test. Further guidance on the potential impacts of climate change is included in Chapter 5.

10 Site Specific Flood Risk Assessment Requirements

10.1 When is a Site-Specific Flood Risk Assessment required?

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

10.1.2 Site specific FRAs are required for any development proposals that fall into the following categories:

- All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3.
- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals of less than 1 hectare in Flood Zone 1 (including a change of use in development type to a more vulnerable class) where the development could be affected by sources of flooding other than the rivers and the sea (for example, surface water).
- Proposals of less than 1 hectare in Flood Zone 1 where there is a critical drainage problem (as notified to the Local Planning Authority by the Environment Agency).

10.1.3 Site specific FRAs may also be required for these situations:

- If the site may be at risk from the breach of a local flood defence (even if the site is in Flood Zone 1).
- Where the site is intended to discharge surface water runoff into the catchment or assets of a Risk Management Authority which requires a Site-Specific FRA.
- Where the site may have an impact on an Internal Drainage Board system.
- Where the Local Planning Authority is aware of evidence of historical or recent flood events.
- In an area of significant surface water flood risk.

10.1.4 All site specific FRAs must follow the NPPF, PPG, Environment Agency and Risk Management Authority guidance, including the Cambridgeshire Flood and Water SPD. This sets out a flood risk management hierarchy to assess, avoid, substitute, control and mitigate flood risk (Figure 10-1).

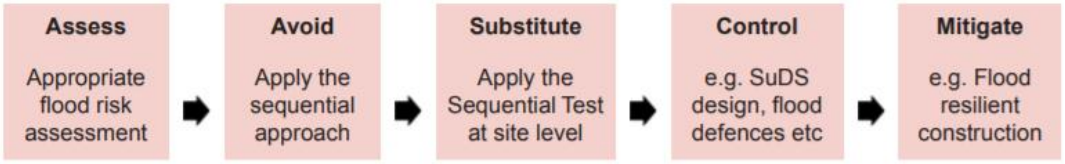


Figure 10-1: The Flood Risk Management Hierarchy (Figure 1.1 of the Cambridgeshire Flood and Water SPD)

10.2 Working together with Risk Management Authorities

To inform a site-specific FRA it is strongly recommended that pre-application consultation is undertaken by the developer with the relevant Risk Management Authority. As outlined in Section 1.3 there are a number of stakeholders who have responsibility for managing flood risk in the Greater Cambridge area. These Risk Management Authorities and their key responsibilities relevant for this SFRA are outlined in

10.2.1 Table 1-1 and the flood risk sources managed by each RMA are summarised in Table 1-2.

10.2.2 The purpose of pre-application consultations is to identify the range of issues that may affect the site and to help determine whether the site is suitable for its intended use, including whether it is necessary to apply the Sequential Test and if necessary the Exception Test.

10.2.3 The key issues to consider and consult on are listed in detail in the Cambridgeshire Flood and Water SPD (Section 4 Step 3). Undertaking this consultation will confirm if a site-specific FRA is required, identify opportunities and constraints with regards to flood risk and drainage, obtain relevant data, and identify if any works consents will be required from the Environment Agency, Internal Drainage Board, Lead Local Flood Authority or water company.

10.2.4 It may be necessary for developers to undertake detailed hydraulic modelling of the flood risk at their site, to provide greater confidence in estimated flood levels, depths, velocities and durations. It is recommended that the scope of any modelling is agreed with the Environment Agency and other relevant RMAs in advance. The modelling will need to be submitted to the Environment Agency or other relevant RMA for checking and agreement, and the timescales and cost of this process will need to be factored into the developer's planning programme.

10.2.5 Breach modelling may be necessary for areas of Greater Cambridge that benefit from raised flood defences. The Environment Agency should be contacted in the first instance to confirm what breach and hazard mapping information is available or to agree the scope for further technical assessment.

10.3 Objectives of Site-Specific Flood Risk Assessments

10.3.1 The scope of site specific FRAs should be proportionate to the magnitude of flood risk, as well as the scale, nature and location of the development. They must demonstrate that the new development is safe in flood risk terms and does not increase flood risk elsewhere.

10.3.2 The site-specific FRA should be undertaken as early as possible in the planning process to inform the site masterplan and application of the sequential approach to layout of buildings according to vulnerability, ideally as part of the feasibility stage instead of the design stage. It should consider and quantify all sources of flood risk to the site (fluvial, tidal, surface water, groundwater, reservoir and sewer). The data included in this SFRA can be used for an initial assessment, but updated data should also be sought from the relevant RMAs.

10.3.3 A site-specific FRA should provide enough information to:

- Clearly state the risk of flooding to the development.
- Consider the vulnerability of those that could occupy and use the development, taking into account the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access during a flood event.
- Identify and propose potential flood risk reduction measures, including opportunities to reduce flood risk off-site.
- Assess the remaining ‘residual’ risk after mitigation measures have been taken into account and demonstrate that this is acceptable for the particular development.
- Consider how the ability of water to soak into the ground may change with development along with how the proposed layout of the development may affect drainage systems (or visa versa) (see Chapter 11).
- Mitigate the risk of flooding arising from the development, making use of sustainable drainage systems (see Chapter 11).
- Fully account for current climate change scenarios and their effect on flood zoning and risk.

10.3.4 Step 4 in Section 4 of the Cambridgeshire Flood and Water SPD sets out the requirements of a site-specific FRA in more detail. A FRA checklist is included in Appendix B2 of the SPD detailing what information must be included. This should be completed by developers and submitted with their FRA in the planning application.

10.4 Flood Risk Management and Mitigation

10.4.1 Section 5.1 of the Cambridgeshire Flood and Water SPD provides detailed guidance on how flood risk from all sources can be managed through site design to ensure that development will be safe from flooding. This includes discussion of:

- The need for modelling and mapping of flood risk to provide sufficient information to demonstrate the safe design of new developments.
- The potential impacts of climate change.
- Site layout.
- Raising floor levels.
- New flood defences.
- Flood compensation storage.

10.4.2 Mitigation measures should be seen as a last resort to address flood risk issues and should be considered only after it has been demonstrated that developing in flood risk areas has been avoided as much as possible and the site and location are appropriate for the chosen type of development.

10.4.3 Chapter 8 of this SFRA outlines potential opportunities for flood risk management in relation to proposed development in the Greater Cambridge area. The scale of development proposed in the area may offer new opportunities to improve existing flood risk issues that would otherwise not have been achievable.

10.5 Managing Residual Risks

10.5.1 Residual risks are those remaining after the sequential approach has been applied to the layout of the different site uses and after specific measures have been taken to control the flood risk to acceptable levels, mitigating any detrimental impacts on flood risk elsewhere. Residual risk management relates to managing flooding in more extreme events than usually designed for (typically the 1% (1 in 100) annual probability event plus climate change). Management of the residual risk is therefore the last stage of designing and planning a site, where all options for removing and reducing risk have already been taken.

10.5.2 Section 5.2 of the Cambridgeshire Flood and Water SPD provides guidance on managing residual risk using flood resistant measures (to minimise water entry, typically for flood depths of less than 0.6 m) and flood resilient measures (to facilitate draining and drying after flooding, typically for flood depths greater than 0.6 m). The aim is for occupiers is to stop what they can, slow what they can't and recover from when it happens. The use and effectiveness of these measures is dependent on actions taken by home occupiers and therefore should be as simple as possible, with clear information provided to home occupiers and training in how to deploy measures such as demountable barriers

and temporary pumps. Passive measures should be prioritised as this requires no active intervention, which may otherwise be a health and safety risk.

10.5.3 Management of residual risks also includes appropriate flood warning and safe evacuation plans. These are discussed in Chapter 12 of this SFRA.

10.6 Consents and Other Assessments

10.6.1 In addition to site specific flood risk assessments, it may be necessary for developers to obtain permits, consents for works, and undertake other assessments related to watercourses:

- Environmental permits[21] are required from the Environment Agency for all work on or near a main river, a flood defence structure, a sea defence, or in a floodplain.
- Ordinary Watercourse Consents are required from the LLFA or Internal Drainage Board for work on or near all other watercourses (non-main river).
- Discharge Consents are required from the respective IDB for the disposal of surface, treated foul and/or groundwater from developments which increase the rate or volume of surface water in the system either directly or indirectly.
- Water Framework Directive assessments may be necessary for specific activities or where an activity could affect a high-status water body. The assessment will need to show that the proposed works support the objectives of the local River Basin Management Plan and meet sustainability criteria. The relevant consenting body will be able to provide advice on whether an assessment is necessary.

[21] Environmental Permits: Detailed Information

11 Surface Water Drainage and SuDS Design

11.1 Introduction

11.1.1 Sustainable Drainage Systems (SuDS) manage surface water run-off from a development in ways that aim to replicate the benefits of natural drainage systems. SuDS collect, store, slow and treat the quality of surface water in order to mitigate the impacts of development on run-off rates, volumes and quality. SuDS generally replace traditional underground, piped drainage systems with overground open channel systems (e.g. swales) and surface storage ponds. They can be integrated into all developments, including heavily urbanised environments. SuDS offer opportunities to improve and connect habitat in existing urbanised environments and will play an important role in delivering and reinforcing wider blue-green infrastructure ambitions for Cambridgeshire.

