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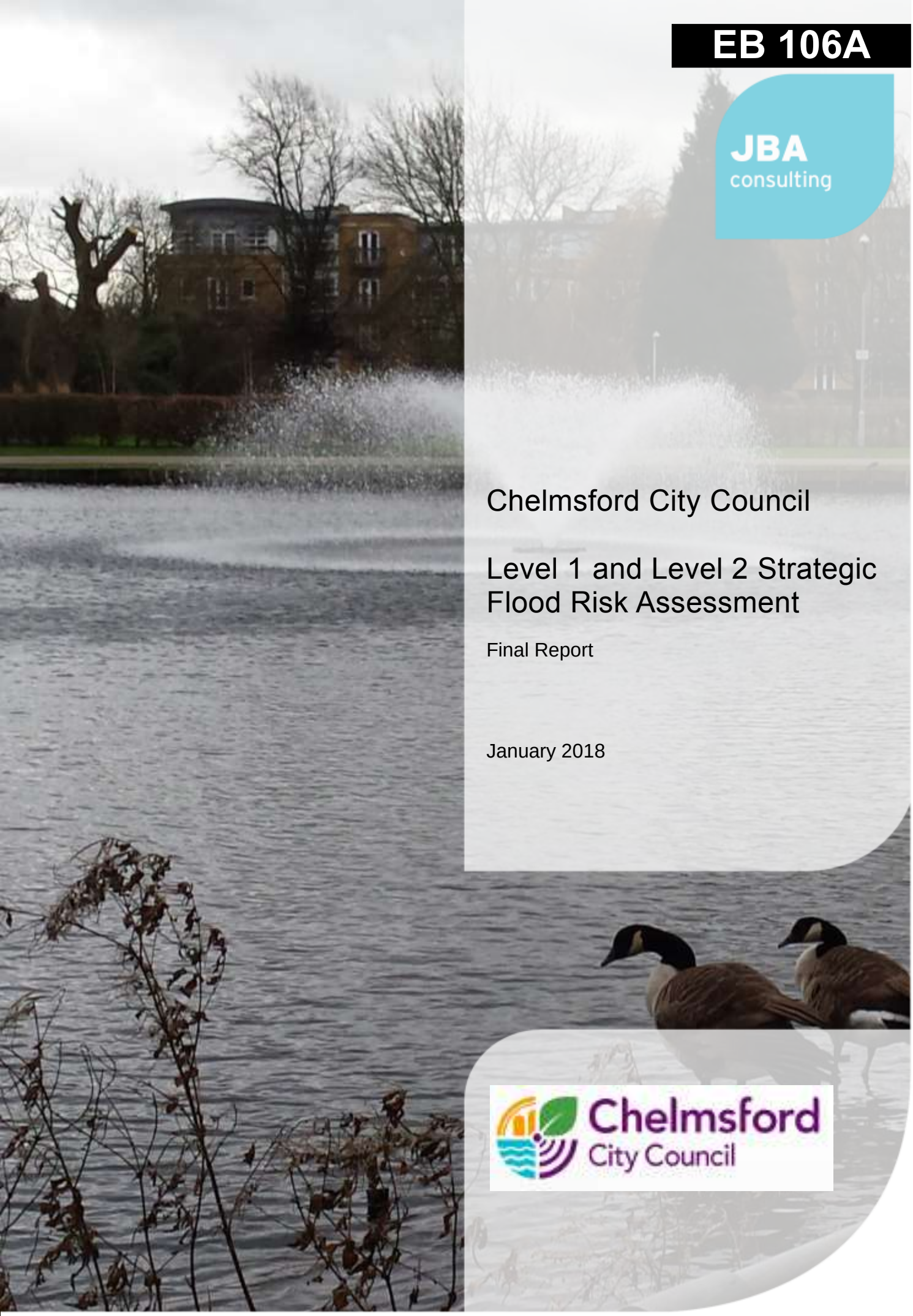

Chelmsford City Council

Level 1 and Level 2 Strategic Flood Risk Assessment

Final Report

January 2018

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Level 1 Draft v1.0 (Dec 2016)		Andy Bestwick (Chelmsford City Council)
Level 1 Draft v2.0 (Jan 2017)	Minor text changes as requested by the council	Andy Bestwick (Chelmsford City Council) Oladipo Lafinham and Tim Simpson (Essex County Council) Environment Agency
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Level 1 and Level 2 Final (January 2018) v3.0	Minor changes to table 12-1	Andy Bestwick (Chelmsford City Council)

Contract

This report describes work commissioned by Chelmsford City Council. The Council's representative for the contract was Andy Bestwick. Claire Gardner, Andrew Waite, Thomas Allen and Joanne Chillingworth of JBA Consulting carried out this work.

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Purpose

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Executive Summary

Introduction

This Strategic Flood Risk Assessment (SFRA) 2016 document replaces the Level 1 SFRA originally published by Chelmsford City Council in 2008. The main purpose of the SFRA is to inform selection of options for Local Plan allocations and support determination of planning applications.

SFRA objectives

The key objectives of the SFRA are:

1. To review the latest flood risk policy, including implications for the Council and developers
2. To collate and analyse the latest information and data for flood risk from all sources
3. To provide guidance and recommendation to the Council for flood risk policy and future flood risk management decision making
4. To provide supporting evidence to support the Council with the preparation of their Local Plan, allowing the application of the Sequential Test in the allocation of future development sites.
5. Provide guidance and information for developers preparing site specific flood risk assessments, including information on Sustainable Drainage Systems (SuDS).

SFRA outputs

- Appraisal of all potential sources of flooding, including Main River, Ordinary Watercourse, the sea, surface water and groundwater.
- Updated review of historical flooding incidents.
- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change
- 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
- Level 2 assessment detailed site summary tables for proposed development sites
- A suite of maps has been produced for the SFRA including
    - Appendix A: Watercourses in Chelmsford
    - Appendix B: Environment Agency Flood Zone Mapping
    - Appendix C: Climate Change Mapping
    - Appendix D: Surface Water Mapping
    - Appendix E: Groundwater Mapping
    - Appendix F: Flood Warning Coverage

Summary

Sources of flood risk

- Flood history shows that Chelmsford has been subject to flooding from several sources of flood risk, with the principal risk from fluvial sources.
- The primary fluvial flood risk is associated with the River Chelmer and its tributaries. The main urban areas at risk is Chelmsford City. Parts of Chelmsford City benefit from defences including flood walls and embankments. Other areas that are shown to be at risk include Margaretting, Bicknacre and Writtle.
- The primary tidal flood risk is associated with the tidal River Crouch, Fenn Creek and Clements Green Creek. The main urban area at risk is South Woodham Ferrers. However, much of the area benefits from defences consisting of sea walls and embankments.
- Surface water risk predominantly consists of overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys, or transport routes.

There is also isolated ponding located in low lying areas. The majority of towns and villages within Chelmsford have a degree of surface water flood risk; whilst, in the majority of cases, the risk is confined to roads and gardens, there are some areas with more notable, prominent flow routes around properties.

- The sewers are managed by Anglian Water. The DG5 register of recorded historical sewer flooding was requested but not provided at the time of publication.
- 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.

Key policies

There are a number of relevant regional and local key policies which have been considered within the SFRA, such as the Catchment Flood Management Plan (2011), River Basin Flood Risk Management Plan (2016), the Preliminary Flood Risk Assessment (2011), Chelmsford Surface Water Management Plan (2014) and Local Flood Risk Management Strategy (2013). 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 (FRAs) have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the Lead Local Flood Authority (LLFA) and the Environment Agency.

Defences

This SFRA provides an overview of existing flood defences in Chelmsford using technical studies undertaken by other Flood Risk Management Authorities including the Environment Agency. There are a number of formal defences in the study area. Defences mainly consist of sea walls and embankments providing protection against tidal sources for South Woodham Ferrers, and walls and embankment providing protection against fluvial sources for Chelmsford City.

Flood warning and emergency planning

A review of the flood warning coverage in Chelmsford was undertaken as well as emergency planning provision.

Strategic flood risk solutions

Potential options for strategic flood risk solutions have been documented.

Level 1 assessment of sites

Proposed allocation sites within the study area were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site. Indication is provided on the proportion of a given site affected by levels and types of flood risk, along with whether historic incidences of flooding have occurred, and any watercourses with a catchment less than 3km^2 flow through the site.

Of the 48 potential development sites provided by Chelmsford City Council for assessment, ten were at risk in Flood Zones 3b, 3a and 2, five were at risk in Flood Zones 3a and 2, and two were at risk in Flood Zone 2. The majority of the sites at risk are located in Chelmsford City. Flood Zones 2 and 3 act as a constraint on land use and layout, and one that needs to be addressed through the Level 2 SFRA, site specific flood risk assessments and site planning. Of the remaining sites, all but three were shown to be at risk of surface water flooding.

It should be noted that the proportion of the site at risk varied. Full details are provided in Table 12-1.

Level 2 assessment of sites

As part of the Level 2 SFRA, detailed site summary tables have been produced for each of the potential development sites taken forward from the Level 1 assessment. These sites are ones which are shown to be at risk of fluvial flood risk from watercourses running either through or adjacent to the site.

The summary tables set out the flood risk to each site, including maps of extent, depth and velocity of flooding as well as hazard mapping. Each table also sets out the flood risk implications for the

site as well as guidance for site-specific FRAs. A broadscale assessment of possible SuDS constraints has also been provided giving an indication where there may be constraints to certain sets of SuDS components.

Recommendations

Development control

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.

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

Cumulative impact of development and cross-boundary issues

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

Development control should ensure that the impact on receiving watercourses from development in Chelmsford has been sufficiently considered during the planning stages and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality, both within Chelmsford and the wider area.

Sequential and Exception tests

The SFRA has identified that areas of Chelmsford are at risk of flooding from both fluvial, tidal and surface water sources. Therefore, potential development sites for the Local Plan will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

Developers should consult with the Council, Essex County Council, the Environment Agency, and Anglian Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

Site-specific flood risk assessments

The 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.

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

Residual risk

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

Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences. They should consider both the impact of breach (both on and off site), 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.

Safe access and egress

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

Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with no warning

Drainage assessments and promotion of SuDS

Drainage strategies and SuDS

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

Development in CDAs should conform with the preferred options for the CDA, as set out in the Chelmsford SWMP.

Future flood management in Chelmsford

- It is preferential that developments take a sequential approach to site layout, with the development being placed furthest away from the source of flood risk and outside of the Flood Zones 2 and 3, if possible
- The construction of upstream storage schemes on watercourses within the district may 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. However, site assessments have shown that the majority of sites are too small, or are on urbanised watercourses, to provide opportunities for storage. The proposed flood storage area on the River Wid at Margaretting, as part of the on-going Flood Alleviation Scheme at Chelmsford city centre, is a key part of the Council and Environment Agency's strategy to protect people and property in Chelmsford.

Flood warning and emergency planning

- 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. All flood sources should be considered. In particular sites should be considered in relation to the areas of drainage critical problems highlighted in the Chelmsford SWMP.
- The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements within Chelmsford. This includes the nominated rest and reception centres (and prospective ones), to ensure evacuees are outside of the high risk flood zones and will be safe during a flood event.

Technical note

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.

Contents

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Using this document

When 'Chelmsford' is referred to in the document we mean the whole of Chelmsford City Council's administrative area, unless there is specific reference to 'Chelmsford City' or 'Chelmsford Urban Area'.

Hyperlinks

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

Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability
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.
CFMP	Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
Defra	Department for Environment, Food and Rural Affairs
Designated Feature	A form of legal protection or status reserved for certain key structures or features that are privately owned and maintained, but which make a contribution to the flood or coastal erosion risk management of people and property at a particular location.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra 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.
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.
FWMA	Flood and Water Management Act
Greenfield	Undeveloped parcel of land
Ha	Hectare
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
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

Term	Definition
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
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.
PPG	National Planning Policy Framework – Planning Practice 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.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
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.
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.
RoFSW map	Risk of Flooding from Surface Water map
WFD	Water Framework Directive

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1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

> ***"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".*** (National Planning Policy Framework, paragraph 100)

This Strategic Flood Risk Assessment (SFRA) 2016 document replaces the Level 1 SFRA originally published by Chelmsford City Council in 2008. The SFRA study area is shown in Figure 1-1.

The key objectives of the 2016 SFRA are:

1. To review the latest flood risk policy, including implications for the council and developers
2. To collate and analyse the latest information and data for flood risk from all sources
3. To provide guidance and recommendation to the council for flood risk policy and future flood risk management decision making
4. To provide supporting evidence to support the Council with the preparation of their Local Plan, allowing the application of the Sequential Test in the allocation of future development sites.
5. Provide guidance and information for developers preparing site specific flood risk assessments, including information on Sustainable Drainage Systems (SuDS).

1.2 Levels of SFRA

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

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

This update fulfils the requirements of both a Level 1 and Level 2 SFRA.

1.3 SFRA outputs

- Appraisal of all potential sources of flooding, including Main River, Ordinary Watercourse, surface water and groundwater.
- Updated review of historical flooding incidents.
- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change.
- Areas at risk from other sources of flooding, for example surface water or reservoirs.
- An assessment of the impact of future large-scale developments both within and outside Chelmsford.
- 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.
- Level 2 assessment detailed site summary tables for proposed development sites

1.4 SFRA user guide

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. The Sequential, risk based approach	Describes the Sequential Approach and application of Sequential and Exception Tests.
4. Climate change	Outlines climate change guidance and its implications for development and planning
5. Sources of information used in preparing the SFRA	Provides an overview of the sources of information and data used in the SFRA preparation.
6. Understanding flood risk in Chelmsford	Introduces the assessment of flood risk and provides an overview of the characteristics of flooding affecting Chelmsford
7. Flood defences	Assessment of current flood risk management infrastructure, including consideration of residual risk
8. FRA requirements and flood risk management guidance	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions that should be followed
9. Surface water management and SuDS	Advice on managing surface water run-off and flooding
10. Flood warning and emergency planning	Outlines the flood warning service in Chelmsford and provides advice for emergency planning, evacuation plans and safe access and egress.
11. Strategic Flood Risk Solutions	Summary of strategic flood risk solutions.
12. Level 1 assessment of potential development sites	Summary of flood risk to proposed preferred options
13. Level 2 assessment of potential development sites	Detailed assessment of specific sites to determine variations in flood risk across the site and identify any site-specific flood risk assessment requirements.
14. Summary	Summarises the work undertaken for the Level 1 assessment
15. Recommendations	Identifies recommendations for the council to consider as part of flood risk management policy.
Appendix A Watercourses	Locations of Main Rivers and Ordinary Watercourses
Appendix B Flood Zones	Chelmsford-wide maps of Flood Zones
Appendix C Climate change	Chelmsford-wide maps of the 2080s climate change allowances
Appendix D Surface water	Chelmsford-wide maps of the Risk of Flooding from Surface Water map.
Appendix E Groundwater	Chelmsford-wide maps of the Areas Susceptible to Groundwater Flooding dataset.

