Central Bedfordshire Council
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Level 1 Strategic Flood Risk Assessment

July 2017

Central Bedfordshire Strategic Flood Risk Assessment (SFRA)

1. Introduction

1.1 The National Planning Policy Framework (NPPF) requires that local planning authorities, when preparing Local Plans, should undertake a Strategic Flood Risk Assessment (SFRA). The SFRA appraises the risk of flooding in Central Bedfordshire. Flooding from all sources is considered (fluvial, groundwater, surface water and reservoirs).

1.2 All development proposals must consider existing and future flood risk, taking into account of climate change effects. This information will form the basis for preparing appropriate policies for flood risk management and assessing sites for development. Sites at low risk should normally be the preferred option. However, with suitable mitigation, essential development within high-risk areas can be achieved and the SFRA is designed to help inform CBC in these circumstances.

1.3 Central Bedfordshire's SFRA is being prepared in two stages:

- The first stage (Level 1) comprises of a desk based study collating and reviewing existing and historic flooding information. The purpose of this first stage is to provide an assessment of the extent and nature of the risk of flooding in Central Bedfordshire and its implications for the Local Plan. This has been completed.
- A more detailed second stage SFRA (Level 2) will be undertaken once CBC has identified areas of new development in locations at flood risk. The purpose of this level of assessment is to assist the Council and developers to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk wherever possible, identifying suitable mitigation where this is unavoidable. This will be undertaken in autumn 2017.

1.4 The SFRA has been produced by the flood risk specialist consultant JBA. It has been developed using the best available information at the time of preparation. The SFRA should be updated regularly to reflect new information on flood risk, flood warning or new planning guidance or legislation.

2. Key Findings of Stage 1

2.1 Central Bedfordshire has been subject to flooding from several sources of flood risk, with the principal risk from fluvial sources (main rivers and ordinary watercourses). The main fluvial flood risk is located along the River Ivel corridor in the east, River Flit and River Hit in the centre and Clipstone Brook through Leighton Buzzard in the far west. The floodplain associated with the tributaries of the River Ivel network is generally broad due to the low-lying topography in this area.

2.2 As well as fluvial flooding, Central Bedfordshire has experienced a number of historic surface water/ drainage related flood events caused by a number of mechanisms, from insufficient storm / drainage capacity to poor surface water management. The Surface Water mapping shows a number of prominent overland flow routes, following topographical flow paths of existing watercourses or dry valleys and local road infrastructure with some isolated ponding located in low-lying areas.

2.3 There have been incidents of historic groundwater flooding in Central Bedfordshire which is thought to primarily be caused by the underlying geology of chalk and Lower Greensand which allow water to pass to and from groundwater aquifers.

2.4 There are eight records of a canal overtopping along the Grand Union Canal since 2007. A high-level review of existing flood defences was undertaken and found few formal defences in the study area.

2.5 The SFRA is also required to show regard to the Water Framework Directive (WFD), which aims to protect water quality. Some of the watercourses in Central Bedfordshire already meet the 'good' overall ecological status including the Clipstone Brook, the River Ivel (upstream of Henlow) and the Ickwell Brook. However, the majority only meet 'moderate' overall status or less.

3. Summary of Implications

3.1 For sites being considered for growth that are within areas of high risk of flooding or that have watercourses flowing through or past them, the sequential approach should be used to locate development away from areas at highest risk. This approach will ensure the watercourses retain their connection to the floodplain, and will enhance the water environment and offers opportunities to use the land as green infrastructure/green corridors.

3.2 Developers need to ensure that new development does not increase the risk of surface water flooding from or to the site and ensure surface water management is undertaken to control run off. Sustainable drainage systems (SuDS) should be used on all new development, designed in response to site characteristics and policy factors.

3.3 Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

3.4 For successful future flood risk management, it is recommended that neighbouring planning authorities adopt a catchment partnership working approach in tackling flood risk and environmental management.

3.5 The Council needs to take positive measures to deliver the WFD and minimise 'deterioration' in ecological status of a watercourse as a result of new development.

3.6 Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard, consideration should be given to the use of developer contributions to fund improvements.

Appendix A

Central Bedfordshire Strategic Flood Risk Assessment

Level 1

Central Bedfordshire Council

Level 1 Strategic Flood Risk Assessment

Draft Report

May 2017

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Contract

This report describes work commissioned by Central Bedfordshire Council. The Council's representative for the contract was Pru Khimasia-John.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to Central Bedfordshire Council.

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- Central Bedfordshire Council, including Highways
- Environment Agency
- Anglian Water
- Thames Water
- Affinity Water
- Canal and River Trust
- Forest of Marston Vale
- Bedford Group of Internal Drainage Boards; and
- Planners at the neighbouring authorities

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Executive Summary

Introduction

JBA Consulting were commissioned by Central Bedfordshire Council to prepare an updated Strategic Flood Risk Assessment (SFRA). The purpose of this study is to provide a comprehensive and robust evidence base to support the production of the Local Plan to 2036 and will replace the existing Strategic Flood Risk Assessments for Mid- and South Bedfordshire (both published in 2008). The 2016 SFRA update will be used in decision-making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

SFRA objectives

The key objectives of the 2016 Strategic Flood Risk Assessment are:

- To provide a tool for assessing flood risk from various sources of current and future flooding and how these may be mitigated.
- To identify the likely effects of climate change on flood risk.
- To inform decisions on the emerging Local Plan including the selection of development sites and planning policies.
- To provide a clear rationale and evidence base for applying the Sequential Test and Exception Test in the allocation of new development sites, and development management decisions, as required by national policy and guidance.
- To draw attention to advice for applicants carrying out site-specific flood risk assessments and outline specific measures or objectives that are required to manage flood risk to the appropriate standard'.

SFRA outputs

This SFRA update includes a Level One and Level Two assessment.

Level 1 outputs

- Identification of policy and technical updates.
- Sequential Test guidance and sequential approach to flood risk.
- Identification of any flood modelling and data gaps.
- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, sewers, groundwater, reservoirs and canals.
- Mapping showing distribution of flood risk across all flood zones from all sources of flooding including climate change allowances, including new and amended data sources.
- Review of historic flooding incidents.
- Reporting on the standard of protection provided by defences.
- Assessment of surface water management and Sustainable Drainage Systems.
- Flood Risk Assessment and Surface Water Drainage Strategy guidance for developers.
- Identification of any cross boundary-implications.
- Assessment of strategic flood risk solutions that can be implemented to reduce risks, along with an overview of green infrastructure plans.
- High-level screening of Shortlisted Site Allocations against fluvial and surface water flood risk.

Level 2 outputs

The Level Two assessment includes detailed assessments of the sites to be carried forward which are at flood risk. Summary tables for each site identify the following:

- An assessment of all sources of flooding.
- An appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure, including an allowance for climate change.

- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff.
- Advice on appropriate policies for sites which could satisfy the first part of the Exception Test and on the requirements that would be necessary for a site-specific FRA supporting a planning application to pass the second part of the Exception Test.
- Consideration of green space, opportunities to restore the natural floodplain and betterment of other flood risks.

Summary of the Level 1 Assessment

Appraisal of flood risk

- Flood history shows that Central Bedfordshire has been subject to flooding from several sources of flood risk, with the principal risk from fluvial sources.
- The primary fluvial flood risk is located along the River Ivel corridor in the east, River Flit and River Hit in the centre and Clipstone Brook through Leighton Buzzard in the far west. The floodplain associated with the tributaries of the River Ivel network is generally broad due to the low-lying topography.
- Central Bedfordshire has experienced a number of historic surface water/ drainage related flood events caused by a number of mechanisms from insufficient storm and combined drainage capacity to poor surface water management. The updated Flood Map for Surface Water (uFMfSW) mapping shows a number of prominent overland flow routes, following topographical flow paths of existing watercourses or dry valleys and local road infrastructure with some isolated ponding located in low-lying areas.
- The sewers are managed by three Water Companies; Thames Water, Anglian Water and Affinity Water. The Flood Management System registers indicated there where 45 recorded flood incidents in Central Bedfordshire's administrative area. The more frequently flooded postcodes are LU1 4 and MK45 5.
- There have been incidents of historic groundwater flooding in Central Bedfordshire which is thought to primarily be caused by the underlying geology of chalk and Lower Greensand which allow water to pass to and from groundwater aquifers.
- There are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Reservoir Act 1975 means that the risk of flooding from reservoirs is relatively low.
- There are eight records of a canal overtopping along the Grand Union Canal since 2007, grouped into four different events in 2007, 2010 and two in 2012. The extent of the overtopping is unknown; however, it is thought that no properties were flooded.
- A high-level review of existing flood defences was undertaken and found very few formal defences in the study area.
- Currently there are nine Flood Alert Areas and seventeen Flood Warning Areas (FWAs) covering Central Bedfordshire.
- Many of the watercourses in Central Bedfordshire already meet the 'good' overall WFD status including the Clipstone Brook, the River Ivel (upstream of Henlow) and the Ickwell Brook. However, the majority only meet 'moderate' overall status or less.

Relevant studies

There are a number of relevant regional and local key studies which complement the SFRA and have been considered, such as the Catchment Flood Management Plan, River Basin Management Plan, the Preliminary Flood Risk Assessment and the Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments have been documented, along with guidance for planners and developers. Links

have been provided for various guidance documents and policies published by other Flood Risk Management Authorities such as the Lead Local Flood Authority and the Environment Agency.

Strategic Solutions and Green Infrastructure

There are lots of positive ongoing projects in Central Bedfordshire Council's study area; for example, the Upper and Bedford Ouse Catchment Partnership and the Chalk Arc Partnership as well as others. Future development should ensure there is no adverse impact on the quality of watercourses. Opportunities to improve the status of watercourses have also been considered as per the River Ouzel enhancement project.

Central Bedfordshire Council has a number of strategic and district plans for Green Infrastructure that seek to integrate information from accessible greenspace, access routes, biodiversity, historic environment, and landscapes to determine the GI assets and the wider GI network within the authority. Central Bedfordshire Council's Green Infrastructure plans are currently separated into The Mid Bedfordshire GI Plan (2008) and The Luton and Southern Bedfordshire GI Plan (2009). In addition to having its own GI Plans, it also falls under the County level Bedfordshire and Luton Strategic Green Infrastructure Plan (2007).

Level 1 site screening

The Council have undertaken a Stage 1 Assessment to filter sites from the 'Call for Sites' process, providing a list of 'pass sites' which have then been subsequently screened against flood risk information. The outcomes of the screening show which sites are at no/ limited flood risk and which sites were at greater flood risk. The screening outcomes show how many dwellings can be allocated in the sites at lowest flood risk prior to considering those at greater flood risk, thus adopting a sequential approach to site allocations.

Policy Recommendations

The following policy recommendations are to be considered by the Council in the development of the Local Plan.

Development and planning considerations

Shortlisted Site Allocations

- It is recommended that the outputs from this study are used as an evidence base for the allocation of potential development areas, directing new development to areas of lowest risk.
- A sequential approach to allocating sites should be adopted following the outcomes of the screening exercises, which identifies dwelling numbers able to be allocated in sites at lowest flood risk, prior to those at increased flood risk, thus reducing the number of sites requiring a Level 2 assessment.
- Where the site screening process has identified a shortlisted site allocation to be in either Flood Zone 2 and/or 3, and/or has an ordinary watercourse running through or adjacent to it, the flood risk to the sites will be investigated in more detail as part of the Level 2 SFRA. If land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development, the Exception Test will need to be applied.

Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the district.

All development proposals must take account of existing and future flood risk (from all sources).

The Local Planning Authority (LPA), Environment Agency and Lead Local Flood Authority (LLFA) should be consulted to confirm the level of assessment required and to provide any information on any known local issues. When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites.

Council review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding.

Central Bedfordshire Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

Site-specific Flood Risk Assessments

The Level 2 SFRA is not intended to replace site-specific FRAs. Site-specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes the Exception Test. A FRA is required for all developments:

- in Flood Zone 2 and 3,
- over 1ha in Flood Zone 1,
- less than 1ha in Flood Zone 1 including a change of use in development type to a more vulnerable class where they could be affected by a source of flooding other than rivers and sea
- in an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.

FRAs should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development. FRAs should account for flooding from all sources.

Developers should consult Central Bedfordshire Council and the Environment Agency (where relevant), at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. Opportunities to reduce flood risk to wider communities could be sought and functional floodplain should be protected from development and returned to greenfield status (where possible).

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

- Reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance
- Relocating development to zones with lower flood risk
- Creating space for flooding, including consideration of Green Infrastructure within the mitigation measures for surface water runoff from potential development

Surface water management and SuDS

Planners should be aware of the conditions and local requirements set by Central Bedfordshire Council for surface water management for major and minor developments and ensure development proposals and applications are compliant with the Council's policy.

All new development should aim to minimise areas of impermeable ground to reduce surface water runoff and sustainable drainage systems (SuDS) should be used on all new development, unless it is proved unfeasible.

It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals, where appropriate. The Council will make the decision on whether SuDS would be inappropriate in relation to a development proposal, with advice from relevant flood risk management bodies and in relation to technical standards published by Defra.

- New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Developers should aim to reduce post-development runoff rates at brownfield sites by at least 30%, in line with Council policy.
- Developers should therefore contact Central Bedfordshire Council and other key stakeholders at an early stage to ensure surface water management is undertaken and

that SuDS are promoted and implemented, designed in response to site characteristics and policy factors.

- Surface water drainage design must comply with Central Bedfordshire Council's drainage guidance and design guide, as well as with CIRIA SuDS Manual, BRE 365, PPG and non-statutory technical standards.
- In line with national SuDS standards, for Greenfield developments the peak runoff rate in the 1 in 1-year event and the 1 in 100-year event to any highway drain, sewer or surface waterbody should not exceed the Greenfield runoff rate for the same event. The 1 in 100-year event should be considered with an allowance for climate change.
- Proposed drainage strategies should account for the impacts of climate change effects, using latest guidance.
- SuDS proposals should contain an adequate number of treatments stages, in line with the CIRIA Manual, to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies.
- The promotion and adoption of water-efficient practices in new development will help to manage water resources and work towards sustainable development; this should also be promoted on all envelopment types.

Infrastructure and safe access

Safe access and egress at sites will need to be demonstrated by the developer; the development should be higher than the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during times of flood. Finished Floor Levels should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', or where the standard of protection is not of the required standard should be identified. Resilience measures will be required if buildings are situated in the flood risk area, and opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought.

Future flood management in Central Bedfordshire

Green Infrastructure and WFD

The evidence base provided in this SFRA should be used to help inform any Green Infrastructure Plans or Strategies in Central Bedfordshire. There are several existing GI plans in Central Bedfordshire which is encouraging for future flood risk management. Potential development site locations, which have watercourses flowing through them, provide an opportunity to use the land as green infrastructure by adopting sequential design to locate development away from watercourses and Flood Zones 2 and 3, and by implementing SuDS. Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

Strategic flood risk solutions

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within the district. Opportunities could consist of the following:

- Floodplain restoration (the most sustainable form of strategic flood risk solution), by allowing watercourses to return to a more naturalised state, for example by bank stabilisation, re-naturalisation, structure removal/ modification and enhancing outfalls.
- The construction of new upstream storage schemes as part of natural upstream flood management approaches, such as where watercourses are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches, providing benefit to the urban area downstream. Some locations where this could be investigated include the Pix Brook catchment, the Ouzel and Clipstone Brook catchments, and the River Flit around Flitwick.
- The 'Linking the Lakes' concept for Stewartby and Brogborough Lakes should be further investigated to ensure a more comprehensive understanding of how this functions, its limitations and the constraining factors. The IDB's modelled extents of the Elstow Brook

catchment do not extend as far as Brogborough Lake so this should be considered to establish the technical feasibility of this concept.

- As a result of Luton Borough's SWMP, areas in Central Bedfordshire (Houghton Regis) have been identified as Critical Drainage Areas which may affect Luton downstream. Opportunities for upstream storage in these areas could be investigated as part of cross-boundary partnership working.
- Opening up culverts, weir removal, and river restoration to improve the WFD status of watercourses. Existing natural drainage features should be retained wherever possible.

It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency.

Cross-boundary partnership working

For successful future flood risk management, it is recommended that neighbouring planning authorities adopt a catchment partnership working approach in tackling flood risk and environmental management. This assessment looked at potential development sites along authority borders, as well as cross-boundary residual risk (such as from reservoir inundation), showing which authority areas have the potential to influence flood risk on others based on topography, river flow direction and residual risk. New developments should mitigate any potential flood risks, but dialogue and understanding between neighbouring authorities can only strengthen the direction of future flood risk management.

Use of Strategic Flood Risk Assessment data

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. The SFRA should be a '**living document',** and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Central Bedfordshire Council, the Highways Authority, Canal and River Trust, Anglian Water, Thames Water, Affinity Water, the Bedford Group of IDBs and the Environment Agency. Such information may be in the form of:

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

It is recommended that the SFRA is regularly reviewed, in line with latest legislation and Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

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Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AIMS Database	Environment Agency Asset Information Management System
AEP	Annual Exceedance Probability
AStGWF	Areas Susceptible to Groundwater Flooding
BGoIDB	Bedford Group of Internal Drainage Boards (BGoIDBs)
Brownfield	Previously developed parcel of land
Call for sites	Bedford Council is in the process of preparing the Local Plan 2035; as part of this, the Council has requested a 'call for sites' to identify potential development sites.
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CERT	Community Emergency Response Teams
CFMP	Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
Cumecs	The cumec is a measure of flow rate. One cumec is shorthand for cubic metre per second; also m^3/s.
Defra	Department for Environment, Food and Rural Affairs
Designated Feature	A form of legal protection or status reserved for certain key structures or features that are privately owned and maintained, but which make a contribution to the flood or coastal erosion risk management of people and property at a particular location.
DMPO	Development management procedure order
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
Exception Test	Set out in the NPPF, the Exception Test is a method used to demonstrate that flood risk to people and property will be managed appropriately, where alternative sites at a lower flood risk are not available. The Exception Test is applied following the Sequential Test.
FCERM	Flood and Coastal Erosion Risk Management
FCRMGiA	Defra's Flood and Coastal Risk Management Grant in Aid
FEH	Flood Estimation Handbook
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Map for Planning	The Environment Agency Flood Map for Planning (Rivers and Sea) is an online mapping portal which shows the flood zones in England. The flood zones refer to the probability of river and sea flooding, ignoring the presence of defences and do not account for the possible impacts of climate change.
Flood Management System	A water-company held online database system of properties and areas which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.

Term	Definition
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRA	Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRM	Flood Risk Management
FWMA	Flood and Water Management Act
FZ	Flood Zones
GI	Green Infrastructure – a network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and urban fringe
GDPO	General Development Procedure Order
Greenfield	Undeveloped parcel of land
Ha	Hectare
IDB	Internal Drainage Board
Indicative Flood Risk Area	Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by Defra and WAG.
JBA	Jeremy Benn Associates
Jflow	2D generalised hydrodynamic modelling software.
Land Charges Search CON29	Local land charges searches comprise a series of standard questions intended to give any potential buyer information about the property. CON29 contains questions relating to Planning, Highways, Building Control and Environmental Health.
LFRMS	Local Food Risk Management Strategy
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
mAOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
NRD	National Receptor Database
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
OS NGR	Ordnance Survey National Grid Reference
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity.
Pound length	Distance of level water impounded between two canal locks.
Qbar	The mean annual flow from a catchment. This is approximately the 2.3-year return period event.
PPG	National Planning Policy Guidance
PPS25	Planning and Policy Statement 25: Development and Flood Risk – superseded by the NPPF and PPG
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.

Term	Definition
Riparian owner	A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	Operating authorities who's remit and responsibilities concern flood and / or coastal risk management.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Sequential Test	Set out in the NPPF, the Sequential Test is a method used to steer new development to areas with the lowest probability of flooding.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SHLAA / SHELAA	Strategic Housing or Employment Land Availability Assessment - The Strategic Housing or Employment Land Availability Assessment (SHLAA) is a technical piece of evidence to support local plans and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing or employment land in the area which is suitable and deliverable.
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SPD	Supplementary Planning Document
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
uFMfSW	Updated Flood Map for Surface Water
WFD	Water Framework Directive – Under the WFD, all waterbodies have a target to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. River Basin Management Plans (RBMPs) set out the ecological objectives for each water body and give deadlines by when objectives need to be met.

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1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

JBA Consulting were commissioned by Central Bedfordshire Council to prepare an updated Strategic Flood Risk Assessment (SFRA). The purpose of this study is to provide a comprehensive and robust evidence base to support the production of the Local Plan to 2036 and will replace the existing Strategic Flood Risk Assessments for Mid- and South Bedfordshire (both published in 2008).

The 2016 SFRA update will be used in decision-making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

1.2 Objectives

The key objectives of the SFRA update are:

1. To provide a tool for assessing flood risk from various sources of current and future flooding and how these may be mitigated.
2. To identify the likely effects of climate change on flood risk.
3. To inform decisions on the emerging Local Plan including the selection of development sites and planning policies.
4. To provide a clear rationale and evidence base for applying the Sequential Test and Exception Test in the allocation of new development sites, and development management decisions, as required by national policy and guidance.
5. To draw attention to advice for applicants carrying out site-specific flood risk assessments and outline specific measures or objectives that are required to manage flood risk to the appropriate standard'.

1.3 Levels of SFRA

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

1. **Level One:** flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
2. **Level Two:** land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

The objectives of this SFRA update are to undertake a Level 1 SFRA, followed by performing a site screening exercise in order to take forward sites located in Flood Zones 2 or 3 to a Level 2 SFRA assessment. This Level 2 assessment will provide a Summary Table per site, assessing flood risk from all sources, an outline SUDS assessment and flood risk management recommendations.

1.4 SFRA outputs

1.4.1 Level One outputs

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

- Identification of policy and technical updates, in particular the introduction of the National Planning Policy Framework and accompanying Planning Practice Guidance (any strategic flooding issues which may have cross boundary implications with neighbouring authorities.
- Review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc.).
- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, sewers, groundwater, reservoirs and canals.

- Updated review of historic flooding incidents.
- Mapping of location and extent of functional floodplain, surface water flood risk, flood warning areas, reservoir inundation, areas susceptible to groundwater.
- An assessment of areas which may warrant further assessment or modelling.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change.
- An assessment of the surface water management issues, how these can be addressed through site allocation and development management policies and the application of Sustainable Drainage Systems (SuDS).
- Flood Risk Assessment and Surface Water Drainage Strategy requirements for developers.
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.
- An assessment of strategic flood risk solutions that can be implemented to reduce risks and avoid exacerbation of flood risk to third parties, in addition to Green Infrastructure projects.
- High-level screening of Shortlisted Site Allocations against fluvial and surface water flood risk.

1.4.2 Level Two outputs

The Level Two assessment includes detailed assessments of the sites to be carried forward for allocation by the Local Plan. These include:

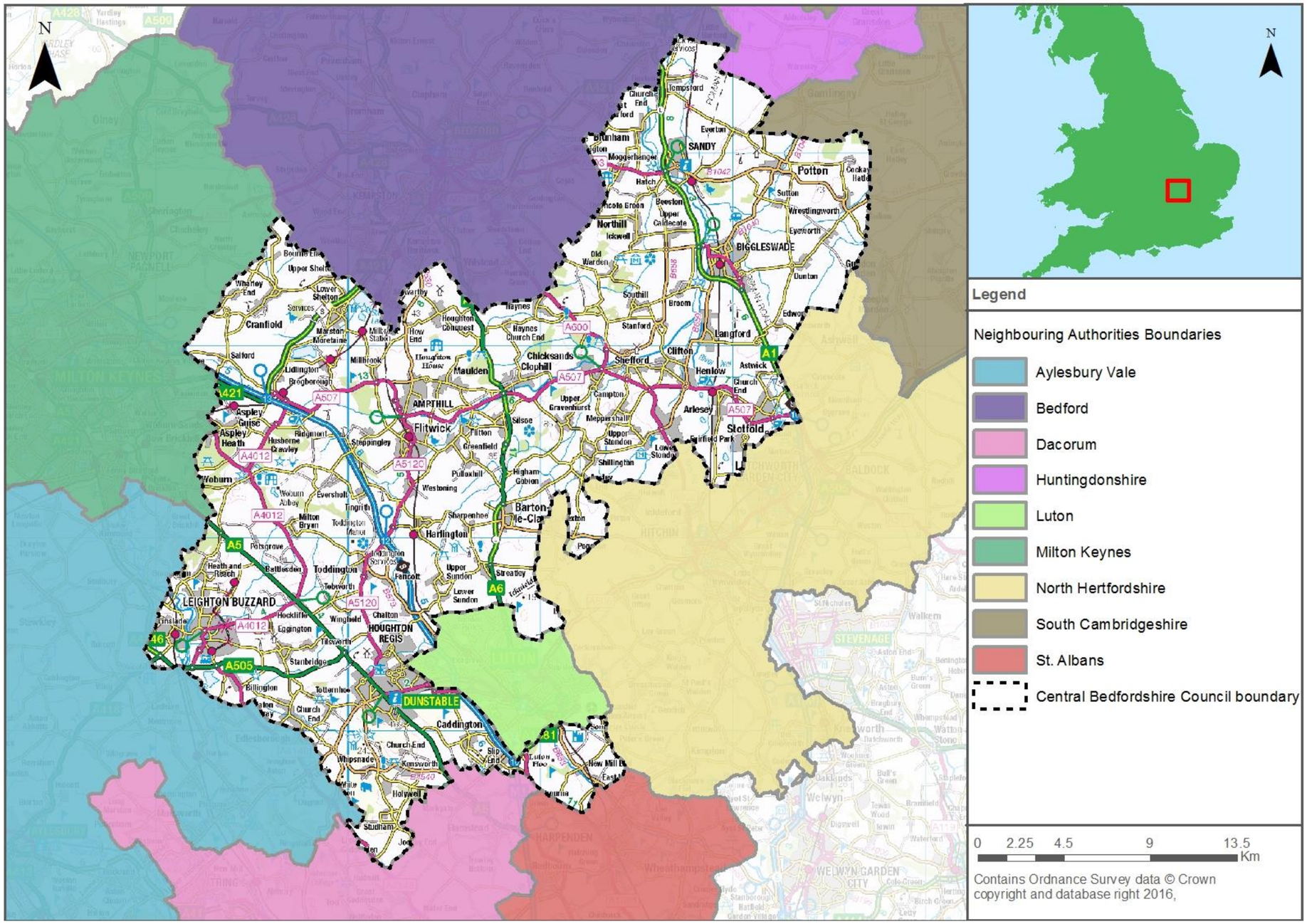
- An assessment of all sources of flooding including:
    - Fluvial flooding, including depth, velocity and hazard mapping
    - Definition and mapping of the functional floodplain
    - Potential increase in fluvial flood risk due to climate change
    - Surface water flooding
    - Sewer flooding
    - Flooding from reservoirs/ canals
    - Groundwater flooding
- Reporting on current conditions of flood defence infrastructure, including the protection provided by the feature.
- An assessment of the impact of future large-scale developments both within and outside the study area.
- An appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure, including an allowance for climate change.
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff.
- Advice on appropriate policies for sites which could satisfy the first part of the Exception Test and on the requirements that would be necessary for a site-specific FRA supporting a planning application to pass the second part of the Exception Test.
- Consideration of interrelated issues including:
    - Water quality and green space
    - Opportunities to restore the natural floodplain and betterment of other flood risks.

1.5 SFRA study area

The Central Bedfordshire Council administrative area covers an area of approximately 716 km^2 and has a population of approximately 254,381 (2011 census). The majority of the district is classified as rural countryside with just under half of the population residing in urban areas. There are a series of small to medium-sized towns within the district, predominately situated on the River Ivel or River Flit corridors. However, the two largest towns of Leighton Buzzard and Dunstable, are situated in the south of the district. An overview of the study area is shown in Figure 1-1.

The River Ivel flows through the central and eastern corridor of the district, entering west of the A1(M) junction 10 and flowing north, passing the major settlements of Sandy and Biggleswade. There are several other notable main rivers in the district, including the River Hit and Flit; the majority of watercourses in the district drain the River Ivel, with the exception of those near the southern and western boundary which flow into the River Ouzel catchments. The key watercourses and their tributaries flowing through the SFRA area are presented in the Chapter 6.

Figure 1-1: Study Area with adjoining authorities



1.6 Consultation

SFRAs should be prepared in consultation with other stakeholders. The following parties (external to Central Bedfordshire) have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Affinity Water
- Anglian Water
- Thames Water
- Canal & River Trust, AINA Waterways, B&MK Waterway Trust
- Central Bedfordshire Council Highways
- Bedfordshire Fire and Rescue
- Forest of Marston Vale
- Neighbouring authorities including:
    - Aylesbury Vale District Council
    - Bedford Borough Council (LLFA)
    - Dacorum Borough Council
    - Huntingdonshire District Council
    - Luton Borough Council (LLFA)
    - Milton Keynes Council (LLFA)
    - North Hertfordshire District Council
    - South Cambridgeshire District Council
    - St Albans City and District Council.

1.7 Use of SFRA data

The primary purpose of this SFRA data is to provide an evidence base to inform Central Bedfordshire Council's Local Plan and any future flood risk policies, as detailed in the objectives listed in Section 1.1. This SFRA is intended to aid Central Bedfordshire Council in applying the Sequential Test for their site allocations and identify where the application of the Exception Test may be required via a Level 2 SFRA.

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

Table 1-1 sets out the structure and content of the SFRA report and associated mapping.

Table 1-1: SFRA report contents

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2 The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
3. Applying the Sequential, risk based approach and the Exception Test	Provides an overview of Flood Zones, application of the Sequential Approach and Sequential/ Exception Test process.
4. Sites submitted for allocation	Outlines the allocation methodology and site screening exercise.
5. Taking account of the impact of climate change	Outlines climate change guidance published by the Environment Agency in February 2016
6. Summary of SFRA mapping for all	Overview of data and sources used to

sources of flood risk and methodology	inform the SFRA, including identification of data gaps
7. Understanding flood risk in Central Bedfordshire	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting the district including historical flooding incidents.
8. Flood defences and assets in Central Bedfordshire	Assessment of flood defences and assets in Central Bedfordshire, including residual risk.
9. Flood warning and emergency planning	Outlines the Flood Warning Service, and emergency planning procedures and considerations.
10. Development in the Internal Drainage Boards area	Introduces the IDB, its remit and byelaws
11. Cumulative impact of development and cross boundary issues	Broadscale assessment of areas where the cumulative impact of development may be detrimental to flood risk. An assessment of potential cross boundary flood risk issues as a result of future large scale developments.
12. Advice for developers on managing flood risk at site-specific level	Outlines requirements for FRAs and SWDSs as well as providing guidance for developers on flood risk management measures
13. Surface water management and SuDS requirements	Advice on managing surface water run-off, and how SuDS play an important role.
14. Green Infrastructure and the Water Framework Directive	Outlines Green Infrastructure plans and the WFD as well as local schemes.
15. Strategic Flood Risk Solutions	Summary of Strategic Flood Risk Solutions, existing projects in Central Bedfordshire and opportunities for future solutions.
Summary and Recommendations	
16. Summary	Summary of SFRA assessment and key findings
17. Recommendations	Outlines key recommendations from the SFRA to inform Local Plan policy
Appendices	
Appendix A: Watercourses in Central Bedfordshire	
Appendix B: Flood Zone mapping, including functional floodplain	
Appendix C: Climate change mapping	
Appendix D: Surface water flood risk mapping	
Appendix E: Areas Susceptible to Groundwater Flooding	
Appendix F: Flood warning coverage	
Appendix G: Groundwater Source Protection Zone	
Appendix H: Reservoir Inundation Mapping	

1.8 Future updates

This SFRA provides an overview of the flood risk to Central Bedfordshire and draws together all sources of flooding including surface water, reservoir, canal, sewer and ground water. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

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

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

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

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2 The Planning Framework and Flood Risk Policy

2.1 Introduction

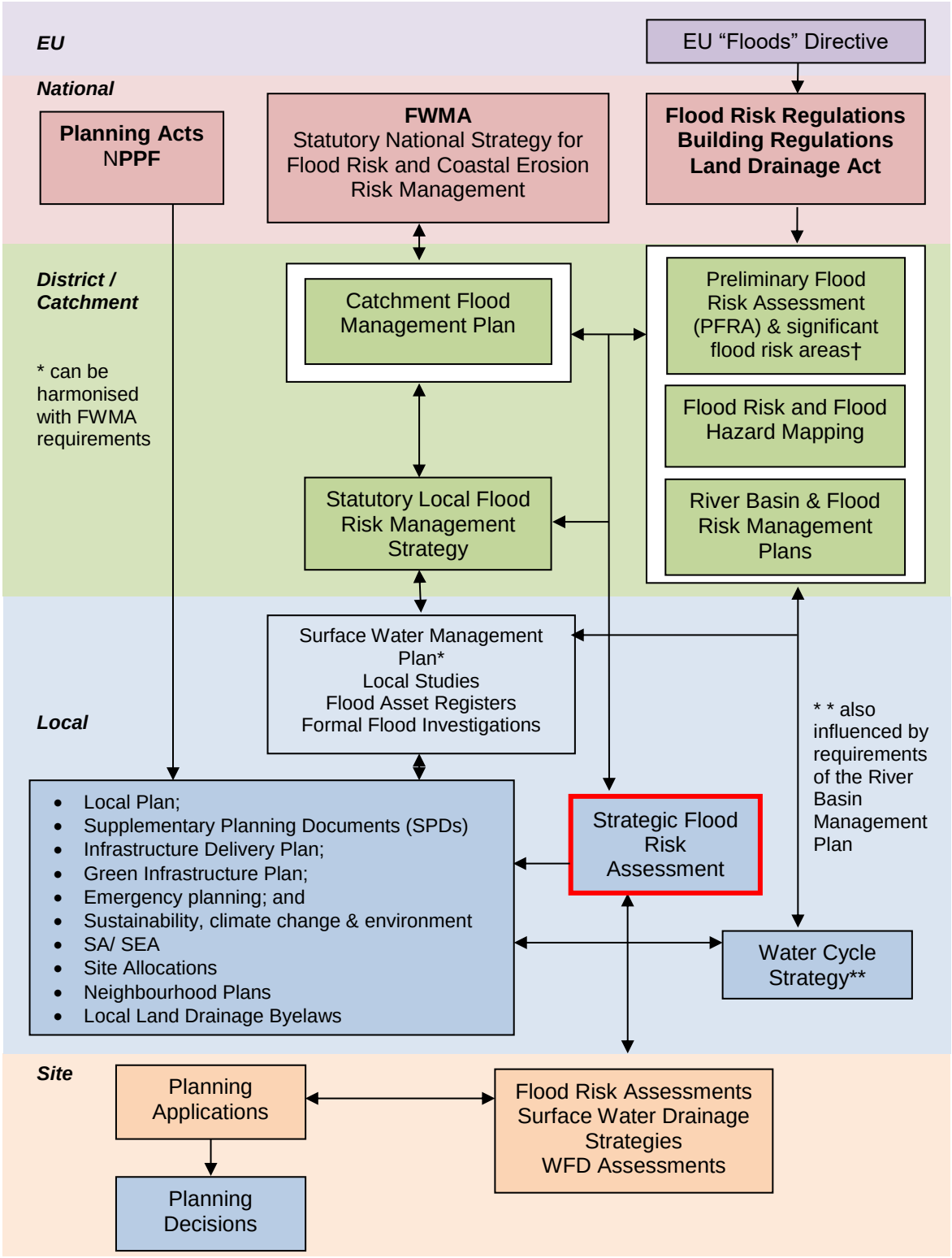
The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and taken into account.