11.1.2 The NPPF, PPG, Non-Statutory Standards for Sustainable Drainage, Buildings Regulations, and adopted and emerging Local Planning policies require SuDS to be applied as the first choice for surface water management for new development in preference to traditional sewer systems (Figure 11-1).

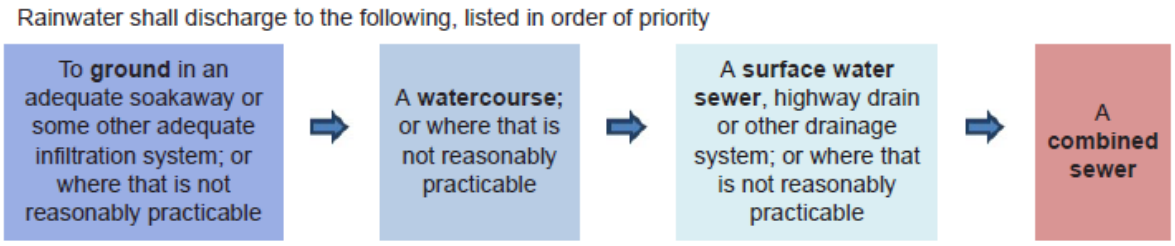


Figure 11-1: Surface water drainage hierarchy (Figure 6.8 of the Cambridgeshire Flood and Water SPD). Note in all instances, adequate stormwater storage will be needed to meet the relevant infiltration or discharge rate and volume requirements.

11.1.3 The following guidance documents apply to the Greater Cambridge area and provide the required design parameters:

- Chapter 6 of the Cambridgeshire Flood and Water SPD
- Cambridgeshire Surface Water Drainage Guidance for Developers.
- Cambridge City Council SuDS Design and Adoption Guide
- SuDS Design and Construction Guidance
- Sewerage Section Guidance

11.1.4 Many of the general principles outlined in Chapter 6 of the SPD can also be applied to traditional surface water drainage. The guidance must be complied

with on all development sites and the provision of SuDS maximised, even at very constrained sites.

11.1.5 Planning applications must include a site-specific surface water drainage strategy, containing details of how the development will manage surface water run-off, the use of SuDS, and how any detrimental impacts on flood risk and water quality will be mitigated. The scope of the surface water drainage strategy should be proportional to the development size, complexity and impacts. Further guidance on the contents of surface water drainage strategies is provided in Appendix B and F of the Cambridgeshire Flood and Water SPD and Section 4 of Cambridgeshire Surface Water Drainage Guidance for Developers.

11.1.6 The Cambridgeshire Surface Water Guidance for Developers contains detailed checklists and technical design parameters (for example in relation to attenuation volumes required, urban creep, flow controls) and should be referred to in the design of all surface water drainage strategies. The guidance and the Cambridgeshire Flood and Water SPD also contain information and further checklists in relation to the level of technical assessment/supporting information required to be supplied by developers for outline, full or reserved matters applications.

11.1.7 The Design and Construction Guidance[22], updated 25th May 2021 and effective as from 1st July 2021, applies to all water companies and sets out the circumstances in which they would be expected to adopt SuDS features which meet the legal definition of sewers.

11.1.8 On the 1st April 2020, new sewerage adoption arrangements came into effect through the Sewerage Section Guidance produced by UK Water on behalf of the water industry for the approval of Ofwat. The guidance includes information on sustainable drainage systems (SuDS) where they meet the legal definition of sewer. These SuDS features can now be adopted by water companies like Anglian Water under S104 of the Water Industry Act 1991, meaning they can be adopted through the same mechanism as pipes, manholes and pumping stations.

11.2 Role of LLFA and LPA in Surface Water Management

11.2.1 Cambridgeshire County Council is the LLFA and is therefore the statutory consultee for surface water run-off management on all major developments. Major developments are defined as:

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

[22] Design and Construction Guidance

- Development carried out on a site size of one hectare or more.

11.2.2 South Cambridgeshire and Cambridge City Council will seek advice from the LLFA to ensure that the proposed standards of operation are appropriate and that there are clear arrangements for on-going maintenance of the infrastructure over the development's lifetime. Responsibility for approving the proposed SuDS design lies within the Local Planning Authority as part of the planning process.

11.2.3 The LLFA offers a pre-application service for all scales of development. The aim of pre-application discussions is to guide developers through the planning process to ensure high quality development can be delivered across Cambridgeshire. Costs associated with the pre-application service are detailed in the Cambridgeshire Surface Water Drainage Guidance for Developers. It is strongly recommended that developers use the pre-application service to avoid unnecessary reworking at later stages. The LLFA can provide advice on the following:

- Topography and drainage patterns
- Proposed surface water destination
- Permitted discharge rates and volumes
- Attenuation volumes and locations
- Flood risk to and from the site
- Third part consents
- Any required off-site works
- Temporary drainage during construction
- Presence of sensitive receptors
- Further maintenance and adoption of SuDS.

11.3 Principles of Sustainable Drainage Systems (SuDS)

11.3.1 SuDS are designed to maximise the multiple opportunities and benefits that surface water management can provide. The four main benefits are referred to as the four pillars of SuDS design:

- Water Quantity – control the quantity (rate and volume) of runoff to support the management of flood risk.
- Water Quality – manage the quality of the runoff to prevent pollution and improve the water environment.
- Biodiversity – create and sustain better places for nature.
- Amenity – create and sustain better places for people.

11.3.2 The Cambridgeshire Flood and Water SPD Section 6.2 outlines the Cambridgeshire SuDS design context and items to consider when developing a SuDS strategy in terms of topography, rainfall and water availability, flood risk, geology, biodiversity and green infrastructure, character and urban design and presence of water features. Some of the key principles are:

- **Plan in SuDS from the start** – considering appropriate SuDS during the preliminary stages of masterplanning design provides greater opportunity to incorporate suitable SuDS measures into a development and ensure sufficient space is provided within the development layout.

- **Mimic natural drainage** – Allowing surface water runoff to follow the natural physical geography requires less earthworks and can eliminate the need for underground piping and pumping of water. All new developments on greenfield sites are required to discharge surface water runoff from the impermeable areas at or below the same greenfield runoff rate in agreement with the LLFA/LPA or IDB. Brownfield sites must reduce the existing runoff from the site as part of the redevelopment, and, where feasible, aim to reinstate greenfield runoff rates.

- **Use the SuDS management train** – The SuDS management train is a central design concept for SuDS with the aim to provide maximum improvement to water quality and control run-off flow rates and volumes. The management train begins with land use decisions and prevention measures, followed by interventions at the property scale and street scale (source control), through to considerations for downstream run-off controls within the overall site boundary. This allows a number of treatment stages to be incorporated to reduce runoff rates and volumes and improve water quality. The number of treatment stages required depends primarily on the source of the runoff. The site-specific drainage strategy will need to demonstrate that an appropriate number of treatment stages are included in the proposals.

- **Water reuse first** – Cambridgeshire is one of the driest areas in England, therefore including water reuse measures wherever possible is important. Recycled rainwater and surface water runoff can be used for non-potable purposes such as toilet flushing and irrigation. Proposed development sites in IDB areas should be discussed with the relevant IDB as a development may also provide the opportunity to improve water supply to the surrounding land (e.g. for irrigation purposes). With future impacts of sea level rise, most water in the Fens may need to be pumped out to sea by 2080; re-using water will not only reduce abstractions, but also reduce carbon from such future Fenland infrastructure.

- **Follow the drainage hierarchy and use infiltration where feasible** – as outlined in Figure 11-1.

- **Place-making through SuDS design and a landscape led approach** - The presence of water features within the urban environment can promote a strong sense of place, bring an urban space to life and create unique amenity areas. A landscape-led approach uses SuDS as a

mechanism to create strong green infrastructure networks and is important to increase connectivity to the wider ecosystem and landscape. Open spaces can provide space for SuDS features to provide attenuation and treatment of surface water runoff.

- **SuDS and constrained sites** –sites that are high density, brownfield or flat are often cited as reasons for not including SuDS within a development, however, this is not acceptable in Cambridgeshire. The SPD provides examples of how to overcome these issues and integrate SuDS within the development.

- **Designing for exceedance** – in line with Sewers for Adoption guidance, there should be no water outside the designed SuDS system for a 3.3% (1 in 30) annual probability rainfall event. In addition, the Cambridgeshire Flood and Water SPD states that in a new development there should be no flooding of any properties from surface water run-off for a 1% (1 in 100) annual probability rainfall event plus an appropriate allowance for climate change. The design should also take into account the potential impacts of flooding on SuDS performance, if located in floodplain areas.

11.3.3 Recommended design parameters and further information for all SuDS features are contained within the Ciria SuDS Manual. The Cambridgeshire Surface Water Guidance for Developers reproduces some of the key design criteria that should be applied to common SuDS features such as filter strips, permeable paving, attenuation basins and wetlands.

11.4 Adoption and Maintenance of SuDS

11.4.1 The site-specific surface water drainage strategy must include evidence detailing who will be adopting and maintaining the drainage system alongside a management plan and maintenance schedule of work detailing the activities required. This should appropriately account for the construction, operation and maintenance requirements of all components of the drainage system over its design life. Appendix A of the Cambridgeshire Surface Water Guidance for Developer has a template maintenance plan that can be used.