Section	Contents
Appendix F Flood warning coverage	Maps showing the extent of the Environment Agency's Flood Warning Service.
Appendix G Level 2 Detailed Site Summary Tables	Detailed assessment of potential development sites shown to be in Flood Zones 2 and 3.

1.5 Consultation

SFRAs should be prepared in consultation with other risk management authorities. The following parties (external to Chelmsford City Council) have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Essex County council (as Lead Local Flood Authority)
- Anglian Water

1.6 Use of SFRA data

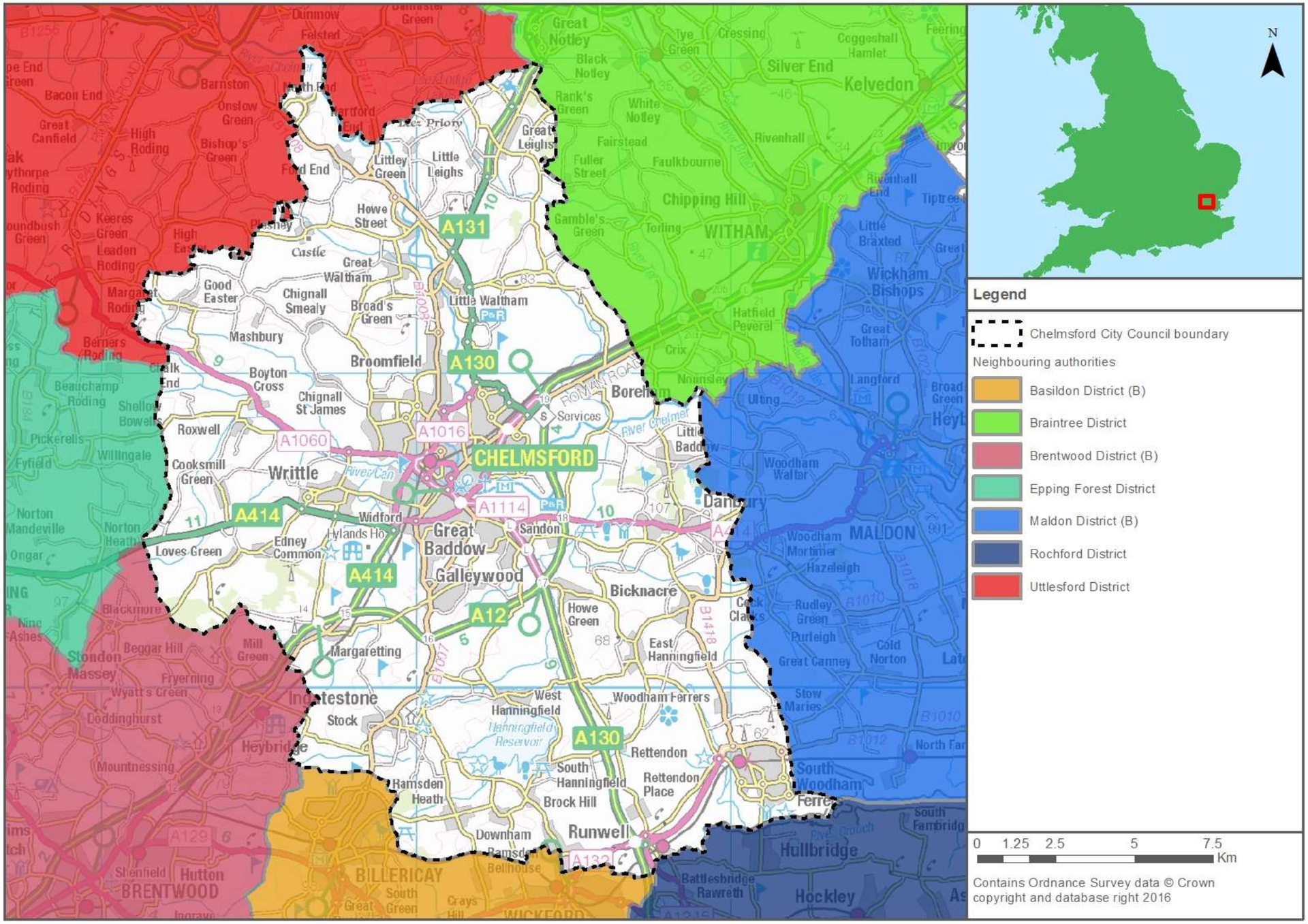
It is important to recognise that Level 1 SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

SFRAs should be a 'living document', and as a result should be updated when new information on flood risk, new planning guidance or legislation becomes available. New information on flood risk may be provided by Chelmsford City Council, the Highways Authority, Essex County Council, Anglian Water and the Environment Agency. Such information may be in the form of:

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

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed regularly to ensure latest data is still represented in the SFRA.

Figure 1-1: Study area



2 The Planning Framework and Flood Risk Policy

2.1 Introduction

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

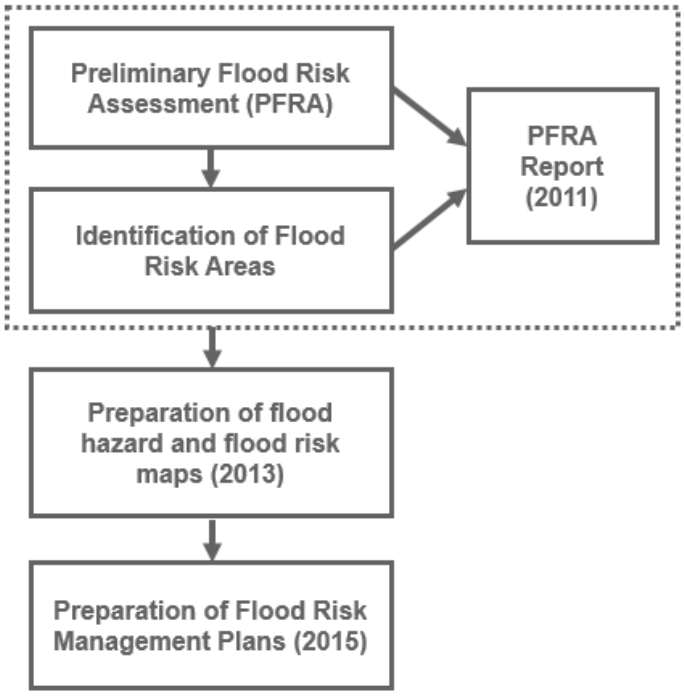
2.2 Flood Risk Regulations (2009) and Flood and Water Management Act (2010)

2.2.1 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 LLFAs. In the instance of this SFRA, the LLFA is Essex County Council.

Figure 2-1 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 2-1: Flood Risk Regulation Requirements



2.2.2 Preliminary Flood Risk Assessments (PFRAs)

Under this action plan and in accordance with the Regulations, LLFAs had the task of preparing a Preliminary Flood Risk Assessment (PFRA) report.

PFRAs report on significant past and future flooding from all sources except from Main Rivers and reservoirs, which are covered by the Environment Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Anglian Water). PFRAs are a high-level screening exercise and considers floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The **PFRA** that covers the study area was published by Essex County Council in 2011. The Regulations require the LLFA to identify significant Flood Risk Areas. The threshold for designating significant Flood Risk Areas is defined by Defra and the PFRA is the process by which these locations can be identified.

Of the ten national indicative Flood Risk Areas that were identified by the Defra/Environment Agency, only the Basildon Flood Risk Area narrowly encroach on the administrative area of Chelmsford City Council and the indicative designations have been accepted.

No Flood Risk Areas have been identified based on critical infrastructure/access routes, sewer/surface water problems and areas prone to significant ponding.

2.2.3 Flood Risk Management Plans (FRMPs)

Under the Regulations 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. The final **Anglian River Basin District Flood Risk Management Plan** (FRMP) was published in March 2016 and covers the period of 2015 to 2021. The FRMP draws on previous policies and actions identified in Catchment Flood Management Plans and incorporates information from Local Flood Risk Management Strategies. There are 11 catchments covered by the Anglian River Basin; Chelmsford lies within the Combined Essex Catchment area.

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.

2.2.4 Flood and Water Management Act, 2010

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

The FWMA established Lead Local Flood Authorities (LLFAs). Essex County Council is the LLFA for Chelmsford. 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.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate LLFAs will perform consenting of works on ordinary watercourses.

2.2.5 Essex Local Flood Risk Management Strategy (2013)

Essex County Council is responsible for developing, maintaining, applying and monitoring a Local Flood Risk Management Strategy for Essex, which covers Chelmsford. **The Strategy** is used as a means by which the LLFA co-ordinates flood risk management on a day to day basis. The high-level objectives proposed in the Strategy for managing flood risk are:

1. Provide information on local flood risk as well as the organisations that are involved in their management.
2. Explain the powers and responsibility of all major organisations
3. Summarise the information available on flood risk in Essex
4. Support annual action plains which will be approved by the Essex Partnership for Flood Management.

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

The Strategy also sets out an action plan of how the LLFA intends to achieve these objectives. The Strategy should be updated regularly or when key triggers are activated. An example of a key trigger would be issues such as amendments to partner responsibilities, updates to legislation, alterations in the nature or understanding of flood risk or a significant flood event, may also require the update of the Strategy and action plan.

2.2.6 LLFAs, surface water and SuDS

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

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

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

Major developments are defined as

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

2.2.7 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 Chelmsford because 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.

The National Flood and Coastal Erosion Risk Management Strategy for England (2011)

The **National Flood and Coastal Erosion Risk Management Strategy for England** provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. It was prepared by the Environment Agency with input from Defra.

The Strategy builds on existing approaches to flood and coastal risk management and promotes the use of a wide range of measures to manage risk. It describes how risk should be managed in a co-ordinated way within catchments and along the coast and balance the needs of communities, the economy and the environment.

The strategy encourages more effective risk management by enabling people, communities, business, infrastructure operators and the public sector to work together to:

- ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risk;
- manage flood and coastal erosion risks in an appropriate way, taking account of the needs of communities and the environment;
- ensure that emergency plans and responses to flood incidents are effective and that communities can respond effectively to flood forecasts, warnings and advice;
- help communities to recover more quickly and effectively after incidents.

2.3 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.

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 Table 3-1 and throughout this report. The Sequential and Exception tests are covered in greater detail in Section 3.

The Sequential Test

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

(National Planning Practice Guidance, paragraph 019)

The Exception Test

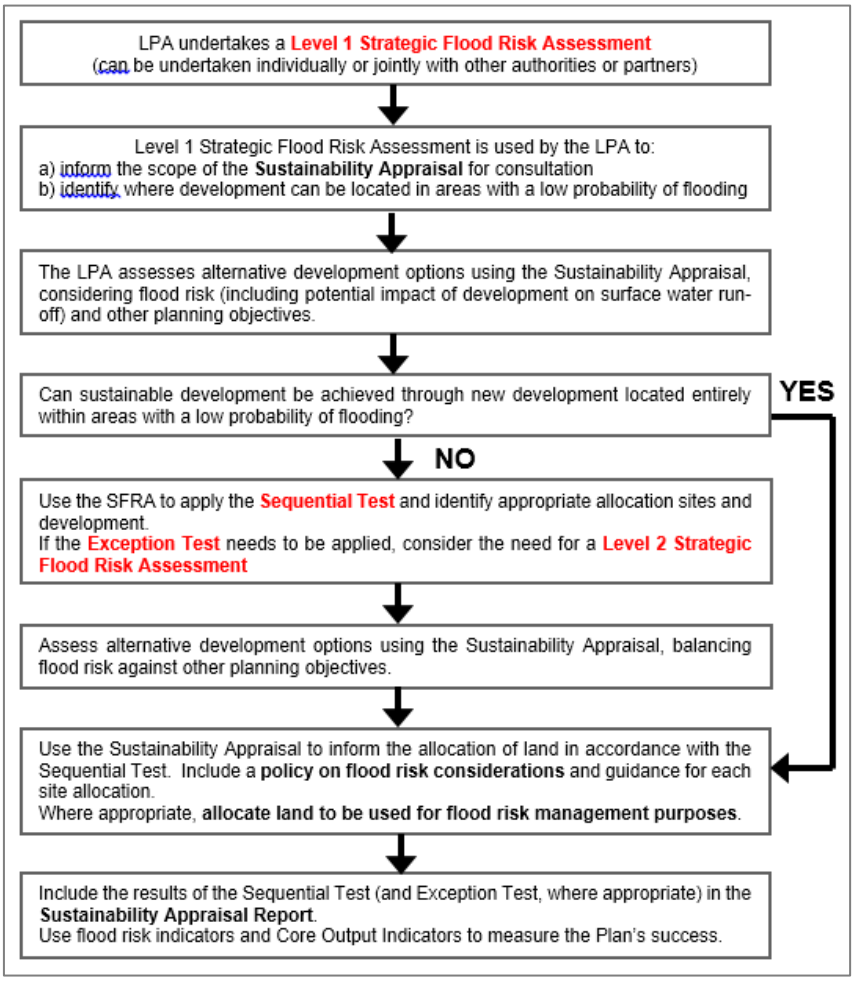
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

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

(National Planning Practice Guidance, paragraph 023)

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

Figure 2-2: 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

2.4 Water Cycle Studies

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

A Water Cycle Study for Chelmsford City Council has been undertaken with **Phase 1** completed in 2010 and **Phase 2** completed in 2011. Phase 1 of the Water Cycle Study identified no unsurmountable technical constraints to the proposed level of growth within the study area. However, it did identify several important issues which need to be further investigated in Phase 2 of the Water Cycle Study. These include the following:

- Provision of a strategic sewer for the North Chelmsford Expansion Area
- Sequential testing under national guidance for any development sites identified by the SFRA as falling within Flood Zone 2 and 3.
- Further water quality modelling to assess the implication of the site allocation proposals for receiving watercourses which will be under taken as part of Phase 2 of the Water Cycle Study.
- Water Cycle Screening to determine whether a full WCS is required to support development in the rest of the Chelmsford City Council administrative area.