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

Figure 2-1 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and Flood and Water Management Act, in conjunction with the Localism Act's "duty to cooperate", introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

There are a number of Risk Management Authorities which operate in Central Bedfordshire; the key Risk Management Authorities, alongside their responsibilities, are summarised in Table 2-1.

Figure 2-1: Strategic planning links and key documents for flood risk



Legend: Responsibilities are indicated using colour coding as follows

European Union	National Government	Local Planning Authority	EA/LLFA/Local Authorities	Developer

† See Table 2-1 for roles and responsibilities for preparation of information

2.2 Implications from the updated policy for Central Bedfordshire Council and other RMAs

The responsibilities under the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009 are summarised in Table 2-1.

Table 2-1: Roles and responsibilities in Central Bedfordshire under FWMA 2010

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	National Statutory Strategy Reporting and supervision (overview role)	• Preliminary Flood Risk Assessment (per River Basin District)* • Managing flooding from Main Rivers and reservoirs and communication flood risk warnings to the public, media and partner organisations. • Identifying Significant Flood Risk Area* • Enforcement authority for Reservoirs Act 1975 • Managing RFCCs and supporting funding decisions, working with LLFAs and local communities. • Emergency planning and multi-agency flood plans, developed by local resilience forums • Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of function of the strategy. • Designating authority of infrastructure with a significant impact on flood risk from surface water and groundwater. • Managing Environmental Permits (formerly Flood Defence Consents).
Central Bedfordshire Council	Input to National Strategy Formulate and implement the Local Flood Risk Management Strategy Input to National and Local Authority Plans and Strategy (e.g. Central Bedfordshire Local Plan – to develop a spatial strategy for growth within the district which accounts for flood risk)	• Power for enforcing and consenting works for ordinary watercourses. • Managing local sources of flooding from surface runoff and groundwater and carrying out practical works to manage flood risk from these sources where necessary. • Preparing and publishing a PFRA • Identifying local Flood Risk Areas • Investigating certain incidents of flooding in the County in Section 19 Flood Investigations • Keeping asset registers of structures and features which have a significant effect on local flood risk. • Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of other functions of the strategy • Designating authority for Infrastructure with a significant impact on flood risk from surface runoff and groundwater • Preparation of a Local Plan to guide development. • The competent determining authority for planning applications and have the ultimate decision on the suitability of a site in relation to flood risk and management of surface water run-off. • Responsibilities for emergency planning as a responder to a flood event. • Own and manage public spaces which can potentially be used for flood risk management.

Road infrastructure (Highways England and the local Highways Authority)	Input to National, and act consistently with, Local Authority Plans and Strategy Maintain and consultee to SUDS in public roads Contribute to sustainable development	• Highway drainage (motorways and trunk roads only) – Highways England • Highway drainage including roadside ditches (excluding motorways and trunk roads) - Central Bedfordshire Council as the local highways authority • Maintain adopted SuDS that are within public roads.
Water and Sewerage Undertakers (Anglian Water, Thames Water and Affinity Water)	Input to National, and act consistently with, Local Authority Plans and Strategy	• Public sewers (foul and surface water) • Properly maintaining, cleaning and inspecting the public system • Register properties that are 'at risk' from flooding (known as the Flood Management System), and record all sewer flooding incidents • Respond to flooding from their sewers and investigate the cause (remedial work is then prioritised on a risk basis)
Internal Drainage Boards (Bedford Group of Drainage Boards)	Input to National, and act consistently with, Local Authority Plans and Strategy Preliminary Flood Risk Assessments Designating assets Consultees to SUDS	• Ordinary watercourses regulation (I.e. consenting/ enforcing) • Watercourse maintenance and improvement • Local storm water management • Habitat creation and management

* The Environment Agency did not prepare a PFRA; instead they exercised an exception permitted under the Regulations.

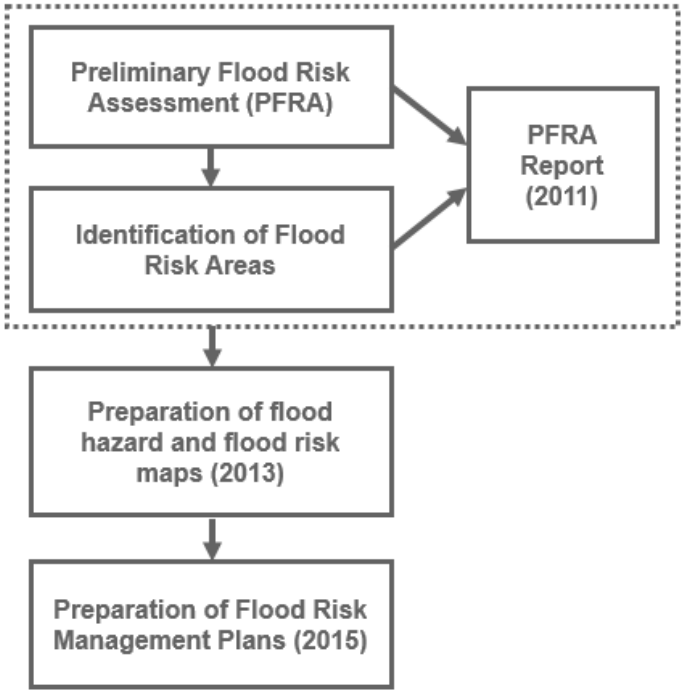
Whilst the responsibilities listed in Table 2-1 have been clearly defined by the corresponding risk management authority, certain responsibilities may overlap depending on land ownership. Riparian owners also have a role in risk management activities, for example by maintaining river beds/ banks, controlling invasive species and allowing the flow of water to pass without obstruction. More information can be found in the Environment Agency publication **'Living on the Edge' (2012).**

2.3 Flood Risk Regulations (2009)

The **Flood Risk Regulations (2009)** are intended to translate the current EU Floods Directive into UK law and place responsibility upon all Lead Local Flood Authorities (LLFAs) to manage localised flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; however, responsibility for local and all other sources of flooding rests with the LLFA (Central Bedfordshire Council) and other Risk Management Authorities (RMAs) (for example water companies, Internal Drainage Boards, Town and Parish Councils etc).

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

Figure 2-2: Flood Risk Regulation Requirements



Under this action plan and in accordance with the Regulations, LLFAs have the task of assessing flood risk from local sources over a six-year cycle, beginning with the preparation of a Preliminary Flood Risk Assessment (PFRA) report.

2.3.1 Preliminary Flood Risk Assessment (PFRA)

The Flood Risk Regulations 2009 require that Preliminary Flood Risk Assessments (PFRAs) are reviewed and updated every six years. The **PFRA** for the first planning cycle was published in 2011 and the PFRA for the second planning cycle has been published in 2017. This gives an overview of local flood risk in Central Bedfordshire based on a review of records of past flooding and data derived from modelling of potential future flooding. It reports on significant past and future flooding from all sources except from Main Rivers and Reservoirs, which are covered by the Environment Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Anglian Water, Thames Water and Affinity Water).

The PFRA is a high-level screening exercise and considers floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The Regulations require the LLFA to identify significant Flood Risk Areas. Where a Flood Risk Area is identified the LLFA must produce 'Flood Hazard and Risk Maps' and a 'Flood Risk Management Plan' (FRMP) setting out measures for the area.

The threshold for designating significant Flood Risk Areas is defined by Defra and the PFRA for each 6-year cycle. No Indicative Flood Risk Areas were identified in Central Bedfordshire in 2011 and 1 indicative Flood Risk Area was identified in 2017.

The determination of Flood Risk Areas is not intended to identity all flood risks to all properties, but rather to identify some of the largest settlements that may be at local flood risk. Whether a property is in a Flood Risk Area or not is indicative more of the size of the settlement rather than the risk to any particular household.

Under the Regulations, the Environment Agency exercised an 'Exception' in 2011 and did not prepare a PFRA for risk from rivers, reservoirs and the sea. This then made it a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP).

2.3.2 Flood Risk Management Plans (FRMPs)

Under the Flood Risk Regulations (2009), the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. This then made it a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP). The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive, discussed in Section 2.10 and Chapter 13.

The FRMP draws on previous policies and actions identified in Catchment Flood Management Plans (CFMPs) and also incorporates information from Local Flood Risk Management Strategies (LFRMS). Central Bedfordshire falls mostly within the **Anglian River Basin District FRMP** (March 2016) with areas below Luton falling within the **Thames River Basin District FRMP** (March 2016). The FRMP summarises flooding affecting the catchments and describe the measures to be taken to address the risk in accordance with the Flood Risk Regulations. Each River Basin District is composed of a group of sub-areas or management catchments, to encourage the protection and enhancement of the water environment at a local level. The Anglian River Basin District is split into 15 management catchments and the Thames River Basin FRMP is split into 17 management catchments. Central Bedfordshire is covered by the following catchments:

- The Upper Lee (Thames)
- The Upper and Bedford Ouse (Anglian)
- The Cam and Ely Ouse (Anglian)*

*Central Bedfordshire's administrative boundary is just clipped by the headwaters of the River Rhee catchment, south-east of Wrestlingworth; therefore, further details have only been provided for the Upper Lee and Upper and Bedford Ouse.

The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations. The measures preparing for risk and Protecting from risk which specifically affect Central Bedfordshire are:

In the Upper Lee catchment:

- working with key stakeholders to better understand and manage flood risk (improving understanding of local flood risk and improving community awareness of flooding)
- improved surface water forecasting and warning systems
- improving the policy for regulation of works on ordinary watercourses
- implementing sustainable drainage systems (SuDS) and management of overland flood flow paths
- a proposed flood storage area at Houghton Regis to reduce the level of risk in Luton - this scheme will incorporate a flood storage area into the new development at Houghton Regis and will provide flood alleviation benefits to Luton

In the Upper Bedford and Ouse catchment:

- Strategic review of assets along the River Ivel to determine where assets can be removed to reduce maintenance requirements and improve the watercourse and meet WFD targets
- Promotion of SuDS in line with government guidance
- Catchment-based action for Property Level Resistance. Gather local flood evidence of past events to confirm the number of properties that will benefit from this project. Further evidence will be gathered by discussion with the communities affected to ensure that PLP is only offered where there is no other feasible way of reducing flood risk.

2.4 Flood and Water Management Act, 2010

The Flood and Water Management Act (2010) (FWMA) aims to create a simpler and more effective means of managing both flood risk and coastal erosion and implements Sir Michael Pitt's recommendations following his review of the 2007 floods. The FWMA received Royal Assent in April 2010, and designated upper tier local authorities as LLFAs.

Under the FWMA, local authorities are responsible for managing the risk of flooding relating to 'Ordinary Watercourses' (i.e. smaller ditches, brooks), with the Environment Agency responsible

for 'Main Rivers'. In Central Bedfordshire, this applies only to watercourses vested in the authority; watercourses vested in the IDB will be managed by the IDB.

The FWMA established the role of LLFAs; in the instance of this SFRA, the LLFA is Central Bedfordshire Council. Duties for LLFAs include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor an LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most. This Strategy acts as the basis and discharge of duty for Flood Risk Management co-ordinated by Central Bedfordshire Council. The 2014 Local Flood Risk Management Strategy was adopted in 2014 and updated in 2016.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents to the standards set out in the FWMA (Section 19 investigations). There are currently two formal flood investigation report; one for the Pix Brook in Stotfold, published 5 November 2015, and another for Cranfield, Dunstable, Aspley Guise and Stotfold, due to be published in 2016.
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area. A Flood Asset Register is currently being prepared for Central Bedfordshire.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it. To date, no features have been designated by the LLFA at the time the SFRA was produced.
- Consenting and Enforcing: When appropriate LLFAs will perform consenting of works on Ordinary Watercourses. In Central Bedfordshire:
    - The Environment Agency is responsible for consent Environmental Permits (formerly Flood Defence Consents) relating to main rivers.
    - The Bedford Group of Drainage Boards is responsible for consenting on ordinary watercourses, vested in both Central Bedfordshire Council and the LLFA.

2.4.1 Central Bedfordshire Local Flood Risk Management Strategy (LFRMS) 2016

Central Bedfordshire Council as LLFA is responsible for developing, maintaining, applying and monitoring a **Local Flood Risk Management Strategy**. The Strategy was published in 2014 and updated in 2016. The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis.

Based on national and local knowledge, the Central Bedfordshire LFRMS includes mapping of areas across the district determined to be at low, medium and high risk of flooding (from all sources) based on the likelihood of flooding occurring and the impact in that area.

Local planning authorities should take the adopted policies and actions in the LFRMS in to consideration when completing the Local Plan and ensure new development is compliant with this.

The high-level objectives proposed in the Strategy for managing flood risk include:

- Establish and maintain effective partnerships within the organisation, with other RMAs, with neighbouring Lead Local Flood Authorities and with local communities.
- Ensure that development looks to reduce the causes and impacts of flooding and that all development uses SuDS as normal practice, and where appropriate safeguard land which is needed for current and future flood management.
- Develop a greater understanding of local flood risk by identifying where assets may influence the impact of local flood risk, how local flood risk may change in the future and improve local knowledge and recording of flooding incidents.
- Establish processes to enable identification of priorities, sources of funding and schemes so that objectives are met.

- To take a collaborative approach, working more effectively as an authority and with our partners, to reduce flood risk and where appropriate seeking opportunities for packaging work.
- Limit the effect of flooding on people's normal way of life by taking action with partners to minimise the impact of local flood risk on communities and environment, engaging with and empowering affected communities and ensuring that clear and useful information is provided to enhance our local communities' preparedness and resilience to local flood risk.

The LFRMS has been updated in 2016.

2.4.2 LLFAs, surface water and SuDS

On 18 December 2014, a Written Ministerial Statement laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015. In considering planning applications, local planning authorities should consult the LLFA on the management of surface water, satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, and through use of planning conditions or obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

In March 2015, the Development Management Procedure (DMPO) was amended making LLFAs a statutory consultee, which came into effect on 15 April 2015. As a result, Central Bedfordshire Council is required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as:

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

In Central Bedfordshire Council's Call for Sites, the range of submissions sought for the Local Plan were for major development and should therefore all demonstrate SUDS in a development proposal, how these function and will be maintained. Criteria for submissions were:

- new settlements of 2,000 or more dwellings
- urban extensions of 500 or more dwellings
- between 10 and 500 dwellings, where these have not been previously submitted or are improved resubmissions with enhanced detail
- employment uses of over 10 hectares
- sites for Gypsy and Traveller accommodation

2.4.3 Reservoirs

The FWMA will also update the Reservoirs Act 1975 by reducing the capacity of reservoir regulation from 25,000m^3 to 10,000m^3. Phase 1 has been implemented in 2013 requiring large raised reservoirs to be registered to allow the Environment Agency to categorise whether they are 'high risk' or 'not high risk'. However, the level and standard of inspection and maintenance required under the Acts means that the risk of flooding from reservoirs is relatively low. The risk of inundation to Central Bedfordshire as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study.

2.5 National Planning Policy Framework

The **National Planning Policy Framework** (NPPF) was issued on 27 March 2012 to replace the previous documentation as part of reforms to, firstly, make the planning system less complex and more accessible, and, secondly, to protect the environment and promote sustainable growth. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs) that were referred to in the previous version of the SFRA. The NPPF is a source of

guidance for local planning authorities to help them prepare Local Plans and for applicants preparing planning submissions. With regards to plan-making and flood risk, the principal provisions of the NPPF are set out in paragraph 100 – 108 (105-108 are associated with coastal flood risk and so are not applicable to Central Bedfordshire.

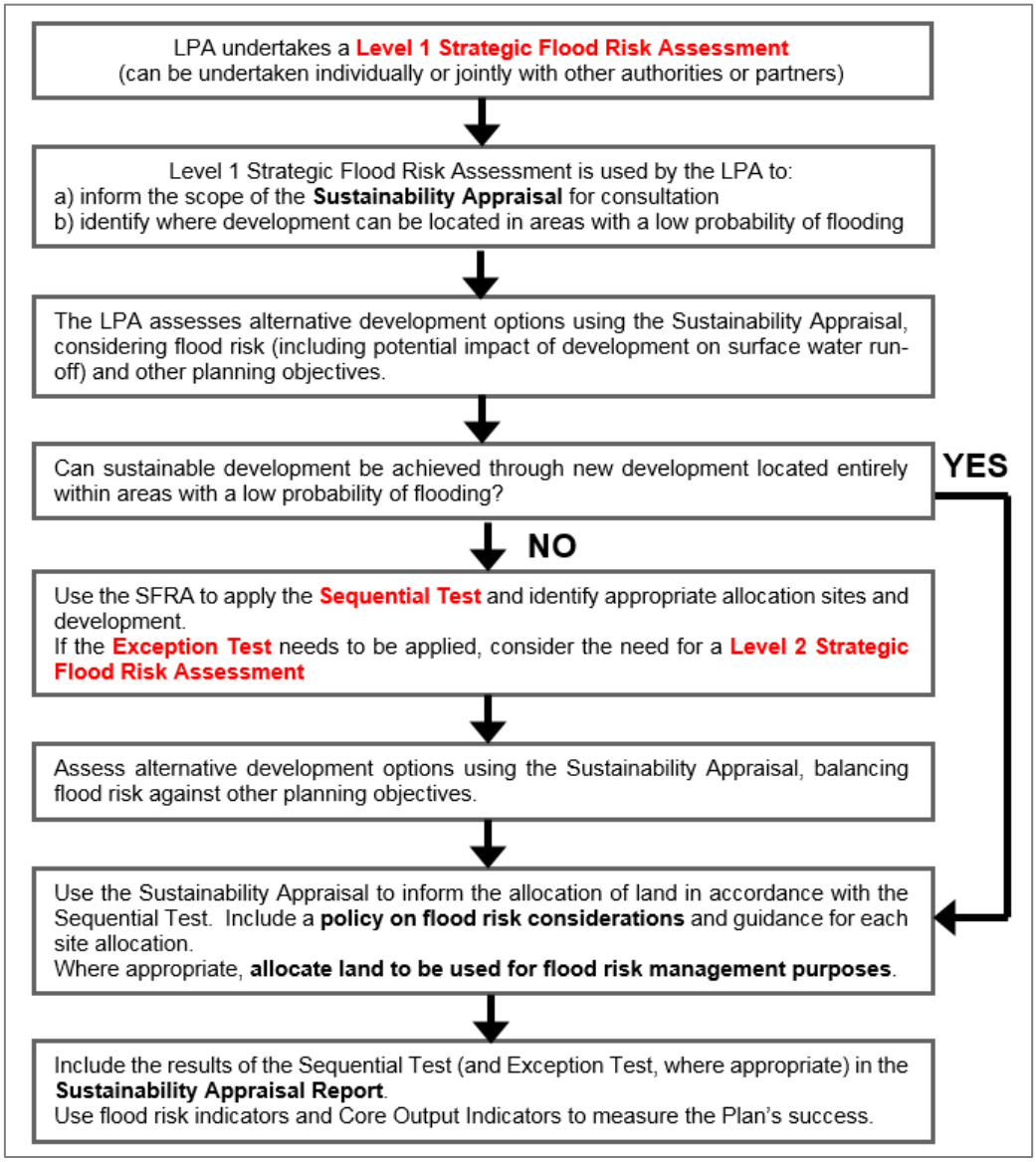
Paragraph 100 of the NPPF:

> *"Local Plans should be supported by a strategic flood risk assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change".*

Planning Practice Guidance on flood risk was published in March 2014 and sets out how the policy should be implemented. NPPF sets out Flood Zones, the appropriate land uses for each zone, flood risk assessment requirements and the policy aims for developers and authorities regarding each Flood Zone. Further details on Flood Zones and associated policy is provided in Chapter 3 and throughout this report.

A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance Figure 2-3.

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



† Based on Diagram 1 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

2.6 Water Cycle Studies

Water Cycle Studies assist local authorities to select and develop growth proposals that minimise impacts on the environment, water quality, water resources, infrastructure and flood risk and help to identify ways of mitigating such impacts. This can be achieved in areas where there may be conflict between any proposed development and the requirements of the environment through the recommendation of potential sustainable solutions.

An outline (2008) and a detailed (2010) Luton and South Bedfordshire WCS were prepared covering the south area. An outline (2009) and a detailed (2012) Bedford Borough and Mid-Bedfordshire District WCS were completed covering the north area.

An updated Water Cycle Study for the whole of Central Bedfordshire has been prepared by JBA Consulting in parallel to this SFRA to support the production of the Local Plan to 2036. This WCS was an assessment of the whole district to inform Central Bedfordshire Council of known capacity issues and available headroom within the water and wastewater services. All settlements have been considered as potential locations for growth at this stage, which allowed recommendations to be provided as to how much growth could be accommodated in an area, without the need for additional resources or investment.

2.7 Surface Water Management Plans and SuDS Guidance

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken, when required, by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments. There is no SWMP at present.

Since the production of the 2008 SFRA, there have been numerous documents published relating to surface water management and SuDS including:

- The Central Bedfordshire Council, Milton Keynes Council and the Marston Vale Surface Waters Plan
- The SuDS Manual (C753), published in 2007, updated in 2015
- **DEFRA Non-statutory technical standards for sustainable drainage systems, 2015**
- **DEFRA National Standards for sustainable drainage systems Designing, constructing (including LASOO best practice guidance), operating and maintaining drainage for surface runoff, 2011**
- BS8582 Code of practice for surface water management for development sites
- **The House of Commons: Written Statement HCWS161 on Sustainable Drainage Systems, 2014**
- **Anglian Water SuDS Adoption Manual**
- The Building Regulations, 2010 (Part H: drainage and waste disposal)
- Central Bedfordshire **Sustainable Drainage Guidance** (Adopted April 2014, Updated May 2015)
- Central Bedfordshire Council **Advice for the provision of surface water drainage systems for new developments** (April 2015)

The previous SFRAs discussed the viability of SuDS, reviewing local geology, local settlements and SuDS techniques. However, this area of flood risk management has significantly progressed since 2008; there is now a national standard for sustainable drainage systems with supporting non-statutory technical standards, a code of practice for surface water management and local supplementary planning guidance / advice published by the Council on surface water drainage systems.

Guidance for Sustainable Urban Drainage Systems (SuDS) is currently being updated and a SuDS Toolkit is currently being prepared for Central Bedfordshire Council. This will detail the SuDS hierarchy and the techniques which are applicable / suitable in the context of Central Bedfordshire e.g. considering local hydrogeological conditions. Central Bedfordshire Council are in the process of introducing byelaws for land drainage, which control activity on/ near a watercourse including flow and pollution, as per the Bedford Group if Internal Drainage Boards (BGoIDBs).

2.8 Land Drainage Act

The **Land Drainage Act (1991)** requires that a watercourse be maintained by its owner so as not to impede the free flow of water. The riparian owner must accept the natural flow from upstream; however, it is not necessary for riparian owners to carry out any works to cater for increased flows resulting from some types of works carried out upstream, for example a new housing development.

If a riparian owner fails to carry out its responsibilities under the Act, or if anyone else causes a watercourse to become blocked or obstructed, the County and District Councils have powers of enforcement by serving a notice under the Act.

The 1994 Act amends the 1991 Act in relation to the functions of Internal Drainage Boards and local authorities.

2.9 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work

with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

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

The study area is covered by the **Great Ouse CFMP** and **Thames CFMP**. The Central Bedfordshire Council area is covered by the following policies:

- Policy Option 3: Areas of low to moderate flood risk where the EA are generally managing existing flood risk effectively (for example Sandy, Biggleswade, Blunham, the River Flit corridor and the majority of the smaller rural villages)
- Policy Option 4: 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 (for example Dunstable, Totternhoe and Kensworth)
- Policy Option 5: Areas of moderate to high flood risk where we can generally take further action to reduce flood risk (covers Leighton Buzzard and surrounding villages)
- Policy Option 6: Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits (covers the area along Clipstone Brook)

2.10 The Water Framework Directive

The EU Water Framework Directive (WFD) seeks to integrate and enhance the way in which water bodies are managed throughout Europe by the preservation, restoration and improvement of the water environment. On 23 October 2000, the European Commission established the WFD Directive (WFD) requiring each Member State of the European Union to satisfy the environmental objectives set by the Directive and implement the legislation. This was transposed into law in England and Wales in 2003. In England, the Environment Agency is responsible for the delivery of the WFD objectives.

The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Ecological Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date.

It is important that developments aim to take positive measures to conform to the WFD, which can be impacted as a result of development, for example in terms of 'deterioration' in ecological status or potential.

2.10.1 River Basin Management Plans

The WFD requires the production of Management Plans for each River Basin District. River Basin Management Plans (RBMPs) summarise ongoing measures which seek to prevent the deterioration in status and improve the quality of the water environment. They aim to ensure that all aquatic ecosystems, riparian ecosystems and wetlands reach 'good status'. To achieve 'good status', a waterbody must be observed to be at a level of ecological and chemical quality.

At a local level, the report also identified partnership measures covering the study area which include the promotion of sustainable drainage systems in new developments and retrofitting existing sites within the catchment to reduce the impacts of urban diffuse pollution on flood risk and water quality.

Central Bedfordshire falls predominantly within the **Anglian River Basin District** and also within the **Thames River Basin District**. The River Basin Management Plans identified a number of pressures that have significantly altered and damaged the environment over the last few hundred years and major challenges to deal with. Priority issues in the Thames Basin include low flows in rivers, pollution from waste water and from rural and urban areas, and modifications, structures and changes to the natural form of rivers. In the Anglian Basin, priority issues include identifying physical modification of watercourses, invasive non-native plant and animal species (INNS) and pollution (diffuse and point source). A number of actions have been proposed to manage these issues. Further information can be found in the RBMP and the **Catchment Based Approach (CaBA) website**.

2.11 Localism Act

The **Localism Act** outlined plans to shift and re-distribute the balance of decision making from central government back to councils, communities and individuals. The Localism Act was given Royal Assent on 15 November 2011.

In relation to the planning of sustainable development, provision 110 of the Act places a duty to cooperate on Local Authorities. This duty requires Local Authorities to *"engage constructively, actively and on an ongoing basis in any process by means of which development plan documents are prepared so far as relating to a strategic matter"*[1].

The Localism Act also provides new rights to allow local communities to come together and shape new developments by preparing Neighbourhood Plans, Neighbouring Development Orders and Community Right to Build Orders. This means that local people can decide not only where new homes and businesses should go and but also what they should look like. As neighbourhoods draw up their proposals, Local Planning Authorities will be required to provide technical advice and support, as well as the Town or Parish Councils. Currently, twenty two **Neighbourhood Planning Areas** have been designated.

2.11.1 Local Plan and Local Strategy

The Central Bedfordshire Council Local Plan will set out the Council's vision on how the area will develop in the future, ensuring growth happens in a structured way. It will outline the principles that will guide future development. The updated SFRA will help inform the Local Plan.

The **Pre-Submission Development Strategy**, which is now **withdrawn**, previously set out the vision, objectives, spatial strategy and overarching policies to guide development in Central Bedfordshire to 2031. Adopted policy will be referred to in the SFRA, using the adopted Mid Beds Core Strategy and the South Beds Local Plan.

It has already been noted in section 2.2.4 that the Central Bedfordshire Council Local Flood Risk Management Strategy has been updated in 2016. Its messages are incorporated in this SFRA to reflect latest strategies in flood risk management.

2.11.2 Neighbouring Plans and Strategies

Other neighbouring authorities' plans and strategies may have an impact on Central Bedfordshire, and vice versa. For example, **Luton Borough's Surface Water Management Plan** (SWMP) identifies Critical Drainage Areas in areas which Central Bedfordshire's catchments drain into. These are considered in the Chapters focusing on cross-boundary issues and strategic flood risk solutions.

2.12 Insurance

2.12.1 Association of British Insurers Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England

The Association of British Insurers (ABI) and the National Flood Forum have published guidance for Local Authorities with regards to planning in flood risk areas[2]. The guidance aims to assist Local Authorities in England in producing local plans and dealing with planning applications in flood risk areas. The guidance complements the National Planning Policy Framework. The key recommendations from the guidance are:

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

1 Localism Act 2011: Section 110. http://www.legislation.gov.uk/ukpga/2011/20/section/110

2 Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England (Association of British Insurers and National Flood Forum, April 2012)

2.12.2 FloodRe

Flood Re went live in April 2016 and seeks to provide more widely available and affordable home and building contents insurance cover, for those properties deemed eligible under the scheme. Flood Re will only operate until 2039 and during those 25 years, the scheme will also offer a greater level of economic security for the insurance industry.

This government subsidy reduces some of the immediate pressures of flood insurance and the primary impact of this, in flood risk management terms, is that this re-insurance levy provides time for the Government, local authorities, insurers and residential homeowners to become better prepared for flooding.

More information on the FloodRe scheme can be found here: **http://www.floodre.co.uk/**.

2.13 United Kingdom exit from the European Union

On 23rd June 2016, the advisory referendum on whether the United Kingdom should remain a member of the European Union (EU) resulted in a majority vote in favour of leaving the EU. At the time of writing, HM Government had not published a timetable for invoking Article 50 of the Lisbon Treaty, which sets out the procedures for a member state leaving the EU. The intention of the UK to leave the EU, however, raises several areas of uncertainty which may impact upon the future applicability of this study, including:

- National and regional economic performance
- Migration and population change
- The future status of EU directives relating to water, for example the Water Framework Directive and the Habitats Directive.

Given these increased uncertainties, it becomes even more important that water companies, planners and regulators co-operate and share information, and to attempt to account for uncertainty in their planning.

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3 Applying the Sequential, risk-based approach and the Exception Test

3.1 What is the Sequential and Exception Test and why is it needed?

The NPPF states that Local Plans should be supported by an SFRA, and that LPAs should use SFRAs to steer development towards low probability of flooding areas by applying the Sequential Test and where necessary the Exception Test.

3.1.1 The Sequential Test and risk-based approach

The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. The Flood Zones remain the starting point for this sequential approach. It is important to note that the NPPF and PPG do not provide Flood Zone definitions for groundwater, sewer, surface water or artificial sources of flooding. However, it is important that flood risk from all sources is considered when carrying out the Sequential Test.

Within each Flood Zone, development should be directed to sites with lower flood risk from all sources, as indicated by the SFRA. A flow chart has been developed to demonstrate how to apply the Sequential Test to site allocations as part of the Local Plan, in Section 3.3.

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

The sequential approach can be applied both between and within Flood Zones.

It is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding, if there are no other suitable sites in areas of lower risk. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale and nature of the flood risks is required; this may require a more detailed hydraulic model as part of a site-specific Flood Risk Assessment to demonstrate whether or not the proposal is acceptable. For development adjacent to a watercourse that is not shown on the EA flood map for planning, modelling will be required to establish the risk from the watercourse and to inform the sequential approach.

Allied to the Sequential Test, NPPF also assigns different vulnerabilities to different types of development (NPPF Table 4-1). If when applying the Sequential Test development in the floodplain is necessary and satisfactorily justified, the LPA should also bear in mind the vulnerability classification of their proposed development to assess if it is appropriate in an area of flood risk (NPPF Table 4-3). Some developments may contain different elements of vulnerability and the highest vulnerability category should be used when applying the sequential test, unless the development is considered in its component parts.

3.1.2 Flood Zones

The **NPPF Guidance** identifies the following Flood Zones. These apply to both Main River and Ordinary Watercourses.

Table 3-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	**About this Zone**: This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		Permitted land use: All land uses are appropriate in this zone.
		Requirements: For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a Flood Risk Assessment.

Zone 2	Medium	**About this Zone:** This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Permitted land use: Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		Requirements: All developments in this zone require an FRA.
Zone 3a	High	**About this Zone:** This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year Developers and the local authorities should seek to reduce the overall level flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Permitted land use: Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		Requirements: All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	**About this Zone:** This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Permitted land use: Only water compatible (e.g. recreational and conservation uses) and essential infrastructure that have no viable alternative location are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere.
		Requirements: All developments in this zone require an FRA and the Exception Test must be passed for essential infrastructure developments to take place in this zone.

Important note on Flood Zone information in this SFRA

Appendix B:

The Flood Zones presented in Appendix B are the same as those shown on the Environment Agency's '**Flood Map for Planning**'.

The Environment Agency Flood Zones do not cover all catchments or ordinary watercourses. As a result, whilst the Environment Agency Flood Zones may show an area is in Flood Zone 1, it may be that there is actually a degree of flood risk from smaller watercourses not shown in the Flood Zones. Additional modelling may be required to demonstrate flood zones for an ordinary rosewater and that a development is appropriate.

Flood Zone 3b - The SFRA identifies this Flood Zone as land which would flood with an annual probability of 1 in 20 years; where detailed modelling exists, the 1 in 20-year flood extent has been used to represent Flood Zone 3b (provided by the Environment Agency). In the absence of detailed hydraulic model information, a precautionary approach has been adopted with the assumption that the extent of Flood Zone 3b would be equal to Flood Zone 3a (i.e. indicative extent of Flood Zone 3b). If development is shown to be in Flood Zone 3a, further work should be undertaken by the developer as part of a detailed site-specific Flood Risk Assessment to define the extent of Flood Zone 3b.

For the purpose of discussing flood risk, the term 'Flood Zones' hereafter, refers to Flood Zones 2/3.

3.1.3 The Exception Test

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding, the Exception Test must then be applied by the Local Planning Authority. These will require further work in a detailed Flood Risk Assessment (FRA).

The aim of the Exception Test is to ensure that more vulnerable property types, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. This is discussed further in Section 3.3. Any site that does not pass the Exception Test should not be allocated for development.