11.4.2 There are a variety of adoption options available, including the sewerage undertaker (Anglian Water), private management companies, Town and Parish Councils, IDBs, private individuals, or trusts and organisations. The proposed SuDS design must meet the adopting authorities design criteria. Section 6.9 of the Cambridgeshire Flood and Water SPD provides further details of adoption procedures and agreements. For developments in Cambridge City Council authority area, the Cambridge City Council SuDS Design and Adoption Guide should be referred to and early consultation undertaken with the LPA.

11.4.3 In addition to the national Design and Construction Guidance, Anglian Water provide guidance and a design manual for SuDS[23]. It is recommended that developers apply to Anglian Water to seek adoption of SuDS at early stages of

[23] Anglian Water: Sustainable Drainage Systems

design to ensure the proposed infrastructure meets Anglian Water requirements.

12 Flood Warning and Emergency Planning

12.1 Introduction

12.1.1 South Cambridgeshire District Council and Cambridge City Council have a statutory responsibility for preparing for emergencies affecting their Council areas within Greater Cambridge and are supported by multi-agency teams. These teams are responsible for ensuring emergency management and business continuity arrangements are maintained in order to respond effectively to a range of emergencies.

12.1.2 Emergency planning can be broadly split into three phases: before, during and after a flood. The plans 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.

12.2 Cambridgeshire and Peterborough Local Resilience Forum

12.2.1 Emergency planning teams at the Local Authority councils in Cambridgeshire are supported by the Cambridgeshire and Peterborough Local Resilience Forum (CPLRF). The CPLRF was established in response to the statutory requirements of the Civil Contingencies Act 2004. The CPLRF acts to ensure effective delivery of those duties under the Act that need to be developed in a multi-agency environment. The CPLRF is made up of emergency services, local authorities, military, public health organisations and others who would all have a role to play should a major emergency occur.

12.2.2 There are a number of sub-groups in the CPLRF that cover specific emergency subjects. The CPLRF sub-groups produce a number of emergency preparedness plans and they outline how responding organisations will work together in the event of an emergency or Major Incident. The work for flooding emergency and response is covered by the severe weather sub-group. The plans include a Fluvial Flood Plan, East Coast Flood Plan, Severe Weather Plan and Reservoir Emergencies Generic Off-Site Plan.

12.2.3 The CPLRF also has a duty to produce a Community Risk Register which highlights risks that have the highest likelihood and potential to have a significant impact to local communities resulting in wide scale disruption. Risks are categorised using a scale from no risk to very high risk. The purpose of the Community Risk Register is to:

- Inform about the highest risks in the county and their consequences.
- Detail steps that can be taken to become better prepared and more resilient in your own home, business and community.
- Provide links to organisations and websites to find out more information.

12.2.4 Urban (fluvial and/or surface water runoff) flooding and local fluvial flooding events are categorised as high-risk events on the Community Risk Register.

12.2.5 CPLRF information is hosted on the Cambridgeshire Fire and Rescue Service website[24] and provides a range of information to assist individuals, businesses and communities prepare for emergencies including flooding.

12.3 The Council's Role in Emergency Planning and Development

12.3.1 South Cambridgeshire District Council and Cambridge City Council are responsible for preparing and delivering the local authority response to a severe flooding event.

12.3.2 Both Local Authority websites have information dedicated to flooding and flood risk management which contain guidance and advice on what to do in a flood, who to contact and roles and responsibilities. The Local Flood Risk Management Strategy also outlines the key responsibilities of the Local Authority in the case of a flood emergency.

12.3.3 At an early stage during a flood event the key agencies consider the recovery process and the activation of the CPLRF Community Recovery Plan. An appropriate agency is identified to lead on recovery, which is normally the District Council in whose area the flooding has taken place. There are arrangements whereby the District Council can request the County Council to lead (e.g. in the event that flooding is countywide). The lead recovery agency will identify and engage the other relevant agencies and establish a recovery coordinating group (chaired by LLFA). Further detail on how the recovery process will be managed is documented in the CPLRF Community Recovery Flood Plan.

12.4 Flood Warnings

12.4.1 The Environment Agency is the lead organisation for providing flood warnings for the risk of flooding from rivers, the sea and groundwater. The areas of Greater Cambridgeshire covered by the Environment Agency flood warning service can be viewed online and are included in this SFRA mapping (refer to map D12 in Appendix D).

12.4.2 There are three levels of flood warning issued by the Environment Agency:

- Flood alert – Prepare. Recommended actions are to prepare a bag that includes medicines and insurance documents and continue to check flood warnings.
- Flood warning – Act. Recommended actions are to turn off gas, water and electricity, move things upstairs or to safety, and move family, pets and vehicles to safety.
- Severe flood warning – Survive. Recommended actions are to call 999 if in immediate danger, follow advice from emergency services, and keep people safe.

[24] Cambridgeshire Fire and Rescue Service

12.4.3 Warnings are issued by phone, email or text to registered individuals[25]. Therefore, the success of the warning scheme is dependent on residents signing up to the scheme. Developers must also bear in mind that warning areas may not be extended to cover new development areas. The scheme only covers flooding from some watercourses and sources. Flooding from rainfall, surface water runoff and smaller watercourses often occur very quickly, making prediction and warning more difficult. Aside from the Met Office warnings, no specific local or national warning system currently exists for these more localised events and developers will need to consider this in ensuring developments will be safe from all sources of flooding, if placing any reliance on flood warnings to mitigate flood risk.

12.5 Flood Evacuation Plans

12.5.1 To demonstrate that development will be safe for its lifetime taking into account the vulnerability of its users, a site-specific FRA may need to show that appropriate evacuation and flood response procedures, within an emergency plan, are in place to deal with the design flood and take into account extreme floods if this could result in flooding at the site. Particular care should be taken at sites where flooding could occur due to breach of defences, due to the potential speed of inundation and the feasibility of evacuation under these circumstances. Proposals that will increase the number of people living or working in areas of flood risk will also require particularly careful consideration, as they could increase the scale of evacuation required.

12.5.2 Practicality of safe evacuation from an area will depend on:

- The type of flood risk present and the extent to which advance warning can be given in a flood event.
- The number of people that would require evacuation from the area potentially at risk.
- Safe access routes located above design flood levels and avoiding flow paths, including those caused by exceedance and blockage (or if this is not feasible, limited depths of flooding may be acceptable, though dependent on flood velocities and risk of debris).
- The adequacy of both evacuation routes and identified places that people could be evacuated to (taking into account the length of time that the evacuation may need to last).
- Sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

12.5.3 As part of a site-specific FRA, the developer should review the acceptability of the proposed safe access route in consultation with the Council, the

[25] Sign up for Flood Warnings

Environment Agency and current guidance[26],[27]. The velocity and depth of flows should be assessed against standard hazard criteria to ensure safe access and egress can be achieved. Wherever possible, evacuation routes should include dry access and escape routes. Flood warning and evacuation plans will need to take account of the likely impacts of climate change e.g. increased water depths and the impact on how people can be safely evacuated.

12.5.4 Situations may arise where occupants cannot be evacuated or where it is safer to remain 'in-situ' and seeking refuge on a higher floor or designated refuge area may be preferable. These allocations should be assessed against the outputs of this SFRA and where applicable a site-specific FRA to help develop emergency plans. The use of on-site refuge must be agreed by emergency service partners. In this situation the LPA will seek to organise a technical meeting with their Emergency Planner that deals with Evacuation Plans for the district, with Cambridgeshire's Fire and Rescue Service and the Police Force in order to agree whether the development's strategy for access, escape and safe refuge is appropriate.

12.5.5 Flood resilience measures can also include information based actions and planning such as:

- The use of clear signage within a development to explain the remaining risks or required responses from residents in the event of a flood such as displaying information on access doors and when to use them, in car parks explaining when to move cars, or on riverside walkways (i.e. when car parks are designed to flood) and defined flood conveyance routes and storage areas.

- Clear signage for evacuation pathways and routes, and where possible, markers (colour coded) used on bollards/lampposts to define the path and changes in depth from shallow to deep for the users. Any subsurface chamber covers should not be located within access routes as covers can lift during floods and become extremely hazardous to pedestrians.

- Ensuring that appropriate flood insurance is available and is in place for buildings and contents.

- Developing and maintaining business continuity plans. It is encouraged that business continuity planning is undertaken across all risk areas.

- Preparing and acting on flood warning and evacuation plans. Particular attention should be given to communicating warnings and the evacuation of vulnerable people including children, the elderly, and those with health concerns.

[26] Flood Risk Assessment Guidance for New Development - FD2320

[27] Flood Risks to People Phase 2 - FD2321

12.5.6 The Environment Agency provides practical advice and templates on how to prepare a flood plan for individuals, communities and businesses[28].

12.6 Emergency Planning and the role of the SFRA

- The SFRA will assist the Council to apply the Sequential Test and where necessary, identify where the Exception Test is required, therefore ensuring new emergency planning uses and any new development required to remain operational during a flood event are located appropriately i.e. in the lowest flood risk zones .For example, the NPPF classifies police, ambulance, fire stations and command centres that are required to be operational during flooding as 'Highly Vulnerable' development, which is not permitted in Flood Zones 3a and 3b and only permitted in Flood Zone 2 providing the Exception Test is passed. Essential infrastructure located in Flood Zone 3a and 3b must remain operational during a flood event.

- The outputs of this SFRA should be compared and reviewed against any existing and new emergency plans and continuity arrangements within the district. This includes the nominated rest centres (and prospective ones), to ensure evacuees are outside of the high-risk flood zones and will be safe during a flood event.