Phase 2 of the Water Cycle Study builds upon the Phase 1 report (2010) whilst incorporating further findings and up to date information from stakeholders and targets areas of uncertainty identified in the phase 1 report.

2.5 Surface Water Management Plans

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

2.5.1 Chelmsford SWMP (2014)

The **Chelmsford Surface Water Management Plan** was published in March 2014 and outlines the preferred surface water management strategy for Chelmsford City. The SWMP was structured in four phases:

Phase 1 – Preparation: Collection and review of surface water information.

Phase 2 – Risk Assessment: This phase involved direct rainfall modelling to identify Critical Drainage Areas (CDA). Critical Drainage Areas are 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. In total 12 CDAs were identified within the study area.

Phase 3 – Options Assessment: This phase involved the modelling of several options to help reduce the likelihood and impact of surface water flooding. This led to the recommendation of several short to medium term actions for Essex County Council and Chelmsford City Council.

Phase 4 – Implementation and Review: This phase established a long-term Action Plan for Essex County Council and other risk management authorities to assist in their roles under the FWMA 2010.

2.6 Catchment Flood Management Plans

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

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

The six national policies are:

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

2.6.1 North Essex CFMP (2011)

The study area is covered by the **North Essex CFMP**. Three sub areas fall within the Chelmsford area; these are

- Blackwater and Chelmer, Upper Reaches and Coastal Streams (Sub-area 1): Covered by Policy Option 2
- River Wid (Sub-area 4): Covered by Policy Option 6
- Chelmsford (Sub-area 5): Covered by Policy Option 5

The primary policy unit for Chelmsford is 'Sub Area 5. The area is covered by Policy Option 5, which is for areas of moderate to high flood risk where the Environment Agency can generally take further action to reduce flood risk. The proposed actions to implement this policy are the following:

- Flood risk should be managed by storing water on the floodplain upstream of Chelmsford City. This should involve the implementation of recommendations from the Chelmer flood risk study and Chelmsford flood alleviation scheme viability study to develop flood storage
- Redevelopment of floodplain areas is an opportunity to increase their flood resilience.
- Flood awareness will be used to manage the consequences of flooding.
- Encourage planners to develop policies for regeneration to follow the principles of national guidance.
- Continue current maintenance activities through the town.

2.7 Shoreline Management Plan

2.7.1 Essex and South Suffolk Shoreline Management Plan 2 (2010)

Shoreline Management Plans (SMPs) are high-level policy documents in which the organisations that manage the shoreline set out their long-term plans. SMPs are an important part of Defra's strategy for managing flooding and coastal erosion.

There are four pre-defined policies that describe the intent for management of the shoreline:

1. Hold the Line – means holding the existing defence line by maintaining or changing the standard of protection
2. Advance the Line – means building new defences seaward of the existing defence line
3. Managed Realignment – means allowing or enabling the shoreline to move, with associated management to control or limit the effect on land use and environment
4. No Active Intervention – means no investment in coastal defences or operations.

Only a small area of Chelmsford is at risk from tidal sources – South Woodham Ferrers. South Woodham Ferrers is covered by Management Unit H (Crouch and Roach Estuaries) of the **Essex and South Suffolk SMP**. In the short and medium term, the intent is to sustain and support the viabilities of communities, tourism and commercial activities while creating new intertidal habitats and focusing flood and erosion risk management on frontages where it is most needed. Under this policy the frontages at South Woodham Ferrers will continue to be held at their current alignment (Hold the Line).

2.8 River Basin Management Plans

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

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

The RBMP describes how development and land-use planning needs to consider several issues relevant to the RBMP including sustainable drainage systems, green and blue infrastructure, sewage treatment options (tertiary phosphate treatments), water efficiency measures, infrastructure and development locations and the reduction of nutrients from diffuse pollution. The

RBMP provides a summary of measures to protect and improve the water environment in the river basin district.

2.9 Implications for Chelmsford

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 Chelmsford

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 communicating flood risk warnings to the public, media and partner organisations. • Identifying Significant Flood Risk Area* • Preparation of Flood Risk and Hazard Maps • Preparation of Flood Risk Management Plan • 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
Lead Local Flood Authority (Essex County Council)	Input to National Strategy. Formulate and implement Local Flood Risk Management Strategy.	• Responsible for enforcing and consenting works for Ordinary Watercourses, risk assessing Ordinary Watercourses. • Managing local sources of flooding from surface water runoff and groundwater and carrying out practical works to manage flood risk from these sources where necessary. • Preparing and publishing a PFRA • Identifying Flood Risk Areas • Preparing Flood Hazard and Flood Risk Maps • Preparing Flood Risk Management Plans • Investigating certain incidents of flooding in Section 19 Flood Investigations • Statutory roles in planning for surface water drainage. • 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
Local Planning Authority (Chelmsford Borough Council)	Input to National and Local Authority Plans and Strategy	• 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.

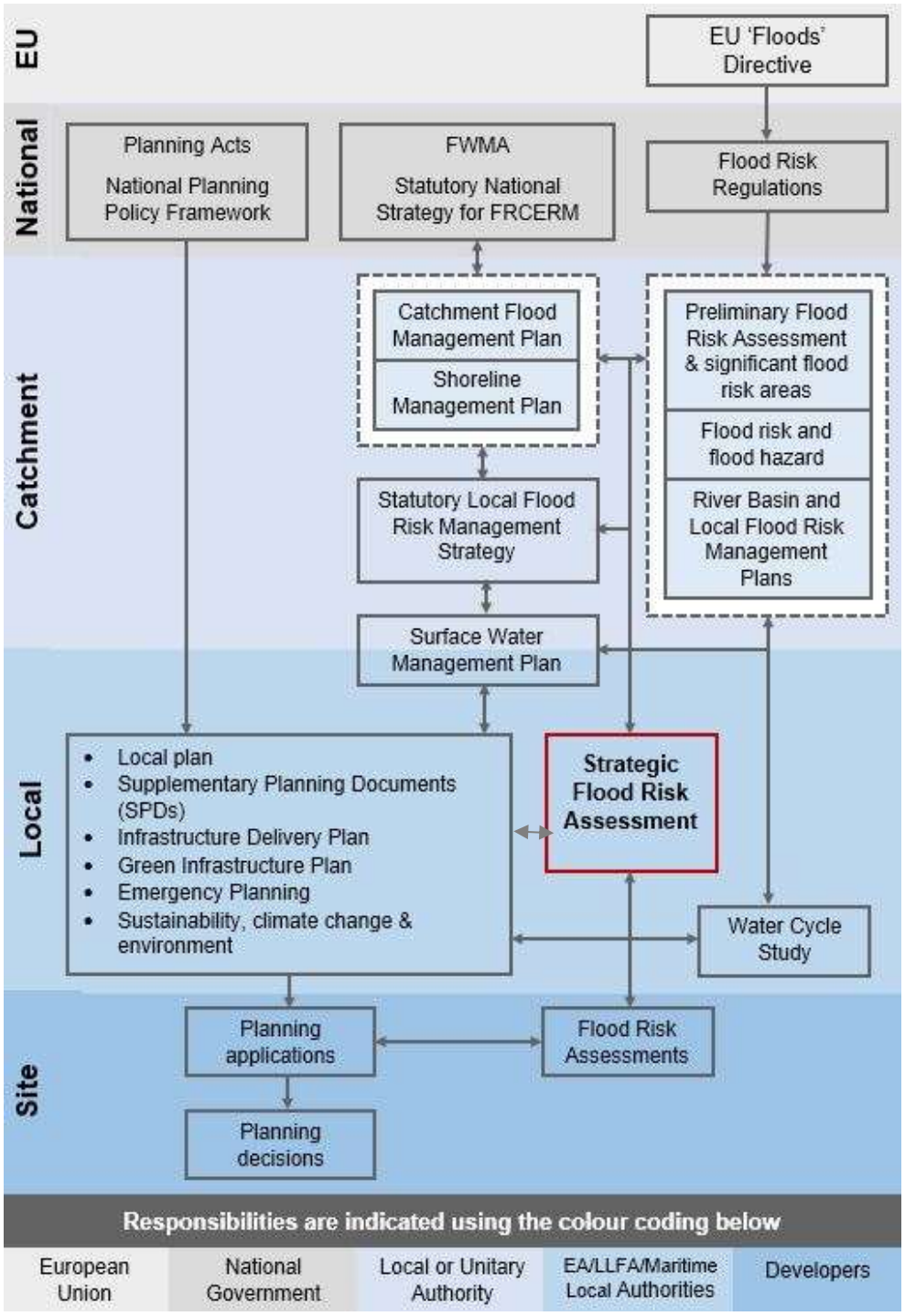
* Environment Agency did not prepare a PFRA; instead they exercised an exception permitted under the Regulations

Figure 2-3 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.

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), Shoreline Management Plans (SMPs), Surface Water Management Plans (SWMPs) and Water Cycle Strategies (WCSs).

Figure 2-3: Strategic planning links and key documents for flood risk



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

3 The sequential, risk based approach

3.1 The sequential, risk-based approach

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

It is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation if there are no defences) are a starting point for a site-specific flood risk assessment (FRA) and are only available where the watercourse has been modelling (where the upstream catchment is greater than 3km^2). In these circumstances a greater understanding of the scale and nature of the flood risks is required.

3.1.1 Flood Zones

The NPPF Guidance identifies the following Flood Zones (see Table 3-1).

Table 3-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land are appropriate in this zone. Highly vulnerable land uses are allowed if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year Developers and the local authorities should seek to reduce the overall level flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances. It is normally classified as the 1 in 20-year (5% AEP) event. In the absence of detailed hydraulic model information, a precautionary approach should be adopted for Flood Zone 3b with the assumption that the extent of Flood Zone 3b would be equal to Flood Zone 3a. If development is shown to be in Flood Zone 3a, further work should be undertaken as part of a detailed site specific flood risk assessment to define the extent of Flood Zone 3b
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere.
		All developments in this zone require an FRA.

3.2 Surface water flood risk information

In 2013, the Environment Agency, working with LLFAs, produced the Risk of Flooding from Surface Water map (RoFSW map). The RoFSW map is a national scale map and assesses flooding scenarios because of rainfall with the following chance of occurring in any given year.

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

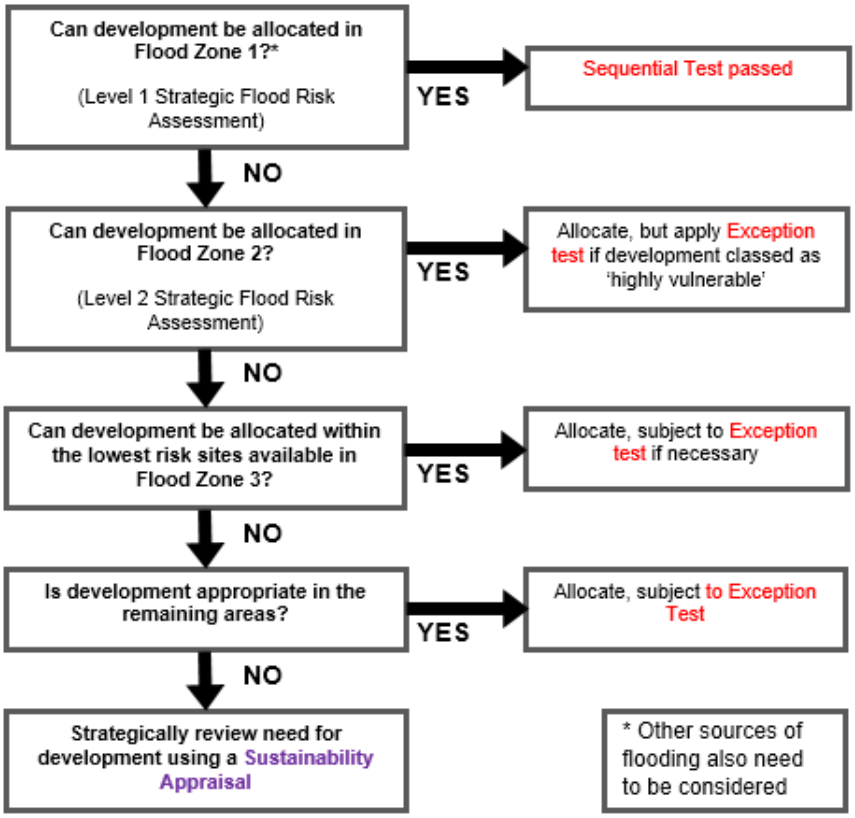
The surface water map is available via the Long term flood risk information page on the government's **website**. In addition to showing the extent of surface water flooding, there are depth and velocity maps for each risk category. These maps should be used when considering other sources of flooding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

3.3 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.