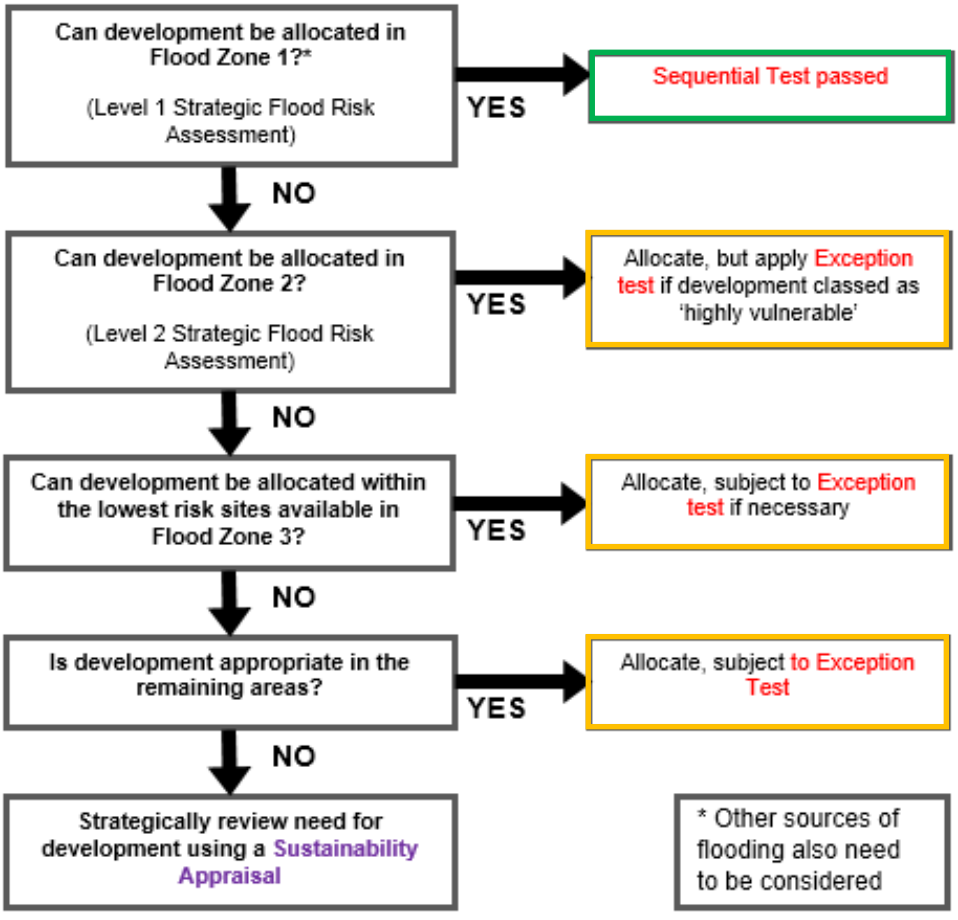
3.2 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a Local Plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using SFRAs to apply the Sequential and Exception Tests where necessary.

The development must be appropriate for the Flood Zone in order to proceed to the Sequential or the Exception Test. The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal, or alternatively, it can be demonstrated through a free-standing document or as part of Strategic Housing Land or Employment Land Availability Assessments (SHLAA or SHELAA).

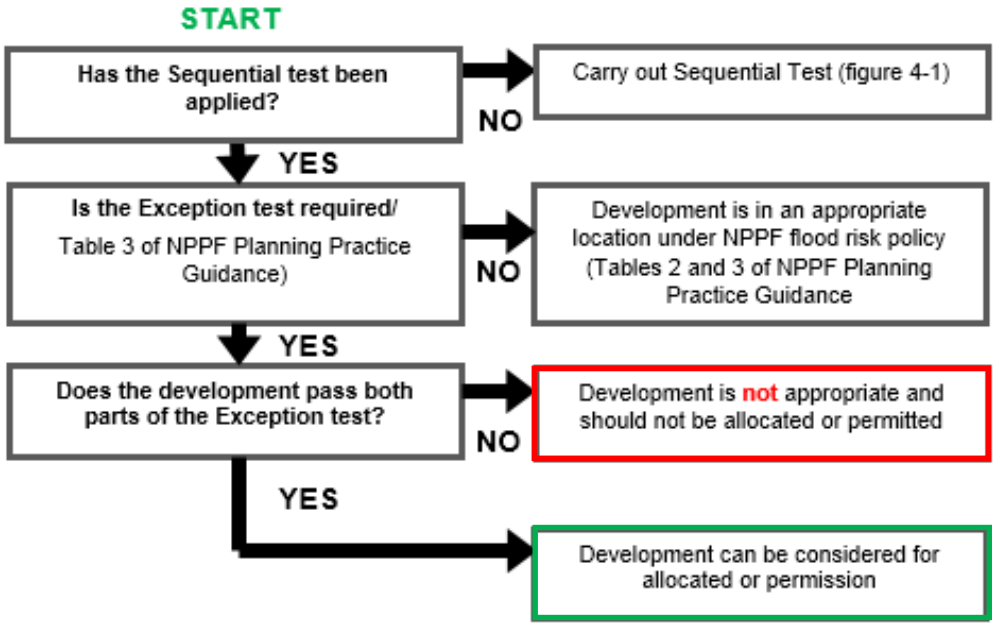
NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan.

Figure 3-1: Applying the Sequential Test in the preparation of a Local Plan



The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. The NPPF PPG describes how the Exception Test should be applied in the preparation of a Local Plan.

Figure 3-2: Applying the Exception Test in the preparation of a Local Plan



3.2.1 How should the SFRA be used to apply the Sequential Test?

Central Bedfordshire Council should use the information presented in this Level 1 SFRA to undertake the Sequential Test. The Sequential Test should be accurately documented to ensure that the decision processes followed for the locating of a development are consistent and transparent.

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. Central Bedfordshire Council should then promote sites accordingly, based on those at least risk of flooding and appropriate land uses.

It is recognised that flood risk information must be considered alongside other spatial planning issues. Allocations are thus "tested" on the basis of their flood risk attributes and the outcome used to inform decisions that include other spatial planning issues, such as transport, housing, economic growth, natural resources, regeneration, biodiversity, the historic environment and management of other hazards.

When applying the Test it will be important for Central Bedfordshire Council to demonstrate that:

- A transparent process has been formulated and followed;
- This process has sought to steer new development to areas with the lowest probability of flooding (according to Table 1 of PPG); and
- Full consideration has been given to reasonably available alternatives on land with a lower probability of flooding.

Chapter 4 discusses Shortlisted Site Allocations and the process undertaken for the screening and filtering of sites and how a sequential approach to site allocations has been adopted by Central Bedfordshire Council.

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

3.3.1 Sequential Test

A sequential approach should be applied at all stages of planning, including windfall sites, redevelopment opportunities as well as major developments.
Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine

the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other Local Plan policies. A pragmatic approach should be taken when applying the Sequential Test.

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

Some developments may contain different elements of vulnerability and the highest vulnerability category should be used when applying the Sequential Test, unless the development is considered in its component parts.
The Sequential Test does not need to be applied for individual developments under the following circumstances:

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

Where an individual site lies within Flood Zone 1, it will be necessary to state this in order to satisfy the requirements of the Sequential Test. Consideration should also be given to risks from all sources, areas with critical drainage problems and critical drainage areas.

3.3.2 Exception Text

For the Exception Test to be satisfied, both of the following elements have to be accepted for development to be allocated or permitted:

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

   Local Planning Authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied, and give advice to enable applicants to provide evidence to demonstrate that it has been passed. For example, if a potential site allocation fails to score positively against the aims and objectives of the sustainability appraisal, or is not otherwise capable of demonstrating sustainability benefits. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[3].

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

   The site-specific Flood Risk Assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. In terms of lifetime of a development, a 60-year design life for non-residential development plans should be used as a guide, with residential development considered for a minimum of 100-year design life unless there is specific justification for considering a shorter period. Developers would be expected to justify why they have adopted a given lifetime for the development when preparing a site-specific Flood Risk Assessment.

   The level of “safety” will vary depending on the vulnerability of the community affected. More vulnerable residents will potentially be more severely affected by the consequences of flooding and levels of safety should be commensurate with the risk.

   The following should be considered at a minimum[4]:

   - The design of any flood defence infrastructure
   - Access and egress
   - Operation and maintenance

3 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014
4 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014

- Design of the development to manage and reduce flood risk wherever possible
- Resident awareness
- Flood warning and evacuation procedures
- Any funding arrangements required for implementing measures.

The above points should be clarified and agreed between the Local Planning Authority and the Environment Agency, and may require additional considerations depending on the precise nature of the proposed development and flood risk on a site by site basis.

The NPPF and Technical Guidance provide detailed information on how the Test can be applied.

3.4 Considering actual and residual flood risk

3.4.1 Actual flood risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of formal flood defences and provides a picture of the safety of existing and proposed development.

The standard of protection afforded by flood defences is not constant, the presumed that the required minimum standards for new development are:

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

An assessment of actual risk is needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

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

- The level of protection afforded by existing defences might be less than the appropriate standards and may need to be improved if further growth is to be delivered.
- The flood risk management policy for the defences will provide information on future commitments to maintain existing standards of protection.
- The standard of safety of defences must be maintained for the intended lifetime of the development. Over time, the effects of climate change will erode the present-day standard of protection and commitment is needed by the defence owner to invest in the maintenance and upgrade of defences if the present-day levels of protection are to be maintained and, where necessary, land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk should include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources.

3.4.2 Residual flood risk

Residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding to make a development appropriate (such as flood defences). It applies to fluvial and all other sources of flooding. It is important that residual risks are quantified in a Flood Risk Assessment to confirm that the consequences can be safely managed and to identify the necessary flood mitigation measures.

Chapter 7 considers this risk in more detail.

4 Sites submitted for allocation

4.1 Overview

The following section sets out Central Bedfordshire Council's current policy stance and outlines the process of screening the sites submitted for housing, employment or gypsy and traveller allocation to determine which of those sites which should be taken forward to a Level 2 SFRA assessment.

4.2 Local Plan

Until the new Local Plan is published, adopted policy is set out in the Adopted Core Strategy for the former Mid Bedfordshire area and the adopted Local Plan for the former South Bedfordshire area. At the time of preparing this SFRA, Central Bedfordshire Council were in the process of compiling a new Local Plan aimed at shaping future development. The Local Development Scheme has been used as the plan-making programme for the Local Plan, approved for publication on 25th February 2016.

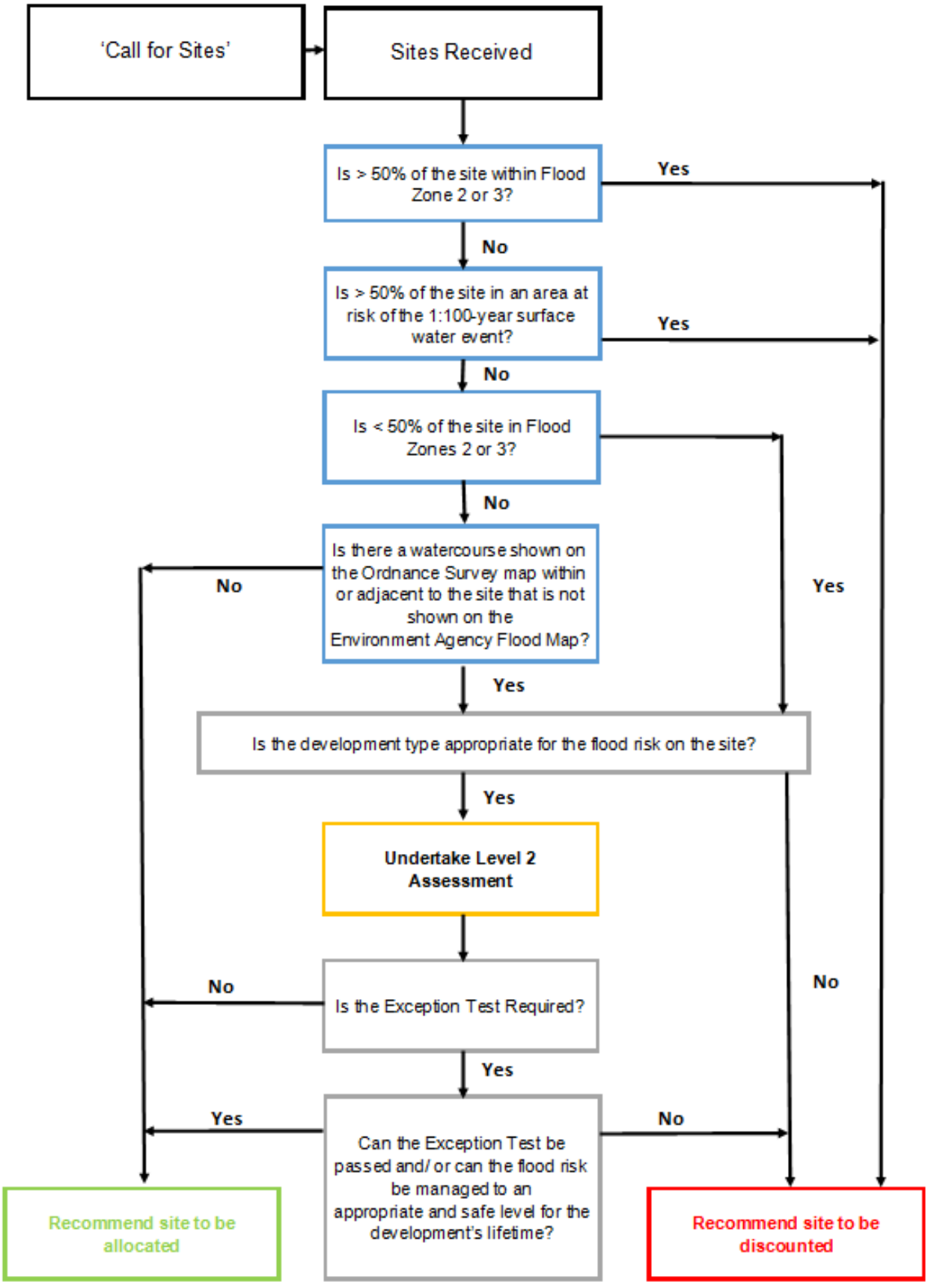
The new Local Plan will replace these previously adopted documents which will contain up to date policies in it, reflecting current guidance. This SFRA will be used as an evidence base, to support the production of the new Local Plan and inform the Council's policies in relation to development and flood risk.

4.3 Site screening methodology and sequential approach

4.3.1 Methodology

A summary flow chart of the site allocation screening process is presented in Figure 4-1 below.

Figure 4-1: Site allocation screening process



4.3.2 Site screening process on **all sites** received from the 'Call for Sites' process

NPPF acknowledges that some areas will be at risk of flooding from sources other than fluvial. Consequently, all sources of flooding must be considered when looking to locate new development. The sources of flooding considered by Central Bedfordshire Council when situating new development allocations include:

- Surface Water / Overland Flow
- Groundwater
- Sewers, and
- Artificial Sources.

Following Central Bedfordshire Council's 'Call for Sites' process, the total number of sites received were screened against flood risk information to provide a summary of flood risk to each site. This screening helps identify sites which may require a Level 2 assessment, and where additional modelling would be required as part of the Level 2 SFRA assessment.

The site screening table therefore assesses the proportion of each site in the following flood risk datasets:

- The proportion of the site in each Flood Zone
- Whether the site is shown to be at risk in the uFMfSW and, if so, the lowest return period from which the site is at risk
- Whether the site is within, or partially within, the Environment Agency's Historic Flood Map
- Whether the site is within, or partially within, the Environment Agency's Reservoir Inundation Map.

Groundwater has not been included because the AStGWF map consists of very large (coarse resolution) squares which relate to a banding of susceptibility, rather than a flood risk percentage.

The screening table also includes information on the NPPF development vulnerability classification, whether the Exception Test would be required, the number of properties in the developable area as well as next step recommendations.

The screening table operates a red/ amber/ green (RAG) system to identify recommendations from the outcomes. Initial recommendations were as follows:

Table 4-1: 'All sites' screening initial recommendations

Initial Recommendation	Criteria
Reject - More than 50% of the site is at surface water flood risk	Based on Central Bedfordshire Council's Stage 1 criteria of more than 50% of the site at risk from surface water flood risk.
Reject - More than 50% of the site is at fluvial flood risk	Based on Central Bedfordshire Council's Stage 1 criteria of more than 50% of the site at risk from fluvial flood risk. These sites are rejected for allocation.
Level 2 assessment required	If a site is located in Flood Zones 2 or 3 >0%<50%, but this does not mean the site is rejected – it requires further investigation as part of a Level 2 assessment
Provisionally no Level 2 assessment required – check OS mapping for Ordinary Watercourses	This is where the site may be shown to be 100% in Flood Zone 1 (hence 'provisionally no Level 2 assessment required'); however, on OS Mapping it is shown that there is a watercourse or drain intersecting the site, which has not been considered in the Flood Map for Planning. These sites are therefore highlighted as requiring a check against the OS Mapping to determine whether a Level 2 assessment would be required to establish the risk. Jflow (2D hydraulic modelling) would be required to provide an indication of flood risk to the site.
Site is at limited risk of surface water flooding, assessment is unlikely	This is where a site is not in the fluvial Flood Zones and has low surface water risk in the 100yr event >0%<50%. No Level 2 assessment is required.

These sites were then screened against the Council's technical site assessment criteria for the site allocations, as part of the Central Bedfordshire Council Stage 1 assessment, which produced a filtered list of 'pass' sites from the total number of sites.

4.3.3 Sequential Testing on all sites which have **passed** the Council's Stage 1 Assessment

Inclusion of sites in the SFRA does not mean that development can be permitted without further consideration of the Sequential Test. The required evidence should be prepared as part of a Local Plan Sustainability Appraisal or alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments (SHLAA).

The screening exercise provided a summary count from the filtered 'pass' sites, passed by Central Bedfordshire Council's Stage 1 Assessment, of how many sites need a Level 2 assessment, how many 'may' need a Level 2 assessment, and how many do not require a Level 2 assessment. The results of the screening will be reported by Central Bedfordshire Council.

The filtered 'pass' sites RAG summary provides an indication of the number of dwellings able to be allocated in the site's developable areas, based on the aim that a sequential approach to site allocations is adopted, whereby all the greens will be filled first (sites not at flood risk/ lowest risk), followed by amber then red, to reduce the number of sites allocated in areas of flood risk and subsequently requiring Level 2 assessments. *If a site is 'red' and deemed to require a Level 2 assessment, this does not mean the site cannot be allocated or developed; it means further investigation of flood risk is required in order to help understand site opportunities and constraints and to provide information required to pass the Exception Test, if required.*

The Sequential Approach Summary for all the Stage 1 'Pass' sites are as follows:

Table 4-2: Pass sites recommendations

Initial Recommendation	Criteria
Level 2 assessment required	Fluvial flood risk (Flood Zones 2/3) is >0%<50%, therefore a Level 2 assessment is required to consider flood risk to the site in further detail.
OW present, JFlow modelling required to confirm flood risk	The key difference here is that, the green and amber sites from the overall site screening recommendations in Table 4-1 identified an ordinary watercourse present from the OS Mapping check and therefore Jflow modelling will be required to confirm the flood risk to the site, to determine whether a Level 2 assessment is required.
Site is at limited risk of surface water flooding, assessment is unlikely	This is where surface water flood risk in the 100yr event (including 30yr) is >0%<50%. No Level 2 assessment is required.

4.4 Level 2 assessment

Following the sequential assessment of sites by Central Bedfordshire Council, where the remaining sites requiring further consideration are shown to be in either Flood Zone 2 and/or 3, and/ or has an ordinary watercourse running through or adjacent to it, the flood risk to the site will be assessed and summarised in more detail in a series of summary tables as part of the Level 2 SFRA.

A Level 2 SFRA assessment of sites helps to determine variations in flood risk, identifying site-specific FRA requirements and helping guide local policies to provide sustainable developments as well as reducing flood risk to existing communities.

JFlow modelling will be undertaken for the sites which showed an ordinary watercourse running through/ adjacent to the site, but which had not been already considered by the Environment Agency. This is to provide the greater level of detail required for the Level 2 assessment.

5 Taking account of the impact of climate change

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050 and to put in place measures to adapt to climate change. Central Bedfordshire Council published its first Climate Change Strategy in 2010 which details how climate change issues will be addressed, the Councils ambitions and drivers for action.

On a national level, the Government published a UK Climate Change Risk Assessment in 2012, which was based on evidence studies including the UK Climate Projections published in 2009 (UKCP09). Central Bedfordshire undertook a local Climate Change Risk Assessment in 2012, following actions identified in the Climate Change Strategy; this identified flooding and water resources as some of the impacts likely to affect Central Bedfordshire.

5.1 Revised Climate Change Guidance

The Environment Agency published **updated climate change guidance** on 19 February 2016, which must now be considered in all new developments and planning applications. The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice. The LLFA should be contacted for advice on flood risk from local watercourses, surface, or groundwater.

5.2 Peak River Flows

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

These allowances (increases) are provided for three climate change 'epochs':

- Total potential change anticipated for '2020s' (2015 to 2039)
- Total potential change anticipated for '2050s' (2040 to 2069)
- Total potential change anticipated for '2080s' (2070 to 2115)

One or two of the percentiles are provided for each combination of vulnerability and flood zone, which in the latter case provides a 'range' of allowances. The peak river flow allowances show the anticipated changes to peak flow by river basin district, for three future epochs and percentiles, as shown in Table 5-1.

Table 5-1: Peak river flow allowances by river basin district

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%
Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%

5.2.1 High++ allowances

High++ allowances only apply in assessments for developments that are very sensitive to flood risk and that have lifetimes beyond the end of the century. Further information is provided in the Environment Agency publication, **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities**.

5.2.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. The guidance states the following

Flood Zone 2

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

Flood Zone 3a

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

Flood Zone 3b

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

5.3 Peak rainfall intensity allowance

Increased rainfall affects river levels and land and urban drainage systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments.

For Flood Risk Assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Table 5-2: Peak rainfall intensity allowance in small and urban catchments

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

5.4 Using climate change allowances

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

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

Worked Example:

Proposal: Residential
Lifetime: 100-years
Vulnerability: 'More Vulnerable'
Flood Zone: 2
Developer/ Applicant Action:
Fluvial - Apply the Central and Higher Central '2080s' allowances to the 100-year return period event (i.e. +25% and +35%).
Rainfall - Apply the Central and Upper End '2080s' allowances to the 100-year return period event (i.e. +20% and +40%).

5.5 Previous climate change studies

5.5.1 Climate Change Adaptation Evidence Base

The Central Bedfordshire Climate Change Adaptation Evidence Base report (2012)[5] states that the climate change impacts most likely to affect Central Bedfordshire the most are:

- Flooding:
  - More than 5,000 homes and 200,000m^2 of commercial floor space are located in Flood Zone 2; almost half of these buildings are also within Flood Zone 3.
  - Fluvial: Indications that a 1 in 100 event is expected to occur 1 in 63 years in the 2050s and 1 in 48 years in the 2080s.
  - 9% of all homes and 34% of all commercial floor space are in areas that are susceptible of surface water flooding.
  - Surface water: Indications that a 1 in 30-year event is expected to occur 1 in 18 years in the 2050s and 1 in 14 years in the 2080s.
- Water resources:
  - At the time of the study, parts of Central Bedfordshire were officially in a drought since 2011 and were at high risk to continue into 2012.
  - Long term projections of water availability indicate a reduction in deployable output of 30% by the 2080s leading to a deficit in water supplies.
  - Water resources are likely to be at deficit in 2050s or even in 2020s under the central scenario, projecting a reduction in deployable output of 30% by the 2080s. When this is taken into account, Anglian Water's current 8% water surplus changes into a 28% deficit in the 2050s, rising to 38% in the 2080s'
- Overheating
- Subsidence
- Risks to the Natural environment

5 http://www.centralbedfordshire.gov.uk/Images/lccr_tcm3-13257.pdf

5.6 The impact of climate change in Central Bedfordshire

The types of climate change impact relevant to Central Bedfordshire are:

- Milder wetter winters
- Hotter drier summers
- Increased rainfall intensity in summer months
- Flashier catchment/site responses and surcharging of piped systems and flooding as a result of poor capacity of structures is expected to increase
- Pressure on existing sewer systems effectively reducing their design standard, leading to more frequent flooding
- The prospect of droughts may increase/water resource shortages

The effect tends to be an increase in the mapped flood extent. Smaller watercourses in the study area tend to be in areas of steeper topography with quite confined floodplains, and in these cases increases in flow do not result in a significant increase in flood extent.

It is important to remember that even where flood extent may not significantly increase, flooding is likely to become more frequent under a climate change scenario. For example, what is currently an event with a 2% probability of occurring in any one year, may increase to say a 5% probability under climate change.

The impact of an event with a given probability is also likely to become more severe. For example, as water depths, velocities and flood hazard increase, so will the risk to people and property. Although qualitative statements can be made as to whether extreme events are likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of the localised impact of these changes.

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

Climate change mapping has been provided in Appendix C, showing areas at future flood risk.

Important note on Climate Change mapping in this SFRA (Appendix C)

For this SFRA update, the existing hydraulic models provided by the Environment Agency (River Ivel and tributaries, Upper and Middle Ouse) were re-run for climate change scenarios to account for the new climate change guidance.

Three scenarios were modelled to reflect the three climate change allowances for the '2080s' timeframe in the Anglian River Basin District, therefore the 100-year plus 25%, 35% and 65%. None of the existing models fell into the Thames River Basin District. The climate change mapping reflects the defended scenario.

Where no detailed hydraulic models are present, Jflow modelling (2D generalised modelling) was undertaken for all watercourses covered by existing CFMP Jflow coverage (but outside of detailed model coverage).

This modelling was undertaken to assist the Council with the preparation of their Local Plan. Developers will need to undertake a more detailed assessment of climate change as part of the planning application process when preparing FRAs.

Adaptation to climate change requires near-term decisions to have regard for the long-term lifespan of buildings and infrastructure, which may include exploiting opportunities to adapt existing built areas, for example by increasing green spaces.

It is recommended that the impact of climate change on a proposed site is considered as part of a detailed Flood Risk Assessment, using the percentage increases which relate to the proposed lifetime and the vulnerability classification of the development. The Environment Agency should be consulted to provide further advice for developers on how best to apply the new climate change guidance.

6 Summary of SFRA mapping for all sources of flood risk and methodology

6.1 Suite of maps to support the SFRA

Mapping of flood risk for the Central Bedfordshire area can be found in the appendices to this SFRA and is presented in the following structure:

- Appendix A: Watercourses in Central Bedfordshire
- Appendix B: Environment Agency Flood Zone Mapping, including functional floodplain
- Appendix C: Climate Change Mapping
- Appendix D: Surface Water Mapping
- Appendix E: Areas susceptible to groundwater flood risk
- Appendix F: Flood warning coverage
- Appendix G: Groundwater source protection zone
- Appendix H: Flooding from artificial sources

6.2 Data used to inform the SFRA

Table 6-1 provides an overview of the supplied data, used to inform the appraisal of flood risk for Central Bedfordshire.

Table 6-1: Overview of supplied data for Central Bedfordshire SFRA

Source of flood risk	Data used to inform the assessment	Data Supplied By
Historic (all sources)	Historic Flood Map and Recorded Flood Outlines Central Bedfordshire Council flooded properties spreadsheet	Environment Agency
	Historic flooding GIS shapefile	Bedford Group of IDBs
	2008 SFRAs	Central Bedfordshire Council (LLFA)
	2011 PFRA Section 19. Flood Investigation Reports	
	Historic flood incidents / records	Central Bedfordshire Council - Highways and LLFA, Canal and River Trust Fire and Rescue Bedford Group of IDBs
	Flood Management System	Thames Water, Anglian Water, Affinity Water
Fluvial (including climate change)	River Ivel Model (including River Ivel, Flit, Potton Brook and Barton le Clay), Capita Symonds, 2011 – flood zone mapping and basis for climate change runs Upper River Great Ouse – Broadscale, Lower and Upper models and flood mapping (Capita Symonds, 2011) Mid Great Ouse Flood Mapping Study – models and flood mapping (Halcrow, 2011); includes nine hydraulic models Lower Ouse – only hydraulic models provided, no reporting. Includes seven hydraulic models.	Environment Agency
Surface water	updated Flood Map for Surface Water	Environment Agency
	Reported flood incident data	Central Bedfordshire Council

Source of flood risk	Data used to inform the assessment	Data Supplied By
		Highways
Groundwater	Areas Susceptible to Groundwater flooding Bedrock geology / superficial deposits maps	Environment Agency (Geostore)
Sewer	Flood Management System	Thames Water, Anglian Water, Affinity Water
Reservoir	National Inundation Reservoir Mapping	Central Bedfordshire Council
Canal	GIS Data showing incidents of overtopping	Canal and River Trust

6.2.1 Surface Water

Mapping of surface water flood risk in Central Bedfordshire has been taken from the **updated Flood Map for Surface Water (uFMfSW)** published online by the Environment Agency. This information is based on a national scale map identifying those areas where surface water flooding poses a risk. Surface water flood risk is subdivided into the following four categories:

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

6.2.2 Groundwater

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

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

6.2.3 Sewers

Historical incidents of flooding are detailed by Anglian Water, Thames Water and Affinity Water through their Flood Management System. The Flood Management System is an online database system which holds records of all flooding incidents reported as 'overloaded' as well as investigating the results. The Flood Management System relates to properties and areas that have suffered or are likely to suffer flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant period. There are 3 at risk reporting categories: '1 in 20 year', '1 in 10 year' and '2 in 10 year'. The reporting category reflects the frequency of flooding incidents in properties/areas and not the return period of the storm that causes the flooding. For confidentiality reasons this data has been supplied on a postcode basis.

The Flood Management System supersedes the DG5 'at risk' register spreadsheet as well as the DG5 preliminary register spreadsheet.

6.2.4 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been identified from the Environment Agency's **'What's in Your Backyard website'**.

6.2.5 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. The Planning Framework and Flood Risk Policy chapter includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to this study.

6.3 Review of existing modelling and data gaps

A review of the supplied data has indicated potential further assessment or data gaps, which could be facilitated through flood modelling. Recommendations for Central Bedfordshire Council have been made for more detailed modelling work, which would provide a greater level of flood risk information and more confidence in results. It is anticipated this modelling could be undertaken by developers as part of site-specific assessments, or by consultants on behalf of the Council where a study is deemed required by the Council. This review has been undertaken by reviewing the Environment Agency's Flood Zone mapping in those areas not covered by existing detailed hydraulic models:

1. The Environment Agency's Flood Zone maps do not cover every watercourse (for example if <3km^2 catchment area), or Ordinary Watercourses. Hydraulic modelling may be required for more detailed Flood Risk Assessment studies, or following on from Section 19 reports, or as part of the Level 2 SFRA, to provide the required detail to support a site's development. If a watercourse or drain is shown on OS mapping but is not covered by a Flood Zone, this does not mean there is no potential flood risk. A model would be required at detailed site-specific level to confirm the flood risk to the site.
2. Most of the settlements deemed to be at fluvial flood risk are covered by either the River Ivel (or its tributaries) model or the Upper/ Middle Ouse models. The locations identified which lie outside of detailed model extents, but which the Flood Zones show properties at flood risk, are: Ickwell Green (on a tributary of the River Ivel), and south-east Leighton Buzzard (a tributary of the Ouzel) in the vicinity of the Cherrycourt Way Industrial Estate. A tributary of the River Lee at Houghton Regis also presents flood risks to properties.
3. The Bedford Group of Internal Drainage Boards use the Environment Agency's Flood Zone maps and the updated Flood Map for Surface Water to assess flood risk; however, it has been noted in the past that some of these flood extents have been challenged in places, and the Environment Agency's protocol for updating Flood Zone maps is for Main Rivers and not Ordinary Watercourses. If deemed required by the IDB or Central Bedfordshire Council, the IDB watercourses could prove to be candidates for further modelling work or investigation.
4. Any existing hydraulic models which are 1D-only could be upgraded in future to 1D-2D hydraulic models, if it is deemed necessary (for example if properties are at flood risk or a flood event has occurred and more detailed information is required). This would provide a greater level of floodplain flood risk information, for example depths, velocity and hazard in the floodplain.
5. There is currently limited hydraulic modelling available in the Elstow Brook catchment; the IDB's modelled extents do not extend as far as Brogborough Lake and its associated drainage channels, so this provides an opportunity for work in the future to provide analysis on the 'linking of the lakes concept' in order to establish how attenuation could be provided using this in the future (See Chapter 14: Strategic Flood Risk Solutions).
6. There is uncertainty surrounding if and how surface water volume storage for Stewartby Lake can be achieved practically, given known challenges with the current effectiveness of the IDB-managed sluice gate and implementation of the (historic) water-level management plan for the Lake. It is recommended that further work is undertaken to ensure a more comprehensive understanding of how this functions, its limitations and the constraining factors.
7. Locations where surface water flooding is the predominant flood risk, could be investigated further by use of surface water hydraulic modelling, or in combination with fluvial modelling, to assess the interactions between the two in more detail. Similarly, for any locations which suffer from sewer flooding or sewer capacity issues; this data can be incorporated into hydraulic models to more accurately represent the surface water system.

Further, water and sewerage company assets could be represented in hydraulic models to develop an integrated model that accounts for the capacity of the sewer network.

8. At site-specific level, any developments shown to be at residual flood risk, for example from a breach or overtopping (e.g. reservoir, canal, perched watercourse), should undergo detailed hydraulic modelling using Environment Agency guidance.

7 Understanding flood risk in Central Bedfordshire

7.1 Topography, geology and hydrology

7.1.1 Characteristics of Central Bedfordshire

Central Bedfordshire is the 18th largest unitary authority in England and covers an area of approximately 716km^2 with a population of approximately 255,200. Central Bedfordshire is predominately rural with the two largest towns, Leighton Buzzard and Dunstable, in the south. The north of the district comprises a series of smaller towns including Sandy and Flitwick.

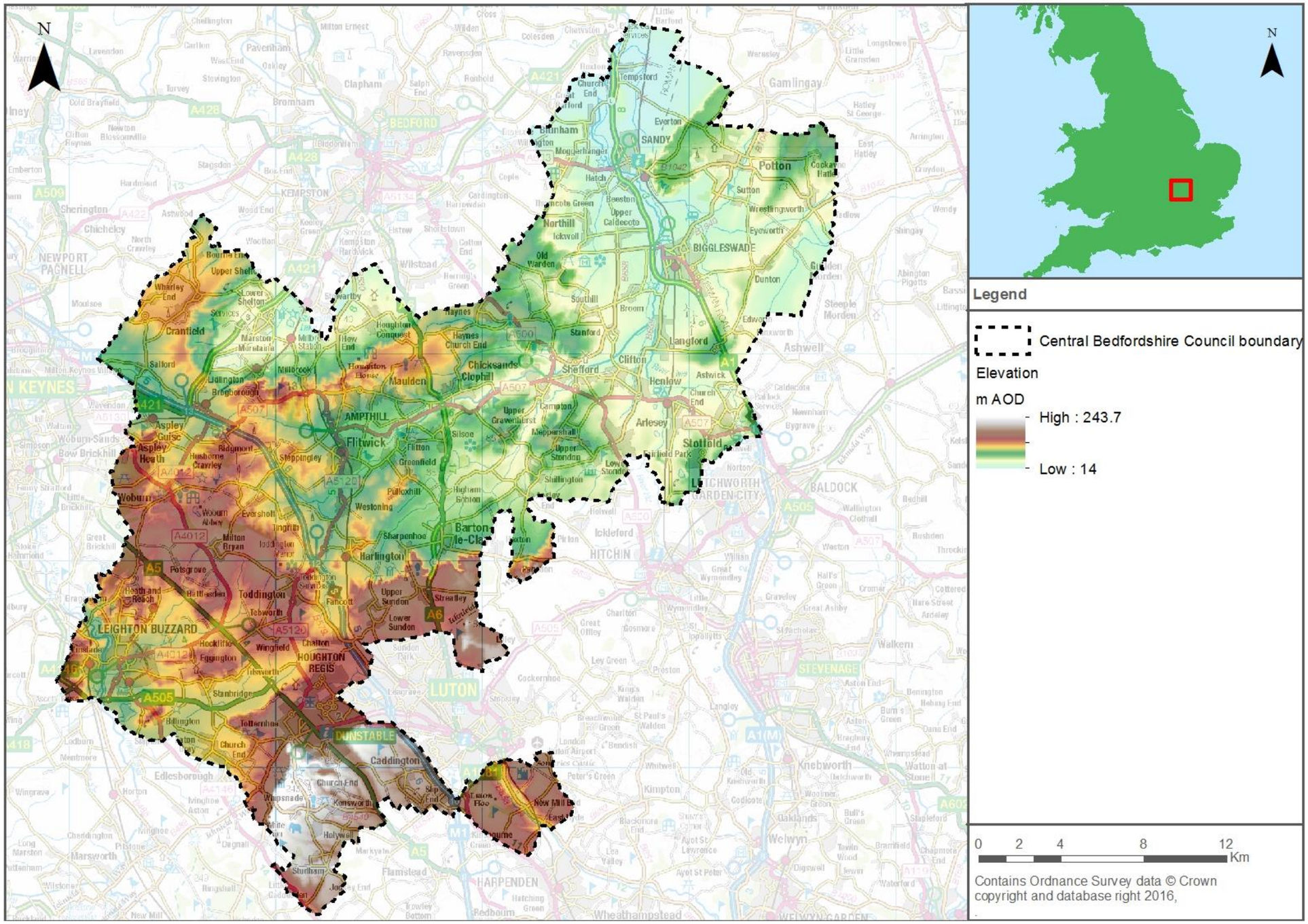
The majority of the land in Central Bedfordshire drains to the catchment of the River Great Ouse, which discharges to the sea in The Wash. A small area of land at the south of Central Bedfordshire drains to the catchment of the River Lee, which discharges to the Thames Estuary upstream of the Thames Barrage.