- A site-specific FRA may be required to help develop emergency plans for particular sites. A proposed new development may not be considered sustainable if it places additional burden on the existing response capacity of the Council (in line with part 1 of the Exception Test criteria) by increasing the number of residents that would require support during a flooding emergency.

[28] Prepare for Flooding

13 Summary and Recommendations

13.1 Summary

13.1.1 This SFRA has collated available information to map flood risk from all sources in the Greater Cambridge area. There remains a high uncertainty in many map extents, including the potential impacts of climate change.

13.1.2 Flood risk opportunities and constraints have been reviewed across the area, to support future Local Plan policies and site allocations.

13.1.3 The information in this SFRA can be used to support the selection of development sites through the application of the Sequential Test and Exception Test, enabling the councils to meet their obligations under the National Planning Policy Framework.

13.1.4 This SFRA provides advice for site specific flood risk assessments, surface water drainage and SuDS design, flood warning and emergency planning. To avoid repetition of material, the Cambridgeshire Flood and Water SPD should be referred to for more detailed guidance.

13.2 Recommendations for Risk Management Authorities

13.2.1 A number of recommendations have been made in this report. These are summarised below for the relevant risk management authority.

Greater Cambridge Local Authorities

- It is recommended that the SFRA is reviewed by the Local Authorities in consultation with the Environment Agency and the Lead Local Flood Authority regularly, to identify and implement any significant updates necessary. This review could be led by the Cambridgeshire and Peterborough Flood and Water Partnership.

Environment Agency

- It is recommended that the Environment Agency set up and lead a cross-boundary working group to manage the flood risk issues at Hinxton, including the Local Authorities, CPPF, relevant landowners and developers, all of whom should contribute financially to the work undertaken.

- It is recommended that the Environment Agency review flood risk options for the Gough Way estate to identify whether a scheme could now qualify for funding.

- Due to the age of many of the hydraulic models in Greater Cambridge, we recommend the Environment Agency begin a regular programme of model updates to ensure reliable information is available for future Local Plans. It may be possible to facilitate model updates through site-specific

flood risk assessments, although the scope of model update should be proportional to the scale of the development.

Lead Local Flood Authority

- There are a number of isolated rural properties and farms potentially at high risk of flooding in the low-lying fenland floodplains associated with the River Great Ouse and lower River Cam. These properties need to be located in these higher risk areas for agricultural purposes. It is recommended that the Lead Local Flood Authority give further consideration to supporting these properties in adapting to climate change, including improved flood warning provision, flood evacuation planning, and property level flood resilience and resistance adaptation.

13.3 Policy Recommendations

13.3.1 It is recommended that the Local Plan include policies with regards to:

- Developers working in partnership with other relevant Risk Management Authorities in respect of flood risk from all sources and how this has informed the planning application.
- Application of the sequential approach to flood risk at all stages of development, including site allocations as part of local preparation, site masterplanning, and building layouts.
- Consideration of all sources of flood risk when applying the Sequential and Exception Tests.
- Requiring all development to be safe for its lifetime, taking into account the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall. This should be applied for all sources of flooding and take into account the impacts of climate change.
- Requiring all development to use appropriate SuDS for surface water drainage which provide multi-functional benefits, designed to the standards set out in the Cambridgeshire Flood and Water SPD and the requirements of the body adopting the SuDS.
- Where appropriate, site-specific policies relating to flood risk opportunities and constraints in that area.

13.3.2 The specific wording of policies should be developed in consultation with stakeholders.

13.4 Requirements for a Level 2 SFRA

13.4.1 Following the application of the Sequential Test, the Councils may consider it necessary to develop a Level 2 SFRA. If it has not been possible for all future development or be located in Flood Zone 1 or areas of low risk, then a more detailed site-specific assessment may be required in a Level 2 SFRA to understand the implications of locating proposed development in Flood Zones

2 or 3. The Level 2 SFRA should consider the risk of flooding in greater detail within a local context to provide confidence that the site can be developed in a safe and sustainable manner.

13.4.2 In general, and with regard to the uncertainty in currently available data, the following has been suggested:

- If development sites are proposed adjacent to or near (<100 m distance or <1 m elevation) of the mapped fluvial flood extents for Main River watercourses, it is recommended that a Level 2 SFRA is undertaken using new or updated flood modelling to confirm extents and the impacts of climate change.

- If development sites are proposed in or near (<50 m distance or <0.5 m elevation) fluvial or surface water flood risk areas for Ordinary Watercourses, it is recommended that a Level 2 SFRA is undertaken using new or updated flood modelling to confirm extents and the impacts of climate change.

- If development sites are proposed in areas benefiting from flood defences, it is recommended that a Level 2 SFRA is undertaken to consider the rate and depth of flooding in the event that flood defences fail, including breach modelling if necessary.

Appendix A Stakeholder Engagement

The table below summarises information obtained directly from key stakeholders, and responses received to an initial communication sent out by the Greater Cambridge Shared Planning Team on behalf of this project to parish councils, residents associations and local groups. Information was sought both for this SFRA and for the wider Integrated Water Management Study.

We recognise that the exceptional circumstances of 2020 may have meant that not all interested stakeholders may have been able to respond or provide information in time for the publication of this report. We recommend that all stakeholders are contacted for updated information when this SFRA is annually reviewed.

Stakeholder	Response	Specific information provided
Abbey People Community Group	Interested and have information to provide	None to date
Anglian Water	Data sharing agreed	See Chapter 6
Babraham Road Residents Association	Interested and would like to be kept informed of progress	N/A
Bartlow Parish Council	Interested and have information to provide	None to date
Cam Valley Forum	Interested and have information to provide	“Let it Flow” Report (now available on the Cam Valley Forum website)
Cambridge ACRE	Interested and have information to provide	Information on Old West River and Fens Biosphere conservation projects
Cambridge PPF	Interested and have information to provide	Information on water issues at their sites of interest
Cambridge Sports Lakes Trust & Milton Country Park	Interested and have information to provide	Information on sports lake proposals and Milton Country Park hydrology
Cambridgeshire County Council (LLFA)	Data sharing agreed	See Chapter 6
Caxton Parish Council	Interested and have information to provide	None to date
Cottenham Parish Council & Cottenham Flood Risk Forum	Interested and have information to provide	Comments on sensitivity of Cottenham Parish to water management in the wider area including upstream catchment development

Stakeholder	Response	Specific information provided
Croydon Parish Council	Interested and would like to be kept informed of progress	N/A
Environment Agency	Data sharing agreed	See Chapter 6
FeCRA	Interested and have information to provide	None to date
Friends of Cherry Hinton Brook	Interested and have information to provide	Comments on vulnerability to drought and further information on website
Friends of Histon Road Cemetery	Interested and would like to be kept informed of progress	N/A
Friends of Jesus Green Association	Interested and have information to provide	None to date
Friends of Jesus Green Lido	Interested and would like to be kept informed of progress	N/A
Fulbourn Forum and Fulbourn Parish Council	Interested and have information to provide	Information of the impact of abstraction on water levels
Gamlingay Parish Council	Interested and have information to provide	None to date
Gough Way Residents Association	Interested and have information to provide	Detailed information on flooding in 1978 and 2001 and links to further documentation
Grantchester Parish Council	Interested and have information to provide	Information on flooding issue on Mill Way
Harston Parish Council	Interested and would like to be kept informed of progress	N/A
Haslingfield Parish Council	Interested and would like to be kept informed of progress	N/A
Hobson’s Conduit Trust	Interested and have information to provide	Information on low flow concerns and proposed groundwater pumping mitigation scheme
Ickleton Parish Council	Interested and would like to be kept informed of progress	N/A

Stakeholder	Response	Specific information provided
Internal Drainage Boards: Middle Level Commissioners, Ely Group of Drainage Boards and Swavesey Internal Drainage Board	Comments and data provided	See Chapter 6
Members of the public (individual responses)	Interested and would like to be kept informed of progress	N/A
Milton Road Residents Association	Interested and would like to be kept informed of progress	N/A
National Farmers Union	Interested and would like to be kept informed of progress	N/A
Natural England	Interested and have information to provide	Comments received primarily relating to abstraction and water quality
Newnham Riverbank Club	Interested and have information to provide	None to date
Orwell Parish Council	Interested and have information to provide	None to date
Over Parish Council	Interested and have information to provide	None to date
Oxford Road Residents Association	Interested and would like to be kept informed of progress	N/A
Residents Association for Old Newnham	Interested and would like to be kept informed of progress	N/A
South Cambridgeshire and Cambridge City Councils	Data sharing agreed	See Chapter 6
Southacre, Latham and Chaucer Road Residents' Association	Interested and would like to be kept informed of progress	N/A
Swavesey Parish Council	Interested and have information to provide	Flood risk update document provided
Trumpington Residents Association	Interested and would like to be kept informed of progress	N/A

Stakeholder	Response	Specific information provided
Wilbraham River Protection Society	Interested and have information to provide	Information regarding low flows and impacts of abstraction
Wildlife Trust	Interested and have information to provide	None to date
Willingham Parish Council	Interested and have information to provide	None to date
Windsor Road Residents Association	Interested and have information to provide	Information on surface water flooding concerns