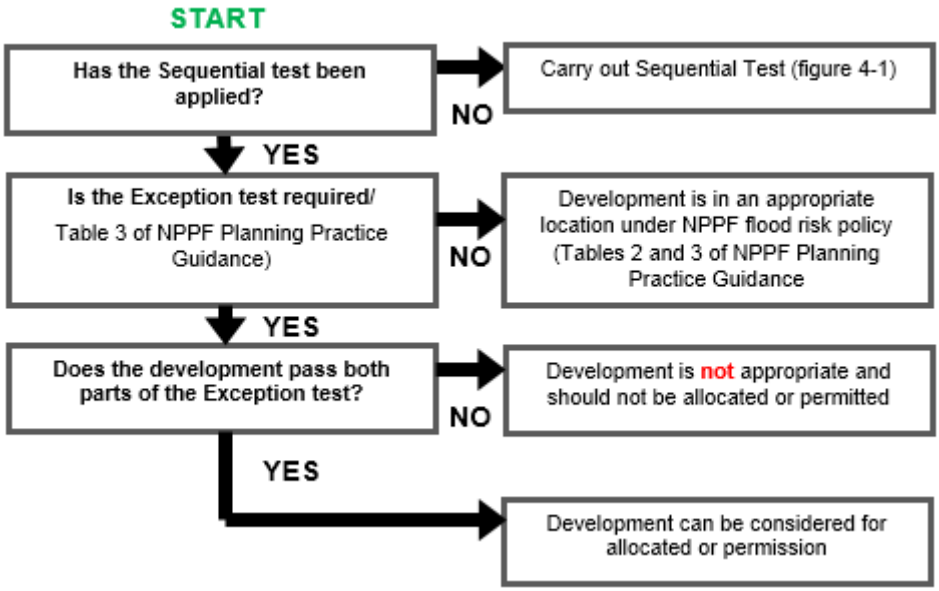
The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. 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).

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).

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



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

3.4.1 Sequential Test

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

Chelmsford City 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.

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).

It is normally reasonable to presume and state that individual sites that lie in Zone 1 satisfy the requirements of the Sequential Test; however, consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas, and future climate change.

3.4.2 Exception Test

If, following application of the Sequential Test it is not possible for the development to be in areas with a lower probability of flooding the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable 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. For the Test to be satisfied, both of the following elements must 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. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[2] .

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. The following should be considered[3]:

   - The design of any flood defence infrastructure.
   - Access and egress.
   - Operation and maintenance.
   - Design of the development to manage and reduce flood risk wherever possible
   - Resident awareness.
   - Flood warning and evacuation procedures.
   - Any funding arrangements required for implementing measures.

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

3.5 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 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 and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) 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.

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

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed.

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

- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change may reduce the standard of protection afforded by defences, due to increased river flows and levels, and so commitment is needed to invest in the maintenance and upgrade of defences if the present-day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where a) the consequences of flooding need to be mitigated or b) where it is proposed to place lower vulnerability development in areas of flood risk.

3.6 Impact of additional development on flood risk

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting increase in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream. This is particularly important in those locations identified as Critical Drainage Areas by Essex County Council in the Chelmsford SWMP (see section 6.8).

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

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

The cumulative impact of development should 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.

3.7 Cross boundary considerations

Development has the potential to affect flood risk to existing development and surrounding areas through increased surface water runoff because of more impermeable surfaces or increased runoff into watercourses causing levels to rise, if suitable SuDS and drainage is not implemented.

NPPF sets out that development should only be considered if it does not impact on flood risk both on and off the site.

Development control should ensure that the impact on receiving watercourses from development in Chelmsford has been sufficiently considered during the planning stages and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality.

4 Climate change

4.1 Climate change and the NPPF

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

4.2 Revised Climate Change Guidance

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

4.3 Climate change allowances

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

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

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

4.4 Peak River Flows

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

The peak river flow allowances 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 allowances for the Anglian River Basin District are provided in Table 4-1.

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Table 4-1: Peak river flow allowances for the Anglian river basin district

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

4.4.1 High++ allowances

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

4.4.2 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	✓		

4.5 Sea level allowances

Sea levels are also expected to increase in the future. Sea level allowances applicable to Chelmsford are provided in Table 4-2.

Table 4-2: Sea level allowance for each epoch (mm)*

1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
4 (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m

* cumulative sea level rise for each epoch in brackets (use 1190 baseline)

To calculate sea level rise due to climate change, add the relevant allowance to the 1990 base sea level year. For example,

- up to 2025, use the 4 mm per year or the 140 mm cumulative
- from 2026 to 2055, the increase in sea level in this period is derived by adding the number of years on from 2025 (to 2056), multiplied by 8.5 to determine the sea level rise in mm (or if the whole time period applies use the cumulative total – 255mm for this epoch)
- treat subsequent time periods e.g. 2056 to 2085 and 2086 to 2115 as you would 2026 to 2055

4.6 Peak rainfall intensity allowance

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

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

Table 4-3: 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%

When designing new development, it should be demonstrated that the upper end allowance for climate change are designed for whenever possible. Should it prove impossible to accommodate these additional volumes within the formal drainage design, it should be demonstrated that the additional volumes could be accommodated elsewhere on the site in the form of managed exceedance flows.[4]

4.7 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

4 Essex County Council (2017)

- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

4.8 Groundwater

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

4.9 The impact of climate change in Chelmsford

Climate change modelling for the watercourses in Chelmsford was undertaken based on the new climate change guidance. Existing Environment Agency fluvial hydraulic models of the Rivers Chelmer, Can and Wid, and the Sandon and Rettendon Brooks were run for the 2080s period for all three allowance categories. The River Crouch tidal model was run for the 0.5% AEP and 0.1% AEP events with the sea level rise allowance for 2115. All models were run for the defended scenarios.

Of the watercourses in Chelmsford, modelling showed the Rivers Can and Chelmer and the River Crouch, to be the most significantly affected by increased flows and sea level rise, respectively, due to climate change.

The most significantly affected areas are detailed below.

- **Chelmsford:** the flood defences at Beach Drive and Roxwell Avenue are shown to overtop when the climate change allowances for the 2080s are applied to the 1% AEP flows, with properties on both roads at risk of flooding. Flooding on the right bank of the River Can is also shown to extend further under the climate change scenarios, putting properties along Beeches Road at risk.

  The Prykes Drive flood defences are also shown to overtop resulting in flood risk from the River Can to properties in this area. Defences on the right bank are already shown to overtop in the present day 1% AP defended event, but when climate change allowances are applied, the extent of flooding extends further to Baker Street and New Writtle Street. The extent of flooding on the right bank of the River Can shows a general trend of increased extent down to the confluence with the River Chelmer.

  Flood extents in the area around the River Can and River Chelmer also increase with climate change with Bellmead, Navigation Road and Mesopotamia Island at risk. Upstream on the River Chelmer, a significant increase in flood risk because of climate change is shown around Victoria Road with the school and leisure centre at risk compared to the present day scenario.

  Downstream of Chelmsford, the extent of flood risk does not increase substantially for any of the climate change allowances when compared to the present day 1% AEP defended event. The only exception to this is at Chelmer Village. The defences are already shown to overtop in the present day 1% AEP defended event, but the extent of the flooding increases with properties at Eglinton Drive and Harrington Mead at risk.

- **South Woodham Ferrers:** flood risk in South Woodham Ferrers is shown to increase significantly in the future compared to the present day 1% AEP event. Although flood defences along the left bank at Marsh Farm Country Park are shown to overtop during the present day 1% AEP defended scenario, sea level risk is shown to increase the flood extent further inland, affecting properties along the southern edge of the town.

  The largest increase in risk due to sea level rise is shown to be on the left bank of Fenn Creek. Although the defences in this area are shown to overtop under the present day 1% AEP defended scenario, the extent to which this risk extends into South Woodham Ferrers increases significantly for sea level rise for both the 0.5% and 0.1% AEP climate change events, with flood risk extending south west to north east across the town.

- **Battlesbridge:** the flood defences at Battlesbridge are already shown to be at risk of overtopping in the present day 0.5% and 0.1% AEP tidal events. However, these events, modelled with an increase in sea level rise for 2115, show the extent of flooding to reach further inland, across Maltings Road. Additionally, Hawk Lane, which is not shown at risk

in the present day defended scenario is shown to flood under the climate change scenarios.

The effect of climate change for the 1% AEP event flood extent tends to be less for the tributaries of the River Chelmer, such as the River Wid and Sandon Brook, and the modelled tributary of the River Crouch the Rettendon Brook. The tributaries tend to have a more confined floodplain and, as a result, increases in flow do not result in a significant increase in flood extent. However, despite climate change not having a significant increase in the flood extent of these watercourses, the modelling does show that those areas that do currently flood are likely to see an increase in flood depths and velocities, and therefore hazard, in the future.

No climate change outlines have been produced for watercourses where no detailed hydraulic models exist; developers should develop detailed hydraulic models as part of a site-specific flood risk assessment and include climate change in the assessment.

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5 Sources of information used in preparing the SFRA

5.1 Summary of SFRA mapping for all sources of flood risk

5.1.1 Fluvial and tidal

The data used to prepare the fluvial mapping for this study is based on Flood Zones and the results from hydraulic models either provided by the Environment Agency or prepared for the purposes of this SFRA. Hydraulic models used include:

- River Chelmer (and tributaries)
- Sandon Brook
- River Crouch

5.1.2 Surface Water

Mapping of surface water flood risk in Chelmsford has been taken from the Risk of Flooding from Surface Water map (RoFSW map) published online by the Environment Agency.

Pluvial modelling was also undertaken by Essex County Council as part of the Chelmsford SWMP which was used to inform the identification of Critical Drainage Areas (CDAs) for the SWMP. The results of the pluvial modelling were not provided for this study, but the location of the CDAs was.

5.1.3 Groundwater

Mapping of surface water 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 likely to suffer the consequences of groundwater flooding.

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

5.1.4 Sewers

Historical incidents of flooding are detailed by Anglian Water through their DG5 register. The DG5 database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. This data was requested for this study but had not been provided at the time of publication.

5.1.5 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been assessed using the outlines produced as part of the National Inundation Reservoir Mapping (NIRIM) study and as shown on the Environment Agency's Long term flood risk information **website**.

5.1.6 Suite of Maps

All the mapping can be found in the appendices to this SFRA and is presented in the following structure:

- Appendix A: Watercourses in Chelmsford
- Appendix B: Environment Agency Flood Zone Mapping
- Appendix C: Climate Change Mapping
- Appendix D: Surface Water Mapping
- Appendix E: Groundwater Mapping
- Appendix F: Flood Warning Coverage

5.2 Other relevant flood risk information

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

- **North Essex Catchment Flood Management Plan** (2011).
- **Essex County Council Preliminary Flood Risk Assessment** (2011)
- **Essex County Council Local Flood Risk Management Strategy** (2013).
- **Chelmsford Surface Water Management Plan** (2014).
- **Chelmsford City Council Water Cycle Study – Phase1** (2010).
- **Chelmsford City Council Water Cycle Study – Phase 2** (2011).
- **Flood Risk Management Plan** in accordance with the Flood Risk Regulations (available in 2015) – Environment Agency and Lead Local Flood Authority.
- **Environment Agency's Asset Information Management System (AIMS)** – users should note that recently completed schemes may not yet be included in this dataset.

6 Understanding flood risk in Chelmsford

6.1 Historical flooding

Chelmsford has a history of documented flood events with the main source being from 'fluvial' (river/watercourse networks) sources. According to the Essex County Council PFRA 4% of the 1,342 flood records were located within Chelmsford. Significant historic flood events are highlighted in Table 6-1.

Table 6-1: Documented historic flooding records within Chelmsford

Location	Date	Source	Additional Information
Chelmsford	March 1947	Previous SFRA (2008)	Flooding relating to heavy rain and snowfall causing significant damage to Chelmsford.
South Woodham Ferrers	January to February 1953	Environment Agency Recorded Flood Outlines	Tidal flooding via over-topping of defences.
River Can catchment	September 1958	Previous SFRA (2008)	Flooding caused by intense rainfall of short duration of the saturated River Can catchment.
River Chelmer catchment	September 1958	Previous SFRA (2008)	Flooding recorded downstream of Paper Mill Bridge. Also flooding at Felsted Mill and Church End.
River Chelmer catchment	October 2000	Previous SFRA (2008)	Flooding resulting from wettest Autumn since 1700s. The worst affected town was Little Waltham where 8 properties were flooded.
River Chelmer catchment	October 2001	Previous SFRA (2008)	10 properties in Great Dunmow, 14 in Little Waltham, 2 in Broomfield, 2 in Brook End and the Rivermead Industrial Estate in Chelmsford.
Various locations	Summer 2007	-	Major flood event throughout the UK which results in significant flooding.
Chelmsford area	February 2009	Media article[5]	Flooding of the River Wid near Chelmsford.
Various locations	Winter 2012	-	Major flood event throughout the UK which results in significant flooding.
Broomfield	December 2013	Media article[6]	Flood records of the River Chelmer out of bank in the vicinity of Broomfield.
Central Chelmsford	July 2014	Media article[7]	Flooding of central roads in Chelmsford.

6.2 Demographic

The Chelmsford City Council administrative area covers an area of approximately 338km^2 and has a population of approximately 168,300 (2011 census)[8]. The main town is Chelmsford City with other major settlements of Great Baddow, Writtle and South Woodham Ferrers. The most populated wards are that of Chelmer Village and Beaulieu Park (approx. population of 11,270) and Moulsham and Central (approx. population of 10,200).

6.3 Topography, geology and soils

6.3.1 Topography

The topography of Chelmsford is primarily comprised of higher ground located along the northern, western and eastern portions of the study area. Elevations reach approximately 100m AOD near

5 http://www.dailymail.co.uk/news/article-1138944/Then-came-floods-As-snow-melts-months-rain-day-brings-blackout-chaos.html (accessed 26/01/2016)

6 http://www.itv.com/news/anglia/2013-12-26/pictures-of-the-river-chelmer-in-flood-in-essex/ (accessed 26/01/2016)

7 http://www.essexchronicle.co.uk/Flooding-Chelmsford-overnight-storms/story-21656244-detail/story.html (accessed 26/01/2016)

8 Census (2011)

http://www.chelmsford.gov.uk/sites/chelmsford.gov.uk/files/files/files/documents/files/Census%202011%20Headline%20Statistics%20Factsheet%20Dec%202012%20WEB.pdf

Danbury, Stock Common and Loves Green. Lower laying land correlates with the main watercourses of the region through Chelmsford and in the south-east corner of the study area.

6.4 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.