7.1.2 Topography

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

The topography of Central Bedfordshire is primarily configured of high ground in the west, with the highest elevations and steepest slopes in the south-west around Dunstable, reaching over 240m AOD. High ground with relatively gradual slopes lies in a corridor between the A5 and the M1 and steep slopes to high ground surrounds Marston Moretaine, extending to Clophill. Steeper slopes can reduce the amount of infiltration into the ground, transferring water quickly as overland flow to the watercourse. This can reduce the time to peak flood levels and possibly increase the maximum water level relative to more gradual slopes, where the shallow relief encourages water to infiltrate. Lower lying land correlates with the main watercourse of the district, the River Ivel and its tributaries, through Biggleswade, Sandy and Tempsford out to north-east corner of the district. Much of this flood risk in these low-lying areas are governed by Internal Drainage Boards. Very flat low-lying land, such as that along the River Ivel corridor, can increase flood risk as only a small amount of flooding can impact a large area, due to the wide and flat floodplain extents. The topography of Central Bedfordshire can be seen in Figure 7-1.

Figure 7-1: Topography of Central Bedfordshire



7.1.3 Geology and soils

The geology of the catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

The bedrock in Central Bedfordshire consists of alternating permeable (Principal) and impermeable (Unproductive) strata layers. The overlaying superficial deposits of the catchment are predominantly permeable (Secondary A and Secondary B undifferentiated) with impermeable deposits (Unproductive) overlaying the high ground to the south. Figure 7-2 shows the bedrock (solid permeable) formations in the district and Figure 7-3 shows the superficial (permeable, unconsolidated loose) deposits.

Principal bedrock are layers of rock with high permeability and provide a high level of water storage. These layers roughly follow the path of the major watercourses in the area, lying north of the River Flit, east of the River Ivel and along the River Ouzel and are associated with sandstone and mudstone. This layer provides some of the major settlements in Central Bedfordshire with high levels of water storage and potentially lower levels of surface water runoff. Principal bedrock can also be found in the south of the district, under the major settlements of Dunstable and Stotfold and is associated with chalk. In particular, areas underlain by Principal bedrock geology may be vulnerable to groundwater flooding. The bedrock geology is predominantly sedimentary and therefore the type of groundwater flooding in the central areas is more likely to be associated with shallow unconsolidated sedimentary aquifers, which overlay non-aquifers, rather than 'clearwater flooding', which is associated the chalk bedrock of the south. Such bedrock tends to mean that groundwater levels are often close to the ground surface during much of the year and are responsive to rainfall events.

The predominantly rural northern and central areas, south of the River Flit, is underlain with unproductive bedrock, which are rock layers and drift deposits with low permeability which impede drainage and therefore have negligible significant for water supply or river baseflow. Outcrops of unproductive superficial deposits, rock layers and drift deposits with low permeability which therefore have little interaction with groundwater can be found over the high ground south of Dunstable. The lower permeability of the bedrock will result in higher runoff than in the areas underlain by permeable deposits.

The **British Geological Survey** provides further information on the nature of groundwater flooding on their website.

Figure 7-2: Bedrock formations for Central Bedfordshire

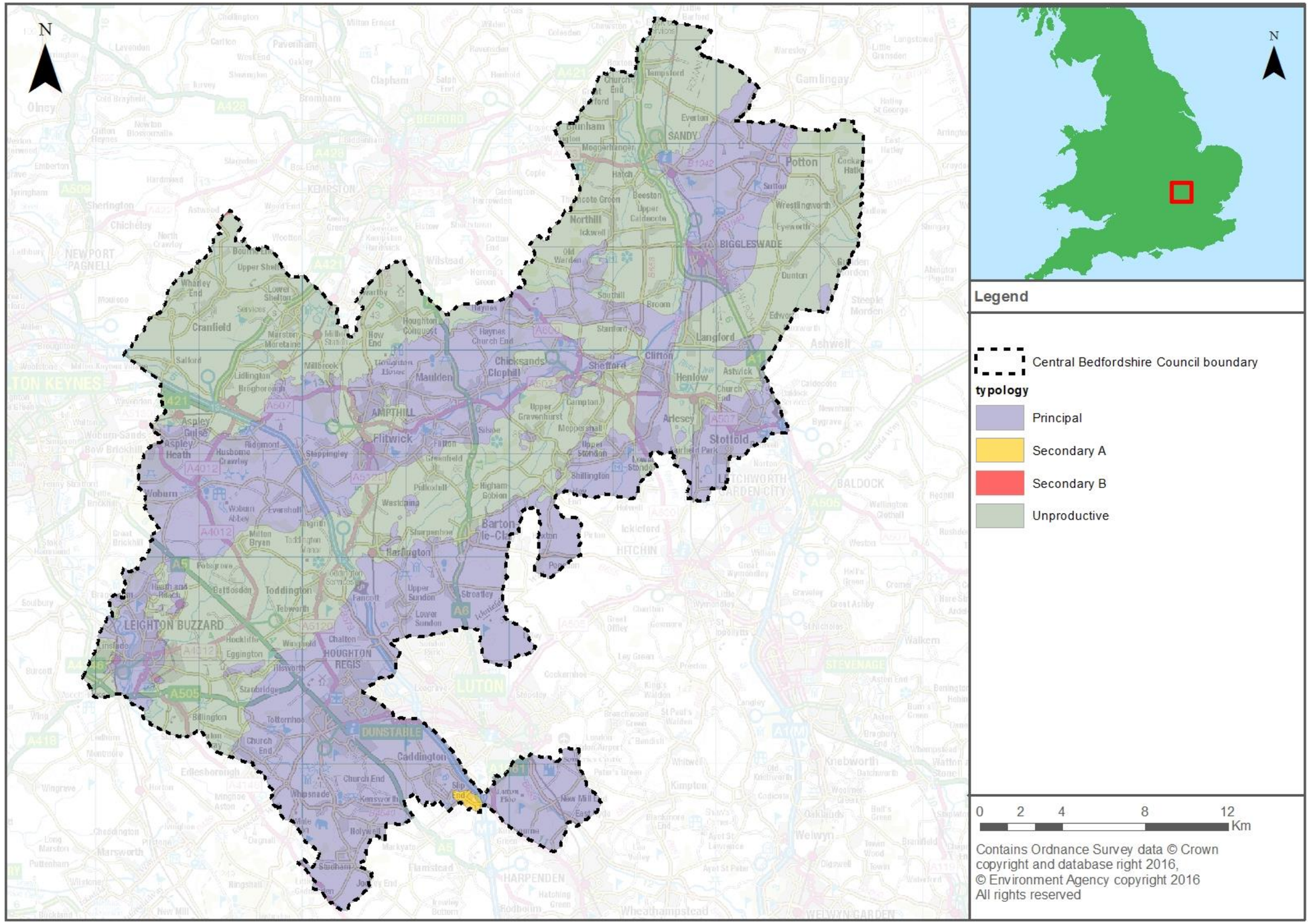
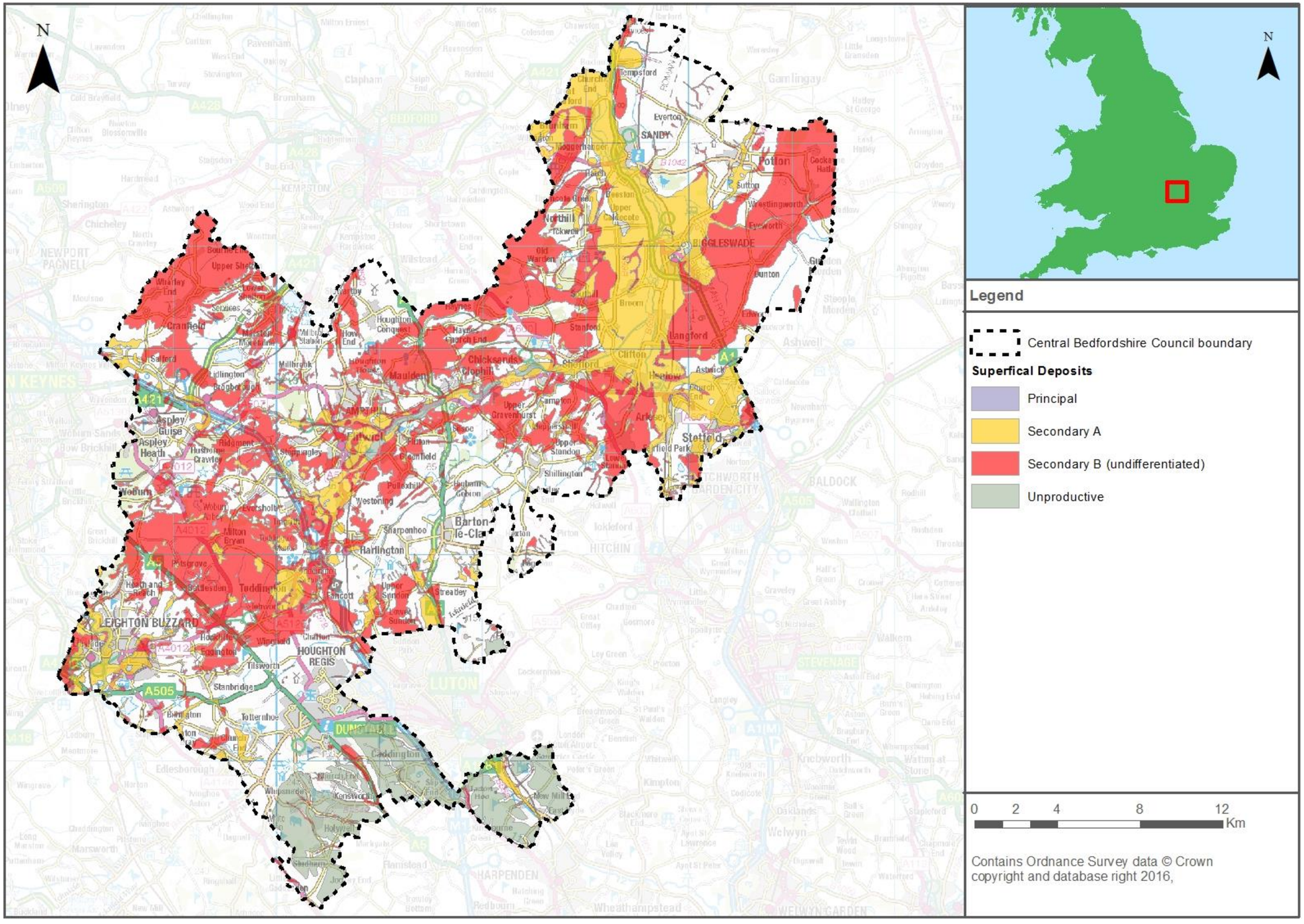


Figure 7-3: Superficial deposits in Central Bedfordshire



7.1.4 Hydrology

The key watercourses and their tributaries flowing through the SFRA area are presented in Table 7-1. Tributaries of these watercourses include smaller ordinary watercourses and numerous unnamed drains. Mapping indicating the location of the key watercourses can be found in Appendix A.

Table 7-1: Description of watercourses in the study area

Watercourse name	Classification	Description
Cat Ditch	Ordinary watercourse	The Cat Ditch enters the eastern part of the study area, north of Stotfold and flows in an easterly direction out of the county. A small 500m section of the Cat Ditch lies in Central Bedfordshire before it joins the River Ivel in Astwick
Clipstone Brook	Main River/ Ordinary watercourse	The Clipstone Brook is located in Leighton Buzzard, in the western extent of the study area. The Brook is classed as Main River at the outskirts of Leighton Buzzard north of Leighton Road and flows in a south-westerly direction, into the River Ouzel. Upstream of Leighton Buzzard, Clipstone Brook is classed as an Ordinary Watercourse for nearly one kilometre.
River Flit	Main River / Ordinary watercourse	The River Flit runs from its source in Charlton in a north-easterly direction until its confluence with the Rivers Hit and River Ivel Navigation. There are a number of drainage channels that adjoin the River Flit channel before it becomes a Main River west of Shefford (TL 14038 39161).
River Gade	Main River/ Ordinary watercourse	The River Gade is located in the southern part of the study area, roughly following the Hemel Hempstead road and is named and classified as Main River as it crosses the district boundary south-west of Little Gaddesden (TL 01885 12989).
Grand Union Canal	Canal	Grand Union Canal flows north through Leighton Buzzard following the path of the River Ouzel.
River Great Ouse and backwaters	Main River	The River Great Ouse and backwaters is located at the most northern boundary of the district, north-east of Willington. This river flows in a predominantly north-easterly direction, along the northern boundary, before being joined by the River Ivel and exiting the study area south-west of Wyboston.
River Hit	Main River/ Ordinary watercourse	A small Ordinary Watercourse which becomes a Main River south of Shefford and confluences with the disused Ivel Navigation Channel and the River Flit at Shefford.
River Hiz	Main River/ Ordinary watercourse	The River Hiz is located in the south-eastern part of the study area. It enters the district around TL 18656, 32847 and flows in a predominately northerly direction, before its confluence with the River Ivel, east of Henlow.
Houghton Brook	Main River	Houghton Brook can be found in the south of the study area in Dunstable flowing east for 2.5km before leaving the district and entering Luton Borough.
River Ivel	Main River/ Ordinary watercourse	The River Ivel enters the district in the south-eastern corner, west of the A1(m) junction 10 and is classified as an Ordinary Watercourse. It flows north until Astwick where it turns west towards Henlow. It becomes a Main River and is joined by the Pix Brook (TL 19185, 38427) before turning north, past Biggleswade, Sandy and Tempsford, until its confluence with the River Great Ouse along the northern boundary. There are other watercourses which join the main River Ivel at Langford and Henlow.
River Ivel Navigation	Main River	A short stretch of disused channel flowing west between Shefford and Langford where it discharges into the River Ivel.
River Lee (Upper)	Main River	The River Lee is located in the southern most extent of the catchment below Luton and flows in a southerly direction for approximately 5km until out of the district.
Mill Race (Disused)	Ordinary watercourse	A short stretch of disused race found west of Barton-le-clay.
River Ouzel	Main River/ Ordinary watercourse	Fed by a spring west of Bison Hill, the ordinary watercourse River Ouzel follows the south western boundary for approximately 10.4km until south of Tiddenfoot Lake. At this point the boundary and river separate with the River Ouzel continuing north and changing to a Main River north of Tiddenfoot Lake and continuing through Leighton Buzzard for 5.6km.

Watercourse name	Classification	Description
Ouzel Brook	Ordinary watercourse	The Ouzel Brook is located in the south-west of the county. The brook flows westerly until its confluence with the River Ouzel on the county boundary south of Billington.
Potton Brook	Ordinary watercourse	Potton Brook enters the district south of Little Heath and flows in a southerly direction past Potton.
Pix Brook	Ordinary watercourse	The Pix Brook enters the study area east of Fairfield Park 20949, 34858. Flowing in a predominantly northerly direction until Stotfold before turning north-west and continuing to its confluence with the River Ivel, north of Church End.
River Rhee/ Cam	Main River	The River Rhee/ Cam is located on the eastern boundary of the study area, east of Dunton. It flows roughly north for 1.5km before leaving the district.
River Ver	Main River/ Ordinary watercourse	The source of the River Ver is in Kenworth Lynch and is an Ordinary Watercourse for approximately 0.5km before flowing the A5 and becoming a Main River at TL 05011, 17877 and leaving the district in the south.
NOTE: This table is based on information found within the Environment Agency's Detailed River Network (DRN) database therefore there may be a number of Ordinary Watercourses within the study area which are not included within this table.		

7.2 Sources of flood risk in Central Bedfordshire

7.2.1 Fluvial flood risk

The fluvial flood risk in central and eastern Central Bedfordshire is primarily caused by the River Ivel and its main tributaries, including the River Flit. These present fluvial flood risk to rural communities as well as some of the main urban centres including, but not exclusively, Sandy, Biggleswade, Flitwick and Stotfold. Particularly in the north-east, the River Ivel's Flood Zones are wide on the low-lying flat topography, presenting a flood risk to the communities along its corridor. The majority of the larger towns, for example Biggleswade and Sandy, have adequate defences that the Ivel and its tributaries do not present a significant risk to properties. In the west of the district where there is higher ground and steeper slopes, the primary flood risk is from the River Ouzel and its tributary the Clipstone Brook, through Leighton Buzzard.

Appendix B presents the Flood Zone maps for Central Bedfordshire. A summary of the locations associated fluvial flood risk in Central Bedfordshire are detailed in section 7.3.2 Historic records and The following summary table collates flood risk information from all sources to settlements in Central Bedfordshire, including a summary of historic recorded flood events. It focuses on 20 settlements, based on areas which have historical flooding records.

Table 7-4.

7.2.2 Surface water flooding.

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding. This can be made worse by local insufficient drainage capacity. Where discharge is directly to a watercourse, locally high water levels can cause back-up and prevent drainage taking place.

The updated Flood Map for Surface Water (uFMfSW) shows that a number of communities are at risk of surface water flooding, as discussed in The following summary table collates flood risk information from all sources to settlements in Central Bedfordshire, including a summary of historic recorded flood events. It focuses on 20 settlements, based on areas which have historical flooding records.

Table 7-4. In general, the uFMfSW shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low-lying areas. Whilst in the majority of cases the risk is confined to roads, there are notable prominent

run-off flow routes around properties, for example properties situated at the foot of surrounding hills.

The uFMfSW mapping for Central Bedfordshire can be found in Appendix D. A summary of the locations associated surface water flood risk in Central Bedfordshire are detailed in section 7.3.2 Historic records and The following summary table collates flood risk information from all sources to settlements in Central Bedfordshire, including a summary of historic recorded flood events. It focuses on 20 settlements, based on areas which have historical flooding records.

Table 7-4.

7.2.3 Groundwater flooding

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

Groundwater susceptibility mapping of Central Bedfordshire has been provided in Appendix E. The Area Susceptible to Groundwater Flooding (AStGWF) shows that the low-lying land of the eastern River Ivel and many of its unnamed tributaries have a >75% susceptibility to groundwater flooding, along with the area between Ampthill and Flitwick before joining the River Flit. Generally, areas of higher ground in the west and more central areas have <25% susceptibility to groundwater flooding with the exception of the areas surrounding the River Ouse and Grand Union Canal in Leighton Buzzard.

Historical groundwater flood events are discussed in 7.3.2 and The following summary table collates flood risk information from all sources to settlements in Central Bedfordshire, including a summary of historic recorded flood events. It focuses on 20 settlements, based on areas which have historical flooding records.

Table 7-4.

7.2.4 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration or entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that the newest surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems. This means that, even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in a given year). Existing sewers can also become overloaded as new development adds to the discharge to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Historical incidents of flooding are detailed by Thames Water, Anglian Water and Affinity Water through their Flood Management System records. This database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons this data has been supplied on a postcode basis.

Table 7-2: Flood Management System recorded flood incidents

Post Code	Ward	Recorded Flood

		Incidents
MK43 0	Cranfield and Marston Moretaine	1
MK44 3	North Northhill Ward and north western Sandy Ward	4
MK45 1	Flitwick Ward	2
MK45 2	Ampthill and south eastern corner of Marston Moretaine	2
MK45 3	Houghton Conquest and Haynes Ward	2
MK45 4	Silsoe and Shillington Ward; Barton-le-Clay Ward	1
MK45 5	Westoning, Flitton and Greenfield Ward; Flitwick Ward	5
LU1 4	Caddington Ward	7
LU6 2	Dunstable-Manshead Ward	1
LU 6 3	Dunstable-Manshead Ward	4
Total		29
Note: Information combined from Anglian Water, Thames Water and Affinity Water		

The Flood Management System data indicates a total of 45 recorded flood incidents in the Central Bedfordshire Council administrative area. The more frequently flooded postcodes are LU1 4, with 7 records and MK45 5 with 5. The LU1 4 postcode is in the south of the study area, in the Caddington Ward.

Historic incidents shown in the data obtained from the Flood Management System records may indicate restrictions in system capacity that should be investigated where new growth or developer connections are proposed in the above Wards.

It is important to recognise the Flood Management System data does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages. Also the system represents a snapshot in time and is only representative of those events which have been reported and recorded to the water and sewerage companies. The system will therefore get outdated with properties being added to the system following rainfall events, whilst risk will be reduced in some locations by capital investment in increase the capacity of the network. As such the sewer flooding flood risk register is not a comprehensive 'at risk register'.

7.2.5 Flood risk from canals

Canals do not generally pose a direct flood risk as they are a regulated waterbody. The residual risk from canals tends to be associated with lower probability events such as overtopping and embankment failure (breach and sudden escape of the water retained in the canal channel).

The residual risk associated with canals is more difficult to determine as it depends on a number of factors including, for example, the source and magnitude of surface water runoff into the canal, the size of the canal, construction materials and level of maintenance. The probability of the risk of a breach is managed by continued maintenance.

Overtopping and breach

The level of water in canals is normally controlled by the level and size of weirs. When surface water enters a canal, the level of water rises. The water level may then reach a point in which it discharges from the canal through control structures such as weirs. If the capacity of these control structures is exceeded, or should they become blocked, overtopping may occur.

Breaches or embankment failure may be caused by a number of factors including:

- Culvert collapse
- Overtopping
- Animal burrowing

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

Recorded flood incidents from the Grand Union Canal

There is one canal within Central Bedfordshire; the Grand Union Canal is located in Leighton Buzzard, in the south-western corner of the study area. The canal runs parallel to the River Ouzel and the OS mapping indicates that the two channels may connect at various junctions. Consequently, the canal has the potential to interact with the River Ouzel and has the potential to become a flow path, if the canal were overtopped or breached.

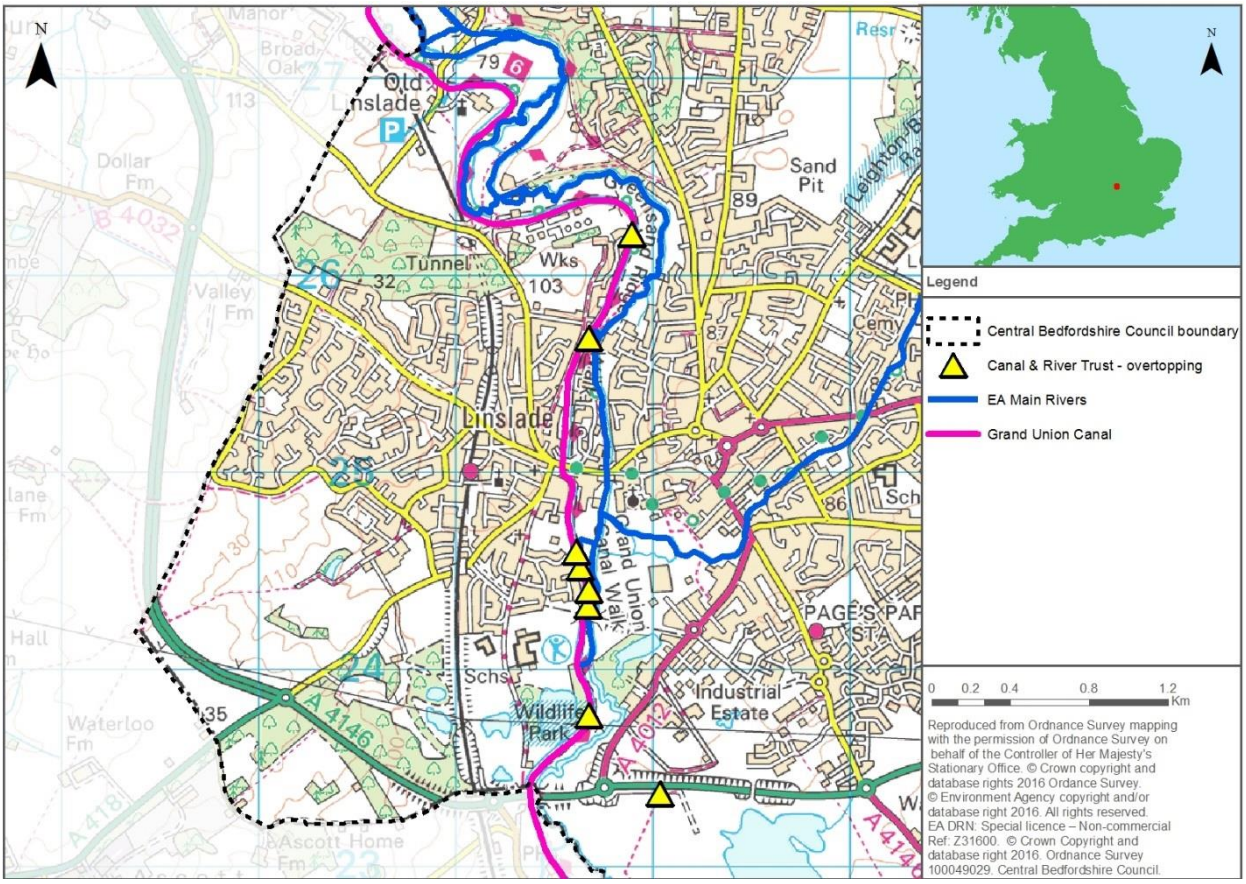
There are eight records of overtopping incidents:

- Four incidents occurred on 21/07/2007; the description accompanying the canal overtopping dataset indicates that for two of these incidents the River Ouzel came level with the canal. In one incident, the canal pond was surcharged by the River Ouzel and in another incident the side pond, at Leighton Lock, overtopped due to silting.
- On 28/02/2010, water overtopped a low point in the bank and tow path, moving water from the canal into a ditch of the River Ouzel, approximately 100m north of the 115A railway bridge.
- During 01/11/2012 and 02/11/2012, two incidents of overtopping occurred in close proximity to each other near Leighton Pound. The records indicate that no property flooding occurred as a result of these incidents. On 22/11/2012, high flow caused overtopping on the towpaths north of the railway bridge in Leighton Buzzard; the flow from the Canal travelled in a tributary ditch of the River Ouzel.

The locations of these recorded incidents is shown within Figure 7-4.

The recorded incidents above indicate that there is interaction between the canal and the River Ouzel. Any development proposed adjacent to a canal, should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific Flood Risk Assessment.

Figure 7-4: Grand Union Canal – location of overtopping incidents in Central Bedfordshire



7.2.6 Flood risk from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low. Recent changes to legislation under the Flood and Water Management Act require the Environment agency to designate the risk of flooding from reservoirs over 25,000 cubic metres and at some time in the future to consider the risk from reservoirs with a volume greater than 10,000 cubic metres. The Environment agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

Flooding from reservoirs occurs following partial or complete failure of the control structure designed to retain water in the artificial storage area.

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

The risk of inundation to Central Bedfordshire as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study.

There are 22 reservoirs shown to affect Central Bedfordshire; this includes reservoirs located within Central Bedfordshire and a number of reservoirs outside of the area whose inundation mapping is shown to affect Central Bedfordshire. The 22 reservoirs are detailed in Table 7-3 and the reservoir inundation extent is shown in Appendix H.

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

Table 7-3: Reservoirs that may potentially affect Central Bedfordshire in the event of a breach

Reservoir	Location (grid reference)	Reservoir owner	Environment Agency area	Local authority
Basin Pond	496080, 232730	Bedford Estates Nominees Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Beckerings Park Farm	501696, 236296	J P Webb & Sons	Cambridgeshire and Bedfordshire	Central Bedfordshire
Brook End Irrigation Reservoir	515672, 247356	F.J. Cope & Son	Cambridgeshire and Bedfordshire	Central Bedfordshire
Cowhill Belt Pond	495297, 233180	Bedford Estates Nominees Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Fish Pond (Battlesden Park Lake)	495694, 228531	Bedford Estates Nominees Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Great Barford Flood Alleviation - East	512683, 253017	Bedfordshire and R. Ivel Int. Drainage Board	Cambridgeshire and Bedfordshire	Bedford
Great Barford Flood Alleviation - West	511634, 252593	Bedfordshire and R. Ivel Int. Drainage Board	Cambridgeshire and Bedfordshire	Bedford
Houghton Regis Quarry (ID297)	501115, 223467	DSM Demolition Ltd	Hertfordshire and North London	Central Bedfordshire
Linden Lake	498039, 232458	Bedford Estates Nominees Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Lodge Farm	511793, 240258	F B Parish & Son	Cambridgeshire and Bedfordshire	Central Bedfordshire
Lower Drakeloe Pond	494972, 233810	Bedford Estates Nominees Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Lower East End Farm	511232, 255488	R.A. Gibson (Colesden) Ltd	Cambridgeshire and Bedfordshire	Bedford
Luton Hoo Lake Lower	511645, 218603	Luton Hoo Park Ltd	Hertfordshire and North London	Central Bedfordshire
Luton Hoo Lake Upper	510998, 219666	Luton Hoo Park Ltd	Hertfordshire and North London	Central Bedfordshire
Old Warden Park	514291, 244414	The Shuttleworth Trust	Cambridgeshire and Bedfordshire	Central Bedfordshire
Park Lake - Gamlingay (ID388)	522771, 251929	Meeks	Cambridgeshire and Bedfordshire	Cambridgeshire
Rooktree Farm (Summerfields)	510320, 242956	Whitbread Farms Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Shoulder of Mutton Pond	495980, 233145	Bedford Estates Nominees Ltd	Cambridgeshire and Bedfordshire	Central Bedfordshire
Standalone Farm Flood Reservoir	520882, 234286	Bedfordshire and R. Ivel Int. Drainage Board	Cambridgeshire and Bedfordshire	Hertfordshire
Stewartby Lake	501242, 242513	Bedfordshire and R. Ivel Int. Drainage Board	Cambridgeshire and Bedfordshire	Central Bedfordshire
Southill Park Lake	514795, 243150	The Southill Estate	Cambridgeshire and Bedfordshire	Central Bedfordshire
Sundon Reservoir	506255, 228275	Anglian Water Services Ltd	Hertfordshire and North London	Central Bedfordshire

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage, as detailed in NPPF.

7.2.7 Risk to development: considerations for developers

Impoundments which fall under the Reservoirs Act are inspected and regularly maintained, and therefore the likelihood of failure is considered to be very low and there has been no loss of life since 1925[6]. Reservoirs governed by the Reservoir Act 1975 have strict regulations; part of this forms maintenance schedules which should help operators identify any issues or changes in behaviour before these become an issue which may compromise the safety of a reservoir.

However; there remains residual risk to development from reservoirs which developers should consider during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include
    - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
    - operation: discharge rates / maximum discharge;
    - discharge during emergency drawdown; and
    - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site.
- Consult with relevant authorities regarding emergency plans in case of reservoir breach.
- The reservoir owners are contacted to confirm the Reservoir Risk Designation (if determined) and the inspection and maintenance regime of the reservoir.
- Consider the impact of a breach and overtopping, particularly for sites proposed to be located downstream of a reservoir. This should consider whether there is sufficient time to respond.
- The EA online Reservoir Flood Maps contain information on the extents, depths and velocities following a reservoir breach (note: only for those reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975). For proposed sites located within the extents, consideration should be given to the extent, depths and velocities shown in these online maps.
- In addition to the risk of inundation, those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

7.3 Historic records of flooding in Central Bedfordshire

7.3.1 Historic flood mechanisms

There are a number of historical flooding mechanisms in Central Bedfordshire, including:

- Heavy storm events which cause high runoff and result in flashier flooding from small streams.
- Culverting of watercourses causing localised flooding problems through the limited capacity of the culverts, surcharging and damage or blocked culverts.
- Insufficient storm and combined drainage capacity.
- Insufficient road ditches / gully capacity and lack of maintenance.
- Land drainage / surface water runoff from fields.

6 Environment Agency SC080046 Lessons Learnt from Dam Incidents at: http://evidence.environmentagency.gov.uk/FCERM/en/Default/FCRM/Project.aspx?ProjectID=f7fd7100-9a12-46ee-907d-e102d88c61c0&PageID=56bad68edcb1-4bf8-84cc-cbfd03ab63a2

- Groundwater flooding; in certain cases, this is thought to have been caused by the underlying geology and high water table.

7.3.2 Historic records

Central Bedfordshire has a history of documented flood events, with the main source of flooding being from fluvial sources. There are also a significant number of flooding events from surface water sources. Historical records of flooding in the study area have been informed from:

- Environment Agency Historic Flood Map and Recorded Flood Outline datasets;
- Previous studies including the 2008 Mid Bedfordshire District Council SFRA and Luton and South Bedfordshire SFRA;
- Central Bedfordshire Council Highways department; and
- Information supplied through consultation with stakeholders.