Appendix B SFRA Maps: Setting

Appendix C SFRA Maps: Geology

Appendix D SFRA Maps: Flood Risk

Appendix E Flood Risk Opportunities and Constraints

Rural Upper Cam

Location	This area includes: • The River Cam upper catchment and headwaters, which rise south of the Greater Cambridge area in Elsenham and flow past Newport, Wendens Ambo, Saffron Walden, and the Chesterfords before entering Greater Cambridge. The Cam then flows through Ickleton, Hinxton, Duxford, Whittlesford, Sawston, the Shelfords, Hauxton, and into Cambridge at Trumpington and Grantchester. • The River Granta catchment, which rises south of Linton, and flow through Linton, Hildersham, the Abingtons, Babraham, Stapleford, and into the River Cam at Great Shelford. • The River Rhee catchment, which rises 2km west of the Greater Cambridge boundary near Eyeworth, and flows past Bassingbourn Barracks, Barrington, Harston and Haslingfield, and into the River Cam at Trumpington. The Rhee catchment includes tributaries draining Bassingbourn, Melbourn and Meldreth, Wimpole and Orwell, Shepreth, Fowlmere, Thriplow and Newton.
Characteristics	This area is characterised by numerous small and medium sized villages set in a rural landscape. The underlying geology is mostly permeable chalk, and the watercourses are vulnerable to low and ephemeral flows in drought years. These watercourses display chalk stream characteristics to varying degrees.
Existing flood defences	Flood defences in the area comprise channel banks and natural high ground alongside the Main River sections. There are no known formal flood defences and structures.
Cross-boundary considerations	Flood risk in this area may be affected by land use changes in North Hertfordshire (Royston area) and Uttlesford (Elsenham to Great Chesterford, including Saffron Walden). The relevant Local Planning Authorities are responsible for ensuring development in these areas has no detrimental impact on flood risk downstream in Greater Cambridge.

Flood History	Historic flood events include March 1947, September 1968 and October 2001, whose extents are mapped for the River Cam, Granta and Rhee. Specific locations in this area where flood risk history has been highlighted by stakeholders in this study are: • Meldreth: There is a history of surface water flooding associated with the highways system, and a Flood Investigation Report was completed following flooding in 2014. Remedial work was undertaken by riparian owners and the Highways Authority. • Barrington: Properties were affected by surface water flooding in 2015 following an extremely intense short rainfall event. Following the event, clearance and maintenance work was undertaken. A Flood Investigation Report was prepared. • Mill Way, Grantchester: The Parish Council reported frequent winter flooding of this road, in some cases lasting several days, leading to hazardous conditions in sub-zero conditions and due to the road layout. Cambridgeshire County Council Highways Authority are aware of the issue and have undertaken maintenance of road gullies. The problem is thought to be groundwater flooding (potentially associated with the nearby River Cam alluvium) combined with blockage of gullies by leaves. The Parish Council continue to monitor.
Constraints to development from Main River fluvial flood risk	Flood risk along the Main River watercourses was modelled and mapped in the Cam Rural modelling project. This was a strategic scale modelling study which does not include the latest hydrological methods, topographic data or climate change allowances. If development sites are proposed, under the Local Plan, adjacent to or near (<100 m distance or <1 m elevation) of the mapped fluvial flood extents for Main River watercourses, it is recommended that a Level 2 SFRA is undertaken using updated flood modelling.
Constraints to development from Ordinary Watercourse fluvial flood risk	Flood risk along Ordinary Watercourse sections is less well understood. Some fluvial flood extent maps are available, based on broad-scale modelling; however, it should not be assumed that if a site is in Flood Zone 1, there is no risk of flooding. For all sites, the surface water flood risk maps should be used as an indicator of flood risk from surface water and ordinary watercourses. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) fluvial or surface water flood risk areas for Ordinary Watercourses, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.

Constraints to development from surface water flood risk	There are numerous locations where existing properties in the villages are located adjacent to or within the surface water flood risk extents. In the Cambridgeshire County SWMP (Chapter 4), Great Shelford, Haslingfield, Linton, Sawston and Whittlesford were identified as priority wetspots. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) surface water flood risk areas, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from sewer flood risk	There are no specific locations where sewer flooding has been identified as a constraint by stakeholders. Foxton suffered sewer flooding in 2015 however no further information is available on the specific location, severity or causes of the flooding. No information is currently available on combined sewer locations or overflows. It is recommended that no surface water drainage connection to combined sewers is permitted.
Constraints to development from groundwater flood risk	There are large parts of this area that are considered susceptible to groundwater flooding at surface level, associated with changes in the underlying geology. If development sites are proposed in these areas, it is recommended that the site-specific FRA investigates the risk further (e.g. through groundwater level monitoring) and includes appropriate mitigation such as site landscaping and additional freeboard for raised finished floor levels.
Constraints to development from reservoir flood risk	There are some areas that are potentially at risk of flooding due to reservoir breach, relating to reservoirs at Wimpole and Babraham. The potential risk is highest in low lying areas immediately downstream of reservoirs. No information is available on the potential loss of life and damage to buildings in the event of dam failure, or whether emergency drawdown of the reservoir (reducing water level) will add to flooding. If failure could lead to major damage or loss of life, it is a statutory requirement for the reservoir undertaker to prepare a Flood Plan to inform emergency responders. This would need to be explored as part of a Level 2 SFRA. If development sites are proposed in these areas, it is recommended that the site-specific FRA considers the risk further in consultation with the Environment Agency and includes appropriate mitigation such as a flood warning and evacuation plan, site landscaping, provision of safe evacuation routes, and additional freeboard for raised finished floor levels.

Opportunities	The division of flows between the Cam, Granta and Rhee means that there is no single location where a large strategic-scale flood mitigation (attenuation storage) scheme could offer significant benefits to the urban River Cam downstream. There are no known major flood defence schemes present or currently planned in this area of Greater Cambridge or upstream of the area. There is an opportunity to improve flood management at Hinxton Watermill, on the River Cam in Hinxton. The sluice gates at this mill are manually operated by volunteers of the charity Cambridge Past, Present & Future (CPPF). Failure to open the sluices after heavy rain would result in property flooding. The sluices are not modern and are difficult to move but are required for the operation of the Grade II Watermill. The proposed solution of an upstream weir would allow the decommissioning of the sluices, but the scheme does not currently have third party agreement, approval, or funding. Hinxton Watermill lies just over 1.5 km from the Uttlesford District Council administrative boundary within Greater Cambridge and as such is an issue the Local Plan can resolve. Moreover, there may be potential for development within Greater Cambridge area surrounding Hinxton and in the tributary catchment flowing through Ickleton. There may also be significant development upstream of the Greater Cambridge administrative boundary in Uttlesford District, including a potential new Garden Village. The Greater Cambridge Local Plan will not be able to influence the flood risk and water cycle strategy impacts of this growth. It is therefore recommended that the Environment Agency set up and lead a cross-boundary working group to manage the flood risk issues at Hinxton, including the Local Authorities, CPPF, relevant landowners and developers, all of whom should contribute financially to the work undertaken (for example, through S106 contributions allocated for betterment of flood risk downstream of development sites). There are many opportunities for natural flood management techniques and land management changes that provide multiple benefits, such as ecological restoration and groundwater recharge (see Box 8-1 and Box 8-2). These have been undertaken through a piecemeal approach, dependent on local interest, landowner willingness and funding availability, involving parties such as the Environment Agency, Local Authorities, local “friends of” groups, the Wild Trout Trust and the Wildlife Trust, Cam Valley Forum and the River Restoration Centre. It is clear there is local appetite for local river maintenance and improvement works, that would benefit from additional funding. There are opportunities for

	development to contribute to these local schemes, where sites overlay or border onto watercourses.

Bourn Brook and Bin Brook

Location	This area includes: • The Bourn Brook catchment, which rises west of Caxton and flows through Caxton, Bourn and Toft before flowing through rural areas to join the River Cam at Trumpington. • The Bin Brook catchment, which rises west of Coton, and flows through Coton and through western parts of Cambridge (Newnham) to join the River Cam near Magdalene Street.
Characteristics	This area is characterised by small, medium and large villages set in a changing landscape, with major new developments at Cambourne and Bourn Airfield (Bourn Brook catchment) and West Cambridge (Bin Brook catchment). Lower parts of Bin Brook in Cambridge are heavily urbanised. The proposed East-West new railway will pass through these catchments. In contrast to the Rural Upper Cam, the underlying geology is mostly impermeable clay bedrock with till superficial deposits. This leads to higher runoff rates and “flashier” responses to rainfall events. There are no flow gauging stations in the catchments, but levels are monitored at three locations for flood warning purposes (Bourn Brook at Bourn and Comberton, and Bin Brook at Newnham).
Existing flood defences	Flood defences in the area comprise natural high ground alongside Main River watercourses. There are no known formal flood defences and structures. A flood defence scheme was previously investigated for Bin Brook, however it did not qualify for funding at the time (see further detailed below).
Cross-boundary considerations	The catchments lie almost entirely in the Greater Cambridge area. A small area of the Bourn Brook headwaters lie outside the area (<2 km distance) east of Great Gransden, but no major development is currently planned in this area.