Figure 6-2 shows the bedrock (solid permeable) formations in the District and Figure 6-3 shows the superficial (permeable, unconsolidated (loose) deposits. These are classified as the following:

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

The bedrock in the north of the area is predominantly classed as unproductive strata which is reflected in the superficial deposits mostly consisting of secondary (undifferentiated) strata, except for river corridors where the strata is classed as secondary A. The bedrock in the south is formed of a mixture of unproductive and secondary A strata. Superficial deposits are limited and are predominantly classed as secondary (undifferentiated). The lower permeability of the bedrock and superficial deposits in the area will results in higher runoff than if the area were underlain by permeable deposits.

The underlying geology and aquifer designation also has implications for what sustainable drainage solutions may be suitable for a site. For example, infiltration SuDS will be dependent on the permeability of the underlying deposits. Further information on geology can be found via the British Geological Society's **Geology of Britain website**.

The British Geological Society have also produced an **Infiltration SuDS map** which gives a preliminary indication of the suitability of the ground for infiltration SuDS.

6.4.1 Hydrology

A summary of the principal watercourses in the SFRA are provided in Table 6-2. Mapping indicating the location of these watercourses can be found in Appendix A.

Figure 6-1: Topography of Chelmsford

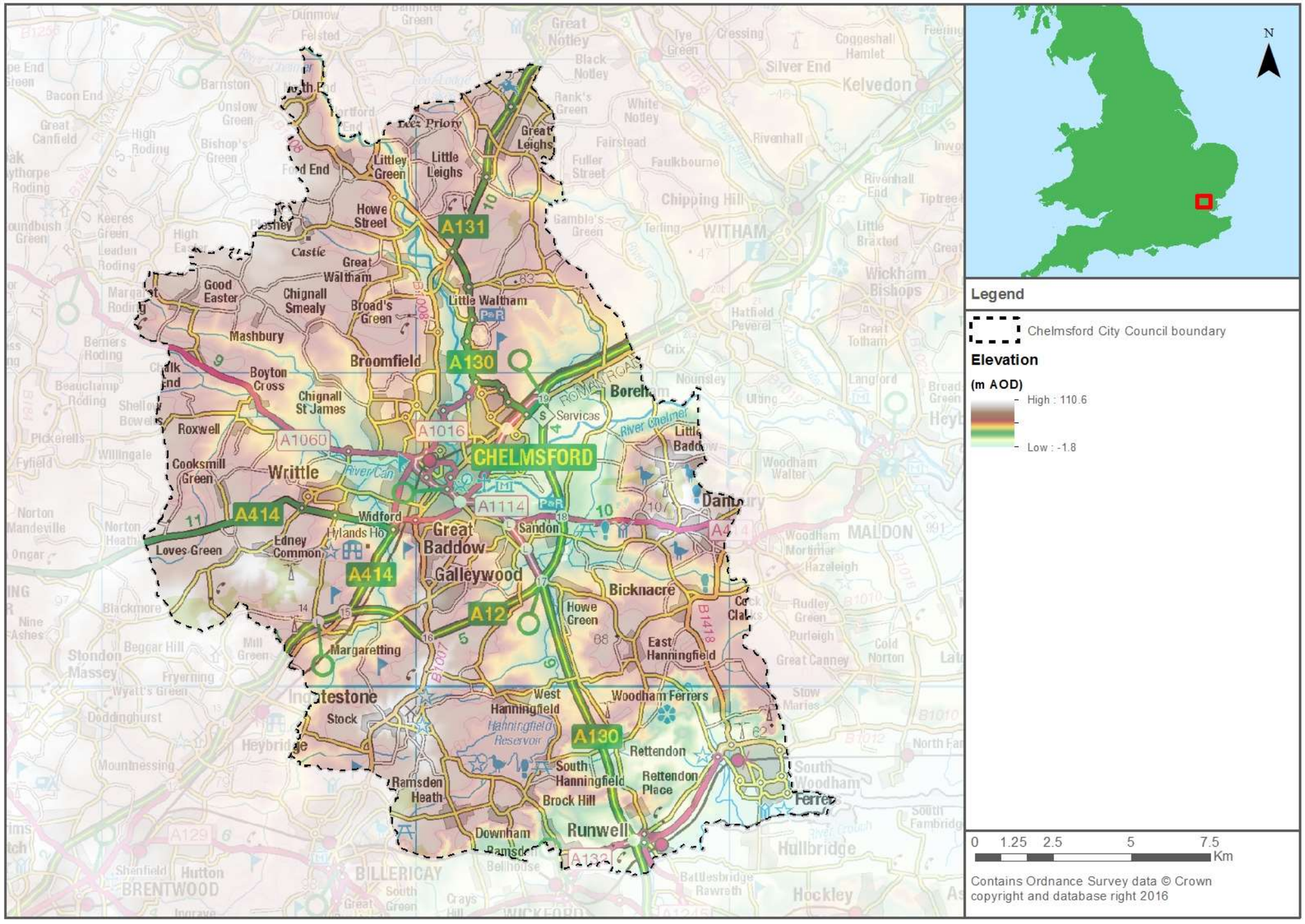


Figure 6-2: Bedrock geology of Chelmsford

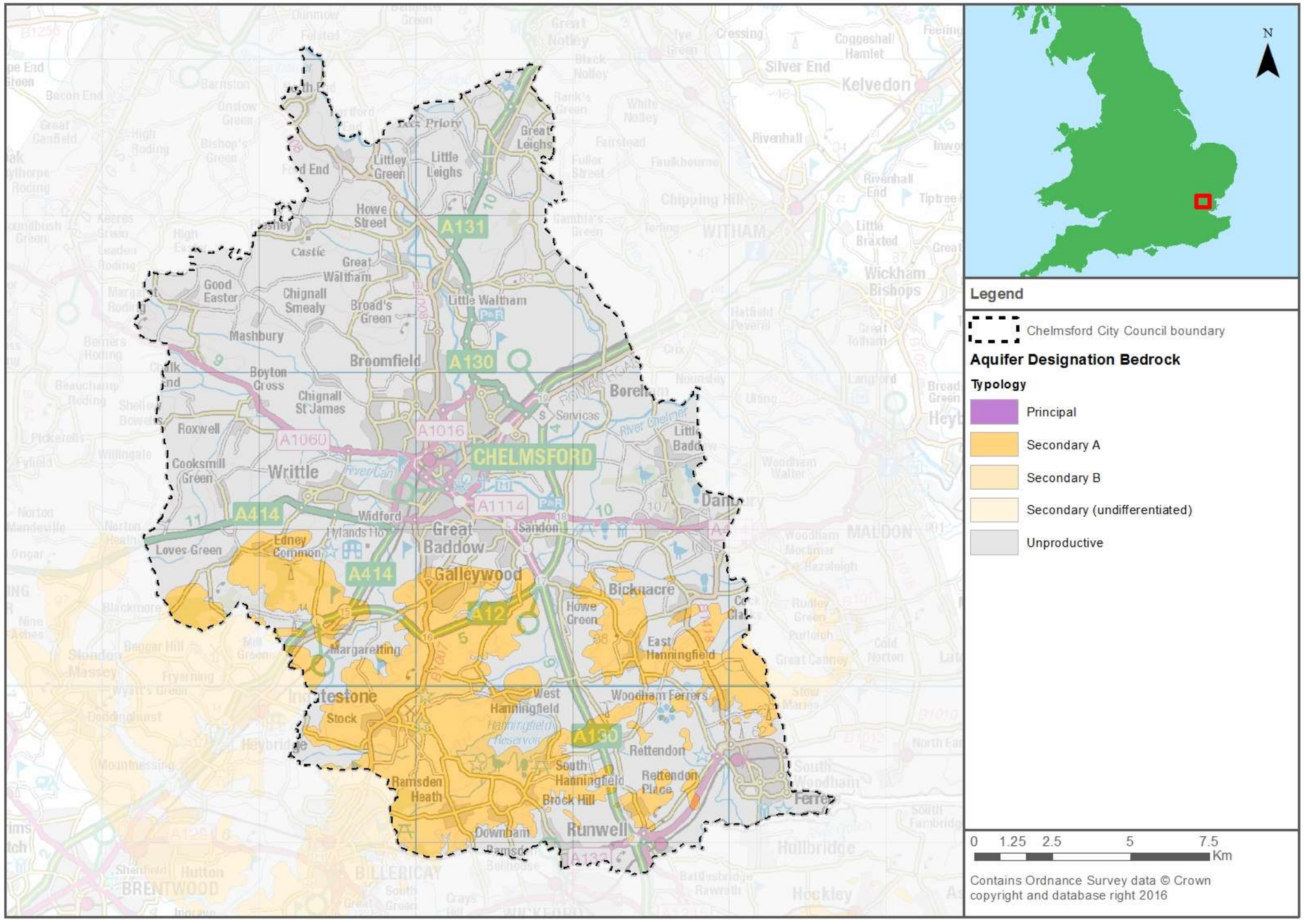


Figure 6-3: Superficial geology of Chelmsford

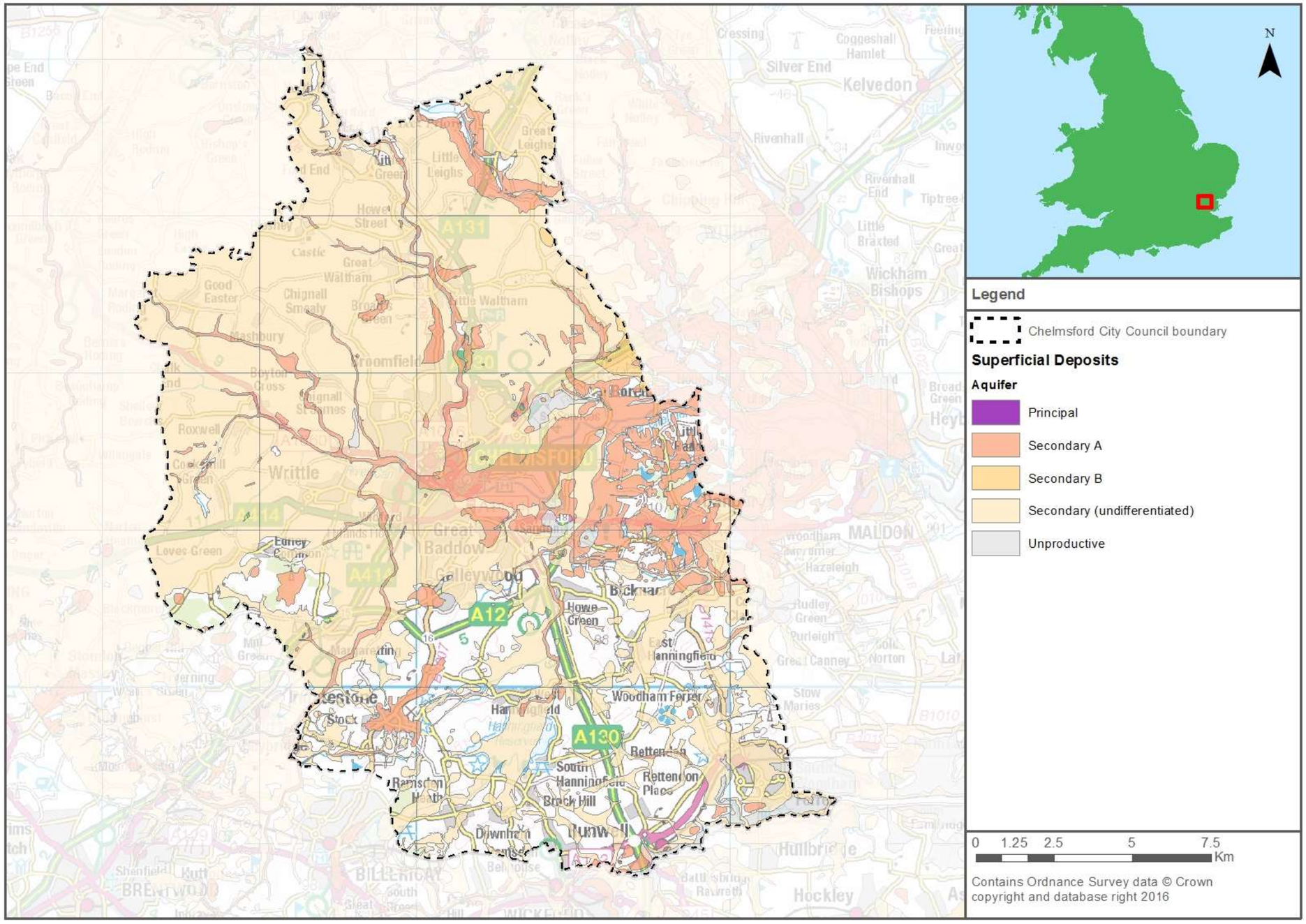


Table 6-2: Key watercourses in the Chelmer catchment

Watercourse	Classification	Description
River Chelmer	Main River	The River Chelmer runs from its source in Thaxted in a south-easterly direction towards its tidal discharge pint in the Blackwater Estuary in the neighbouring district of Maldon. There are a number of navigation channels with adjoin the main River Chelmer channel in Chelmsford City; these are termed “the Chelmer and Blackwater Navigation”.
River Can	Main River	A tributary of the River Chelmer, the River Can source is located along the western boundary of the district. Flowing in a south-easterly direction where the River Can has a confluence with the River Chelmer within Chelmsford City.
River Wid	Main River	A tributary of the River Can, the River Wid source is located outside of the study area. Within the study area it flows in a north-easterly direction where the River Wid has a confluence with the River Can west of Chelmsford City.
Sandon Brook	Main River	The Sandon Brook is located downstream of Hanningfield Reservoir; the OS mapping and DRN suggests that the discharge channel from this reservoir flows into the Sandon Brook. The Sandon Brook flows in a predominantly north / north-easterly direction, east of Chelmsford City, to its confluence with the River Chelmer.
River Ter	Main River	The River Ter is enters the north-east corner of the study area, upstream of Lodge Lake and Lavender Lake and flows in a predominantly south-easterly direction, through Little Leighs, before exiting the study area. The River Ter is a tributary of the River Chelmer.
Margaretting Brook	Main River	Margaretting Brook is located in the western part of the study area. It is named and classified as a Main River at Ivy Barns Lane, east of Handley Green. The Margaretting Brook flows in a south-easterly direction to its confluence with the River Wid downstream of the railway, around TL 67489, 00821. Around Margaretting primary school, the Brook is joined by an un-named section of Main River.
Newlands Brook	Main River / Ordinary Watercourse	The Newlands Brook is located in the western part of the study area and flows in an easterly direction to Boyton Cross, where it turns southwards and changes to a Main River classification (TL 64820, 09188). It continues to flow southwards to its confluence with the Roxwell Brook.
Roxwell Brook	Main River / Ordinary Watercourse	The Roxwell Brook is located in the western part of the study area. It starts as an ordinary watercourse, around TL 62935, 06217and flows in a north-easterly direction. It is classified as Main River, from downstream face of Patience Bridge (TL 63241, 07099), continuing to flow in a north-easterly direction, before turning south-east around Roxwell and continuing to its confluence with the River Can, north of Writtle College.
Wares Brook	Main River	The Wares Brook is located in the western part of the study area, east of Good Easter and flows in southerly direction until its confluence with the River Can.
One Bridge Brook Chignall	Main River / Ordinary Watercourse	The One Bridge Brook Chignall flows in a mainly southerly direction, past the western edge of Chelmsford City, until its confluence with the River Can. The watercourse is named and classified as Main River, downstream of an access track leading from Gray’s Farm, around TL 67793, 10738.
Stock Brook	Main River	The Stock Brook is located in the western part of the study area. It is named and classified as Main River, downstream of Stock Road in Stock (TL 68600, 97886) and flows in a westerly direction, to its confluence with the River Wid.