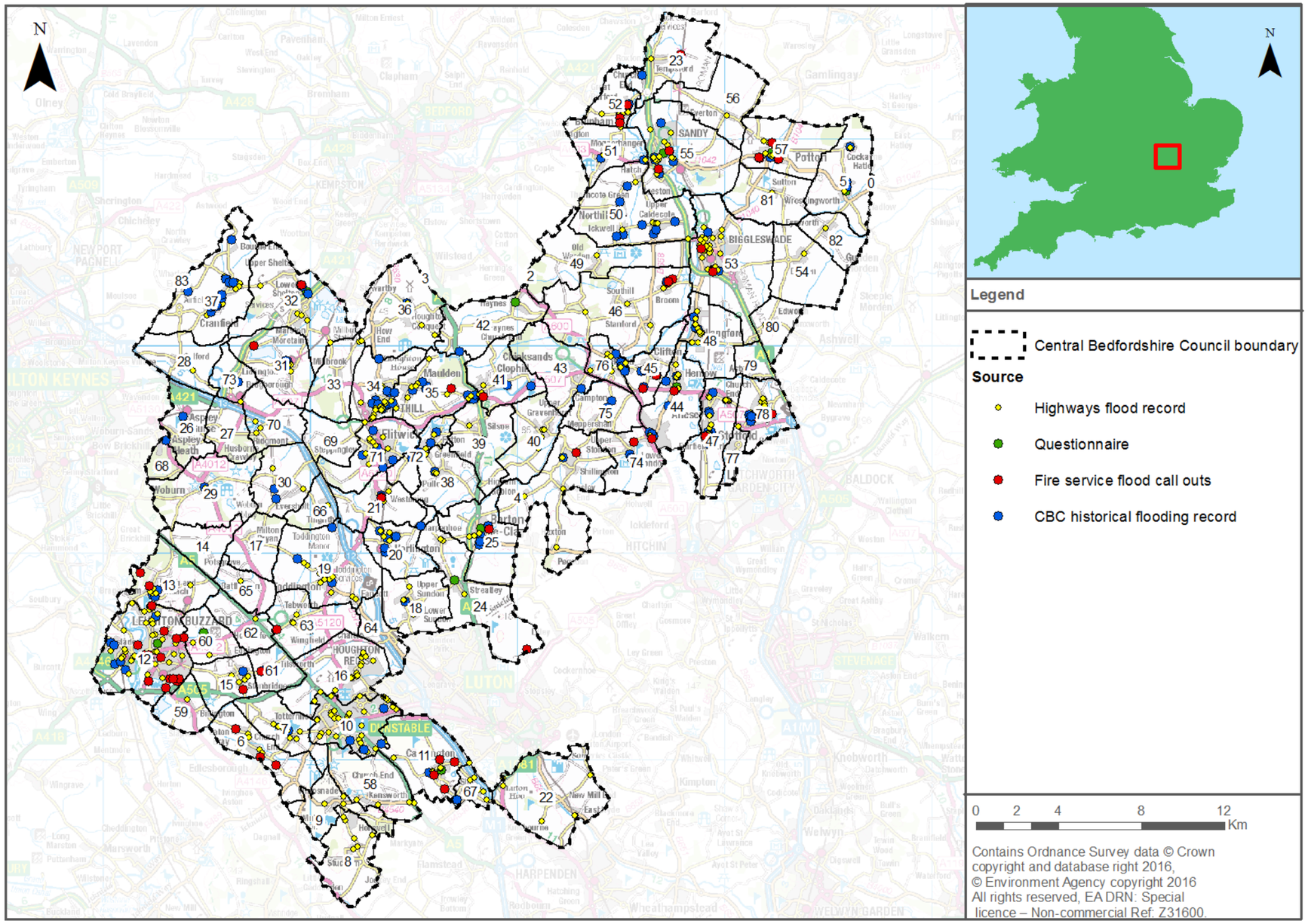
Central Bedfordshire Council Highways department supplied flooding records since 2009, since becoming unitary. There are 1,815 reported flood incidents in the Highways flooding records between 21/04/2009 - 24/02/2016, with the highest frequency of highway flooding recorded in Leighton Buzzard, Dunstable, Biggleswade and Caddington.

The historical records show widespread flood events throughout Central Bedfordshire. As part of the update to the Local Flood Risk Management Strategy work, there are several parishes which been identified as 'high risk'. High risk parishes in Central Bedfordshire are Ampthill, Caddington, Clophill, Leighton Buzzard and Stotfold.

Figure 7-5 presents historical flooding records in the district and their corresponding parishes.

Figure 7-5: Historical flooding records in Central Bedfordshire

ID	Parish Name	ID	Parish Name
0	Tadlow	42	Haynes
1	Wilshamstead	43	Campton
2	Eastcotts	44	Henlow
3	Wixams	45	Clifton
4	Shillington	46	Southill
5	Wrestlingworth	47	Arlesey
6	Eaton	48	Langford
7	Totternhoe	49	Old
8	Studham	50	Northill
9	Whipsnade	51	Mogerhanger
10	Dunstable	52	Blunham
11	Caddington	53	Biggleswade
12	Leighton-Linslade	54	Dunton
13	Heath	55	Sandy
14	Potsgrove	56	Everton
15	Stanbridge	57	Potton
16	Houghton	58	Kensworth
17	Milton	59	Great
18	Sundon	60	Eggington
19	Toddington	61	Tilsworth
20	Harlington	62	Hockliffe
21	Westoning	63	Chalgrave
22	Hyde	64	Chalton
23	Tempsford	65	Battlesden
24	Streatley	66	Tingrith
25	Barton-le-Clay	67	Slip
26	Aspley	68	Aspley
27	Husborne	69	Steppingley
28	Hulcote	70	Ridgmont
29	Woburn	71	Flitwick
30	Eversholt	72	Flitton
31	Lidlington	73	Brogborough
32	Marston	74	Stondon
33	Millbrook	75	Meppershall
34	Ampthill	76	Shefford
35	Maulden	77	Fairfield
36	Houghton	78	Stotfold
37	Cranfield	79	Astwick
38	Pulloxhill	80	Edworth
39	Silsoe	81	Sutton
40	Gravenhurst	82	Eyeworth
41	Clophill	83	North



7.4 Summary of flood risks in Central Bedfordshire

The following summary table collates flood risk information from all sources to settlements in Central Bedfordshire, including a summary of historic recorded flood events. It focuses on 20 settlements, based on areas which have historical flooding records.

Table 7-4: Summary of flood risks in Central Bedfordshire

Settlement	Fluvial flood risk	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Historic, recorded flood events
			<25%	>=25% <50%	>=50% <75%	>=75%		
Ampthill and Maulden	Fluvial flood risk in Ampthill and Maulden is primarily from several unnamed ordinary watercourses which split the towns flowing north to south towards a series of unnamed watercourses which drain into the River Flit. The Environment Agency's Flood Zones do not extend to these ordinary watercourses, leaving Ampthill and Maulden in Flood Zone 1. However, there is potentially some risk to properties in the vicinity of the watercourses.	<u>Ampthill</u> The surface water extent in the 30-year event is minimal in Ampthill, with risk predominantly confined to roads and existing watercourses. In the higher return periods, these flow routes become considerably wider with risk to properties along existing watercourses and a greater number of roads becoming flow paths. <u>Maulden</u> The majority of surface water flood risk is in the vicinity of the existing watercourse which bisects the village, with properties at risk from the 30-year event. The rest of Maulden surface water risk is confined to roads, notably the Brache and Moor Lane.	✓		✓	✓	Inundation from Beckerings Park Farm reservoir my affect properties in the vicinity of the A507/A5120 roundabouts and properties along Doolittle Yard.	<u>Ampthill</u> Fluvial: Sweet Briar Brook 2002, watercourse unknown 2016 Surface water: 1993, 2002, 2016 <u>Maulden</u> Surface water: 1987 and 2016 Groundwater: 1987
Arlesey and Church End	<u>Arlesey</u> Flood Zones show no fluvial flood risk to Arlesey. However, there are unnamed ordinary watercourses / drains that flows east to west through the village. These watercourses may potentially pose a flood risk to the houses in the vicinity of the watercourses. <u>Church End</u> Church End is affected by flood risk from the Pix Brook, and a few properties on Pix Court are at risk during the 1,000-year event and are located in Flood Zone 2. The majority of the village is located in Flood Zone 1.	In the 30-year event, mapping shows risk to be confined to roads and surface water ponding in open spaces and gardens in Arlesey and Church End, with the exception of Old Oak Close, which shows risk to properties. By the 1,000-year event, the majority of the main roads in Arlesey and Church End become flow routes including High Street, Stotfold Road and Church Lane. There is also significant ponding in the topographic low points of Old Oak Lane in Church End and cross roads where Primrose Lane, Station Road and Mill Lane meet in Arlesey.	✓		✓	✓	None	Fluvial: River Hit 1947 and Pix Brook 2002 Surface Water: 1993 and 2007
Aspley Guise and Cranfield	<u>Aspley Guise and Cranfield</u> The primary flood risk in Aspley Guise and Cranfield is from several unnamed watercourses which bisect the villages. The majority of these ordinary watercourses are not covered by the Environment Agency's Flood Zones but could still present a risk of fluvial flooding.	<u>Aspley Guise</u> The primary surface water flood risk is a flow route through the centre of Aspley Guise which presents risk to properties from highway surface water flooding. This flow route extends west of Duke Street towards the junction of Wood lane and West Hill, presenting risk to properties in the vicinity. The flow is then directed along Bedford Road to a low point where the primary surface water culvert is located which directs flows to a pond system in the grounds alongside Aspley House and the unnamed watercourse in the north. <u>Cranfield</u> Surface water mapping shows that flood risk to Cranfield is confined to existing watercourses and ponding in open areas and gardens in the 30-year and 100-year event. In the 1,000-year event, roads become flow routes toward the existing watercourse outside of the village, with Merchants Lane, Lincroft and Orchards Way at notable risk.	✓	✓	✓	✓	None	<u>Aspley Guise</u> Fluvial: River Ivel, 2003, watercourse unknown 2016 Surface water: 2016 Groundwater: 2004 <u>Cranfield</u> Fluvial: Chicheley Brook, 2016 Surface water: 2016 Groundwater: 2016 Sewer: 2016

Settlement	Fluvial flood risk	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Historic, recorded flood events
			<25%	>=25% <50%	>=50% <75%	>=75%		
Biggleswade	Flood Zones show that the main fluvial flood risk is from the River Ivel, although there are a number of unnamed drains which are present in the outskirts of the town. The majority of Biggleswade is not at risk of fluvial flooding according the Environment Agency's Flood Zone maps. This is due to the River Ivel having a small eastern floodplain. Conversely, the floodplains to the west of the River Ivel are broad and present a flood risk to the farms and residential properties, west of the A1.	Risk is predominantly confined to roads and ponding in rural areas and gardens. Areas notably at risk include the railway line.	✓		✓	✓	None	Fluvial: River Ivel 1947 and 1998 Surface water: 2012 Unknown: 2003
Blunham	Mapping shows that the predominant fluvial flood risk in Blunham is the River Ivel to the east of the village. Flood Zone 1 predominately covers Blunham. Flood Zones 3a and 2 are significantly wider than Flood Zone 3b and properties west of High Street are at risk in the 100-year and 1,000-year events. A summary of the fluvial flood defences in Central Bedfordshire are detailed in Section 8 and further information on the Clipstone Brook. There are several unnamed drains in Blunham which are not covered by the Environment Agency's Flood Zones but may still present risk to properties. Flooding is known to occur at the culvert under High Street causing water to spill onto the road at the junction, due to blockages from the heavily vegetated channel and undersized culvert displaying surface cracks and crazing.	According to surface water maps, the majority of Blunham is not affected by the surface water extent. Risk is confined to roads and ponding in open spaces and gardens in the 1,000-year event.			✓	✓	Inundation from Southill Park Lake may affect east of high street in the vicinity of the River Ivel.	Fluvial: River Ivel, 1947, 1993, 2003
Dunstable	Located at a raised elevation, only a small area of Dunstable is located within Flood Zones. Flood Zone 2 of an unnamed watercourse which drains towards Luton and covers Frogmore Road, Richmond Drive, Holyrood Drive, Balmoral Road and Tudor Drive in the Houghton Regis area.	Due to the topography of the area the majority of surface water flood risk is confined to roads and dry valleys leading to watercourses outside of the town. In the higher return period events, the flood extent is extensive due to threshold levels and present flood risk to properties from highway surface water flooding.	✓				None	Surface water: 2016
Caddington	According to the Environment Agency's Detailed River Network, there are no watercourses or drains in the vicinity of Caddington and therefore has no Flood Zone data available. According to a local study of Caddington, there is a watercourse to the south-west of the village which could present flood risk to properties. It is known that fluvial flooding from culverts of insufficient capacity occurs in higher return periods, for example along the Mancroft Road. Notably in the 1,000-year event the flood relief culvert is bypassed.	Mapping shows overland flow routes occur along roads and highways. There are prominent flow routes along Little Green Road, Manor Road, Edgecote Close and Hyde Road. There is also significant surface water risk to the properties in the vicinity of the watercourse. From the local study, there are flow routes showing risk to be in the vicinity of the junction of Dunstable and Mancroft Road, Mardle Close, at Mancroft Road junction to Pipers lane and Mancroft Road at Aley Green.	No Data				None	Fluvial: unnamed watercourse, 2014

Settlement	Fluvial flood risk	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Historic, recorded flood events
			<25%	>=25% <50%	>=50% <75%	>=75%		
Flitwick	The predominant flood risk in Flitwick is from the River Flit in the south and one of its tributaries to the north. The majority of the town is outside of the Environment Agency's Flood Zones. However, there are two ordinary watercourses which could present fluvial flood risk to Flitwick which are not included in the Flood Zones.	Mapping shows surface water flood risk in Flitwick generally follows similar flow paths to the River Flit and its tributaries. Away from the watercourses, it is mainly confined to residential roads and ponding in rural areas and gardens. There is also a prominent flow route from the 100-year event from Flitwick Wood toward the railway in a north easterly direction.	✓		✓	✓	None	Fluvial: ongoing since 1996 due to culverted watercourse with insufficient capacity Surface water: 2002
Langford	To the west of Langford is the confluence of three rivers, including the River Ivel, the disused Ivel Navigation and an unnamed watercourse. Between Leys Road and Cambridge Road, west of High Street, the properties along Ivel Close and Riverside Gardens are located in Flood Zone 2. Properties west of the River Ivel south of Langford Road are in Flood Zones 2 and 3. There are three ordinary unnamed watercourses which flow east to west through Langford but are not covered by the Environment Agency's Flood Zones, but will likely present flood risk.	The majority of Langford is at risk from surface water flooding in the 1,000-year event, as the village is intersected by several ordinary watercourses. Flood risk follows the path of roads and the existing watercourses. There is also a notable area of ponding over Central Bedfordshire College.				✓	None	None
Leighton Buzzard	The primary fluvial flood risk in Leighton Buzzard is along the River Ouzel and the Clipstone Brook, each of which is covered by Flood Zone maps. Properties in the vicinity of these two watercourses are at risk of flooding according to the Environment Agency's Flood Zones. However, the Environment Agency's Flood Zones are an undefended snapshot of fluvial flood risk. In 2015, works on the Clipstone Brook significantly reduced risk of flooding to houses on Carina Drive, on the left bank of the Brook due to a 1 in 100-year flood defence; this is not reflected in the Flood Zones. There are also several ordinary watercourse tributaries of each river, which are not covered by the Environment Agency's flood maps but may present fluvial flood risk to properties.	There are numerous overland flow routes following existing watercourses, major and residential roads through Leighton Buzzard, in particular the A4012 Hockliffe and Heath Road. There is a large area of ponding in residential areas north of Tiddenfoot Leisure Centre. A section of the Leighton Buzzard railway, after the Linslade tunnel and Leighton Road, is highlighted in the surface water maps. There is an overland flow route starting in Rushmere just outside of Leighton Buzzard and following Linslade Road until Brickhill Road and sections of the A421 near Marston Moretaine.	✓	✓	✓	✓	Inundation from Fish Pond (Battlesden Park Lake) in areas of Leighton Buzzard in the vicinity of the Clipstone Brook and River Ouzel	Fluvial: River Ouzel 1947, Clipstone Brook 1950, Grand Union Canal 1979, Great River Ouzel 1992 and 1993 Surface water: 2002 and 2012.
Marston Moretaine	The primary flood risk to Marston Moretaine is an unnamed ordinary watercourse which bisects the village in the north and another on the south-eastern boundary which splits at Station Road, continuing along the eastern boundary and flowing through the centre of the village. Only one of the three watercourse in Marston Moretaine are covered by the Environment Agency's Flood Zones. In the lower return periods, the Flood Zones extent are relatively narrow and do no impact the town. This is with the exception of upstream of station road where all three flood zones are significantly wider with fluvial flood risk impacting properties on St Marys Close.	The surface water flood extent during the 1,000-year event around Marston Moretaine is significant along the path of the existing watercourses, impacting properties in there vicinity, notably on Bedford Road and Lake View in the north and Great Blakelands, St Marys Close and Manor Road in the South.			✓	✓	None	Fluvial: watercourse unknown 2003 Surface Water: Frequently blocked culvert
Potton	Mapping shows Potton's fluvial flood risk comes from the Potton Brook, flowing in a southerly direction along the village's eastern boundary. Due to this, the majority of Potton is outside of the Environment Agency's Flood Zones. Properties are at risk on Judith Gardens, Sheepswalk Close, Ambergate Close and Manor Way all in close vicinity to the Potton Brook. There is one unnamed ordinary watercourse which flows parallel to the Potton Brook, which is not included in the flood zones. This watercourse could cause additional fluvial flood risk to Potton.	Surface water mapping shows that risk is confined in Potton to roads and flow routes in dry valleys leading to the watercourse.			✓	✓	None	None

Settlement	Fluvial flood risk	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Historic, recorded flood events
			<25%	>=25% <50%	>=50% <75%	>=75%		
Sandy and Beeston	Sandy: The River Ivel flows in a northerly direction, west of Sandy and provides the principal flood risk to the town. Flood Zones 3a and 2 are relatively wide, particularly north of Beeston after the confluence of the River Ivel with several unnamed ordinary watercourses. North of the A603, properties west of the A1, the western end of Bedford Road and west of London Road including those on Sandford Rise, are at risk of fluvial flooding in Flood Zone 2 and 3a. The majority of Sandy is located in Flood Zone 1. However, there are a few unnamed drains which could provide flood risk to the north eastern corner of Sandy. Beeston: Similar to Sandy, the majority is located in Flood Zone 1 and Flood Zones 3b and 3a do not cover properties. However, properties in north-west Beeston are at risk of fluvial flooding in Flood Zone 2. Properties most at risk are on Ash Close, Meadow Close, Lime Avenue, the Knolls and Grange Gardens.	Sandy: Mapping shows surface water flood risk consists predominantly of pockets of water ponding on roads and in gardens throughout the town in the lower surface water events. In the highest event, roads are more heavily affected, particularly those oriented east to west such as Bedford Road. Significant ponding can be found in a similar extent to Flood Zone 2 and over properties around Maple Tree Lower school from Partridge Piece and Wren Close. Beeston: In the lower return periods, surface water maps show there is very little risk to properties in Beeston. In the highest return period, there is significant flood risk to properties south of the Green, particularly in the vicinity of the watercourse and along The Knolls.	✓	✓	✓	✓	Inundation from the Brook End Irrigation Reservoir and Southill Park Lake may affect the airfield and farm building west of the River Ivel.	Fluvial: River Ivel 1875, 1947,1974, 1987 1993, 2003, 2006 Surface water: 1907
Shefford	Shefford is at the confluence of three rivers: The River Ivel Navigation to the east, River Hit in the south and River Flit to the West. Despite the flat topography there are not many properties in Shefford located in the Flood Zones. There is notable risk to the west to properties on Hazel Close and The Hollies, where the Flood Zones of several unnamed drains that discharge into the River Flit. Properties either side of Northbridge Street and Riverside Close is also located in Flood Zone 2.	Urban areas adjacent to the unnamed river in Shefford are vulnerable to surface water flooding, particularly through the centre of Shefford and around the vicinity Southbridge and Northbridge Street. Runoff. Flow routes exist down dry valleys leading to the watercourses.	✓	✓	✓	✓	Inundation from the Lodge Farm Penseroso reservoir may affect north of High Street and Southbridge Street up to Stanford Road till Heronslee.	Fluvial: River Flit 1992 2003, River Ivel 1841, 1947; unknown 1918; River Hit 1993 Surface water: 1993, 2003 Groundwater:2006
Stotfold	Flood Zones show fluvial flood risk is predominantly from the River Ivel in the east and the Pix Brook in the west. The Pix Brook has very narrow floodplains and does not impact any properties through Stotfold. The River Ivel between Baldock Road and Queens Street has relatively wide floodplains and affects properties on Prince Harry Close and Prince Edward Way. The Environment Agency Flood Zones to not account for risk of blockages at culverts, which is known to be a problem on the Pix Brook at the Hitchin Road and Brook Street culverts. When flooding occurs due to blocked culverts the flood extent may be larger than the flood zones and present risk to a greater number of properties in the vicinity.	Risk in the 30-year event is mostly ponding in gardens; however, in the higher surface water events there are several major flow routes and ponding, over the Central Bedfordshire College, following the topographic low points towards watercourses outside of the town.	✓	✓	✓		Inundation from the Standalone Farm Flood Reservoir may affect the area in the vicinity of the Pix Brook.	Fluvial: watercourse unknown 2016 Groundwater: 2006
Tempsford	The major flood risk in Tempsford is the River Great Ouse in the west and an unnamed drain in the east. The majority of the village is located away from these watercourses and therefore not in the Environment Agency's Flood Zones. South of Station road, the three Flood Zones have similar extents and put proprieties west of the A1 at risk from fluvial flooding.	The majority of Tempsford is not within surface water extents. However, it is affected by isolated areas of ponding and small amount of risk to Station Road.		✓	✓		Inundation from the West and Great Barford Flood Alleviation – East may affect Tempsford west of the A1, in the vicinity of the River Great Ouse.	Fluvial: River Ivel 1937, 1947, 1998 Unknown source: 1998

8 Flood defences and assets in Central Bedfordshire

8.1 Flood defences

8.1.1 Formal and informal flood defences

Flood defences are raised structures that prevent floodwater from entering properties in times of flooding. They affect natural flow patterns and can be described as either 'formal' or 'informal'.

- **Informal flood defences** are measures or infrastructure or obstructions that are not likely to have been designed, constructed or maintained to the same standards as formal flood defences and impede the flow of flood waters. Examples of informal defences can include motorway, canal and railway embankments, raised landfill sites, garden walls and buildings.
- **Formal flood defences** are those maintained by the Environment Agency or Local Authority and/ or IDB, designed to protect to a certain standard of protection.

The Environment Agency Flood Map for Planning shows flood defences built to protect against river floods with a 1% (1 in 100-year) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

8.1.2 Defence standard of protection and condition

Flood defences are designed to give a specific **standard of protection**, reducing the risk of flooding to people and property in flood prone areas. For example, a flood defence with a 1% AEP standard of protection means that the flood risk in the defended area is reduced to a 1% chance of flooding in any given year. Although flood defences are designed to a standard or protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to climate change.

The condition of existing flood defences and whether they will continue to be maintained and/ or improved in the future is a factor that needs to be considered by developers as part of the risk-based sequential approach and, in light of this, whether proposed land allocations are appropriate and sustainable. The Local Planning Authority should check whether the condition and maintenance of flood defences have been considered in site-specific Flood Risk Assessments, submitted as part of the evidence based supporting a planning application.

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

Table 8-1: Defence asset condition rating

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

Source: Condition Assessment Manual – Environment Agency 2006

8.1.3 Advice for specific sites

Site-specific FRAs will need to thoroughly explore the condition of defences, especially where these defences are informal. It is important that all of these assets are maintained to a good condition and their function remains unimpaired. Developers should also consider the Standard

of Protection (SoP) provided by defences and residual risk as part of a site-specific FRA. As with fluvial flooding, there is still risk present from assets which have not been mapped and the emphasis is therefore on the developer to demonstrate this.

8.1.4 Overview of defences

Along the River Ouzel and Clipstone Brook in Leighton Buzzard, the Environment Agency AIMS dataset lists formal flood defence 'assets', which are shown in Table 8-2.

Table 8-2: Formal Flood Defence Assets in Central Bedfordshire (AIMS database)

Watercourse / IDB Reference	Location	NGR	Type	Design SoP	Approx. Length (m)	Comments
River Ivel	North of the A603 and south of Saw Mill and Mill Lane	TL 15761 53026 To TL 16323 48989	Raised embankment	1 in 10-year for majority reduces to 1 in 5-year in sections	Total length 8793.12	Both Banks
River Ivel	Blunham Mill	TL 15513 51965	Raised embankment	1 in 10-year	126.03	Left Bank only
Clipstone Brook	Embankment on river channel from south of Meadway road to Hydrus Drive	TL 93271 25578 To TL 93893 25956	Raised embankment	1 in 10-year	386.56	Left Bank Only
Clipstone Brook	Embankment north of Hockliffe Road on floodplain	TL 93144 25324 to TL 93254 25536	Raised earth embankment	1 in 100-years	277.94	Left Bank Only
Bedford Group of Internal Drainage Board defences (adapted from 2008 SFRA)						
FD_IDB_1	Barton le Clay	TL 08100 31900	Storm balancing reservoir	Unknown	Approx. 15	Reservoir
FD_IDB_2	Eggington Brook	TL 94200 24700	Flood relief reservoirs	Unknown	Unknown	Reservoir
FD_IDB_3	Doolittle Mill sluice	TL 99000 20100	Water Level Management	Unknown	Unknown	Unknown
FD_IDB_4	Cherrycourt Way	TL 93800 25000	Storm balancing reservoir	Unknown	Approx. 34	Reservoir
FD_IDB_5	Leedon Farm est.	TL 93600 25400	Storm balancing reservoir	Unknown	Unknown	Reservoir
FD_IDB_6	Acacia Close flood	TL 94000 24800	Embankment	Unknown	Unknown	Left Bank

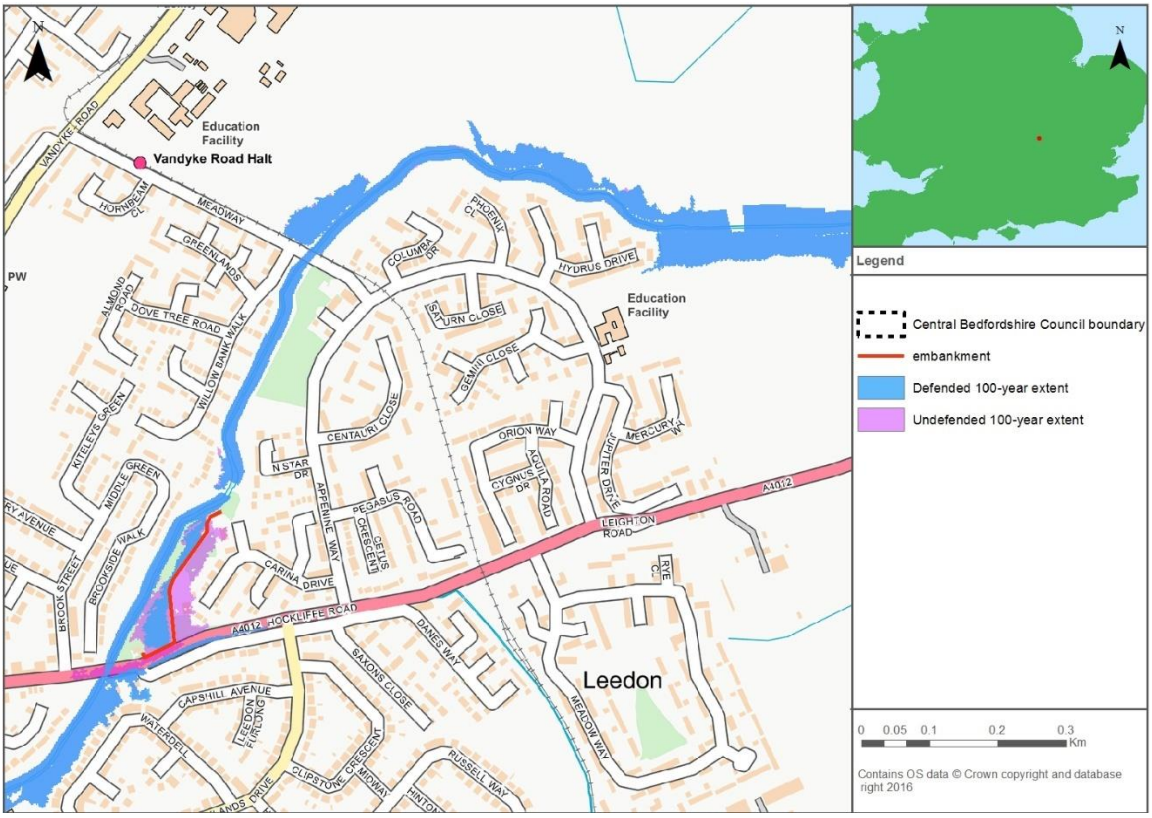
Source: AIMS dataset, Environment Agency and previous 2008 SFRA

8.1.5 Leighton Buzzard – Clipstone Brook

The raised earth embankment along the Clipstone Brook floodplain is a flood defence asset built in 2015 to improve flood protection for 29 houses in Carina Drive. The defence consists of an area of widened river banks, a small earth embankment approximately 278m in length and a small section of lowered ground on the Carina Drive side of the Brook to redirect floodwater away from homes. This will reduce the flood risk from a 1 in 25-year probability of flooding to a 1 in 100-year annual exceedance probability. The embankment is considered to be in "very good" overall condition.

On the left bank of the Clipstone Brook from Nebular Street and following the channel till the end of Hydrus Drive is a raised earth embankment protecting for the 1 in 10-year chance of flooding. This defence overall is in classified "poor condition" to "very poor" in places.

Figure 8-1: Flood defences in Leighton Buzzard



8.1.6 Raised embankments

There are a number of raised embankments throughout the district, for example along the River Ivel corridor; however, not all of these are considered as 'formal defences'. Raised embankments not considered as formal defences may still enhance conveyance capacity but will not formally designed to provide flood protection.

The aim of IDB defences is primarily to control storm water discharges from developments, to minimise the impact of those developments on downstream areas.

8.1.7 Watercourses

There are a number of small watercourses, open channel and culverted, across the study area. It is important that a maintenance regime is in place to ensure that there is regular cleaning and debris removal to prevent blockages from occurring. Where blockages do occur, flooding can occur quickly and although the disruption caused may be localised, flood depths and hazards can be significant. Across the study area, the responsibility for these watercourses lies with different organisations; but primarily with the Riparian owner (the person owning the banks). Development which introduces new stakeholders to watercourse maintenance regimes should implement

measures which make these new stakeholders aware of their responsibilities. Anglian Water, Thames Water, Central Bedfordshire Council, the IDB and the Environment Agency have powers and duties to maintain certain watercourses.

8.2 Flood Risk Assets

8.2.1 LLFA Asset Register

Central Bedfordshire Council have developed an **online Flood Risk Asset Register** for the County under Section 21 of the FWMA (2010). This list is compiled from flood investigations and local Flood Risk Assessments enabling data to be collected on structures and features which are likely to have a significant effect on flood risk within Central Bedfordshire. Central Bedfordshire Council have defined a 'significant effect' on flood risk as those which could cause flooding of residential or commercial property or adversely affect critical infrastructure. Examples of structures include culverts, bridges, embankments and can be both natural and man-made.

An asset that is defined as having a significant effect on flood risk and therefore warrants inclusion on the Asset Register and Record is one that, should it fail, would have the potential to cause a 'locally significant' flooding event.

Before structures are added to the Asset Register, the relevant information about each asset such as ownership and condition are recorded. The list will then be updated periodically as Central Bedfordshire Council becomes aware of significant assets.

Assets on the online Flood Risk Asset Register may not all be owned or maintained by Central Bedfordshire Council. In addition, if an asset is listed on the register, this does not place any additional responsibilities on Central Bedfordshire Council for the asset's condition or performance.

8.2.2 Long term operation and management of defences and assets

The potential for flooding can be increased in areas where flood alleviation measures are not maintained regularly and/ or adequately. It is the responsibility of the riparian owner to maintain the watercourses or defences to a suitable standard. The Local Authority (for Ordinary Watercourses), the Environment Agency (for Main Rivers) and the IDB (for IDB Drains) have permissive powers to act should the riparian owner not satisfy their maintenance requirements.

8.2.3 Implications for owners of significant assets

There will be implications for developments which have significant assets. Managers and owners of structures or features included within the Asset Register shall, in accordance with Section 14 of the Act (Power to request information), be required to:

a) Provide information on the structure(s) or feature(s), and

b) Inform the LLFA of any material changes that occur to the structure(s) or feature(s) that would require the details held on the record to be updated.

8.3 Taking account of residual flood risk and flood defences

The residual risk of flooding in an extreme flood event or from failure of defences should be carefully considered. Flood defences do not completely remove the chance of flooding; they can be overtopped or fail in extreme weather conditions.

The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges.
- Failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.

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

The impact of a breach or impoundment failure is dependent on the location, the magnitude of the event, and the type of breach. Siting of any built development downstream within close proximity should be avoided unless it can be demonstrated that flood risks due to rapid inundation may be eliminated or adequately mitigated. The Environment Agency should be consulted at site-specific development level for advice on breach/ overtopping parameters, if it is a requirement to model such an event.

8.3.1 Residual risk in Central Bedfordshire

The locations benefiting from formal flood defences in Central Bedfordshire is listed in Table 8-2; as shown, not many places rely on formal flood defences, and therefore, there are no resulting significant zones of rapid inundation potential in the event of a breach/ failure. Any inundation resulting from a failure in raised embankments (which are not formal flood defences and no areas of development are currently indicated as benefiting from, or being reliant upon, these structures), it would be unlikely that flooding would extend beyond the Flood Zones or impact upon any existing development, or any future built development.

In terms of impounding structures, such as reservoirs, although the probability of occurrence is low, there is the potential for the structures to fail suddenly, releasing significant volumes of floodwater within a short duration towards downstream areas. Consequences downstream are relatively high if there is residential and commercial development, and critical infrastructure. The terrain is also quite flat and low lying in Central Bedfordshire, so this increases the potential for the floodwaters to spread wider. Consequences would be lower where downstream areas are predominantly rural, but the topography would still be the dominant factor in determining how quickly flood flows could be routed towards urban areas.

The Bedford Group of Drainage Boards has identified a number of attenuation areas/basins, whose failure, through the blockage of outfalls, may result in a residual flood risk to surrounding areas. However, there is no hydraulic modelling available to establish the areas benefiting from the IDB's flood defences. In addition, topographic data for many of the attenuation basins is not available and consequently it is not possible to define residual risk areas. As the residual risk areas are unknown, development located downstream of attenuation areas / basins or behind IDB flood defences, may need to consider the risk of a breach, overtopping, uncontrolled and controlled release of water and how this risk will be managed over the lifetime of the development.

8.3.2 Flood infrastructure maintenance

There is potential for the risk of flooding to increase in areas where flood alleviation measures are not maintained regularly and/or adequately. Breaches in raised flood defences are most likely to occur where the defence has been degraded or not maintained to its design standard. Drainage infrastructure in urban areas can also frequently become blocked with debris which can lead to blockages in culverts and backing up of a watercourse, resulting in flooding of property and infrastructure. It is therefore essential that all flood alleviation schemes and hydraulic structures are regularly maintained to their specified design standard.

The Council do not routinely maintain any private assets as they have no legal duty to do so. It is the responsibility of the riparian owner to maintain the watercourses or defences to a suitable standard. The Local Authority, IDB and/ or Environment Agency have permissive powers to act should the riparian owner not satisfy their maintenance requirements.
Impoundments which fall under the Reservoirs Act are inspected and regularly maintained, and therefore the likelihood of failure is considered to be very low.

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9 Flood Warning and Emergency Planning

9.1 Introduction

This chapter provides a high-level overview of:

- Flood emergency planning arrangements in Central Bedfordshire
- Emergency planning related requirements for new development under the NPPF
- How flood emergency plans can be used to support the second criteria of the Exception Test
- Existing flood warning arrangements
- How the SFRA information should be used in relation to emergency planning.

9.2 Flood emergency planning arrangements in Central Bedfordshire

Flooding can develop into an emergency situation; emergency planning is one option to help manage flood related incidents. Emergency planning is a core component of civil protection and public safety practices and seeks primarily to prevent, or secondly mitigate the risk to life, property, businesses, infrastructure and the environment. In the UK, emergency planning is performed under the direction of the 2004 Civil Contingencies Act (CCA).