Flood history	Historic flood events for which extents are mapped include September 1968 (Toft and downstream), May 1978 (Caxton, Bourn and Newnham), and October 2001 (Bourn, Newnham). Specific locations in this area where flood risk has been highlighted by stakeholders in this study are: • Caldecote. Flooding in 2014 affected 12 properties and a residential care home. A Flood Investigation Report was completed by the LLFA and works undertaken to clear highways gullies. • The Gough Way Estate, from Bin Brook in Newnham. Here, the watercourse passes beneath the estate via a culvert that restricts flows. An existing flood relief channel (constructed after flooding in 1978) diverts some flows around the estate but has insufficient capacity for the volume of water that occurs in extreme events, and flooding occurred again in October 2001 affecting properties. Subsequent investigations identified an upstream flood storage reservoir as the preferred option for reducing flood risk in Gough Way, with ecological benefits through the creation of a small permanent wetland area. Although the scheme was initially allocated Defra FCERM grant funding in 2007, this was subsequently withdrawn following a review of the benefit/cost ratio. An alternative was proposed that involved property level resilience measures. Properties at risk of flooding now have individual property protection flood guards provided by the Environment Agency, although these have not yet needed to be deployed and so are untested. The Gough Way Residents Association continues to monitor local flood risk and meet annually with the Council and the Environment Agency to discuss flood mitigation. Defra grant funding rules have changed since 2007 and it is recommended flood risk options for the Gough Way estate are reviewed to identify whether a scheme could now qualify for funding.

Constraints to development from Main River fluvial flood risk	Existing properties are at risk of fluvial flooding from Bourn Brook in Caxton, Bourn and Toft, and from Bin Brook in Cambridge. Flood risk along the Main River watercourses has been modelled and mapped by the Environment Agency. Bourn Brook was included in the Cam Rural modelling project, while Bin Brook was represented in the Gough Way model. Both of these studies do not include the latest hydrological methods, topographic data or climate change allowances. If development sites are proposed adjacent to or near (<100 m distance or <1 m elevation) of the mapped fluvial flood extents for Main River watercourses, it is recommended that a Level 2 SFRA is undertaken using updated flood modelling.
Constraints to development from Ordinary Watercourse fluvial flood risk	Flood risk along Ordinary Watercourse sections is less well understood. Some fluvial flood extent maps are available, based on broad-scale modelling; however it should not be assumed that if a site is in Flood Zone 1, there is no risk of flooding. Flood zones are not available for minor watercourses in villages such as Comberton, Barton and the Eversdens. For all sites, the surface water flood risk maps should be used as an indicator of flood risk from surface water and ordinary watercourses. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) fluvial or surface water flood risk areas for Ordinary Watercourses, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from surface water flood risk	There are numerous locations where existing properties in the villages are located adjacent to or within the surface water flood risk extents. In the Cambridgeshire County SWMP (Chapter 4), Bourn, Caxton, Comberton and Coton were identified as priority wetspots. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) surface water flood risk areas, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from sewer flood risk	There are no specific locations where sewer flooding has been identified as a constraint by stakeholders. Some villages suffered sewer flooding in 2013 and 2015 (Bourn, Comberton, Hardwick), however no further information is available on the specific location, severity or causes of the flooding. No information is currently available on combined sewer locations or overflows. It is recommended that no surface water drainage connection to combined sewers is permitted.

Constraints to development from groundwater flood risk	Some parts of this area are considered susceptible to groundwater flooding at surface level, associated with changes in the underlying geology. If development sites are proposed in these areas, it is recommended that the site-specific FRA investigates the risk further (e.g. through groundwater level monitoring) and includes appropriate mitigation such as site landscaping and additional freeboard for raised finished floor levels.
Constraints to development from reservoir flood risk	There are no areas currently mapped as potentially at risk of flooding due to reservoir breach.
Opportunities	There are no known major flood defence schemes present or planned in this area of Greater Cambridge. The proposed Bin Brook flood storage reservoir would have been located west of the M11 in the Coton Countryside Reserve, managed by the charity Cambridge Past Present & Future (CPPF). In 2019, CPPF received funding for a feasibility study to create a new water treatment wetland and identify opportunities for natural flood management in the catchment (Box 8-3), with reporting due to be completed in late 2020. The Bourn Brook suffers from invasive species such as giant hogweed and Himalayan balsam. The Wildlife Trust and the Countryside Restoration Trust have been leading the Bourn Free project (Box 8-4), supporting by local volunteers, to control non-native species, improve the river habitat and water quality, and find opportunities to accommodate flood flows. There is also a Flood Action Group in the village of Bourn, set up following the 2001 floods, to monitor water levels and advise on action. It is therefore clear that in the Bourn Brook and Bin Brook catchments there is local appetite and support for river improvement and flood risk works, that would benefit from additional funding. There are opportunities for development to contribute to these or other local improvement schemes, where sites overlay or border onto watercourses.

Urban Cambridge

Location	This area includes: • The River Cam main river from Grantchester to Baits Bite Lock at Milton. The River Cam Conservancy are the statutory navigation authority for the River Cam here and aim to manage the river in a manner sensitive to environmental interests and balancing the needs of all river users and local residents. • Hobsons Brook / Vicar's Brook tributary and its catchment, including Nine Wells Spring. Hobson's Conduit Trust are responsible for the upkeep of Hobson's Brook from Nine Wells to the Conduit Head and its underground channels. • The Cherry Hinton Brook tributary and its catchment. • Northern parts of the city around Arbury, which drain northwards to the River Great Ouse via a network of drains.
Characteristics	This area is characterised by heavily urbanised areas within the city. The underlying geology is permeable chalk in the south-eastern half, changing to impermeable clay bedrock in north-western parts although with extensive permeable superficial river terrace deposits. There has been significant recent development in southern parts of this area, including Trumpington Meadows, Glebe Farm, Clay Farm and the Biomedical Campus at Addenbrookes.
Existing flood defences	Flood defences in the area comprise natural high ground alongside the Main River, with some riverside properties benefiting from property-level demountable defences. Water levels in the River Cam are managed by sluice gates and weirs at the Mill Pond, Jesus Green and Baits Bite Lock.
Cross-boundary considerations	There are no cross-boundary considerations for this area.
Flood history	Historic flood events for which extents are mapped include October 2001, May 1978, and March 1947. Specific locations in this area where flood risk has been highlighted by stakeholders in this study are: • Oxford Road / Windsor Road junction, a local low point where surface water flooding is reported by the Windsor Road Residents Association to occur after heavy rain. • Historic sewer flooding affecting Windsor Road, which has been addressed.

Constraints to development from Main River and ordinary watercourse fluvial flood risk	Flood risk along the Main River watercourses was modelled and mapped for the River Cam in the Cam Phase 2 (Cam Urban) project. Separate hydraulic models are also available for Vicar's Brook and the Cherry Hinton Brook ordinary watercourses. All of these models do not include the latest hydrological methods, topographic data or climate change allowances. If development sites are proposed adjacent to or near (<100 m distance or <1 m elevation) of the mapped fluvial flood extents for Main River watercourses, it is recommended that a Level 2 SFRA is undertaken using updated flood modelling.
Constraints to development from surface water flood risk	There is extensive surface water flood risk in the urban area. This is indicated by the Environment Agency's Risk of Flooding from Surface Water maps, and in the Cambridge and Milton Surface Water Management Plan (SWMP, 2011). The SWMP used area-wide hydraulic modelling to identify priority wetspots within the study area for detailed investigation. The SWMP also produced flood depth, velocity and hazard mapping for the Cambridge and Milton study area. It has not been possible to obtain this data for reproduction in this study. If development sites are proposed within the urban area, the SWMP mapping should be consulted to provide further information on surface water flood risk, in addition to the Environment Agency's Risk of Flooding from Surface Water maps.
Constraints to development from sewer flood risk	There are no specific locations where sewer flooding has been identified as a constraint by stakeholders. No information is currently available on combined sewer locations or overflows. It is recommended that no surface water drainage connection to combined sewers is permitted.
Constraints to development from groundwater flood risk	Large parts of the area are considered susceptible to groundwater flooding at surface level, associated with changes in the underlying geology. If development sites are proposed in these areas, it is recommended that the site-specific FRA investigates the risk further (e.g. through groundwater level monitoring) and includes appropriate mitigation such as site landscaping and additional freeboard for raised finished floor levels.
Constraints to development from reservoir flood risk	There are no areas currently mapped as potentially at risk of flooding due to reservoir breach.

Opportunities	There are no known major flood defence schemes present or planned in this area of Greater Cambridge, but future development can support them by: The Cambridge and Milton SWMP investigated flood risk mitigation options for the Cherry Hinton, King's Hedges and Arbury (incl. Windsor Road) wetspots. The detailed investigations evaluated a range of potential engineering measures and options, including cost-benefit appraisal. The 'Do Minimum' option of continuing current maintenance arrangements was identified as the most cost-effective option for both wetspots. However, it was recognized that this option does not deliver any reduction to the number of properties vulnerable to flooding and will not address increasing flood risk associated with climate change. Therefore, the recommended option was a combination of: • Increased maintenance of ordinary watercourses and surface water drains in the wetspots • A combined engineering option to include installation of attenuation features and swales within the catchment, to be taken forward for detailed design • Actions for risk management authorities to assess key assets in the study area, campaign to increase the uptake of water butts and other SuDS in existing residential areas, and improved data management including upkeep of a Flood Incident Register by the LLFA. No further update is available on the progress of these recommendations. Most existing developments in the area will have been constructed before SuDS became a planning requirement and will have high run-off rates from impermeable surfaces. There are opportunities for redevelopments of these brownfield sites to reduce run-off rates to greenfield equivalent or better. The space required to achieve this may have implications for the quantum of development that could be achieved within the site, and it may be necessary for flood storage to be provided subsurface. This is less preferable to surface storage because it presents fewer opportunities for environmental enhancement. Developers should consult as early as possible with the Lead Local Flood Authority to agree the site-specific drainage design. Within the area, local volunteer groups support the work of Hobsons Conduit Trust and the River Cam Conservancy in river management. In addition, the Friends of Cherry Hinton Brook are a local voluntary group that aim to keep Cherry Hinton Brook clear of rubbish and in a healthy state, whilst also restoring the habitat and flow of the river (Box 8-5). It is clear there is local

	appetite for local river maintenance and improvement works, that would benefit from additional funding. There are opportunities for development to contribute to these local schemes, where sites overlay or border onto watercourses.