Watercourse	Classification	Description
Straw Brook	Main River / Ordinary Watercourse	The Straw Brook is located in the north-east part of the study area. The OS mapping suggests the source of the Straw Brook is north-west of Hyde Hall. It is classified as Main River, from where the A131 crosses over it. The Straw Brook flows in an easterly direction, to its confluence with the River Ter, east of Goodmans Lane.
Erme Drain / Erme	Main River	The Erme Drain / Erme enters the eastern part of the study area, south-west of Danbury, at Slough Bridge (TL 80636, 03225). The Erme Drain flows in a westerly direction, to its confluence with the Sandon Brook.
Baddow Brook / Great Baddow Brook	Main River	The Baddow Brook / Great Baddow Brook is located in Chelmsford City and is named and classified as Main River from Craiston Way (TL 7263, 04310). This Brook flows in a north-easterly direction, to its confluence with Baddow Meads Ditch.
Baddow Meads Ditch	Main River	Baddow Meads Ditch starts around the A138 / A1114 roundabout in Chelmsford City and flows in an easterly direction, to its confluence with the River Chelmer, downstream of Sandford Mill Road (TL 73906, 06026).
Bicknacre Brook	Main River	The Bicknacre Brook is located in the eastern part of the study area, in Bicknacre. It is named and classified as Main River from TL 78160, 02453 and flows in a north-easterly direction, through Bicknacre, to its confluence with the Erme Drain / Erme.
Boreham Brook	Main River	The Boreham Brook is located in the eastern part of the study area and is named and classified as Main River from Brick House Farm, north of the railway line (TL 75462, 10389). This Brook flows in a westerly direction, circling beneath the railway bridge and the A12, and turning to flow in a south-westerly direction, to its confluence with the River Chelmer.
Kings and Worlds End Ditch	Main River	The Kings and Worlds End Ditch starts outside the study area, north-east of Little Baddow and flows in a south-easterly direction. This Ditch flows just within the eastern border of the study area, for 200m and joins its confluence with the River Chelmer, outside the study area.
Pannhouse Farm Brook	Main River	The Pannhouse Farm Brook is located north-east of Hanningfield Reservoir and is named and classified as Main River from Southend Road, (TL 75210, 00097). This Brook flows in a westerly direction to its confluence with the Sandon Brook.
Tributary of the River Chelmer	Main River	At TL 72067 05986 the DRN shows that the “Tributary of the River Chelmer” flows from just upstream Meadgate Avenue, 300m northwards to join the Baddow Meads Ditch, in Chelmsford City.

Table 6-3: Key watercourses in the River Crouch catchment

Watercourse	Classification	Description
River Crouch	Main River	The River Crouch is located along the south-eastern boundary of the study area. The upper tidal limit of this watercourse is located downstream of Battlebridge which is with the study area.
Clements Green Creek	Main River	Clements Green Creek flows southwards along the eastern edge of South Woodham Ferrers, before changing to an easterly course before joining the River Crouch at Brandyhole Reach.
Runwell Brook	Main River	The Runwell Brook is located at the southern boundary of the study area, around Brock Hill road, north of Wickford. This Brook flows in a predominantly south-easterly direction, through a residential estate, before exiting the study area boundary and joining the River Crouch, south of Runwell.
Quart Pot Brook	Main River / Ordinary Watercourse	The Quart Pot Brook is located near the southern boundary of the study area, around Runwell. The Brook classified as Main River downstream of the A132 Runwell Road. Upstream of this location it is classed as Ordinary Watercourse. It starts to flow in a south-easterly direction and then runs parallel to an access track, turning southwards and joining the River Crouch.
Hawk Ditch, Battlebridge	Main River	The Hawk Ditch, Battlebridge is located near the southern boundary of the study area. This Ditch is named and classified as Main River from upstream of Hawk Lane and flows in a south-easterly direction, to its confluence with the River Crouch.
Fen Brook	Main River	The Fen Brook is located north of South Woodham Ferrers, in the south-east part of the study area. The Brook classed as Main River downstream of Workhouse Lane and flows in a southerly direction, into the Fenn Creek. Upstream of Workhouse Lane the watercourse is classed as Ordinary Watercourse.
Rettendon Brook	Main River / Ordinary Watercourse	The Rettendon Ditch is located in the southern part of the study area; it is classified as Main River downstream of Chalk Street in Coalhill (upstream of this location is it classed as Ordinary Watercourse). This Brook flows in an easterly direction, south of Rettendon and turns southwards, around the A132 Burnham Road and joins the Fenn Creek, west of South Woodham Ferrers.
Eyots Farm Ditch	Main River	The Eyots Farm Ditch is located in the south-east part of the study area, in South Woodham Ferrers. The Brook starts at Hullbridge Road, flowing in a south-westerly direction, past The Chetwood Primary School and joins the Fenn Creek, downstream of Inchbonnie Road.
Fenn Brook	Main River	The Fenn Brook flows along the western edge of South Woodham Ferrers before becoming part of the tidal Crouch at the confluence of the Fen Brook and the Rettendon Brook.

6.5 Fluvial flood risk

The primary sources of fluvial flood risk in Chelmsford is fluvial flooding associated with the watercourses in the Chelmer and Crouch catchments. Locations with associated fluvial flood risk in Chelmsford (as well as other sources of flooding) are detailed in Table 6-5.

In 2015 the Essex Flood and Water Management Alliance set up a project “Where Does Water Go?” aimed at identifying critical watercourses (ditches, culverts etc) and their owners as well as educating the community about the riparian responsibilities.

6.6 Tidal flood risk

The primary source of tidal flood risk is the River Crouch. In undefended areas, tidal flooding can result from a storm surge, high spring tides or both event combined. In defenced areas, tidal flooding can occur through a breach in the sea defences, failure of a mechanical barrier or overtopping of defences. Locations with associated tidal flood risk in Chelmsford (as well as other sources of flooding) are detailed in Table 6-5.

6.7 Flood defences

There are several flood defence schemes within Chelmsford. Figure 6-4 and Figure 6-5 show the areas benefitting from defences in Chelmsford City and South Woodham Ferrers as designated by the Environment Agency. The Environment Agency’s Areas benefitting from defences dataset shows areas that benefit from flood defences in the event of a river flood with a 1% chance of happening in any one year. If the defences were not these areas would be flooded. The dataset may not yet include areas benefitting from recently completed schemes. Defences are covered in greater detail in Section 7.

Figure 6-4: Areas benefitting from defences in Chelmsford City

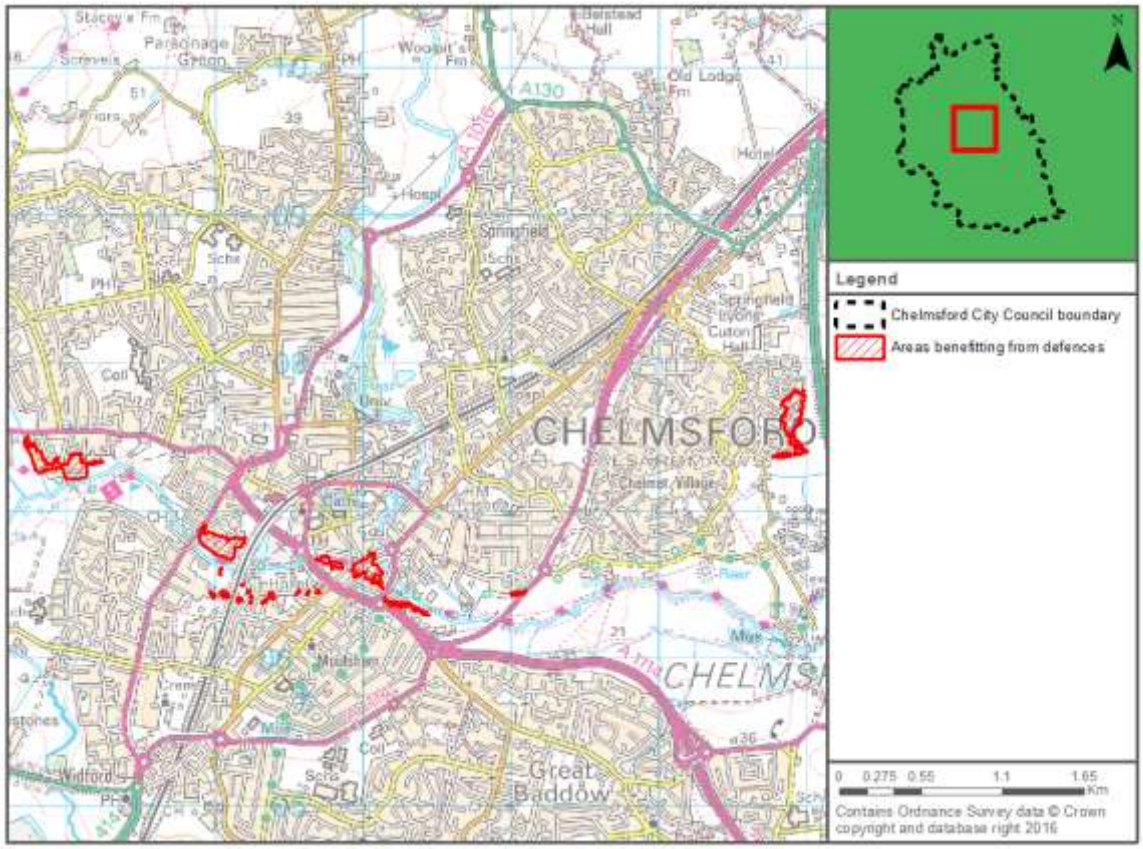
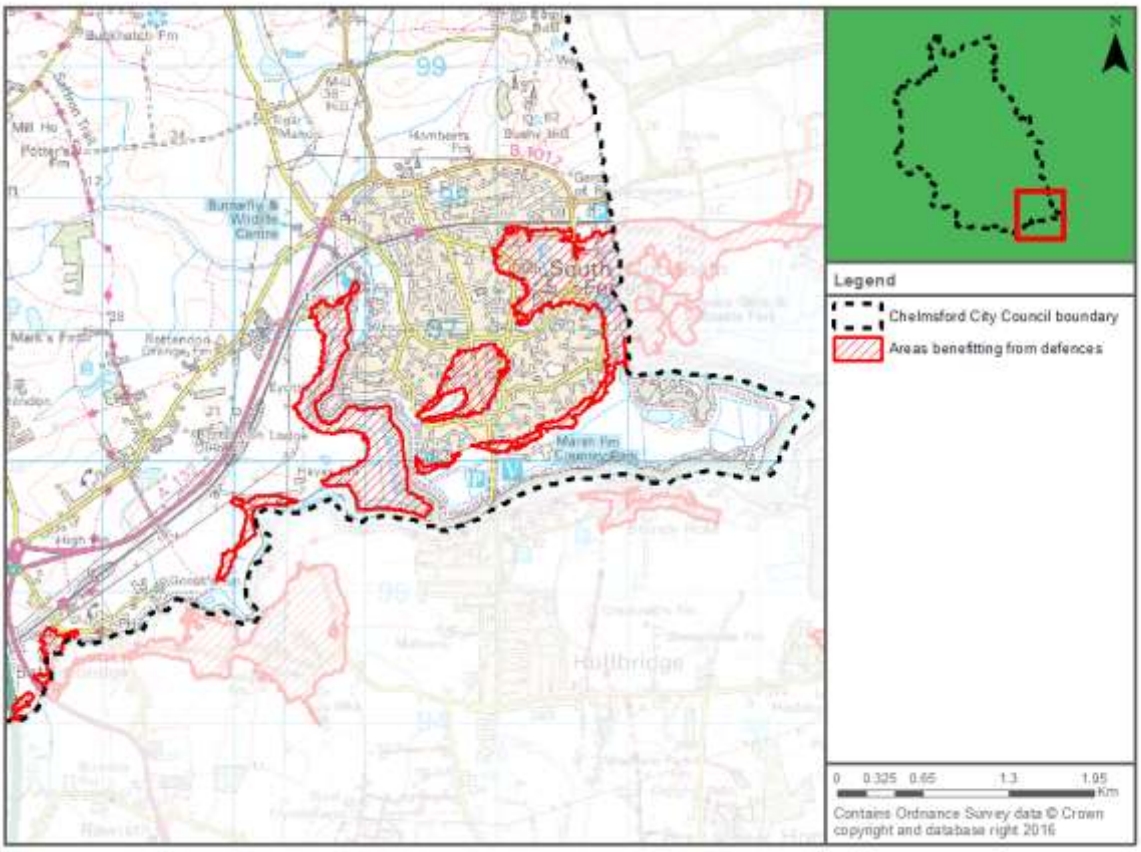