From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding. In development planning, a number of these activities are already integrated in national building control and planning policies e.g. the NPPF.

Emergency planning and flood risk management links

- **2004 Civil Contingencies Act**
- **DEFRA (2014) National Flood Emergency Framework for England**
- **Government guidance for public safety and emergencies**

9.2.1 Managing flood emergencies – local arrangements

Central Bedfordshire Council have a statutory responsibility for preparing for emergencies affecting Central Bedfordshire and are supported by the emergency volunteers partnership BLEVEC[7] including Community Emergency Response Teams and the Bedfordshire Local Resilience Forum (BLRF).

Bedfordshire LRF maintain a Community Risk Register which details all hazard that face Bedfordshire and assesses the risk; flooding is deemed a high risk. Emergency plans are subsequently developed to prepare for, mitigate and respond to the primary risks in Bedfordshire. The emergency plans relevant to managing flood emergencies for Central Bedfordshire include: Bedfordshire LRFs **Multi-Agency Flood Plan** and Multi-Agency Adverse Weather Plan, Central Bedfordshire Council Generic Crisis Management Plan and Severe Weather Plan, and local community Emergency Plans.

Bedfordshire LRF **What would you do if?** website provides a range of information to assist individuals, businesses and communities prepare for emergencies including flooding. More specific information related to flooding has also been produced or signposted by the Bedfordshire LRF on their website on their **flood risk** and **flood plan** pages.

Public Flood Guidance

- **Flooding: Advice for the Public**
- **Prepare your property for flooding**
- **What to do before, during and after a flood**
- **Preparing an emergency kit**
- **Central Bedfordshire Council Flood Guide**

7 Bedfordshire Local Emergency Volunteers Executive Committee

9.2.2 Central Bedfordshire Council's role

Central Bedfordshire Council is responsible for preparing and delivering the local authority response to a severe flooding event and is subject to the full set of duties, as a Category 1 responder under the CCA. Central Bedfordshire Council website has a page dedicated to **flooding and flood risk management** which contains guidance and advice on what to do in a flood, who to contract, roles and responsibilities, investigating a flood, flood asset register, land drainage consent, SuDS and new developments and additional information.

Local councils are not legally obliged to provide the public with sandbags. Further, the Council advocates sand-less alternatives to sand bags, which have been proven to be more effective. Although sand bags are not the preferred method to protect property it is acknowledged that sometimes, there are no alternatives. Property owners can purchase sandbags from a local builders' merchant, in advance of a flood event. The Environment Agency has also produced a leaflet on: **Sandbags: how to use them properly for flood protection**. For long durations of flooding, Kitemarked flood resistance and resilience products should be considered if a property is known to be at risk.

The Council will decide whether to grant planning permission for development applications in its administrative area. Part of the role is to consider flood risk and whether the Sequential Test and if necessary, the Exception Test have been satisfied.

9.2.3 Community Emergency Response Teams and plans

Certain communities in Central Bedfordshire have established Community Emergency Response Teams (CERT). As defined in the LFRMS, CERT is a group of volunteers from an area that can help the community build resilience before, during and after an emergency. CERT teams currently active at: Fairfield, Shefford, Stotfold and Slip End. Anyone in Bedfordshire can volunteer and join the Bedfordshire CERT.

Central Bedfordshire Council and CERT have created and implemented community emergency plans. These plans outline responsibilities and arrangements within local communities typically at a town and parish council level. The Bedfordshire Local Resilience Form community emergency plan template is supplied to prioritised areas and Central Bedfordshire Council and CERT volunteers will assist the areas in preparing these plans.

9.3 Emergency planning and development

9.3.1 NPPF

The NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. All flood sources such as fluvial, surface, groundwater, sewers and artificial sources (such as canals and reservoirs) should be considered.

9.3.2 Safe access and egress

The **NPPF Planning Practice Guidance** outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test[8]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development.

As part of a FRA, the developer should review the acceptability of the proposed access in consultation with Central Bedfordshire Council and the Environment Agency.

9.3.3 Potential evacuations or containment

During flood incidents, evacuation may be considered necessary. The NPPF Planning Guidance states practicality of safe evacuation from an area will depend on[9]:

8 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014

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

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

The vulnerability of the occupants is also a key consideration.

Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. developments located immediately behind a defence and at risk of a breach).

9.3.4 Flood warning and evacuation plans

Flood warning and evacuation plans are a potential mitigation measure to manage the residual risk, as listed in the NPPF Planning Practice Guidance.

It is a requirement under the NPPF[10] that a flood warning and evacuation plan is prepared for

- sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels); and
- essential ancillary sleeping or residential accommodation for staff required by uses in this category [water-compatible development], subject to a specific warning and evacuation plan.

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

The Environment Agency and DEFRA provide standing advice for undertaking Flood Risk Assessments for planning applications. Please refer to the government **website** for the criteria on when to following the standing advice. Under these criteria, details of emergency escape plans will need to be provided for any parts of the building that are below the estimated flood level.

The Environment Agency also provides practical advice and templates on how to prepare a flood plans for individuals, communities and businesses (*see links in text box*).

It is recommended that the emergency planners at Central Bedfordshire Council are consulted prior to the production of any community emergency flood plan. This consultation should also seek to identifying where site-specific flood warning and evacuation plans may link and connect with any existing community flood plans and arrangements (see Section 9.2).

Guidance documents for preparation of flood warning and evacuation plans

- **Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups**
- **Environment Agency (2014) Community Flood Plan template**
- **Environment Agency Personal flood plans**
- **Flood Plan UK 'Dry Run' - A Community Flood Planning Guide**

9.3.5 Exception Test

The Planning Practice Guidance states that developers can use flood warning and evacuation procedures to demonstrate that the development will be safe and that residual risk can be overcome. However, this should be a 'last resort' after all other options have been investigated and considered and be used as part of a package of measures to manage the residual risk. As such, flood warning and evacuation plans can also be used to help satisfy the second criteria of

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

the Exception Test (see Chapter 3), which is in part to demonstrate that the development will be safe for its lifetime.

Flood warning and evacuation plans can help to manage the safety of persons on site. However, to help assist in imbedding the flood warning and evacuation plan arrangements over the lifetime of the development, training and exercising schedules and a periodic plan review cycle should be stated in the plan. Flood warning and evacuation plans should also support the first criteria of the Exception Test which discusses the sustainability of the development and wider benefits to the community. A proposed new development may not be considered sustainable if it places additional burden on the existing response capacity of the Council.

9.4 Existing Warning Systems

The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. The Environment Agency supplies Flood Warnings via the Floodline Warnings Direct (FWD) service, to homes and business within Flood Zones 2 and 3. Warnings are issued using a set of four easily recognisable codes. Generic advice and examples on actions to be taken on receipt of the warning are shown in the column called “What to do”.

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

There are currently nine Flood Alert Areas covering significant parts of Central Bedfordshire; these are particularly centred around the River Ivel and River Ouzel and their tributaries. There are Seventeen Flood Warning Areas (FWAs); these tend to be centred around the River Great Ouzel and tributaries in Leighton Buzzard, and along the River Ivel corridor around the settlements of Shefford, Biggleswade and Sandy.

Appendix F shows the FWA coverage for Central Bedfordshire. If a home or business falls within the FWA coverage, this means that the Environment Agency can provide flood warnings.

9.5 How the SFRA should be used in relation to emergency planning

- This SFRA will assist the Council to apply the Sequential Test and where necessary, identify where the Exception Test is required.
- It is essential that any development which will be required to remain operational during a flood event is located in the lowest flood risk zones, to ensure that in an emergency operations are not impacted on by flood water (i.e. through the application of the Sequential Test). 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 or 3b must be operational during a flood event to assist in the emergency evacuation process.
- 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. Consideration of the residual risk and the sustainability and safety of the development should be considered in line with the NPPF, local planning guidance and this SFRA. This is discussed further in Chapter 11.
- 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 the Exception Test criteria).

10 Development in the Internal Drainage Boards area

10.1 What is an Internal Drainage Board (IDB)?

During the 1930s, under the newly formed Land Drainage Act, catchment boards based on the UK's major river basins were created. Within these river basins, areas of particularly sensitive drainage with a long history of local water level management authorities, where designated Internal Drainage Boards. The subsequent Land Drainage Act (1991 and 1994) set out the powers and duties of IDBs:

- To exercise a general supervision over all matters relating to the drainage of land within their districts, and
- To have such other powers and perform such other duties as are conferred or imposed by the Acts

The powers provided for Internal Drainage Boards are to:

- improve and maintain the drainage system
- regulate activities in and alongside the drainage system, other than on those waterways designed as Main River, which are under the control of the Environment Agency.
- Drainage Boards may also undertake works on watercourses outside their drainage district in order to benefit the district.

Each Board operates within a defined district and has a general supervisory power over all aspects of land drainage including maintenance and improvement of watercourses and related infrastructure such as pumping stations, weirs, sluices, culverts and embankments within their drainage districts. In addition, Boards can undertake works on watercourses outside their drainage district in order to benefit the district.

Permissive powers mean that the IDB are permitted to undertake works on ordinary watercourses but the responsibility remains with the riparian owner as the IDB are not obliged. Much of their work involves the maintenance of rivers, drainage channels, outfalls and pumping stations, facilitating drainage of new developments and advising on planning applications.

10.2 Bedfordshire Group of Internal Drainage Boards

10.2.1 Area of responsibility

Within Central Bedfordshire, the Bedfordshire Group of Internal Drainage Boards (BGoIDB) is split into two drainage districts; the Bedfordshire and River Ivel IDB administer to the northern, eastern and central ordinary watercourses including the Rivers Flit and River Hit upstream of Shefford, Pix Brook in Stotfold and Potton Brook through Potton. The Buckingham and Ouzel IDB manage the ordinary watercourse sections of Clipstone brook, Ouzel brook and the associated drains of these watercourses. Both are managed by the Bedford Group of Internal Drainage Boards. Any development which will impact on waterways within the IDBs' jurisdiction will need to consult with them.

10.2.2 Aims and objectives

The aims and objectives set out by the BGoIDBs are as follows:

- Provide and maintain an arterial surface water drainage system that is managed to achieve sustainable standards of flood protection.
- Conserve and enhance the environment whenever practical ensuring there is no net loss of biodiversity.
- Ensure that the Boards in the Bedford Group comply with the current UK and EU legislation.

Figure 10-1 shows an outline of the IDB watercourses in Central Bedfordshire. The BGoIDBs' website also provides an interactive Board Area Map.

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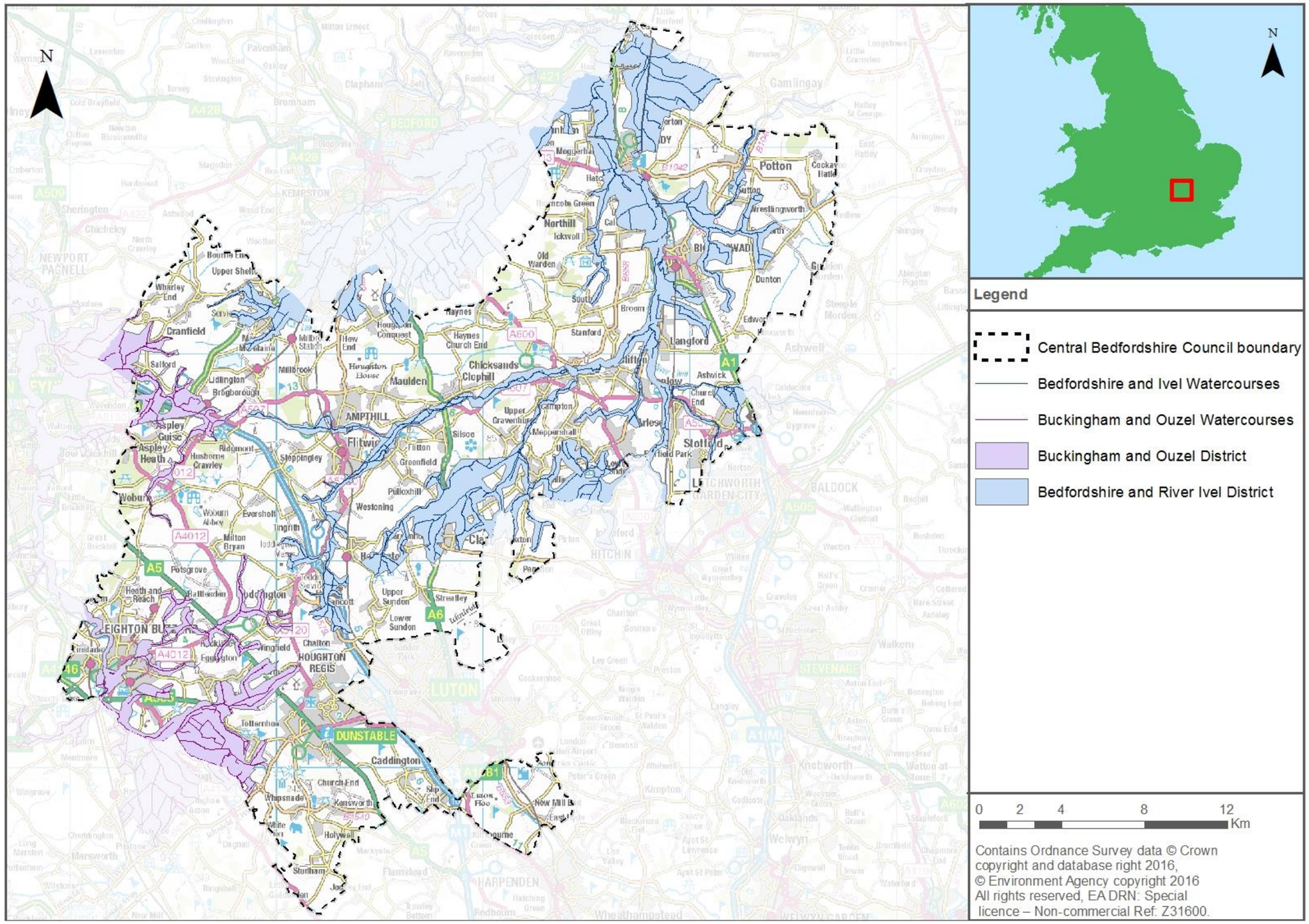
- Conserve and enhance the environment whenever practical ensuring there is no net loss of biodiversity.
- Ensure that the Boards in the Bedford Group comply with the current UK and EU Legislation.

Figure 10-1: IDB districts and main drains



10.3 Drainage Byelaws

By the powers granted under the Land Drainage Act 1976, IDBs have established a number of local byelaws to secure the efficient working of those parts of the drainage system under their responsibility. These **byelaws** protect the water corridor to ensure the watercourse is accessible for inspection and maintenance. They can prohibit the obstruction of watercourses within their district, thus, anyone constructing or altering a weir, bridge, embankment, culvert or similar obstruction must first seek the consent of the IDB before undertaking works. IDBs also have a series of byelaws relating to the management of watercourses and can designate features and structures within their district which relate to managing flood risk. A designation prevents the owners from altering, removing or replacing the structure or feature without the consent of the IDB.

Bedford Group of Drainage Boards byelaws focus on the maintenance of flow within the drainage system, placing controls on discharges to the watercourses and structures used to regulate flows.

The overriding principle is that no works or discharges to the system may take place that have the potential to result in a detrimental impact to downstream areas.

These include provisions to restrict:

- Development (including any structure or feature) within 9m of the edge of a watercourse;
- Any development or temporary storage of material on the floodplain;
- The creation or diversion of watercourses;
- The introduction of water to the areas administered by the boards;
- Interference with flow control infrastructure.

In addition, the Bedford group of Drainage Boards has a policy requiring any development of five dwellings or more to provide attenuation of the site runoff before discharging into the local drainage system. This is in keeping with their byelaws.

10.4 Roles and responsibilities of the IDBs in Central Bedfordshire

The BGoIDBs' main responsibility is to manage water levels within their designated watercourses with the purpose of reducing flood risk and sustaining land uses and the environment. This is achieved through the provision of technically, environmentally and economically sound and sustainable defence measures in accord with local needs and central government policy.

The Group intends to play a positive role in fulfilling its statutory and other responsibilities for nature conservation. Policies include:

- seeking to avoid, wherever possible, damage to the natural environment;
- fully complying with legislation protecting species;
- aiming to ensure that there is no net loss to habitats and species covered by Biodiversity Action Plans;
- seeking opportunities to enhance the aquatic environment;
- ensuring that Water Level Management Plans are completed, implemented as appropriate and reviewed in accordance with Defra targets;
- co-operating with other bodies to make an input into the development of Local Environment Agency Plans and Biodiversity Action Plans;
- co-operating in the development of a Biological Records Database for Bedfordshire.

10.4.1 Planning process

The IDB plays an important role in the planning process and brings detailed knowledge of the catchment giving drainage advice on proposed development affecting the District. In this capacity, the Bedford Group advises Planning Authorities as to the appropriate surface water and flood risk management measures required for development both within the Drainage District and outside the District if such development is considered by the IDB to have an impact on the Drainage District.

10.4.2 Development Control

In the capacity of 'operating authorities', the Bedford Group advises Planning Authorities as to the appropriate surface water and flood risk management measures required for development both within the Drainage District and outside the district if such development is considered by the IDB to have an impact on the Drainage District.

The BGoIDB uses the Environment Agency's Flood Map for Planning (Flood Zones) and surface water flood map, as using them both together generally gives a good indication of flood risk.

With regards to surface water drainage, the IDB will need to review and approve surface water drainage plans and proposed discharge rates, and their local drainage byelaws may apply.

10.4.3 Consents

The Land Drainage Act 1991 Section 23 prohibits any person from causing an obstruction to flow in any Ordinary Watercourse. Any works being carried out on an Ordinary Watercourse in an IDB district requires Land Drainage Consent from the IDB prior to any works taking place, applicable to both permanent and temporary works. Applicants for Consent are also required to comply with the IDB's Byelaws, which protect the water corridor to ensure the watercourse is accessible for inspection and maintenance.

In areas which IDBs do not cover, this Consenting role transfers from the Environment Agency to the Lead Local Flood Authority, as of 6th April 2012. In Central Bedfordshire, the Consenting role is being undertaken by the Bedford Group of Drainage Boards under the Flood and Water Management Act Section 13 (4). Applicants are required to comply with the Land Drainage Act Section 23 "the prohibition on obstructions etc in watercourses" and the Buckingham and River Ouzel IDB Byelaws (5th November 2002), pending the publication of the 'Local Flood Risk Strategy' and local authority Byelaws.

Consent application guidance notes are provided by the IDB. The IDB also hold a database of consents.

10.4.4 Maintenance and improvement

The IDBs have a rolling programme of maintenance for many of the watercourses within their control. The majority of lowland rivers and watercourses have been heavily modified by man or are totally artificial channels. All are engineered structures designed and constructed for the primary function of conveying surplus runoff to their outfall efficiently and safely, managing water levels to sustain a multitude of land functions. The potential for flooding in an area can be increased where flood alleviation measures such as raised flood defences are not maintained regularly or adequately. Drainage infrastructure in urban areas can frequently become blocked with debris which, if not removed, can lead to blockages in culverts and backing up of a watercourse resulting in flooding of property. It is an essential aspect of flood risk management practice that all flood alleviation schemes and hydraulic structures are regularly maintained to a specified design standard, to prevent breaches or defence degradation.

The Bedfordshire and River Ivel Works Programme and the Buckingham and River Ouzel Works Programme can be viewed **here**.

11 Cross-boundary Considerations

11.1 Cumulative impact of development

When allocating land for development, consideration must be given to the potential cumulative impact of the loss of floodplain storage volume. The effect of the loss of volume should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

Depending on the location, size and nature of development within the possible sites, there is the potential for loss of storage and floodplain connectivity in the upper reaches of these watercourses which could potentially increase flood risk downstream. However, conditions imposed by Central Bedfordshire Council should allow for mitigation measures so any increase in runoff as a result of development is properly managed and should not exacerbate flood risk issues either within, or outside of, the Council's administrative area.

11.2 Cross-boundary issues

Future large-scale development, both within and outside of Central Bedfordshire can have the potential to affect flood risk to existing development and surrounding areas. Central Bedfordshire has boundaries with the following Local Authorities:

- Aylesbury Vale District Council
- Bedford Borough Council (LLFA)
- Dacorum Borough Council
- Huntingdonshire District Council
- Luton Borough Council (LLFA)
- Milton Keynes Council (LLFA)
- North Hertfordshire District Council
- South Cambridgeshire District Council
- St Albans City and District Council.

Neighbouring authorities were contacted and, where possible, Local Plans and SFRAs (if available) were reviewed to assess whether there are any proposed large-scale developments that may affect flood risk in the SFRA area. Neighbouring authorities, where possible, provided locations of proposed sites in order for an assessment of their location against the Central Bedfordshire authority boundary and topography to be made.

The topography of the study area means that a large number of the watercourses rise within or just outside Central Bedfordshire and flow through the district into neighbouring authorities' administrative areas. In particular, the main River Ivel rises within the North Hertfordshire District Council's administrative area, before flowing in a predominantly northerly direction, through Central Bedfordshire before joining the River Great Ouse at the northern boundary of the study area. The River Ivel is also fed by tributaries which rise in the central and eastern part of the District as well as within the North Hertfordshire District Council's administrative area to the south.

Around the periphery of the Central Bedfordshire administrative area, there are numerous watercourses which rise and flow into neighbouring authorities' administrative areas. This includes,

- The Rhee / Mill Stream towards the east of the study area which, flows into the South Cambridgeshire District;
- The River Ouzel to the west of the study area which, flows into the Aylesbury Vale District and subsequently the Milton Keynes District; and
- The Houghton Brook to the south of the study area which, flows into the Luton and St. Albans Districts.

The neighbouring authorities which therefore, have the potential to affect flood risk within Central Bedfordshire is predominantly North Hertfordshire District Council and Aylesbury Vale District Council.

Of the nine neighbouring authorities approached, eight have provided information on their Strategic Site Allocations within their Local Plans.

11.2.1 Aylesbury Vale District Council

Strategic Site Allocations were identified during the 2004 Local Plan; two site allocations fall near the boundary of Central Bedfordshire, around the vicinity of the River Ouzel.

The Vale of Aylesbury Local Plan 2013-33 is currently under development and site allocations are yet to be formalised. Consultation with the Council confirmed that the emerging sites are not located near the boundary of Central Bedfordshire. However; if emerging sites and development are sited along the upper reaches of the River Ouzel and tributaries such as the Whistle Brook, this can potentially increase flood risk within the Central Bedfordshire. For example, any increase in impermeable area at the sites, post-development, has the potential to increase runoff entering the River Ouzel.

11.2.2 Bedford Borough Council

The adopted 2002 Local Plan and accompanying policies map for Bedford Council identified strategic development sites; the proposals map was updated in January 2014 to account for the adoption of Allocations and Designations within the 2013 Local Plan. The H13 and H14 site allocations are either located immediately adjacent to or near the vicinity of the boundary with Central Bedfordshire.

Bedford Council is in the process of preparing the Local Plan 2035; as part of this, the Council has requested a 'call for sites' to identify potential development sites. There are clusters of potential development sites in the Great Barford, Stewartby, Roxton and Chewston areas; sites 223, 270, 271, 308, 316, 336, 483, 569 and 570 are located near the vicinity of the Central Bedfordshire boundary.

11.2.3 Dacorum Borough Council

The Dacroum Borough Council Local Plan is still in development and at the time of preparation of this SFRA there were no definitive proposals for site allocation. Pre-submission Site Allocations (not yet adopted) provide an indication of the preferred sites in Dacorum Borough. None of the site allocations fall on the Central Bedfordshire boundary and are located on watercourses which drain away from Central Bedfordshire.

11.2.4 Luton Borough Council

The emerging Pre-Submission Luton Local Plan (2011-2031) identified potential development sites. Those sites which border or are near the border with Central Bedfordshire include:

- A housing allocation site called land to the west of Newlands Road
- The Butterfields Area comprising B1 use
- Two sites which will host between them a 500-place primary and a 900-place secondary school
- The south of Stockwood Park site which will comprise football stadium, ancillary sports facilities, retail and B1 uses, Napier Park which will comprise 600 new homes, a food store, a hotel and B1 uses
- A park and ride site
- Expansion of Luton airport which will accommodate 18 million passengers per year; B1-B8 uses, small-scale A1-A3 and D2 and a hotel.

Central Bedfordshire borders the north, south and west of Luton Borough. The River Lee flows from the Dunstable / Broughton Regis area of the District into Luton Borough and flows in a south-westerly direction before entering back into Central Bedfordshire, south of the A1081. A number of the sites listed above are located near the vicinity of the River Lee and / or in close proximity to each other.

Luton Borough's Surface Water Management Plan (SWMP) also considers the contributing hydrological catchments that lies within Central Bedfordshire. Pluvial modelling in the SWMP identified that flooding is heavily influenced by existing and historic river valleys, and impacts a number of regionally important infrastructure assets.

It advises that the two Councils should work together to manage and coordinate development in their adjacent areas, for example in the area of the North Houghton Regis Strategic Site Specific Allocation, and this may require exploring the implementation of upstream storage in Central Bedfordshire to provide attenuation downstream in Luton Borough, for example. Short and medium-term recommendations for both Councils set out in the SWMP, include engaging with residents regarding flood risk and their responsibilities for property drainage (especially in the Critical Drainage Areas identified), informing on mitigation measures and maintenance regimes and employing effective communication.

11.2.5 North Hertfordshire District Council

North Hertfordshire District Council's adopted Local Plan dates from 1996 and the majority of sites allocated in this Plan have since been developed. The Council has consulted on a number of sites listed within the February 2013 Housing Options papers. Strategic sites which are located near the border Central Bedfordshire include the North of Letchworth site where 1,000 homes, new school and potentially a new neighbourhood centre are proposed. This site is not located near any Main Rivers. Due to the steep topography and proximity to watercourses, development at this site is unlikely to significantly affect flood risk within Central Bedfordshire, particularly if appropriate drainage is adopted at the sites.

The Preferred Options Local Plan in 2015 included sites to meet strategic housing targets and the Council is developing a Proposed Submission Plan. The sites listed in the Preferred Options document which are located near the border Central Bedfordshire includes site 331 which has the potential for 100+ dwellings. This site is located near a couple of open drains which flow in an easterly direction into the River Ivel; the River Ivel then flows into Central Bedfordshire. The increase in impermeable area at these locations has the potential to increase runoff entering the open drains. However, if appropriate drainage is adopted at the site, the likelihood of any significant effect on the level of flood risk within Central Bedfordshire is low. It would be a requirement that consideration was given to the wider catchment implications of drainage mitigation measures, rather than just assessing immediate local effects.

11.2.6 South Cambridgeshire District Council

There are a number of large scale developments allocated within the adopted Local Development Framework or included as proposed allocations in the March 2014 Local Plan for South Cambridgeshire District Council. None of the site allocations fall on the Central Bedfordshire boundary and are located on watercourses which drain away from Central Bedfordshire. Further, consultation with South Cambridgeshire District Council confirmed that the impacts of these developments on flood risk has been undertaken in the process of identifying the sites for allocation.

11.2.7 St Albans City and District Council

The emerging Strategic Local Plan for St. Albans City and District Council identified four locations for future development; these are broad locations and although under consideration, are not currently adopted. The proposed North West Harpenden site, for 498 dwellings, is located on the border of Central Bedfordshire. However; this proposed site is not located on a watercourse and due to the steep topography, development on this proposed site is unlikely to significantly affect flood risk within Central Bedfordshire, particularly if appropriate drainage is adopted at the site. It would be a requirement that consideration is given to the wider catchment implications of drainage mitigation measures, rather than just assessing immediate local effects and noting the proximity of the sites, consider the cumulative impact of development to flood risk.

11.2.8 Huntingdonshire District Council

Huntingdonshire District Council has identified potential site allocations within the emerging Local Plan. None of the potential site allocations fall on the Central Bedfordshire boundary and are located on watercourses which drain away from Central Bedfordshire.

11.2.9 Water quality considerations

In addition to cross-boundary issues regarding flood risk, there are also cross-boundary issues relating to water quality. Development or agriculture in the upper catchments of watercourses that flow across boundaries into Central Bedfordshire can potentially impact on the quality of watercourses within the study area. Development should consider the quality of the water that is released from sites and the impact it may have on the water quality on any receiving waterbodies. Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area. Any impacts identified should then be considered in relation to the WFD Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives. Opportunities to improve the status of watercourses should also be considered. This is particularly important for Central Bedfordshire as there are several reaches of watercourses designated as 'bad overall status' and 'poor overall status, primarily due to diffuse pollution and phosphate levels. Most watercourses are designated as 'moderate' with some 'good'. Further details on the WFD requirements are in Section 14.

11.3 Summary

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

Due to the topography and the direction of watercourse flow in most of the neighbouring authorities, development is unlikely to affect flood risk within Central Bedfordshire, particularly if appropriate drainage is adopted at the sites.

For potential development sites along authority borders, or where there is a cross-boundary flood risk and / or mitigation measures (such as from reservoir inundation or SuDS), developers should engage with neighbouring authorities including neighbouring Lead Local Flood Authorities, to discuss flood risk and appropriate mitigation measures.

12 Advice for developers on managing flood risk at site-specific level

12.1 Introduction

Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk at a site are fully addressed. Different sites will trigger the need for a site-specific Flood Risk Assessment, as well as a surface water drainage strategy, to demonstrate the feasibility of a development proposal.

Some sites may additionally be put forward for the Exception Test following the Sequential Test if the Sequential Test indicates the proposed development inappropriate or unsuitable. These will require further work in a detailed Flood Risk Assessment (FRA). Any site that does not pass the Exception Test should not be allocated for development.

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

12.2 Requirements for site-specific Flood Risk Assessments

12.2.1 What are site-specific Flood Risk Assessments?

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

12.2.2 When is a FRA required?

In accordance with NPPF and the General Development Procedure Order (GDPO)[22] FRAs should always be provided with planning applications in the following circumstances:

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

Advice should be sought from the LPA and the Environment Agency at the pre-planning application stage to determine the need for a site-specific FRA. DEFRA's Guidance notes ***FD2320/TR2 'Flood Risk Assessment Guidance for New Development'*** and ***FD2321/TR2 'Flood Risks to People'*** should also be consulted.

When a Flood Risk Assessment is not deemed required, developers should still submit Central Bedfordshire Council's **'*Flood Risk and Drainage Pro-Forma*' Checklist** with all planning applications where there is likely to be a material impact on flood risk or drainage, to ensure all key flood risk and drainage considerations have been addressed as part of the site planning process. As stated in 12.3.2, a Surface Water Drainage Strategy will be required with all major planning applications, therefore the Council's **Sustainable Drainage Guidance** should be referred to and complied with. All minor applications should provide the Pro-Forma checklist.

12.2.3 Objectives of site specific FRAs

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

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

To meet the above objectives, a FRA should provide enough information to:

- Clearly state the risk of flooding arising from the development in addition to the risk of flooding to the development and identify, where possible, the opportunities to reduce the existing flood risk
- Identify the vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access
- Identify and propose potential flood risk reduction measures
- Assess the remaining 'residual' risk after risk reduction 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 development may affect drainage systems
- Fully account for current climate change scenarios and their effect on flood zoning and risk.

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

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

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

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

12.3 Requirements for site-specific Surface Water Drainage Strategies

12.3.1 What are Surface Water Drainage Strategies (SWDSs)?

A Surface Water Drainage Strategy (SWDS) demonstrates planning, design, construction, and maintenance considerations for surface water management systems. This applies to both greenfield and previously developed sites. A Surface Water Drainage Strategy should be appropriate to the scale, nature, and location of the development that is proposed, taking into account the requirements set out in national and local policy.

The requirement for a Surface Water Drainage Strategy is in addition to a Flood Risk Assessment (FRA); however, the two documents will include similar details and should inform one another. A Surface Water Drainage Strategy may therefore form part of the FRA but for validation purposes must be clearly identified. Failure to do so may result in an application not being made valid.

Central Bedfordshire Council's **Surface Water Advice Note** (June 2015) sets out guidance and checklists for developers wishing to submit a planning application with surface water drainage

implications. Some of the validation criteria outlined in this Advice Note is documented below for reference.

12.3.2 When is a SWDS required?

- **All major applications** submitted to Central Bedfordshire Council must include a Surface Water Drainage Strategy, which will set out the appropriateness of SuDS to manage surface water run-off and provision of maintenance for the lifetime of the development which they serve. Major applications which do not meet this requirement will not be made valid.
- **Minor applications** should demonstrate that surface water drainage arrangements have been considered, and should give priority to the use of SuDS. Central Bedfordshire Council will not require particular drainage submissions to make a minor application valid but encourage that enough evidence is provided in order for an assessment of surface water drainage implications arising from the site may be made. It is expected that surface water drainage will be considered by the applicant and sufficient detail of proposed drainage arrangements will be provided with the application, submitting the Council's **'*Flood Risk and Drainage Pro-Forma*' Checklist** as a minimum.

Where the discharge of surface water from the development site is considered to pose an increased flood risk to third parties downstream, and/or which may exacerbate an existing flooding problem, all application types will be required to pay particular attention to the management of surface water run-off.

The inclusion of SuDS within developments should be seen as an opportunity to enhance ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought.

More detail on the use of SuDS is provided in Section 13 alongside relevant hyperlinks to guidance.

12.4 Flood risk management guidance – mitigation measures

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

For potential development sites along authority borders or where there is a cross-boundary flood risk and / or mitigation measures (such as from reservoir inundation or SuDS), developers should engage with neighbouring authorities including neighbouring Lead Local Flood Authorities, to discuss flood risk and appropriate mitigation measures.

12.4.1 Minimising risk through site layout and design

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

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

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and regionally. Where a previous connection from a site was to a surface water or foul public system, the approach should be to find alternatives using SuDS in order to relieve existing pressures, or reduce flow rates received by the systems. Development locations should be assessed to ensure capacity exists within both the on- and off-site network.

The only way to fully reduce flood risk from groundwater would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1 in 100-

year plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream. This is because groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. It is therefore advised that groundwater depths and permeability are established as early on in the process as possible.

Areas adjacent to watercourses which have known overland flow routes can act as Green Infrastructure (discussed in Chapter 13). This is where land can be used for recreation, amenity and environmental purposes, whilst allowing the preservation of flow routes and flood storage, thus contributing to other sustainability objectives. Landscaping in developments should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

12.4.2 Making space for water

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

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

The provision of a buffer strip can 'make space for water', allow additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes. As a minimum, developers should leave a buffer strip of 9m.

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

12.4.3 Raised floor levels and basements

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

The Environment Agency advises that minimum finished floor levels should be set 300mm above the 1% AEP plus climate change peak flood level, where the new climate change allowances have been used (see Chapter 4 for the climate change allowances). The minimum finished floor level should be set 600mm above the 1% AEP plus climate change peak flood level, where only a 20% allowance for climate change is available. The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA. All levels stated in assessments should be in relation to Ordnance Datum (i.e. the height above sea level).

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

Similarly, the use of basements should be avoided within flood affected areas. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Access should be situated 300mm above the design flood level and waterproof construction techniques used. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties.

For minor extensions, floor levels should be either no lower than existing floor levels or 300mm above the estimated flood level. If the former, specific flood resistance and resilience measures will need to be demonstrated, as discussed in Section 12.5 and 12.6.