Lower River Cam

Location	This area includes: • The River Cam from Baits Bite Lock at Milton, to Upware where it flows northwards away from the Greater Cambridge area, and ultimately into the River Great Ouse (Ely Ouse) at Stretham. • The upper catchment of the Wilbraham Fen Lode, a tributary of the River Cam. The lower catchment of Wilbraham Fen Lode, and the other Cam Lodes tributaries (e.g. Bottisham Lode) lie outside the Greater Cambridge area. The catchment is managed by the Swaffham Internal Drainage Board (Ely Group of Drainage Boards). • The Waterbeach catchment, which is drained by pump into the River Cam. The catchment is managed by the Waterbeach Internal Drainage Board (Ely Group of Drainage Boards)
Characteristics	The area is characterised by a transition to a low-lying fenland landscape. The underlying geology is complex, including permeable chalk to the east of the Cam and impermeable clay to the west, overlain by permeable river terrace deposits and peat in northern parts. The area is mostly rural, although a new town is proposed at the former Waterbeach barracks and airfield. Levels in the lower River Cam are influenced by the Ely Ouse downstream.
Existing flood defences	The River Cam is embanked with raised formal defences. Surrounding land is drained via pump stations operated by the Internal Drainage Boards and the Environment Agency. Therefore, although large areas are indicated to be at high risk of fluvial flooding (Flood Zone 3), many locations are classified as “areas benefiting from defences”. In these locations, there is a residual risk of flooding due to overtopping or breach of the River Cam embankments.

Cross-boundary considerations	Downstream cross-boundary considerations for the Ely Ouse are discussed in the River Great Ouse area review. Although not within the Greater Cambridge area, the Wicken Fen National Nature Reserve, a component of Fenland Special Area of Conservation (SAC), lies downstream within the Cam Lodes tributary catchments. The reserve represents a fragment of the East Anglian Fen and has an exceptionally rich flora and fauna, with SSSI and Ramsar Site designations. The site drains via Wicken Lode into Reach Lode and then discharged via sluice gates into the River Cam at Upware, with pumping available for when the River Cam is high. The structures at Upware limit the impact of the River Cam on water levels or quality in Wicken Fen. Therefore there is unlikely to be any impact on Wicken Fen from new flood risk management infrastructure or procedures in the River Cam catchment, although further screening and consultation with Natural England and the Environment Agency should be undertaken at the detailed planning stage.
Flood history	Historic flood events for which extents are mapped include October 2001. Specific locations in this area where flood risk has been highlighted by stakeholders in this study are: • Bannold Road in Waterbeach, where flooding occurred in 2014. These were investigated by the LLFA and a Flood Investigation Report completed. Local improvement works were undertaken by the riparian owner and Anglian Water.
Constraints to development from Main River fluvial flood risk	To quantify the residual risk of flooding due to overtopping or breach of the River Cam embankments, the Environment Agency have undertaken breach modelling in the Cam Phase 2 (Cam Urban and Cam Lodes) project. However this modelling does not include the latest hydrological methods, topographic data or climate change allowances. If development sites are proposed adjacent to or near (<100 m distance or <1 m elevation) of the mapped fluvial flood extents for the River Cam, it is recommended that a Level 2 SFRA is undertaken using updated flood modelling.

Constraints to development from Ordinary Watercourse fluvial flood risk	Flood risk from the ordinary watercourses and pumped catchments is less well understood. The Environment Agency's Risk of Flooding from Surface Water maps indicate a relatively low risk of flooding from surface water. However these maps do not take into account the pump station capacity constraints on discharge of water from catchments. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) IDB drains or Ordinary Watercourses, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from surface water flood risk	Surface water flood risk is less extensive than in some other areas but does affect existing development at Waterbeach and elsewhere. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) surface water flood risk areas, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from sewer flood risk	There are no specific locations where sewer flooding has been identified as a constraint by stakeholders. No information is currently available on combined sewer locations or overflows. It is recommended that no surface water drainage connection to combined sewers is permitted.
Constraints to development from groundwater flood risk	Large parts of this area are considered susceptible to groundwater flooding at surface level, associated with changes in the underlying geology. If development sites are proposed in these areas, it is recommended that the site-specific FRA investigates the risk further (e.g. through groundwater level monitoring) and includes appropriate mitigation such as site landscaping and additional freeboard for raised finished floor levels.
Constraints to development from reservoir flood risk	There are no areas currently mapped as potentially at risk of flooding due to reservoir breach.

Opportunities	There are no known major flood defence schemes present or planned in this area of Greater Cambridge. The Cambridge Sport Lakes is a proposed development to the west of the River Cam between Milton and Waterbeach. The development will comprise a rowing lake and a water storage lake, with surrounding cycling facilities. The site was granted planning permission in 2013 following submission in 2006, however due to subsequent significant changes in planning policy, the application was withdrawn. An updated planning application is now being prepared. The scheme is likely to involve the construction of a canal to link the lakes to the River Cam upstream of Baits Bite Lock, and the lakes may provide up to 34% increase in floodplain storage volume compared to existing. Detailed modelling is expected to be undertaken to support the updated planning application which will quantify the potential beneficial impacts of this scheme in flood risk upstream and downstream. The Wilbraham Fen Lode is supported by the Wilbraham River Protection Society (Box 8-6). The watercourse supports the Great Wilbraham Common (grassland) and Wilbraham Fen (wetland) SSSIs. Concerns for the watercourse mainly centre on low river flows, rather than flood risk. There are opportunities for development to contribute to local improvement works, where sites overlay or border onto watercourses. The Lower River Cam catchment is included in the proposed “Buffer Zone” of the Fens Biosphere vision (Box 8-7). This designation will have no statutory implications but indicates the area in which the Fens Biosphere project will be working on activities that link people, science and conservation, including flood risk and water management. No specific activities have been identified at present.

River Great Ouse and Tributaries

Location	This area includes:
	• The old River Great Ouse, also known as the Old West and Ely Ouse, from Earith to the A10 crossing where it flows northwards away from the Greater Cambridge area.
	• Tributaries of the River Great Ouse that overlie the Greater Cambridge area:
	  ○ Ordinary watercourses draining Papworth Everard and Papworth St Agnes, into West Brook and thence the River Great Ouse at Fenstanton.
	  ○ Oxholme Drain and Covell's Drain catchments, which include Elsworth, Conington and Fen Drayton.
	  ○ The Swavesey Drain catchment, including the Swavesey Internal Drainage Board area.
	  ○ The Willingham Lode catchment.
	  ○ The Cottenham Lode catchment, including its headwaters in Girton, Bar Hill, Oakington, Histon and Impington, and the Old West Internal Drainage Board area.

Characteristics	This area is characterised by numerous small and medium sized villages in a rural landscape. The underlying geology is mostly impermeable Clay bedrock, but there are extensive permeable river terrace and peat deposits, and a narrow band of permeable Lower Greensand bedrock also intersects the area. There is therefore a very variable hydrological response to rainfall.

Existing flood defences	Flood risk from the old River Great Ouse is controlled by raised embankments and flow control structures. At Earith, flows are diverted into the Hundred Foot River and the Old Bedford River, flooding the Ouse Washes during high flow conditions. The Old West (Earith to confluence with River Cam) and Ely Ouse (also known as Ten Mile River, from confluence with River Cam to Denver) is the former course of the River Great Ouse before construction of the Old Bedford River in 1630. The flow from the old River Great Ouse downstream into the Great Ouse Tidal River is regulated by Denver Sluice, which also prevents tidal ingress into the Ely Ouse. The IDBs maintain a network of watercourses and pumps in their districts. Low lying areas around Cottenham are drained by the Old West IDB via a network of 3 pumping stations into the old River Great Ouse. Flood risk in these areas will be dependent on the operation and capacity of these pumps. There are particular flood management arrangements in the Swavesey Drain catchment. The Swavesey Drain is primarily reliant on gravity drainage into the River Great Ouse via sluice gates at Webbs Hole. A pumping station at Webbs Hole provides some additional outflow capacity when the sluice gates are closed, mainly for discharge from the Uttons Drove Water Recycling Centre located in the catchment. While the sluice gates are closed, water backs up in the Swavesey Drain catchment, contained initially within watercourse raised embankments, and then overtopping onto four Fen areas (Middle, Mow, Mare and Cow Fens). Due to the long duration of restricted gravity outflows while the River Great Ouse is high, developments in the catchment have been required to provide additional long-term storage for surface water run-off from sites. On-site attenuation ponds have been designed to hold water for up to 3 weeks, with outflows controlled by sluices connected by telemetry to the Webbs Hole gates. The Swavesey IDB have further concerns over high summer levels in the River Great Ouse and the condition of the main river embankments.