Figure 6-5: Areas benefitting from defences in South Woodham Ferrers



6.8 Surface water flooding

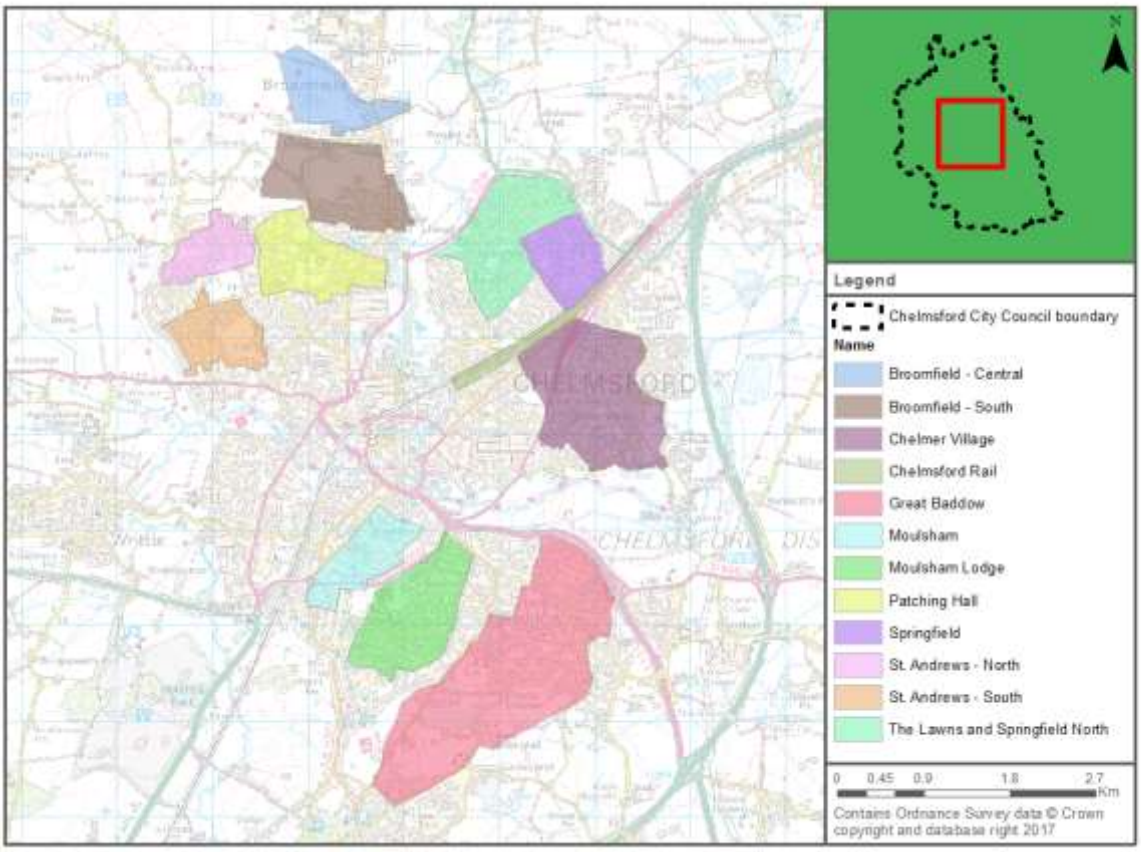
Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding.

The Risk of Flooding from Surface Water map (RoFSW map) predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas.

A summary of surface water flood risk to key locations in Chelmsford (as well as other sources of flooding) are detailed in Table 6-5. The RoFSW map mapping for Chelmsford can be found in Appendix D.

In addition to the RoFSW mapping, Essex County Council have provided the CDAs identified as part of the Chelmsford SWMP. These are shown in Figure 6-6. Development in these areas should be consistent with the preferred options for the CDA, as set out in the SWMP.

Figure 6-6: Chelmsford SWMP CDAs



6.9 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. Under the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on Major Aquifers. However, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high 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 because of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

Mapping of the whole Borough has been provided showing the AStGWF dataset and can be found in Appendix E.

6.10 Flooding from artificial sources

6.10.1 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 most new 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.

6.10.2 Flooding from reservoirs

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

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate, but it is less likely than flooding from rivers 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 Chelmsford because 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. Five reservoirs are located within the district; however, there are also reservoirs outside of the area whose inundation mapping is shown to affect district. Details of the reservoirs are detailed in Table 6-4. Maps of the flood extent can be found on the Environment Agency's Long term flood risk information **website**.

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 6-4: Reservoirs that may potentially affect Chelmsford in the event of a breach

Reservoir	Location	Reservoir Owner	Environment Agency area	Local Authority	In the District ?
Hanningfield	573647, 199344	Essex & Suffolk Water Ltd	Essex, Norfolk and Suffolk	Essex	Yes
Handley Barn	565261, 201823	Knowles	Essex, Norfolk and Suffolk	Essex	Yes
Margaretting Hall	566539, 199900	RH Currie & Co	Essex, Norfolk and Suffolk	Essex	Yes
Herongate Reservoir 2	563269, 191448	Essex & Suffolk Water Ltd	Essex, Norfolk and Suffolk	Essex	No
Mashbury Hall Farm	565370, 211372	C J H Farming Limited	Essex, Norfolk and Suffolk	Essex	Yes
Chignall Hall Farm	567064, 209972	Philpot	Essex, Norfolk and Suffolk	Essex	Yes

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

- Developers should seek to contact the reservoir owner to obtain information which may include
    - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
    - operation: discharge rates / maximum discharge;
    - discharge during emergency drawdown; and
    - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site. The following questions should be considered
    - can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?

- can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
- can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?

- Consult with relevant authorities regarding emergency plans in case of reservoir breach
- In addition to the risk of inundation those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

Table 6-5: Summary of flood risk to key towns and villages in Chelmsford

Settlement	Fluvial / tidal flood risk	Defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk
				<25%	>=25% <50%	>=50% <75%	>=75%	
Chelmsford City	Flood Zones show several areas in Chelmsford City to be at risk from fluvial flooding. These include Roxwell Avenue and Beach's Drive which is located on the confluence of the River Can and the One Bridge Brook, Beeches Road, Andrews Place, Prykes Drive and Meteor Way which are at risk from the River Chelmer. Other areas at risk from the River Chelmer include properties located between the railway line and the A1060, properties along the left bank of the River Chelmer at Chelmer Village, as well as numerous properties around the confluence of the River Chelmer with the River Can.	Chelmsford City is shown to benefit from defences in the following areas: Roxwell Avenue, Beach's Drive, Prykes Drive, Alma Drive, Elgin Avenue, Coval Lane, Bellmead, Stone Bridge, High Street, Harrington Mead, Eglinton Drive and Cowdrie Way. Note: not all properties on these roads benefit from the defences.	Risk is a combination of flow routes along roads, flow routes along dry valleys and ponding in gardens and some roads. The majority of risk is 100 years or higher. Other areas of risk correspond with the floodplains of the River Chelmer, River Can, Baddow Brook and One Bridge Brook.	✓	✓	✓	✓	Inundation from Mashbury Hall Farm Reservoir, Margaretting Hall Reservoir and Chignall Hall Reservoir may potentially affect rural land to the west of the town.
South Woodham Ferrers	Flood zones show the main areas at risk from flooding are in the west and the south east of South Woodham Ferrers. In the west the risk is predominantly located in an area bounded by the railway line, Ferrers Road, Inchbonnie Road and Clements Green Lane. The risk is from the tidal River Crouch and Clements Green Creek. In the south eat the risk is predominantly located in an area bounded by Inchbonnie Road and Ferrers Road. The risk is from the tidal River Crouch and Fenn Brook / Creek. Other areas at risk include Old Wickford Road, which is at risk from Fenn Brook and Marsh Farm, which is at risk from the tidal River Crouch. Except for Marsh Farm and Old Wickford Road, the areas at risk listed above are shown to benefit from defences.	South Woodham Ferrers is shown to benefit from flood defences. These defences include man-made raised defences and maintained channels. A sea wall extents from Fenn Creek near Bywater Road, along the bank of the tidal River Crouch to Clements Green Creek. Further protection is provided by an embankment that forms part of Clements Green Creek Washland / Flood Storage Reservoir.	Risk is a combination of flow routes along roads and small drains and ponding in gardens and some roads. Areas at greatest risk largely correspond with the areas at fluvial and tidal flood risk. In addition to these areas, there is a flow path rising near Woodville Primary School with flows south along Clements Green Lane, before taking a south westerly route across Tanners Way and the railway line to Haltwhistle Road and Ferrers Road. Other areas of risk correspond with the floodplains of the Fenn Brook / Creek and Clements Green Creek.	✓	✓	✓		Inundation from Clements Creek Flood Storage Reservoir may potentially affect rural land to the west of the town.
Great Leighs	Flood Zones show no fluvial flood risk from Main River to the village. However, there is an unnamed ordinary watercourse / drain that flows through the rural land to the east of the village. This watercourse may potentially pose a flood risk to the Catherine's Close area as well as any future development to the east of the village.	None	Risk is predominantly confined to roads, with the majority of the risk being at 100 years or higher. The road with greatest risk is Main Road as it heads south towards the junction with the A131.	✓	✓			None
Boreham	The Boreham Brook flows to the north of the village, before meandering around the west of the village; however, Flood Zones suggest there is not risk to the village from this watercourse. There is a small, unnamed drain that flows south from Juniper Road to the Boreham Brook which may pose some potential risk of fluvial flooding.	None	Risk is a combination of flow routes along roads and small drains and ponding in gardens and some roads. A number of flow routes from southwards through the village before joining the Boreham Brook.	✓	✓			None
Great Waltham	The Walthambury Brook flows to the north of the village; however, Flood Zones show the majority of the village is not at risk from fluvial flooding with only a couple of properties at risk. An unnamed drain flows through rural land to the south of the village; however, Flood Zones how it poses no risk to the village.	None	Risk is predominantly confined to roads, with the majority of the risk being at 100 to 1,000 years. All the key roads into and out of the village are shown to be at risk from surface water flooding.	✓	✓			None

Settlement	Fluvial / tidal flood risk	Defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk
				<25%	>=25% <50%	>=50% <75%	>=75%	
Little Waltham		None	Risk Is predominantly from a number of flow paths originating in the rural land to the east of the village that flow through the village to the River Chelmer. There are also smaller pockets of risk where water is ponding on the surface, mainly along roads. The level of risk ranges from 30 to 1,000 years.	✓	✓	✓		None
Writtle	Flood Zones show the main fluvial flood risk is from the River Wid to the Bridge Street, Lawford Lane and Chelmsford Road area. There are three unnamed drains that rise by Lodge Road and drain to the River Wid. Two of these drains are culverted along the majority of their length; blockage or surcharge of these culverts could result in flooding. Another unnamed ordinary watercourse flows to the south of the village before joining Sandy Brook. This watercourse may pose potential fluvial flood risk to Chequers Road / Lodge Road area.	None	Risk is predominantly confined to roads, with the majority of the risk being at 100 years or 1,000 years. All the key roads into and out of the village are shown to be at risk from surface water flooding. Roads with greatest risk include Lordship Road, Bridge Street and Lodge Road	✓	✓	✓		Inundation from Margaretting Hall and Handley Barns Farm reservoirs may potentially affect the easternmost edge of the village.
Danbury / Little Baddow	Flood Zones show no fluvial flood risk to the village.	None	Risk is predominantly along most of the roads in the village, with the majority of the risk being at 100 years or 1,000 years. Other areas of risk appear as overland flow routes that correspond with small, unnamed, drains.	✓		✓		None
Margaretting	The Margaretting Brook flows around the outskirts of the village. Flooding is limited to properties around Penny's Lane and Brook Farm. The River Chelmer flows to the east of the village but Flood Zones show no risk to the village from this watercourse. OS mapping suggests there are two small, unnamed drains that flow through the village before joining the River Chelmer. The first flows to the south of Wantz Road, through the allotment gardens and under the railway embankment. The second flows to the north of Orton Close where it becomes culverted before exiting the culvert at the railway embankment. Although not shown in the Flood Zones, both watercourses may pose a flood risk to the village	None	Surface water mapping shows a flow route that corresponds with the small, unnamed, drains that run through the village. Surface water flood risk is also shown to significantly affect Wantz Road and the B1002 as well as Orton Close and Parsonage Lane.	✓		✓		Inundation from Handley Barns Farm reservoir may potentially affect the south westernmost edge of the village. Margaretting Hall, Handley Barns Farm and Herongate Reservoir 2 may potentially affect rural land to the east and south east of the village.
East Hanningfield	Flood Zones show no fluvial flood risk to the village. OS mapping suggests there are a number of small, unnamed, drains flowing through the village that may potentially pose a flood risk.	None	Risk consists predominantly of ponding on roads. Areas of greatest risk appear as overland flow routes that correspond with the small, unnamed, drains.	✓	✓	✓		None
Howe Green	Flood Zones show no fluvial flood risk to the village. A small, unnamed, drain flows from Southlands Chase before entering a long culvert at Three Oaks, emerging again at Orchard View, before flowing into the Sandon Brook. This drain may pose a flood risk to the rural land to the south of the village.	None	Risk consists predominantly of flow routes and ponding on East Hanningfield Road, Alexander Mews and Chalklands. Surface water mapping also shows an overland flow route to the south of the village; however, this does not correspond to the small, unnamed drain, possibly because the surface water mapping may not reflect the presence of the culvert.	✓	✓			Inundation from Hanningfield reservoir may potentially affect the south and west of the village

Settlement	Fluvial / tidal flood risk	Defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk
				<25%	>=25% <50%	>=50% <75%	>=75%	
Bicknacre	The Bicknacre Brook flows through the north of the village. Flood Zones show properties at risk along Westerings, Five Acres, Peartree Lane, Augustine Way and Blenheim Close. There is also a small, unnamed, drain that flows into the Bicknacre Brook at Five Acres. This drain is not covered by the Flood Zones but may pose a flood risk. The drain is also largely culverted where it flows through the village and therefore may pose a risk of flooding through blockage or surcharge of the culvert.	None	Flood risk consists predominantly of flow routes and ponding along roads in the village. There are also a couple of overland flow routes. The first corresponds with the small, unnamed, drain that flows into the Bicknacre Brook. The second begins along Hill View, flowing through property and gardens along Bicknacre Road and Augustine Way before flowing into the Bicknacre Brook. There is also a large overland flow route to the south of the village, starting at Brockenhurst Way, flowing across the playing field and land along Leighams Road before entering an unnamed drain.	✓	✓	✓		None
Stock	Flood Zones show no fluvial flood risk to the village.	None	Risk consists of ponding on roads and flow routes following small unnamed drains flowing away from the village. The majority of the risk is at 100 or 1,000 years, although some there are some pockets of 30 years, notably at Mill Road / High Street junction.	✓				None
Ramsden Heath	Flood Zones show no fluvial flood risk to the village. The upper reaches of the Sandon Brook flow to the north of the village and a tributary of the River Crouch flows behind properties on Park Lane. The Sandon Brook is located a fair distance from the village and is unlikely to pose a risk; however, the tributary of the River Crouch may potentially pose a risk due to its proximity to property.	None	Risk consists predominantly of ponding on roads and gardens. Areas of higher risk (30 years) include Short Lane, Downham Road and Church Road. Surface water maps also show a significant overland flow route stretching from Church Road, near Downham C of E Primary School, northwards across rural land to Downham Road near the sports field before continuing north to flow into Sandon Brook.	✓	✓	✓		None

7 Flood defences

7.1 Flood defences

Several flood alleviation schemes (FAS) have been investigated and commissioned within Chelmsford.