12.4.4 Development and raised defences

Site-specific FRAs will need to thoroughly explore the condition of defences, especially where these defences are informal. It is important that all assets are maintained to a good condition and their function remains unimpaired. Developers should also consider the Standard of Protection (SoP) provided by defences and residual risk as part of a site-specific FRA.

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

Temporary or demountable defences are not acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe but the time required to install the defences, for example in an overtopping scenario would be achievable and realistic. In addition to the technical measures, the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate. The preferred method is retro-fit passive protection, as no action is required by inhabitants, only normal maintenance.

12.4.5 Modification of ground levels

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

Where development is proposed within Flood Zone 3, compensatory flood storage must be provided on a level for level and volume for volume basis. Land identified for floodplain compensation must be in the immediate vicinity of the site, outside of Flood Zone 3 and within the red line boundary of the planning application.

Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land or property. Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels will need to be assessed as part of a detailed Flood Risk Assessment.

12.4.6 Developer and FCRMGiA contributions

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

Defra's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[11] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local

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

businesses or other parties benefitting from the scheme. FCRMGiA should not be used to enable new development to come forward, which should be bearing full costs itself.

FCRMGiA can be obtained by **operating authorities** (for example the Environment Agency, Local Authority and IDB) to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding (for example raised by the Regional Flood and Coastal Committee), special levy (raised by IDBs for drainage and water level management), local businesses, developers or other parties benefitting from the scheme.

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

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

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

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

12.5 Flood risk management guidance - resistance measures

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 1 in 1,000-year scenario. In these cases, and for existing development in the floodplain, additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. **These measures should not normally be relied on** for new development as an appropriate mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The following measures are often deployed:

- **Permanent barriers**

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

- **Temporary barriers**

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

- **Community resistance measures**

  These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the

deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

12.6 Flood risk management guidance - resilience measures

Buildings should be constructed in such a way that although floodwater may enter the building, its impact is reduced (i.e. no permanent damage is caused, structural integrity is maintained and drying and cleaning is facilitated). This type of **approach** is often more appropriate when the predicted depth of flooding is greater than 0.3m or flooding is expected to last for a long time. In these cases, the use of more durable materials that will not be easily damaged by floodwaters as well as the use of construction materials that are more effective at draining and drying are recommended.

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier. Interior design measures to reduce damage caused by flooding include:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level
- Water-resistant materials for floors, walls and fixtures
- Non-return valves to prevent waste water from being forced up bathrooms, kitchens or lavatories
- If redeveloping existing basements for non-residential purposes, new electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to minimise damage if the development floods.
- Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.
- Installation of pumps in basements may be acceptable as a resilience measure in existing developments, to mitigate against groundwater flooding. However, for new development this is not considered an acceptable solution.

These should aim to be provided on any development going forward in a Flood Zone, in addition to minor extensions in the floodplain and where there is surface water flood risk.

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13 Surface water management and SuDS requirements

13.1 What is meant by Surface Water Runoff?

Introduction of impervious surfaces leads to increased surface water runoff rates and volumes when compared against Greenfield sites. These increases exacerbate existing or create new surface water flood risks downstream of a site and can also cause pollution of the water environment. Land clearing and re-grading for the purpose of construction activities can also remove existing rainwater storage depressions and compact soils limiting their infiltration potential.

Any additional post-development surface water (including any existing drainage patterns) needs to be managed to prevent it flowing on to other properties or flowing unrestricted into watercourses and potentially exacerbating flood risk elsewhere. Development can also reduce the water quality of runoff generated from the site, the mitigation of which should be managed on-site to prevent adverse impacts on any receiving watercourses.

13.2 Managing surface water from new development

All development should therefore aim to achieve pre-development greenfield run-off rates. If this is not proposed, evidence must be submitted demonstrating why it has not been possible to achieve the greenfield run-off rate and why it is only possible to achieve the proposed discharge rate. This will be considered by the Local Planning Authority.

Brownfield sites should provide betterment of the existing drainage regime on site, and wherever possible, achieve greenfield run off rates and volumes. Where it is demonstrated that greenfield cannot be achieved, brownfield sites should provide a betterment of at least 30% of the existing discharge rate and volume.

All new major development proposals should ensure that sustainable drainage systems for management of run-off are put in place, though minor developments should still aim to use SuDS also. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

Under CBC's validation criteria, all major planning applications are required to be accompanied by a detailed SuDS drainage design, this is a separate requirement to provision of an FRA. Minor applications should demonstrate the approach to surface water drainage and submit this as part of the planning application, as set out in Section 13.3.2.

The LLFA is not a statutory consultee on minor developments as minor developments are unlikely to raise significant flood risk issues unless:

- they would have an adverse effect on a watercourse, floodplain or its flood defences;
- they would impede access to flood defence and management facilities; or
- where the cumulative impact of such developments would have a significant effect on local flood storage capacity or flood flows.

For developments in these situations, the LPA must establish the requirements for FRAs and assess their suitability as part of the planning application. The LPA may choose to consult with the LLFA on these sites to determine the suitability of development against flood risk.

The proposed drainage system shall be designed in accordance with the Non-Statutory Technical Standards for Sustainable Drainage Systems and any forthcoming Sustainable Drainage Systems Guidance from Central Bedfordshire Council and best practice such as the **CIRIA 753 The SuDS manual**.

13.3 What are Sustainable Drainage Systems (SuDS)

SuDS aim to mimic the natural drainage patterns by reducing the post-development runoff rates and volumes to the equivalent pre-development flows to prevent increased flood risk to new developments and existing downstream sites. SuDS also provide runoff treatment through

sediment settlement, filtration and biological processes to mitigate against the adverse impact of new developments on the quality of the receiving water environment.

SuDS provide a means of dealing with the quantity and quality of surface water whilst offering additional benefits over traditional systems of improving amenity and biodiversity. It is often found that SuDS are cheaper to construct and maintain that traditional piped drainage solutions, and a well-designed SuDS system can increase property values.

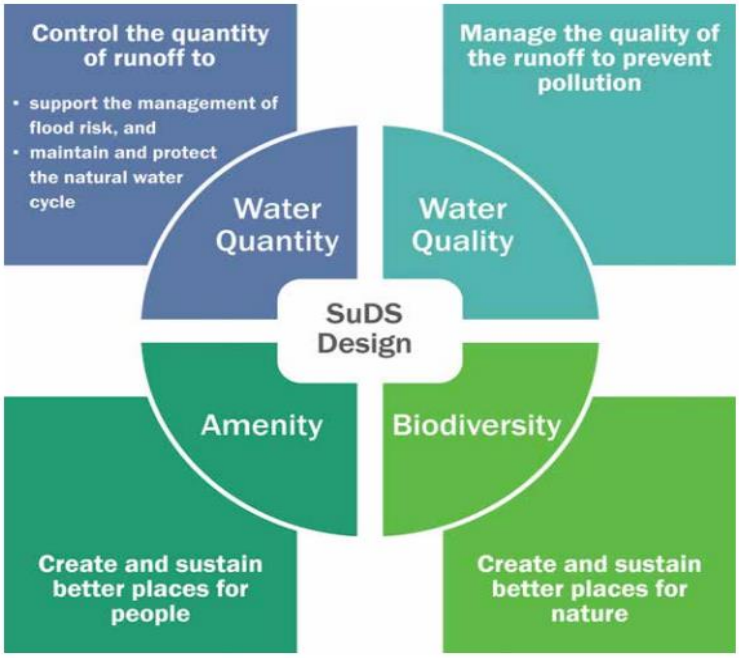
SuDS can take many forms, and can therefore be designed to fit into the majority of spaces within a development, either as a new-build or retrofit solution. New surface water systems should ideally follow a **'drainage hierarchy'** starting with prevention at source using on site disposal through measures such as rainwater harvesting. Where this is not feasible, infiltration on site is the preferred option for surface water discharge, followed by discharge to a watercourse and then connection to a sewer as a last resort. This is in line with **CIRIA 753 The SuDS manual**.

The correct use of SuDS also allows developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing groundwater supplies. SuDS can improve the quality of life within a development offering addition benefits such as:

- Improving air quality
- Regulating building temperatures
- Reducing noise
- Providing education opportunities

It is essential that the consideration of sustainable drainage takes place at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These four principles are shown in Figure 13-1.

Figure 13-1: Four pillars of SuDS design



Source: The SuDS Manual (C753)

13.4 SuDS Local Requirements

There are locally adopted requirements for SuDS in Central Bedfordshire Council; these are:

1. Plan in SuDS from the start

2. Replicate natural drainage
3. Water re-use first
4. Enhance biodiversity
5. Focus on multi-functional waste in SuDS
6. Minimise carbon and waste in SUDS
7. Design for easy access and maintenance
8. Linked design through every scale
9. Place making through SuDS design
10. Surface conveyance over pipes.

In addition to the surface water management requirements, these help to meet other local planning policies, such as climate change mitigation and adaptation, green infrastructure and ecological enhancements, managing water quality and flood risk, landscape character, and open space for healthy and sustainable communities. These are further detailed in Central Bedfordshire Council's **Sustainable Drainage Guidance**.

13.5 SuDS Design Considerations

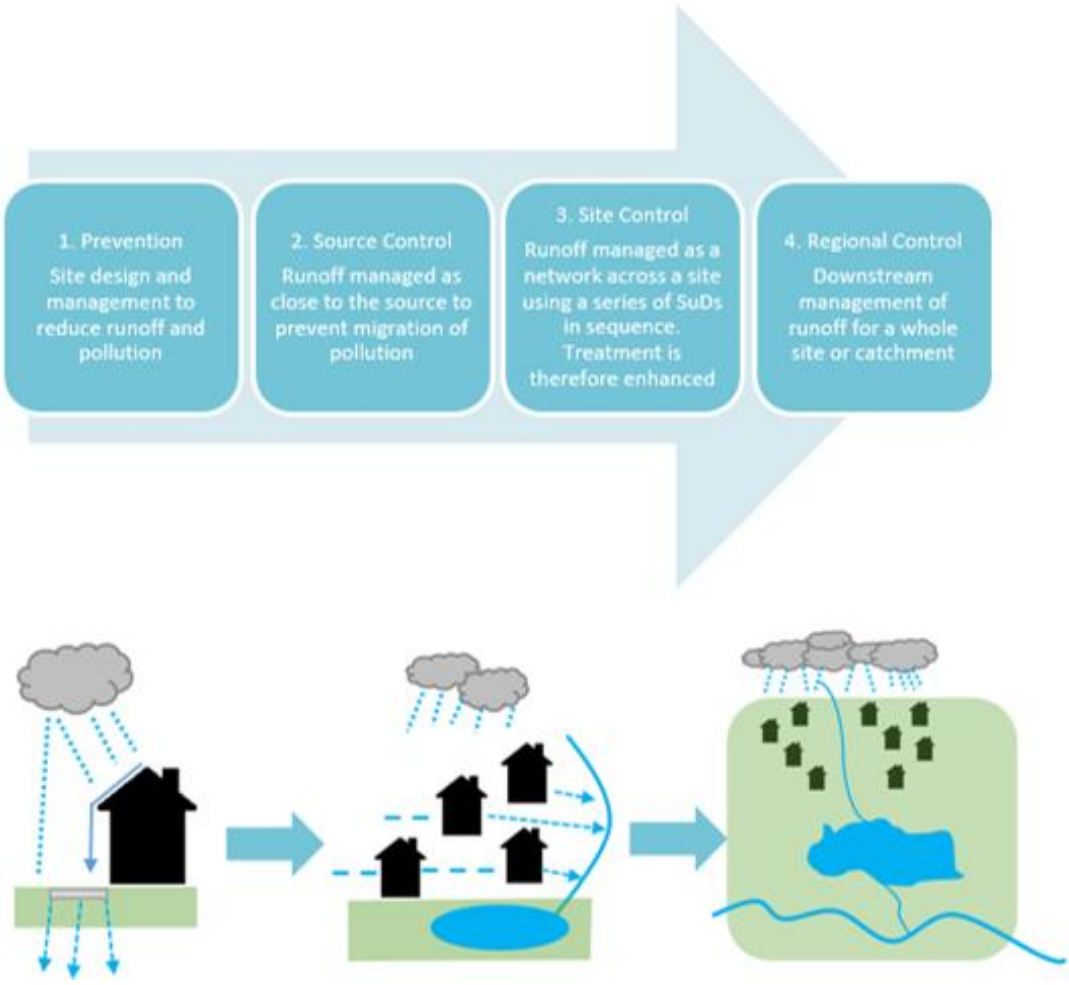
SuDS need not be challenging or expensive. The design of a SuDS system will be influenced by a number of physical and policy factors. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Such physical and policy factors could include:

- Topography, e.g. steep or shallow slopes
- Local Geology and soil permeability
- Development Density and available land area
- Former site use, e.g. ground instability, contaminated soils
- Location of existing and proposed services and utilities
- Groundwater conditions
- Proposed site use
- Landscape Character of the development and its surroundings
- Future adoption and maintenance arrangements

13.5.1 SuDS management train

SuDS components should be selected based on design criteria and how surface water management is to be integrated within the development and landscaping setting. By using a number of SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development, helping conform to the water quality objectives of the Water Framework Directive, discussed in Chapter 13. Figure 13-2 highlights the different types of SuDS management, beginning with prevention and source control at the source-level, progressing to site control and regional control.

Figure 13-2: SuDS management train



Central Bedfordshire Council's **Sustainable Drainage Guidance** provides more detail on consideration of options and types of SuDS along with their benefits.

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

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

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

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

reasonably practicable should be through reference to Defra's Non-Statutory Technical Standards[12] and should take into account design and construction costs.

The **Adopted SuDS guidance: Sustainable drainage Supplementary Planning Document (SPD)** was produced by Central Bedfordshire Council in their role as LLFA to support the provision of effective, innovative SuDS, and to set out the requirements of the LPA in planning applications etc.

13.7 SuDS policies and sources of SuDS guidance

13.7.1 Central Bedfordshire's Adopted Sustainable Drainage Guidance

Central Bedfordshire Council's **Adopted SuDS guidance: Sustainable drainage Supplementary Planning Document (SPD)** was adopted in April 2014, and updated in May 2015, to reflect the changes to SuDS and how they are considered as part of the planning process.

The use, design and layout of SuDS must satisfy strategic requirements as set out in this guidance. The document emphasises that surface water should be managed as close to source (where it falls) and on the surface wherever possible, that the principles of the SuDS management train be applied and that wherever possible the passage of water between individual parts of the train be delivered through the use of natural conveyance systems (e.g. swales and filter trenches) in place of conventional pipework.

The SPD considers four main parts, and provides many useful hyperlinks to supporting information and guidance:

1. **Policy background** - With regards to SuDS, the emerging development strategy for Central Bedfordshire focuses on two main policies:
    - Policy 48: Adaptation – focusing on SuDS as a means to prevent surface water flooding, and using SuDS to deliver multiple benefits beyond flood risk.
    - Policy 49: Mitigating flood risk – this policy also supports the need to improve water quality and impact positively on the environment.
2. **The approval process** - As part of the approval process, the SPD provides checklists for major and minor planning applications from pre-application, to outline application, to full planning application and discharging conditions. It outlines who the Statutory Consultees are and when they should be consulted, and the adoption of SuDS by Third Parties (see Section 10.5).
3. **Design considerations and local requirements** – This outlines design considerations relating to the SuDS team, local requirements and relevant SuDS planning policies.
4. **Consideration of local nuance (development of local SuDS zones)** – Central Bedfordshire has a number of unique landscape characteristics, which will impact the way SuDS are designed. This section outlines how the existing landscape should inform the design of SuDS in four unique zones (as set out in page 65 of the **SuDS Guidance**):
    1. Southern Chalk Lands;
    2. Greensand Ridge and Valley;
    3. Clay Hills and Vales; and
    4. Clay River Floodplain

The Council will update the SPD periodically in light of any new policy changes at the Local or National level.

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

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

Central Bedfordshire Council have an **Advice Note** for the provision of Surface Water Drainage Strategies, published in June 2015. This document is discussed in more detail in Section 12.3: Requirements for site-specific Surface Water Drainage Strategies.

13.7.3 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development. Guidance within the document complements information found within Central Bedfordshire Council's SuDS Guidance.

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

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

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

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

13.8 SuDS adoption and maintenance

There are a variety of maintenance options open to developers that allow an element of flexibility. The developer can maintain the SuDS themselves or they may negotiate with a third party to maintain the SuDS. Sustainable drainage systems should be designed to ensure that the maintenance and operation requirements are economically proportionate.

The SPD discussed in Section 10.4.1 outlines the various parties below who may adopt SuDS, in detail:

- Private Management Companies
- Sewerage Undertaker (Thames Water or Anglian Water)
- Central Bedfordshire Council (Leisure)
- Central Bedfordshire Council Highways
- Town and Parish Councils
- Bedford Group of IDBs
- Private Individuals
- Trusts and organisations (i.e. Greensand Trust)

Developers need to provide this information in conjunction with the application to Central Bedfordshire Council. Central Bedfordshire Council, the IDB and Water Companies should be consulted early on to establish and requirements they may have to adopt and/ or maintain SUDS.

As part of recent changes to the **Land Charges Search CON29**, information should be provided on SuDS serving properties to ensure future homeowners and subsequent homeowners will be aware of any maintenance requirements/ responsibilities for surface water drainage. This information needs to be provided to the Local Authority as part of a detailed application to allow Central Bedfordshire Council to provide this as part of a Land Charge search.

Further measures could be proposed by the applicant and may include, for example, information provided to the first purchaser of the property and designation or registration of the SuDS so that it appears as a Land Charge for the property, and as such is identified to subsequent purchasers of the property.

Under the Flood and Water Management Act 2010, county and unitary authorities will be able to levy a maintenance charge on occupiers of properties that are served by an adopted SuDS, therefore it is important that buyers are able to find out who is responsible for collecting the maintenance charges and subsequently the amount of the charge. Any methods involving designation or registering a Land Charge are to be agreed with the Local Planning Authority.

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14 Green Infrastructure and the Water Framework Directive

14.1 Green Infrastructure

Green Infrastructure (GI) is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe and consist of:

- Open spaces – parks, woodland, nature reserves, lakes
- Linkages – River corridors and canals, and pathways, cycle routes and greenways
- Networks of "urban green" – private gardens, street trees, verges and green roofs

The identification and planning of GI is critical to sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. GI is also central to climate change action and is a recurring theme in planning policy.

With regards to flood risk, green spaces can be used to manage storm flows and free-up water storage capacity in existing infrastructure to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. GI can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity. It should be considered as critical infrastructure embedded at the start of projects.

14.1.1 Green Infrastructure Plans concerning Central Bedfordshire

As Central Bedfordshire Council is a relatively new entity (established in 2009), its Green Infrastructure (GI) Plans are still separated into the authority's predecessors; The **Mid Bedfordshire GI Plan** (2008) and the **Luton and Southern Bedfordshire GI Plan** (2009). In addition to having its own GI Plans, it also falls under the County level **Bedfordshire and Luton Strategic Green Infrastructure Plan**, whilst within the district there are multiple **community level GI Plans** developed by town and parish councils.

Both the strategic and district plans seek to integrate information from: accessible greenspace, access routes, biodiversity, historic environment, and landscapes to determine the GI assets and the wider GI network within the authority.

Additionally, as part of the Milton Keynes South Midlands (MKSM) growth area, Central Bedfordshire is incorporated within the growth area's GI framework **guidance document**.

These GI plans identify existing GI assets that should be protected from and integrated in developments. They also identify opportunities which developments should deliver in order to protect and enhance the GI network.

14.1.2 Mid Bedfordshire GI Plan (2008)

The Mid Bedfordshire GI Plan has the primary aim of identifying the existing and potential natural, historic, cultural and landscape green infrastructure features that should be protected and enhanced or created to ensure the foundation for sustainable communities and a connected multi-functional green infrastructure network going forward.

The objectives of the Plan include protecting, enhancing and creating GI assets within the district whilst maintaining the GI network, improving links between people and wildlife, delivering integrated social, economic and environmental benefits that contribute to improved quality of life and minimising the impacts of global warming. There are two main rivers in the Mid Bedfordshire GI Plan; the River Ivel and the River Flit, whose floodplains play a vital role in flood alleviation. Opportunities for increased flood storage will be investigated where possible, by recreating river valley flood meadows from arable farm land (for examples in the Lower Ivel catchment) and wet woodland (for example in Biggin Wood, Clay Vale), restoring wetlands and grassland, such as those in the Flit Valley.

Priority networks of GI within Mid Bedfordshire have been summarised into six sub-areas:

- Forest of Marston Vale
- Ivel Valley
- Greensand Ridge Nature Improvement Area
- Flit Valley
- Southern Clay Ridge and Vale
- Chilterns

14.1.3 Luton and southern Bedfordshire GI Plan (2009)

The **Luton and southern Bedfordshire GI Plan** has the aim of determining the GI assets and opportunities within the authority, as well as identifying the GI network for Luton and southern Bedfordshire, based on a multifunctional network of accessible greenspace, access routes. biodiversity, historic environment, and landscapes. Additionally, it seeks to increase the connectivity between the urban and rural areas of the district.

The plan's objectives include: informing the local planning policies for the protection, enhancement and creation of GI assets, positively influencing and guiding proposals that seek to enhance green spaces, identify priority areas of the GI network and suitable projects that will further enhance the network, improve links between people and wildlife, improve the community's quality of life and mitigate the impact of climate change. The linking of habitats and wildlife sites allows these areas to adapt to climate change more easily. To reduce the effects of increased flood risk from climate change, this plan intends to explore options of increased floodplain storage and the protection of floodplain capacity from future development. For example, recreating the floodplain of the River Ver by the busy A5 and protecting flood meadows along the River Ouse in Leighton Buzzard by creating informal open space.

Within the plan, four Network Areas have been identified:

- The Ouzel Valley
- The Chalk Arc
- Leighton-Linslade to Dunstable
- The Upper Lea Valley

14.1.4 The Bedfordshire and Luton Strategic Green Infrastructure Plan (2007)

The **Bedfordshire and Luton Strategic GI Plan** was published in 2007 with the aim of developing a framework for the spatial vision of strategic green infrastructure necessary to provide the foundations for sustainable communities across Bedfordshire and Luton, including Central Bedfordshire until 2021. It identifies areas that offer the best opportunity in terms of creating multi-functional green infrastructure whilst also serving to guide landowners, planners and developers to ensure developments deliver maximum environmental and GI benefits. Rivers in particular where identified as key corridors for species dispersal and migration, but also areas where opportunities to create and extend wetland habitats, would serve in the management of flood alleviation and water storage.

It identifies eleven corridors where investment and project delivery can make the greatest impact in securing multi-functional GI, and sets out the GI opportunities at each corridor below:

- Milton Keynes to Grafham Water
- Upper Great Ouse River Valley
- Lower Great Ouse River Valley
- Ivel River Valley
- Bedford to Milton Keynes
- Greensand Ridge
- Ouzel River Valley
- Flit Valley

- The Chalk Arc
- Leighton Linslade to Dunstable
- Upper Lea River Valley

14.1.5 Green Infrastructure in the Forest of Marston Vale

The Forest of Marston Vale have a document called **Creating Green Infrastructure in the Marston Vale**, which provides example projects and partnerships in the Forest of Marston Vale. GI sites in the Marston Vale include:

- Rectory Wood, Cranfield
- Millennium Country Park and Forest Centre
- NCN Route 51
- Conquest Community Woodland
- Bedford's Green Gateway
- British Car Auctions Development
- Houghton Conquest Housing Development
- Marsh Leys Distribution Park

Other Case Studies are shared on the 'Marston Vale Surface Waters Plan', 'Sustainable transport infrastructure linking new and existing environmental assets', 'Working with developers' and 'Application of the model to a small housing development'.

14.1.6 Additional Central Bedfordshire sources on Green Infrastructure

Additional Information is provided on Central Bedfordshire Council's website, including pages on **Green Infrastructure** and **Green Infrastructure Plans,** as well as the **Design Guide** that provides an overview of all the principles and standards that influence new developments, including Green Infrastructure considerations.

14.1.7 Using SFRA data to support GI Strategies

The evidence base provided in this SFRA should be used to help inform any Green Infrastructure Plans or Strategies in Central Bedfordshire. River corridors identified as functional floodplain can provide flood storage during a flood event. The Council GI strategies should also incorporate any areas identified within the urban environment or upstream of a critical surface water flood area. Creating flood storage areas or flow paths areas and improving accessibility to this land can help protect current and future property.

Potential development site locations, as identified by the Council, which have watercourses flowing through them, provide an opportunity to use the land as green infrastructure by adopting the Sequential design to locate development away from watercourses and Flood Zones, and by the use of SuDS. This can provide multiple benefits across a number of disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes.

Developers should refer to Central Bedfordshire Council's **Design Guide.**

14.2 The Water Framework Directive

The EU Water Framework Directive (WFD) is a piece of European water legislation that is designed to improve and integrate the way water bodies are managed throughout Europe. The WFD was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Ecological Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date.

The WFD aims to achieve at least 'good' status for all water bodies; the default deadline for achieving this objective is by 2021 although, in some cases, where it is deemed more appropriate,

less stringent objectives have been set with extended deadline of 2027 or beyond. The WFD requires the production of Management Plans for each River Basin District. These plans assess the pressures facing the water environment in each district. Each District is composed of a group of catchments termed river basins to which all water bodies are assigned.

In England, the Environment Agency (EA) is responsible for the delivery of the WFD objectives. The EA has produced River Basin Management Plans (RBMP) for the whole of England which describe how the WFD will be achieved. RBMPs set out the ecological objectives for each water body and give deadlines by when objectives need to be met. All waterbodies have to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. GEP is the best ecological improvements that can be achieved for a water body while still enabling Flood and Coastal Erosion Risk Management (FCERM) works to be undertaken to protect people and property from flooding.

The WFD defines the flow, shape and physical characteristics of a watercourse as its 'hydromorphology.' Any in-channel works can impact upon the shape of a watercourse and the natural processes that occur within it, including:

- flow patterns
- width and depth of a channel
- features such as pools, riffles, bars and bank slopes
- sediment availability/transport
- interaction between a channel and its floodplain
- ecology and biology (i.e. habitats which support plants and animals)

Any adverse impacts can cause a waterbody's ecology to deteriorate and prevent environmental improvements from being undertaken. Nevertheless, in-channel works can also be beneficial if they can be designed to help achieve environmental improvements included in the RBMP, thus enhancing the water environment for plants and animals.

14.2.1 Preventing Deterioration in Status

Any activity which has the potential to have an impact on the ecology of a waterbody will need consideration in terms of whether it could cause deterioration in its Ecological Status or Potential.

For each waterbody, three different status objectives are identified. These are the overall status objective, the ecological status or potential objective and the chemical status objective. A default objective for all water bodies is to prevent the deterioration in the Ecological Status (or Ecological Potential for Heavily Modified and Artificial Water Bodies) of the waterbody.

14.2.2 Artificial or Heavily Modified Waterbodies

Artificial and heavily modified waterbodies have a target to GEP. Specific mitigation measures have been identified for each Artificial and Heavily Modified Waterbody within the River Thames and the Anglian basin (both intersect the Central Bedfordshire Council boundary). There are no Artificial or Heavily Modified Waterbodies within the Central Bedfordshire Council boundary and in the Thames river basin. The majority of Anglian river basin waterbodies are classified as Artificial or Heavily Modified and outlined in the Anglian RBMP.

A map showing the overall status of the main waterbodies in the Central Bedfordshire Council administrative area is shown in Figure 14-1. This is based on the classification status for waterbodies reported in 2015. *Note, not all the watercourses in the study area are shown on this map.* Below is a list of heavily modified waterbodies and their ecological status:

Table 14-1: WFD Status of Central Bedfordshire Watercourses

Watercourses	WFD Status
Cat Ditch and River Lee	'Bad' Overall Status
Broughton Brook	'Poor' Overall Status

Campton Brook, Chicksands Brook, Flit tributary, Barton Brook, River Ivel Navigation Channel, Stondon Brook, River Ivel (Langford to Roxton reach), Millbridge-Common Brooks, Stone Brook, Pix Brook, Rhee, Ouzel Brook, River Ouzel and Elstow Brook	'Moderate' Overall Status
Clipstone Brook and tributary, New Inn Brook, Hexton Brook, River Ivel (upstream of Henlow) and Ickwell Brook	'Good' Overall Status

There are mitigation measures identified for the waterbodies within the Central Bedfordshire study area, detailed in the RBMP. These mitigation measures are necessary to reduce the existing hydromorphological impacts on the waterbody and all measures need to be in place in order for the waterbody to achieve Good Ecological Status or Potential.

14.2.3 WFD Assessments

A detailed assessment should be undertaken to determine the effects that any proposed works within or adjacent to a watercourse could have upon Water Quality Elements. Any impacts identified should then be considered in relation to the Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives.

In order to establish whether the strategy complies with the WFD it is necessary to ascertain whether the preferred options have the potential to result in

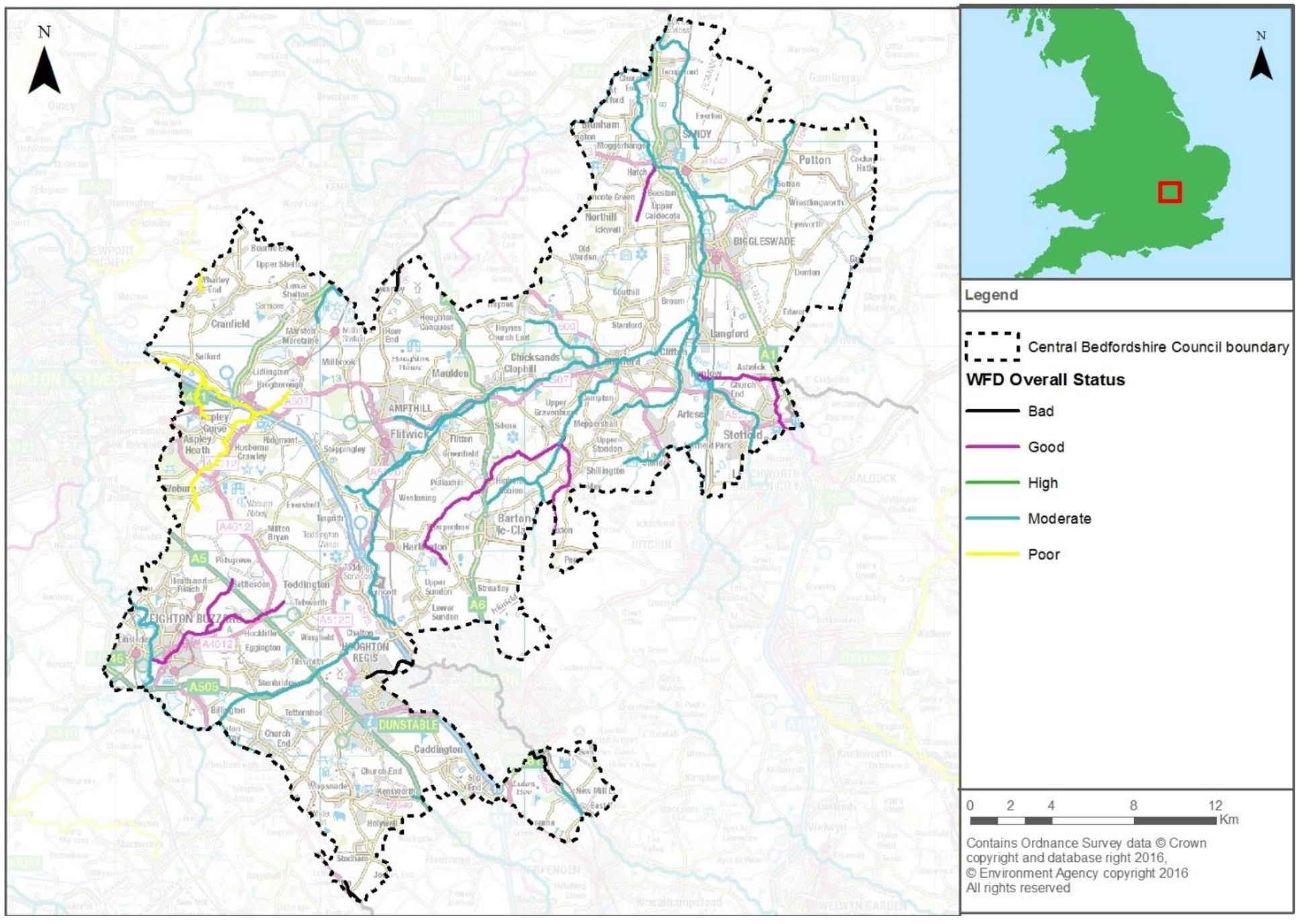
- failure of a water body to achieve good ecological status or potential; or
- failure to prevent a deterioration in the ecological status or potential of a water body.

If the answer to these questions is 'no' the strategy can be considered WFD-compliant. If either of these failures is identified, further assessment will be required to identify if the strategy meets all of the conditions set out by the WFD Legislation.

Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area. Opportunities to improve the status of watercourses should also be considered. Development or agriculture in the upper catchments of watercourses that flow across boundaries into Central Bedfordshire can potentially impact on the quality of water of these watercourses.

The Environment Agency is working with its partners, businesses and the community to investigate improvements to the ecological status of these water bodies and techniques such as "sediment fingerprinting". Further information on the ecological status of waterbodies is available on the Environment Agency's **Catchment Data Explorer**.

Figure 14-1: WFD overall status of the main waterbodies in Central Bedfordshire



15 Strategic flood risk solutions

15.1 Types of strategic flood risk solutions

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the district. This chapter considers the different types of flood risk management measures which may offer natural flood risk solutions, where there are future opportunities for such solutions in Central Bedfordshire and where there are existing projects in the district seeking to reduce flood risk whilst enhancing the river environment.

15.1.1 Natural flood risk management

Natural Flood Management (NFM) embraces a range of techniques that aim to help to reduce flooding by working with natural processes to slow down and/ or temporarily store flood waters in the landscape. NFM alone cannot prevent the consequences of more extreme floods, especially in larger catchments. However, they can make a significant contribution to mitigating some of the effects of small to medium magnitude floods and also help to increase the resilience of existing or new flood risk management infrastructure to the effects of climate change.

Since the publication of the Pitt Review into the Summer 2007 floods in England, together with its recommendations, there has been an increasing interest and need to explore how working with natural processes and the implementation of natural flood management approaches in catchments can effectively compliment more traditional flood risk management techniques (structural and non-structural) and help to increase resilience to projected climate change effects. The scale, nature and location of NFM measures within catchments also provide a wide range of additional benefits to the environment and society.

Defra, the Environment Agency and Lead Local Flood Authorities are now actively applying the concepts of working with natural processes and NFM within existing catchment partnerships to projects to ensure that multiple benefits are achieved.

Natural flood risk management measures can include woodland creation, land management, upland flood storage areas and river restoration. '**Re-wilding**' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example.

'Leaky' dams play a very important role by impeding flood flows and pushing them out of bank onto small, localised patches of floodplain.

Woodlands are another integral part of these projects, long known to reduce flood flows by evaporating more water, increasing water absorption by the soil, roughening up land surfaces and decreasing soil erosion. This means rainwater will take longer to get into the rivers.