Cross-boundary considerations	Flood risk from the Old West (old River Great Ouse course) would be affected by land use changes and flood defence schemes in the large upstream catchment, which includes Huntingdon, St Neots, Biggleswade, Bedford, Milton Keynes, Leighton Buzzard, Buckingham and Brackley. The Environment Agency are currently undertaking a Great Ouse Storage and Conveyance study to assess how flood risk in the wider catchment can be managed now and into the future. Sites near to the River Great Ouse may be identified for strategic flood storage, however the outcomes of the study will not be available for several years. Flood risk from the Old West will also be affected by the operation of the River Great Ouse water level management infrastructure downstream. Although not within the Greater Cambridge area, the Ouse Washes SSSI and Ramsar site lies downstream of the River Great Ouse between Earith and Denver. The Washes is a flood storage area that lies between the Old Bedford River and the Hundred Foot River. It is often inundated during winter months, providing an internationally significant wetland habitat for wintering and breeding wildfowl and wader bird species. Any new flood risk management infrastructure for the River Great Ouse would require further screening and consultation with Natural England and the Environment Agency.

Flood history	Historic flood events for which extents are mapped include October 2001, Easter 1998, October 1993, May 1981, May 1978, and March 1947. Specific locations in this area where flood risk has been highlighted by stakeholders in this study are: • Swavesey Drain, as noted above. • Cottenham Lode catchment and Old West Internal Drainage Board area: The Cottenham Parish Council and Cottenham Flood Risk Forum raised concerns that the nature of the topography in the area means that it is very sensitive to water management in the wider area, and potentially impacted by development upstream in North West Cambridge. • Oakington: There is a history of flooding (multiple sources) in the village, including 1978, 2001 and 2014. A Flood Investigation Report was completed following the flooding in 2014. A scheme has now been completed to install property level protection to 53 homes. • Longstanton: Properties were affected by surface water flooding in 2014, and a Flood Investigation Report completed by the LLFA. Completed improvement works (Hatton's Road balancing ponds) as part of the Northstowe development are anticipated to substantially reduce future flood risk. • Bar Hill: Following extensive flooding in 2014, a Flood Investigation Report was completed by the LLFA, and clearance and maintenance work undertaken by a number of Risk Management Authorities. A surface water management plan is now being prepared by the LLFA, to assess potential improvement options for Bar Hill.
Constraints to development from Main River fluvial flood risk	Flood risk from the old River Great Ouse has been modelled and mapped by the Environment Agency in the Lower Great Ouse study. Due to instabilities, this model does not currently include the latest climate change allowances. If development sites are proposed adjacent to or near (<100 m distance or <1 m elevation) of the mapped fluvial flood extents for Main River watercourses, it is recommended that a Level 2 SFRA is undertaken using updated flood modelling.

Constraints to development from Ordinary Watercourse fluvial flood risk	Flood risk in the tributary catchments and in particular along Ordinary Watercourses is less well understood. Some fluvial flood models are available, but these studies do not include the latest hydrological methods, topographic data or climate change allowances. For all sites, the surface water flood risk maps should be used as an indicator of flood risk from surface water and ordinary watercourses. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) fluvial or surface water flood risk areas for Ordinary Watercourses, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from surface water flood risk	There is extensive surface water flood risk in some of the villages in the tributary headwaters. In some locations, detailed Surface Water Management Plans have been prepared. It has not been possible to obtain this data for reproduction in this study. If development sites are proposed within these areas, the SWMP mapping should be consulted to provide further information on surface water flood risk, in addition to the Environment Agency's Risk of Flooding from Surface Water maps**.**
Constraints to development from sewer flood risk	There are no specific locations where sewer flooding has been identified as a constraint by stakeholders. No information is currently available on combined sewer locations or overflows. It is recommended that no surface water drainage connection to combined sewers is permitted.
Constraints to development from groundwater flood risk	There are large parts of this area that are considered susceptible to groundwater flooding at surface level, associated with changes in the underlying geology. If development sites are proposed in these areas, it is recommended that the site-specific FRA investigates the risk further (e.g. through groundwater level monitoring) and includes appropriate mitigation such as site landscaping and additional freeboard for raised finished floor levels.

Constraints to development from reservoir flood risk	There are large parts of this area that are potentially at risk of flooding due to reservoir breach, relating to reservoirs at Elsworth and upstream of the area in the River Great Ouse catchment. The potential risk is highest in low lying areas immediately downstream of reservoirs. No information is available on the potential loss of life and damage to buildings in the event of dam failure, or whether emergency drawdown of the reservoir (reducing water level) will add to flooding. If failure could lead to major damage or loss of life, it is a statutory requirement for the reservoir undertaker to prepare a Flood Plan to inform emergency responders. If development sites are proposed in these areas, it is recommended that the site-specific FRA considers the risk further in consultation with the Environment Agency and includes appropriate mitigation such as a flood warning and evacuation plan, site landscaping, provision of safe evacuation routes, and additional freeboard for raised finished floor levels.
Opportunities	There are no known major flood defence schemes planned in this area of Greater Cambridge. As noted earlier, the Environment Agency are investigating options for strategic flood storage and conveyance improvements in the River Great Ouse catchment, however the conclusions from the study are not yet available. In the upper urbanised parts of the tributary catchments, schemes to reduce surface water flood risk have been or are being investigated. Although there are no current schemes being taken forward, development could contribute to flood risk mitigation through increased on-site attenuation of flows, where sites overlay or border onto watercourses. There are also many opportunities for flood management schemes to include natural flood management techniques with multiple benefits. For example, Cambridgeshire ACRE are undertaking a landscape-scale conservation project on and around the Old West river (Box 8-8), that will include environmental enhancements such as creation of two-stage channels and ponds that will have flood risk betterment. This area is also included within the Fen Biosphere reserve proposal (Box 8-7).

Edge of District

Location	This area includes areas outside the River Cam catchment: • Draining westwards around Gamlingay (Potton Brook, managed by the Bedfordshire & River Ivel Internal Drainage Board) and Croxton • Draining eastwards around Castle Camps and Weston Green.
Characteristics	These small areas of the district fall outside the other river basin areas and are the uppermost headwaters of watercourses in adjacent administrative boundaries. The areas are rural with small villages. The underlying geology is mainly impermeable superficial deposits (till). There are no major developments currently planned in these areas.
Existing flood defences	There are no known flood defences in these areas.
Cross-boundary considerations	Land use and flood risk management changes in these areas could affect areas downstream in neighbouring administrative areas. Any development will need to demonstrate that there is no detrimental impact on flood risk downstream. A whole catchment management approach is practiced by the Bedfordshire & River Ivel Internal Drainage Board for the areas around Gamlingay.
Flood history	There are no mapped historic flood events available. No specific flood events have been identified through this study.
Constraints to development from Main River and ordinary watercourse fluvial flood risk	There are no main rivers in this area. Flood risk along Ordinary Watercourse sections is not well understood. Due to the small size of watercourses, no hydraulic modelling has been undertaken. However it should not be assumed that if a site is in Flood Zone 1, there is no risk of flooding. For all sites, the surface water flood risk maps should be used as an indicator of flood risk from surface water and ordinary watercourses. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) fluvial or surface water flood risk areas for Ordinary Watercourses, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.
Constraints to development from surface water flood risk	There are some constraints to development due to surface water flood risk, and Gamlingay was identified as a priority wetspot in the Cambridge County SWMP. If development sites are proposed in or near (<50 m distance or <0.5 m elevation) surface water flood risk areas, it is recommended that a Level 2 SFRA is undertaken using flood modelling to confirm extents and the impacts of climate change.

Constraints to development from sewer flood risk	There are no specific locations where sewer flooding has been identified as a constraint by stakeholders. No information is currently available on combined sewer locations or overflows. It is recommended that no surface water drainage connection to combined sewers is permitted.
Constraints to development from groundwater flood risk	The Gamlingay and Croxton areas are potentially susceptible to groundwater flooding at surface level, associated with changes in the underlying geology. If development sites are proposed in these areas, it is recommended that the site-specific FRA investigates the risk further (e.g. through groundwater level monitoring) and includes appropriate mitigation such as site landscaping and additional freeboard for raised finished floor levels.
Constraints to development from reservoir flood risk	There are some areas that are potentially at risk of flooding due to reservoir breach, relating to reservoirs at Gamlingay. The potential risk is highest in low lying areas immediately downstream of reservoirs. No information is available on the potential loss of life and damage to buildings in the event of dam failure, or whether emergency drawdown of the reservoir (reducing water level) will add to flooding. If failure could lead to major damage or loss of life, it is a statutory requirement for the reservoir undertaker to prepare a Flood Plan to inform emergency responders. If development sites are proposed in these areas, it is recommended that the site-specific FRA considers the risk further in consultation with the Environment Agency and includes appropriate mitigation such as a flood warning and evacuation plan, site landscaping, provision of safe evacuation routes, and additional freeboard for raised finished floor levels.
Opportunities	There are no known major flood defence schemes present or planned in this area of Greater Cambridge. The scope for major flood defence works is small, given the small catchment sizes. However there may nevertheless be opportunities for local flood improvement works, including natural flood management, land management and river restoration.