Further information on this project can be found on the **Forestry Research website**. These are cheap, quick and easy to build measures and could be viable measures of flood risk management in Central Bedfordshire.

Case Study: Pickering, North Yorkshire

Natural flood risk management is being used to alleviate flooding via the **'Slowing the Flow'** project, reducing the risk of flooding in the town from a 25% change in any year to less than a 4% change. This included building a flood storage area by placing 167 'leaky' wood dams and 187 heather bale dams within streams, building timber bunds, planting 44ha of woodland and improving farmland, moorland and woodland management.

15.1.2 Flood storage schemes

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

- enlarging the river channel;

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

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

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

The construction of new upstream storage schemes as part of upstream catchment-based approaches within Central Bedfordshire would provide one potential strategic solution to flood risk. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream.

It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency. In addition, as part of the Price Review 19, water companies are investigating whether their assets can be used for flood risk management purposes and leasing, for example using the reservoirs in Central Bedfordshire. This is contributing to the future direction of Flood Risk Management.

15.1.3 Floodplain restoration solutions

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

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

Loss of floodplain connectivity in the upper reaches of these tributaries which flow through urban areas in the district could potentially increase flooding within these areas. This will also negate any need to build flood defences within the sites.

Structure Removal and / or modification (e.g. weirs)

Structures, both within watercourses and adjacent to them, can have significant impacts upon rivers, including alterations to the geomorphology and hydraulics of the channel through water impoundment and altering sediment transfer regime. Many artificial weirs and culverts are often redundant and/ or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, some artificial structures may have important functions or historical/ cultural associations, which need to be considered carefully when planning and designing restoration work.

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

Further information is provided in the '**Trash and Security Screen Guide 2009'**, published by the Environment Agency/ Defra, which should be used as evidence for any culvert assessment, improvement or structure retention.

Bank Stabilisation

It is generally recommended that bank erosion is avoided where possible and to encourage all landowners to avoid using machinery and vehicles close to or within the watercourse. In an area where bankside erosion is particularly bad and/ or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spiling, can be particularly

effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils.

Bank removal, set back and/ or increased easement

The removal or realignment of flood embankments and walls can allow the natural interrelationship between the river channel and the floodplain to be reinstated. This can be achieved at a small scale within urban areas providing pockets of attractive green spaces along rivers, whilst also improving floodplain storage within confined urban environments at times of flooding. A detailed assessment would need to be undertaken to gain a greater understanding of the response to the channel modification, including flood risk analysis to investigate flood risk impacts.

Re-naturalisation

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

15.1.4 New flood defences

There are very few formal flood defences present within Central Bedfordshire (see Section 8 for further information). Flood mitigation measures should only be considered if, after application of the sequential approach, development sites cannot be located away from higher risk areas. If defences are constructed to protect a development site, it will need be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

15.1.5 Payment for ecosystems benefits

'Ecosystem services' refers to the diverse benefits obtained from the natural environment, for example food, water and timber supply (provisioning services); air quality, climate and flood risk regulation (regulating services); recreation, tourism and education (cultural services); and supporting services such as soil formation, water and nutrient cycling. The **Payments for Ecosystem Services: A Best Practice Guide** outlines this concept in more detail.

'Paid Ecosystem Services' (PES) therefore refers to payments made to the stewards or providers of ecosystem services from scheme beneficiaries or users of ecosystem services, i.e. those who provide ecosystem services, like any service, should be paid for doing so. It provides an opportunity to put a price on previously un-priced ecosystem services, bringing them into the wider economy. Central Bedfordshire Council depend on these ecosystem services provided by the environment.

15.2 Opportunities for strategic solutions in Central Bedfordshire

15.2.1 Stewartby and Brogborough Lakes

Stewartby Lake is the primary asset in the existing Surface Water Strategy for the Vale; however, its ability to fulfil this role with potential large-scale development in the southern Vale is unclear and untested. There is uncertainty surrounding if and how surface water volume storage can be achieved practically, given known challenges with the current effectiveness of the IDB-managed sluice gate and implementation of the (historic) water-level management plan for the Lake.

It is recommended that further work is undertaken to ensure a more comprehensive understanding of how this functions, its limitations and the constraining factors. A known area of concern is the long length of the out-flowing brook which is culverted as it runs through the old Stewartby brickworks site, alongside Stewartby Landfill (from Central Bedfordshire into Bedford Borough Council authority areas). This is an important length about which very little is known due to the channel having been 'hidden' for a long time.

The concept of 'Linking the Lakes' could be a great opportunity to assist with optimising the use of Stewartby Lake, by using Brogborough Lake as something akin to a 'header tank' for spring/ summer recharge. However, the IDB's modelled extents of the Elstow Brook catchment do not extend as far as Brogborough Lake and its associated drainage channels; this should be considered going forward to establish the technical feasibility of this concept, as it could provide a

strategic solution for the area. Stewartby Lake may also have limitations on attenuation for new development in the long-term future and potentially this and any implications downstream should be established as new development comes forward.

15.2.2 Houghton Regis and Luton

Central Bedfordshire Council are working with Luton Borough Council on the outcomes of the SWMP, which identified Critical Drainage Areas crossing Central Bedfordshire's boundary. There are opportunities here to investigate upstream attenuation in Central Bedfordshire to relieve flood risk downstream in Luton Borough, and also sites within Central Bedfordshire within the watershed around Houghton Regis.

15.2.3 Pix Brook catchment

The cross-boundary issue discussed in 14.2.4 is also mirrored in Stotfold and Church End/ Arlsey, where the Letchford (Pix Brook), Baldock (River Ivel) and Hitchin (River Hiz) catchments drain into Central Bedfordshire.

There could be opportunities to work in partnership to investigate the feasibility for any upstream catchment schemes, to reduce flood risk downstream towards the River Ivel confluence, for example in the Pix Brook catchment, attenuation could be provided between Letchworth and Stotfold, to reduce flooding downstream in Stotfold and further downstream.

Maintaining the existing flood storage areas, such as Pix Brook Flood Storage Reservoir, is also key to future flood risk management in this catchment.

15.2.4 Leighton Buzzard

Following review of the Flood Zone mapping, the upper reaches of the Clipstone Brook and River Ouzel could hold potential for investigating small-scale storage schemes to reduce flow downstream to Leighton Buzzard, and into the bordering authority areas.

15.2.5 Flitwick to Shefford

The floodplain at Shefford is wider and forms a confluence area of several watercourses. There are some lakes around Clophill which will provide some degree of attenuation, and the railway embankment at Flitwick provides a barrier against which water can back up against, providing some storage upstream in times of flood. Implementing smaller scale 'slowing the flow' measures discussed in 14.2 could be investigated in the upstream areas near Flitwick, to relieve some pressures on communities downstream around Chicksands and Shefford.

Further downstream between Biggleswade, Sandy and Tempsford, the River Ivel floodplain is flatter and more extensive. Floodwater in this reach is largely spread over rural areas, and therefore there is less risk to properties. Upstream catchment management could result in reduced flood extents downstream, though downstream the wider floodplain will act as a form of attenuation for the floodwater.

15.2.6 Catchment Flood Management Plan Actions

Central Bedfordshire is covered by three Policy Units as part of the Thames CFMP and Great Ouse CFMP, as described in Section 2.6. In these Policy Units, there are specific 'actions' to manage flood risk. Those relevant to Central Bedfordshire, in relation to strategic flood risk mitigation, are:

- To maintain the existing capacity of the river system by keeping the channels clear and free from obstruction, to reduce the impacts of more frequent flood events. Work needs to be undertaken to identify opportunities to make the existing systems more efficient (for example, where there are significant restrictions to flow from undersized culverts or bridges).
- Local Planning Authorities to retain the remaining floodplains for uses that are compatible with flood risk management and put in place polices that lead to long-term adaptation of urban environments in flood risk areas.
- To develop environmental enhancement projects to improve the natural state of the rivers and their habitats.
- Encourage planners to locate new development outside the floodplain. The floodplain should be maintained as an asset to make space for water.

- Continue with, and implement, the recommendations from the Leighton Buzzard flood alleviation scheme to create flood storage along the Clipstone Brook.
- Investigate developing a strategic flood storage study to consider creating/ developing storage within the Great Ouse river corridor. The study should investigate the most appropriate storage options and locations for floodplain storage.

15.2.7 Clustering site allocations

The Council could consider strategic flood risk solutions in the form of 'clustering' by site allocations, for example by considering strategic attenuation for a group of sites, rather than separate schemes. This would be more cost-efficient, would encourage partnership working and help to deliver benefits to a number of site allocations as well as to the receiving communities downstream.

15.3 Existing Projects in Central Bedfordshire

There are a number of ongoing projects and partnerships in Central Bedfordshire which seek to enhance the river environment and alleviate flood risk. This demonstrates a proactive and encouraging attitude within Central Bedfordshire for promoting strategic flood risk solutions.

15.3.1 Upper and Bedford Ouse Catchment Partnership

The Upper and Bedford Ouse Catchment Partnership collaborate with relevant partners to deliver projects that will improve water quality, channel structure, habitat quality and biodiversity in the Upper and Bedford Ouse Catchment. The Upper and Bedford Ouse catchment is one of 11 management catchments forming the Anglian River Basin District.

Their key objectives are:

- to work collaboratively on the production of a Catchment Plan;
- to identify the key issues and opportunities within the Catchment to improve the environment;
- to champion key projects with key decision makers and funders

The Upper and Bedford Ouse catchment is divided into 5 smaller operational catchments, each of which have identified a series of projects that begin to address the issues outlined in the WFD criteria and relevant CFMP. The 5 operational catchments are listed below with some of the relevant projects being undertaken in the area:

- **Upper Ouse**
- **Ouzel & Milton Keynes**
  - Ouzel enhancement (Riverside Walk)
- **Bedford Ouse**
- **Ivel**
  - Flit Valley Local Action Group
  - Sandy Smith NR water level management
  - Campton Wood
  - Ivel embankments and weirs
  - The Riddy, Sandy
  - Sandcast Wood
  - Potton brook
  - Biggleswade Common
  - Seal Bank, Langford
  - Wet-wood Copse
- **Lower Ouse**

15.3.2 Chalk Arc Partnership

Bedfordshire and Luton Green Infrastructure Consortium set up the **Chalk Arc Initiative** to create, protected and enhance green spaces in and around the new housing in South Luton, Dunstable,

Houghton Regis and Leighton-Linsdale. The partnership has completed almost 40 projects in the area, which range from increasing access to green spaces to creating new orchards.

By improving pond habitats like Toddington Village Pond, where rubbish and silt where removed, increases the pond's ability to retain surface run off during high intensity rainfall. In Central Bedfordshire Council's study area 26 areas of open space have been protected and newly created green space and ponds are listed below.

New open spaces:

- King St and Avery's Meadows
- Billington Park Green
- Vandyke Curve and Chamberlain Branch Wildflower Meadow
- Fancott Woods
- Totternhoe Nature Reserve

New Pond locations:

- Houghton Regis Chalgrave site
- Toddington Village Pond
- Whipsnade Tree Cathedral Development 2010 – Pond reinstated
- Harlington – Pond restoration

These areas of green space have often been converted from hard impermeable surfaces like concreate which increase surface water runoff in urban areas. By removing these surfaces and adding green spaces, it allows water to infiltrate the ground, increasing the possible flow paths for rainfall, reducing the rate and volume of run off.

15.3.3 Forest of Marston Vale

The creation of the **Forest of Marston Vale** is the largest regeneration project in Bedfordshire, covering 61 square miles between Milton Keynes and Bedford. Responsible for leading the creation of the Forest, is the Forest of Marston Vale Trust, an independent registered charity. Central Bedfordshire Council is one of the current Members of the Trust and is committed to its adopted **Forest Plan**.

The Forest is one of 12 Community Forests across England in the 1990s, created to address the effects of industrial activities (brick-making industry). There are already over 1 million trees planted and numerous woodlands created, leading to the woodland cover trebling from 3% to around 10%. The target is 30% coverage in the Marston Vale by planting over 5 million more trees by 2031.

Each of the woodlands created are listed and hyperlinked below:

- **Bedford's Green Gateway**, near Wootton
- **Grange Estate and Octagon Wood**, near Willington/ Cople
- **Shocott Spring**, near Shortstown/ Cotton End
- **Forest Centre and Millennium Country Park**, near Marston Moretaine
- **Conquest Wood**, near Houghton Conquest
- **Folly Wood and Granary Wood**, near Lidlington
- **Rectory Wood**, near Cranfield

Central Bedfordshire Council also expect to see a range of tree and woodland planting opportunities explored, throughout development sites in the Forest area. The guidance note available on development and woodland creating in the Forest of Marston Vale will help developers design such features into sites, and there is also a **Creating Green Infrastructure in the Marston Vale** document which provides example projects and partnerships.

15.3.4 Marston Vale Surface Waters Plan (2002)

The Surface Waters Plan, created on behalf of the Marston Vale Surface Waters Group, looks into the main opportunities and challenges faced when managing the surface water in the Forest of

Marston Vale. The Group comprises the Forest of Marston Vale, the Environment Agency, Bedford Group of IDBs and three local authorities.

The Forest of Marston Vale covers about 16,000 hectares. Busy trunk roads around Milton Keynes, Luton and Stevenage and two railways cross the Vale but the area is predominately an open arable landscape with pockets of woodland, settlements and gravel pits with gently undulating topography.

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

- Promote the policies of the Surface Waters Group.
- Support local plan policies dealing with flooding and surface water drainage.
- Assist with consideration of development proposals.
- Identify solutions for dealing with the impact of development pressure on watercourses and lakes.
- Provide guidance to landowners and developers on approaches to management of surface water.
- Encourage schemes that result in a range of benefits including management of flood risk and enhancement of the environment.

Development pressure in Marston Vale within the Elstow Brook catchment is high, identified as a Strategic Development Corridor. Developments will require some form of surface water runoff control to avoid increasing flood risk to other properties. Mitigation measure identified in the Plan are as follows:

- 'Source control' methods, such as soakaways and swales, that allow surface runoff to percolate into the ground.
- Strategic watercourse improvements or balancing ponds designed to serve large development areas.
- Balancing tanks or similar systems forming part of the adopted piped sewerage system.
- Private balancing tanks or ponds serving individual developments.

Strategic solutions represent the best option for managing surface water runoff for the majority of Marston Vale developments, and have the added benefit of enhancement of the water environment and ecology, by providing a variety of habitats, increased opportunities for land and water-based recreation, and improved management flows.

The Surface Waters Group will update the Surface Water Plan to reflect changing legislation and seek to identify potential opportunities for the creation of specific strategic surface water facilities or provide enhanced management of the system.

15.3.5 Bedford and Milton Keynes Waterway Park

The **Bedford & Milton Keynes (B&MK) Waterway Park** is a strategic project to link the main UK waterway network with the Fens waterways of East Anglia. This development is being promoted by the B&MK Waterway Trust, set up in 1995 for this purpose. This scheme will be developed by linking Bedford to Milton Keynes with a new waterway that is set within a multi-functional green corridor connecting east and west, opening up the Marston Vale region.

The benefits of the scheme include the creation of new places of recreation, sport, habitation and business, a new channel for water supply and drainage and a green corridor at the heart of new developments in the area.

The Council is part of a **consortium** of eight organisations that have agreed to work together with the aim of delivering the Bedford & Milton Keynes Waterway Park.

A guidance note entitled '**A Brief Guide to Space, Design and Other Technical Issues in providing for the Bedford Milton Keynes Waterway**' should be referred to by developers, and proposals should demonstrate positive design towards the Waterway Park.

15.3.6 Flitwick Moor and Folly Wood

Flitwick Moor and Folly Wood is the largest area of wetland in the Central Bedfordshire study area. It is formed on clay and chalk deposits and allows water from the underlying aquifer to come to the surface in a series of springs. It lies east of Flitwick on the downhill slope to the River Flit. This woodland of oak and birch has a dense underbrush of bracken and can absorb and delay the release of flood flows from the surrounding hill sides, reducing the maximum flood peak in the River Flit. In the wettest areas, such as part of the River Flit floodplain, are Alder Woods which are a rarity due to land drainage and wetlands being converted to farm lands. By helping slow the passage of the flood peak, water will also allow some of the flood water to be returned to the underlying aquifers.

15.3.7 River Ouzel enhancement project

River Ouzel enhancement project at riverside walk plans improve a section of the River Ouzel working with the Environment Agency, Central Bedfordshire Council and others to improve the river corridor for wildlife, for people and to reduce flood risk. To achieve this in the first phase, it is planned to:

- Thin the tree cover to let in more light
- Strengthen banks with bundles of wood where erosion is currently causing banks to collapse and silt to get into the channel
- Manage vegetation in the channel to create a more sinuous shape
- Create new 'riffles' for fish spawning and invertebrate habitat
- Improving accessibility and safety
- Removing alien species such as Himalayan Balsam and helping native species re-establish

15.3.8 Environment Agency River Ivel project

This Environment Agency (EA) project intends to investigate each of the structures that they currently maintain and review what, if any, flood risk management purpose they have, both individually and as part of a system. The River Ivel project aims to review how to best manage flood risk locally and what should be done with any existing structures, alongside looking into options to improve the water environment. Structures with limited or no flood risk benefit will not automatically be removed, there are a range of options that would work and it is possible that structures could be:

- altered
- removed
- replaced with an alternative structure
- maintained by other organisations, groups or landowners

15.3.9 Bedfordshire and Luton Biodiversity Action Plan

Under law in created in 1992, the UK must conserve biodiversity according to directions outlined in the Convention on Biological Diversity. Since 2001, the Bedfordshire and Luton Wildlife Working Group has been developing and maintaining individual plan for species and habitats as part of the **Biodiversity Action Plan (BAP).** Plans that affect Central Bedfordshire study area are listed below:

- Arable field margins
- Floodplain grazing marsh
- Hedgerows
- Lowland dry acid and calcareous grassland
- Lowland heathland and meadows
- Ponds
- Reed bed
- Traditional orchards

- Wet woodland
- Wood-pasture and parkland
- Woodland

15.4 Engaging with key stakeholders

Flood risk to an area or development can often be attributed to a number of sources such as fluvial, surface water or groundwater. In rural areas the definition between each type of flood risk is more distinguished; however, within urban areas flooding from multiple sources can become intertwined. Where complex flood risk issues are highlighted it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions.

Engagement with riparian owners is also important to ensure they understand their rights and responsibilities including:

- maintaining river beds and banks;
- allowing the flow of water to pass without obstruction; and
- controlling invasive alien species e.g. Japanese knotweed.

More information about riparian owner responsibilities can be found in the Environment Agency publication **'Living on the Edge'** (2012)[14].

14 Living on the edge: a guide to your rights and responsibilities of riverside ownership (Environment Agency, 2014)

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16 Summary

16.1 Overview

This SFRA delivers a strategic assessment of risk from all sources of flooding in Central Bedfordshire. It also provides an overview of policy and provides guidance for planners and developers.

16.2 Sources of flood risk and historical records

- Flood history shows that Central Bedfordshire has been subject to flooding from several sources of flood risk, with the principal risk from fluvial sources. Additionally, the uFMfSW shows a notable surface water flood risk throughout the study area and historic flood records include surcharging or blocked culverts and overwhelmed highway drains. There have also been various historic cases of groundwater flooding.
- The key watercourses flowing through the study are the River Ivel network, including the River Hiz and its tributaries; the River Flit, River Hit, River Ivel Navigation. Another major watercourse is the River Ouzel in Leighton Buzzard and its tributary the Clipstone Brook. The majority of recorded fluvial flood events are associated with these watercourses but there are numerous unnamed drains and Ordinary Watercourses in Central Bedfordshire.
- The primary fluvial flood risk is located along the River Ivel corridor in the east, River Flit and River Hit in the centre and Clipstone Brook through Leighton Buzzard in the far west. The floodplain associated with the tributaries of the River Ivel network is generally broad due to the low-lying topography, especially after Biggleswade and towards the Ivel's confluence with the River Great Ouse.
- Central Bedfordshire has experienced a number of historic surface water/ drainage related flood events caused by a number of mechanisms from insufficient storm and combined drainage capacity to poor surface water management. The uFMfSW further shows a number of prominent overland flow routes, following topographical flow paths of existing watercourses or dry valleys and local road infrastructure with some isolated ponding located in low-lying areas. Of particular note are areas in Leighton Buzzard and Wrestlingworth which are shown to be at significant risk within the uFMfSW.
- The sewers are managed by three Water Companies; Thames Water, Anglian Water and Affinity Water. Each provided their Flood Management System data that recorded historical sewer flooding. The combination indicated there where 45 recorded flood incidents in Central Bedfordshire's administrative area. The more frequently flooded postcodes are LU1 4, with 7 records and MK45 5 with 5.
- There have been incidents of historic groundwater flooding in Central Bedfordshire which is thought to primarily be caused by the underlying geology of chalk and Lower Greensand which allow water to pass to and from groundwater aquifers. The study area is known to have a high water table, and the bedrock geology indicates some areas are vulnerable to groundwater flooding.
- There are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low.
- There are eight records of a canal overtopping along the Grand Union Canal since 2007, grouped into four different events in 2007, 2010 and two in 2012. The extent of the overtopping is unknown; however, it is thought that no properties were flooded.

16.3 Relevant studies

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

16.4 Flood risk and surface water assessments

A site-specific FRA is required for all developments which are located within the Environment Agency's Flood Zones, or for developments greater than 1ha in size (regardless of Flood Zone).

They are also required for developments less than 1 ha in Flood Zone 1 where there is a change to vulnerability classification, where the development could be affected by sources of flooding or all developments located in an area which has been highlighted as having critical drainage problems.

All major applications submitted to Central Bedfordshire Council must include a Surface Water Drainage Strategy. Major applications which do not meet this requirement will not be made valid. Minor applications should demonstrate that surface water drainage arrangements have been considered, and should give priority to the use of SuDS. It is expected that surface water drainage will be considered by the applicant and sufficient detail of proposed drainage arrangements will be provided with the application, submitting the Council's '*Flood Risk and Drainage Pro-Forma*' Checklist as a minimum.

Climate change should be taken into account using latest guidance from the Environment Agency.

16.5 Defences and residual risk

A high-level review of existing flood defences was undertaken and found very few formal defences in the study area. A series of raised banks were identified along the main watercourses including the River Ivel; however, these are not considered 'formal defences'. A more detailed assessment along the raised earth embankments along Clipstone Brook was undertaken. Further, the condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is a factor that needs to be considered as part of the risk-based sequential approach and, in light of this, whether proposed land allocations are appropriate and sustainable.

16.6 Cross-boundary considerations

A high-level assessment has been undertaken of the potential impact of development in neighbouring authorities surrounding Central Bedfordshire. The location of the potential development locations has been assessed to in terms of where there is currently flood risk issues and where the impact of development has potential to make flood risk worse if preventative measures are not put in place. Assessment showed that the majority of developments in neighbouring authorities would not impact flood risk within Central Bedfordshire due to the topography, meaning water would flow away from Central Bedfordshire. Any potential issues should be mitigated against by adopting appropriate drainage on site.

16.7 Green Infrastructure and the Water Framework Directive

Central Bedfordshire Council has a number of strategic and district plans for Green Infrastructure that seek to integrate information from accessible greenspace, access routes, biodiversity, historic environment, and landscapes to determine the GI assets and the wider GI network within the authority.

In England, all waterbodies have to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. Many of the watercourses in Central Bedfordshire already meet the 'good' overall status including the Clipstone Brook, the River Ivel (upstream of Henlow) and the Ickwell Brook. However, the majority only meet 'moderate' overall status or less, including the Cat Ditch and the River Lee which are classed as 'bad' overall status by the WFD requirements.

16.8 Strategic Flood Risk Solutions

There are lots of positive ongoing projects in Central Bedfordshire Council's study area; for example, the Upper and Bedford Ouse Catchment Partnership and the Chalk Arc Partnership as well as others. Future development should ensure there is no adverse impact on the quality of watercourses. Opportunities to improve the status of watercourses have also been considered as per the River Ouzel enhancement project.

Opportunities have also been identified where strategic flood risk solutions could be investigated, such as upstream catchment management (flood storage) to reduce flows to downstream communities, such as in the Pix Brook, Ouzel, Clipstone Brook and Flit catchments. The Stewartby and Brogborough Lakes have great potential for 'linking' which should be investigated further to reduce flood risk and create a green corridor.

16.9 Shortlisted Site Allocations

The Council have undertaken a Stage 1 Assessment to filter sites from the 'Call for Sites' process, providing a list of 'pass sites' which have then been subsequently screened against flood risk information. The outcomes of the screening show which sites are at no/ limited flood risk and which sites were at greater flood risk. The aim of the screening outcomes is to show how many dwellings can be allocated in the sites at lowest flood risk prior to considering those at greater flood risk, thus adopting a sequential approach to site allocations.

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17 Policy Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA. Following this, recommendations have been made for the Council to consider as part of their planning policy for flood risk management, and for incorporation into the Local Plan policies. These have been summarised below.

17.1 Development and planning considerations

17.1.1 Shortlisted Site Allocations

It is recommended that the outputs from this study are used as an evidence base for the allocation of potential development sites, directing new development to areas of lowest risk.

The screening outcomes show how many dwellings can be allocated in the sites at lowest flood risk prior to considering those at greater flood risk, thus adopting a sequential approach to site allocations. Where the site allocation screening process has identified a shortlisted site allocation to be in either Flood Zone 2 and/or 3, and/or has an ordinary watercourse running through or adjacent to it, the flood risk to the sites should be investigated in more detail as part of a Level 2 assessment. If land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development, the Exception Test will need to be applied.

17.1.2 Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; this approach must be adopted for all future developments within Central Bedfordshire.

All development proposals must take account of existing and future flood risk (from all sources). New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance
- Relocating development to zones with lower flood risk
- Creating space for flooding, including consideration of Green Infrastructure within the mitigation measures for surface water runoff from potential development

Developers must apply the sequential approach to locating development within the site, with consideration to flood risk vulnerability and vulnerability of users.

Proposed development sites will be required to pass the Sequential Test and, where necessary, Exception Tests in accordance with the NPPF. To demonstrate the Exception Test has been passed, flood resilience design and emergency planning must be accounted for including:

- The development will remain safe and operational under flood conditions
- A strategy for safe evacuation and/ or safely remaining in the building under flood conditions
- Key services will continue to be provided under flood conditions; and
- Buildings are designed for a quick recovery following a flood

Central Bedfordshire Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan. Developers should consult Central Bedfordshire Council, the Environment Agency (where relevant) and the IDB at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

17.1.3 Windfall sites

Windfall sites are sites that have not been specifically identified in the Local Plan, that do not have planning permission and have unexpectedly become available. Local authorities are expected to make a realistic allowance for windfall development based on past trends.

Windfall applications should be considered at the strategic level through a policy, underpinned by the Sequential Test to steer sites away from areas at risk of flooding. The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting

out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms. In the event of there being no windfall policy, the Local Authority must apply the Sequential Test on a site-by-site basis. It may be possible for the Local Authority to apply the Sequential Test, taking into account reasonably available sites, historic windfall rates and their distribution across the authority area relative to Flood Zones.

17.1.4 Council review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding, in addition to the LFRMS, SuDS guidance and so on. When considering planning permission for developments, planners will need to consider the following:

- Will the natural watercourse system which provides drainage of land be adversely affected;
- Will a minimum 9m width access strip be provided adjacent to the top of both banks of any Main River or Ordinary Watercourses, for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits;
- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up;
- Sustainable drainage systems are given priority to manage surface water flood risk;
- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk; and
- Is the application compliant with the conditions set out by the LLFA.

17.2 Site-specific assessment considerations

For development sites located in Central Bedfordshire, it is recommended that developers consider the following:

- Aim to take positive measures to conform to the WFD, which can be impacted as a result of development, for example in terms of 'deterioration' in ecological status or potential. This is of particular importance for sites located in the Cat Ditch and Broughton Brook catchments where waterbodies are failing to meet the WFD objectives.
- The Environment Agency published updated climate change guidance on 19 February 2016, which must now be considered in all new developments and planning applications. Developments should be sustainable and support the mitigation and adaption to climate change impacts, which may involve flood resilience and resistance measures.
- Any site-specific FRA would need to adequately assess the local topography, geology and drainage systems (including sewer capacity) to ensure the risk posed from surface water is appropriately taken into account, for example discharge destinations and justifications.
- Any development proposed adjacent to a canal should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific Flood Risk Assessment.
- Consider reservoir flooding and residual risk at the planning stage.
- Safety is a key consideration for any new development and includes the likely impacts of climate change and, where there is a residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.
- The adoption and maintenance of drainage systems and flood defence infrastructure should also be considered.

17.2.1 Flood Risk Assessments

The Level 2 SFRA is not intended to replace site-specific FRAs. Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test. A FRA is required for all developments:

- in Flood Zone 2 and 3,
- over 1ha in Flood Zone 1,
- less than 1ha in Flood Zone 1 including a change of use in development type to a more vulnerable class where they could be affected by a source of flooding other than rivers and sea
- in an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.

Developers must, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove whether the Exception Test can be passed. Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

Where there is historical evidence of flooding at sites, any developments will require a detailed Flood Risk Assessment to fully understand and verify flood risk and flooding mechanisms.

Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites, through reductions in the amount of surface water runoff generated on a site. The functional floodplain should be protected from development and returned to greenfield status (where possible).

17.2.2 Surface water drainage assessments and SuDS

Planners should be aware of the conditions and local requirements set by Central Bedfordshire Council for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies can be found in the '*Supplementary Planning Document 'Central Bedfordshire Sustainable Drainage guidance: May 2015'* and should be referred to in the Local Plan.

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

Requirements for developers are as follows:

- New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Developers need to ensure that new development does not increase the surface water runoff rates from the site and should therefore contact Central Bedfordshire Council and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed in response to site characteristics and policy factors.
- Surface water drainage design must comply with Central Bedfordshire Council's drainage guidance and design guide, as well as with CIRIA SuDS Manual, BRE 365, PPG and non-statutory technical standards.
- In line with national SuDS standards, for Greenfield developments the peak runoff rate in the 1 in 1-year event and the 1 in 100-year event to any highway drain, sewer or surface waterbody should not exceed the Greenfield runoff rate for the same event. The 1 in 100-year event should be considered with an allowance for climate change in line with other flood risk management policy.
- Proposed drainage strategies should account for the impacts of climate change effects. On-site attenuation schemes would need to be tested to ensure flows are not exacerbated downstream within the catchments.
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems.

- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies.
- The promotion and adoption of water-efficient practices in new development will help to manage water resources and work towards sustainable development.

Central Bedfordshire Council should ensure their policies and decisions on applications support and compliment the building regulations on sustainable rainwater drainage, giving priority to infiltration over watercourses and then sewer conveyance.

17.2.3 Safe access and egress

Safe access and egress will need to be demonstrated at all development sites; the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during times of flood. Finished Floor Levels should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', or where the standard of protection is not of the required standard should be identified.

17.3 Future flood risk management in Central Bedfordshire

17.3.1 Flood defences

Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard should be identified and the use of developer contributions considered to fund improvements.

Developers should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

Should any proposed defences go ahead, developers with sites proposed to be located in these communities should contact the Environment Agency for up to date information on these schemes. Any protection and flood risk management measures that are required must be satisfactorily implemented and maintained.

17.3.2 Strategic flood risk solutions

The SFRA provides a basis for investigating potential strategic flood risk solutions within the district. There are many existing positive schemes ongoing in Central Bedfordshire to enhance the environment, such as the Forest of Marston Vale, Upper and Bedford Ouse Catchment Partnership, Chalk Arc Partnership, Ouzel enhancement project and many more.

Future opportunities identified in Central Bedfordshire, which could be promoted in the Local Plan, consist of the following:

- Floodplain restoration (the most sustainable form of strategic flood risk solution), by allowing watercourses to return to a more naturalised state, for example by bank stabilisation, re-naturalisation, structure removal/ modification and enhancing outfalls.
- The construction of new upstream storage schemes as part of natural upstream flood management approaches could be considered, such as where watercourses are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches, providing benefit to the urban area downstream.
- Some locations where this could be investigated is in the Pix Brook catchment (to reduce flooding downstream in Stotfold and Church End), the Ouzel and Clipstone Brook catchments (to reduce flooding downstream in Leighton Buzzard), and the River Flit around Flitwick (to reduce flooding downstream around Shefford).
- The 'Linking the Lakes' concept for Stewartby and Brogborough Lakes should be further investigated to ensure a more comprehensive understanding of how this functions, its limitations and the constraining factors. The IDB's modelled extents of the Elstow Brook catchment do not extend as far as Brogborough Lake and its associated drainage

channels; this should be considered going forward to establish the technical feasibility of this concept, as it could provide a strategic solution for the area.

- As a result of Luton Borough's SWMP, areas in Central Bedfordshire (Houghton Regis) have been identified as Critical Drainage Areas which may affect Luton downstream. Opportunities for upstream storage in these areas could be investigated as part of cross-boundary partnership working.
- Opening up culverts, weir removal, and river restoration should be considered to improve the WFD status of watercourses. Existing natural drainage features should be retained wherever possible.
- For those sites considered within the Local Plan and/ or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain and will enhance the water environment.

Such strategic flood risk solutions can have benefits such as reducing flood risk, improving water quality and biodiversity, enhancing social and amenity value and reducing costs of maintaining hard engineering structures. It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency.

The Catchment Flood Management Plan actions echo these solutions, recommending environmental enhancement projects to improve the natural state of rivers and their habitats and developing outside of the floodplain to make space for water. The Council should consider incorporating the actions detailed within the River Thames and Great Ouse CFMPs into Local Plan policies.

17.3.3 Green Infrastructure opportunities

The evidence base provided in this SFRA should be used to help inform any Green Infrastructure Plans or Strategies in Central Bedfordshire. There are several existing GI plans in Central Bedfordshire which is encouraging for future flood risk management. Potential development site locations which have watercourses

flowing through them, provide an opportunity to use the land as green infrastructure by adopting sequential design to locate development away from watercourses and Flood Zones, and by implementing SuDS. Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

17.3.4 Cross-boundary partnership working

For successful future flood risk management, it is recommended that neighbouring planning authorities adopt a catchment partnership working approach in tackling flood risk and environmental management. This assessment looked at potential development sites along authority borders, as well as cross-boundary residual risk (such as from reservoir inundation), showing which authority areas have the potential to influence flood risk on others based on topography, river flow direction and residual risk. New developments should mitigate any potential flood risks, but dialogue and engagement between neighbouring authorities can only strengthen the direction of future flood risk management and flood risk solutions.

17.4 Technical recommendations

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

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

The SFRA should be **periodically updated** when new information on flood risk, flood warning or new planning guidance or legislation becomes available. It is recommended that the SFRA is reviewed internally on a quarterly basis, in line with the Environment Agency's Flood Zone map

updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with Central Bedfordshire Council, the Highways Authority, Water Companies and the Environment Agency for any new information.

17.4.1 Note on Flood Zones

The Environment Agency's Flood Map for Planning is updated quarterly and thus the Flood Map on the Environment Agency/ Defra website in the future will supersede the version of the Flood Map shown in Appendix B. For up to date information on the suite of flood maps, please refer to **http://apps.environment-agency.gov.uk/wiyby/**.

G Groundwater Source Protection Zones

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

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

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