Flood alleviation schemes identified within the SFRA area may inform formal defences, initiatives to improve drainage, and/or land management to reduce the risk of high velocity overland surface runoff.

7.1.1 Defence standard of protection and residual risk

One of the principal aims of this SFRA is to outline the present risk of fluvial flooding from watercourses across Chelmsford that includes consideration of the effect of flood risk management measures (including flood banks and defences). The fluvial flood risk presented in the SFRA is of a strategic nature for preparing evidence on possible site options for development. In the cases where a specific site risk assessment is required, detailed studies should seek to refine the current, broad, understanding of flood risk from all sources.

Consideration of the residual risk behind flood defences should be considered as part of detailed site specific flood risk assessments. The residual risk of flooding in an extreme flood event or from failure of defences should also be carefully considered.

Developers should also consider the standard of protection provided by defences and residual risk as part of a detailed FRA.

Standard of Protection

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

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

7.1.2 Defence condition

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 7-1. This detail, in addition to descriptions and standard of protection for each, were provided by the Environment Agency for preparing this SFRA which reports on the standard of protection using this information.

Table 7-1: 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

A review of key defences across Chelmsford, their condition and standard of protection is included in the following sections.

7.2 Overview of defences

7.2.1 Chelmsford City

A number of river improvements that were carried out in the 1960's to mitigate the severe impacts of flooding within Chelmsford City in March 1947 and September 1958. These measures included:

- Installation of Chelmsford City Sluice Gates, located downstream of the confluence of the Rivers Chelmer and Can and downstream of the main urban area. The system comprises of one tilting gate and two radial gates, which are all fully automatic and dependent on river levels. These are used to retain an artificially high water level through Chelmsford City and were designed to pass flood flows of up to the magnitude of the severe March 1947 flood event
- River realignment comprising river widening, straightening and deepening, from upstream of Springfield Gauging Station at Victoria Road Bridge on the River Chelmer to the sluice gates;
- River realignment comprising of river widening, straightening and deepening, upstream of Beach's Mill Gauging Station on the River Can to the confluence with the River Chelmer; and
- Raising of flood embankments on the River Can and within the main shopping centre on the River Chelmer.

The Environment Agency's AIMS database lists the standard of protection of the embankment at Roxwell Avenue and Beach's Drive as 1 in 100-years along the River Can and 1 in 10-years along One Bridge Brook. The condition of both defences is listed as fair. The embankments on the left and right bank of the River Can at Andrews Place / Prykes Drive and Meteor Way have a 1 in 100-year standard of protection. The left bank embankment condition is listed as fair and the right bank condition is listed as good.

The flood walls along the right bank downstream of the railway bridge and at Meadows Carpark have a standard of protection of 1 in 100-years and a condition class of fair.

Chelmer village is protected by a concrete flood wall which has a standard of protection of 1 in 100-years. The condition of this defence is classed as very good.

7.2.2 Chelmsford City Flood Defence Scheme

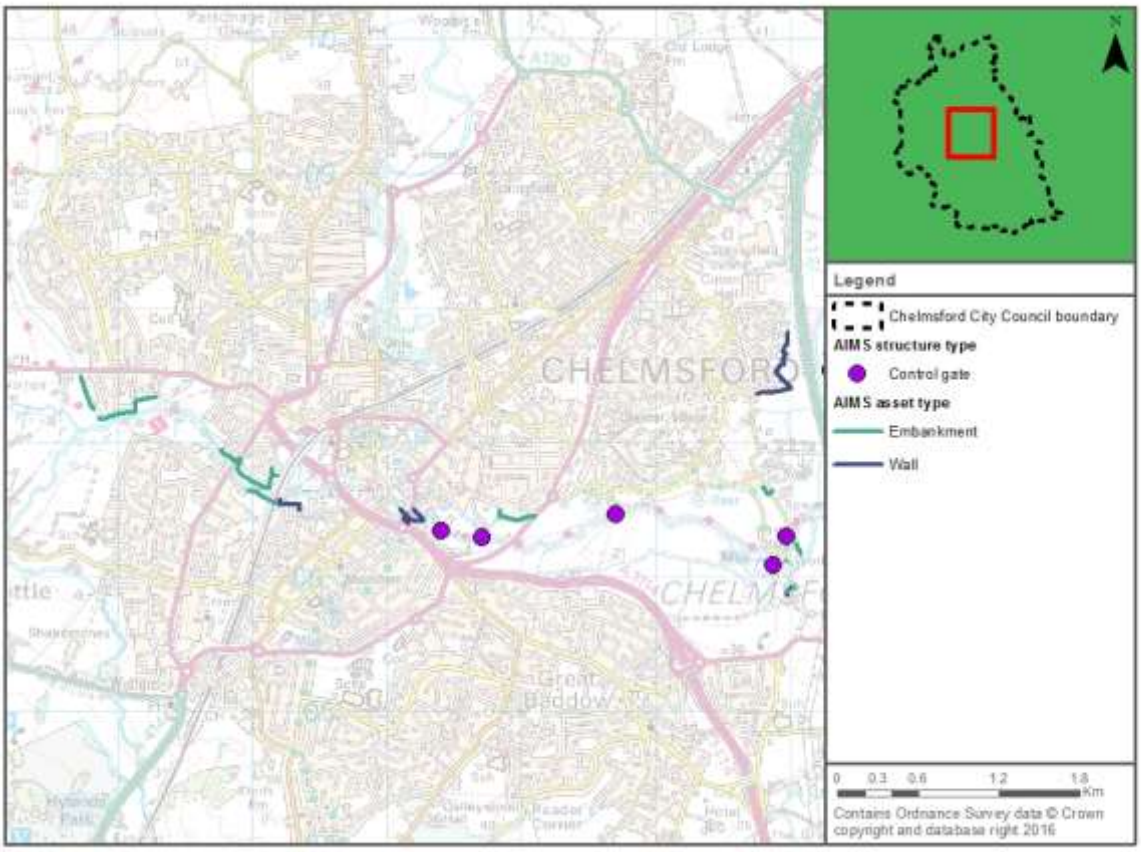
Technical studies were carried out by the Environment Agency following near miss flood events to Chelmsford City in 2000 and 2001. These established a high number of residential and commercial properties at risk[9] and recommended an improvement to existing city wide flood defences.

The solution comprised two elements – a flood wall to the east of the urban area at Chelmer Village and an on-line flood storage area on the River Wid at Margaretting. The Chelmer Village scheme was completed in 2013 and safeguards 125 properties. The Margaretting project is larger and would comprise an earth embankment up to 5.3m in height capable of creating a temporary reservoir of some 2.1 million cubic metres of storm water. It would provide a minimum of a 1 in 75-year standard of protection to properties in the city centre of Chelmsford, primarily along the River Can. Overall the works would benefit 462 residential and 176 commercial properties[9].

Preparatory work has begun at Margaretting, but is currently halted following a series of High Court actions. Further construction work is delayed pending the outcome of a legal case to be heard at the Court of Appeal in January 2017.

[9] Environment Agency Project Appraisal Report April 2010 para 1.4.13

Figure 7-1: Chelmsford City flood protection



7.2.3 South Woodham Ferrers

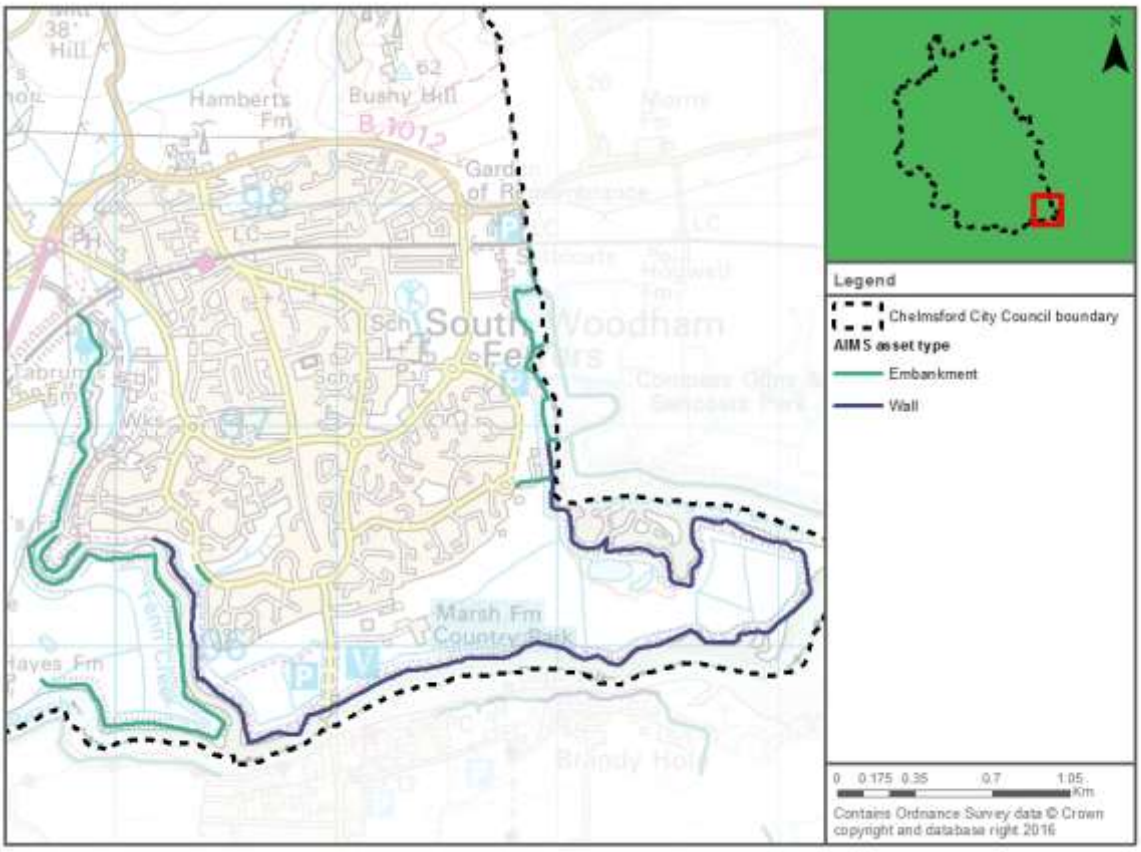
The flood defences at South Woodham Ferrers consist of man-made raised defences and maintained channels.

A sea wall extents from Fenn Creek near Bywater Road, along the bank of the tidal River Crouch to Clements Green Creek. This defence has a 1 in 200-year standard or protection and the condition ranges from fair along Clements Green Creek to very poor along the tidal River Crouch.

Further protection is provided by an embankment that forms part of Clements Green Creek Washland / Flood Storage Reservoir. The Flood Storage Reservoir was designed to a 1 in 1,000-year standard of protection and it is aimed to maintain this standard.

To the west of South Woodham Ferrers, an embankment runs along the right bank of Fenn Creek from the railway line to the confluence with the tidal River Crouch. This defence has a standard of protection of a minimum of 1 in 200-years and a fair condition rating.

Figure 7-2: South Woodham Ferrers flood protection



7.3 Residual flood risk

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

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

Defences in Chelmsford City are generally shown to be in good condition and have a high standard of protection. However, the Environment Agency's AIMS database shows some of the tidal defences at South Woodham Ferrers are in a poor condition with a low standard of protection.

In the event of a breach, depending on the extent and magnitude of the breach, water could rapidly inundate areas behind defences with little warning. Although most areas protected by defences are within the Environment Agency's Flood Warning Service, the service does not provide a warning in the event of a breach.

There is also the potential that the risk of defences overtopping in the future may increase due to increased flows due to climate change.

7.3.1 Implications for development

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 be

given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

Developers should include an assessment of the residual risk where developments are in areas benefitting from defences. They 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.

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8 FRA requirements and flood risk management guidance

8.1 Over-arching principles

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

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

8.2 Requirements for site specific flood risk assessments

8.2.1 What are site specific FRAs?

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

8.2.2 When are site specific FRAs required?

Site specific FRAs are required in the following circumstances:

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

8.2.3 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

FRAs for sites located in Chelmsford should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Chelmsford City 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)
- **Essex County Council SuDS Design Guide** (Essex County Council)

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**

8.3 Flood risk management guidance – mitigation measures

Mitigation measures should be 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.

8.3.1 Site layout and design

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

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

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

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 to manage adverse consequences for people and the economy that can result from flooding and coastal erosion while achieving environmental and social benefits.

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.

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.

8.3.2 Raised floor levels

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

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

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

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of

multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days.

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

8.3.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory floodplain 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. 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.

8.3.4 Modification of ground levels

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

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

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.

8.3.5 Developer contributions

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

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

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

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other

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

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 need improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions.

8.4 Flood risk management guidance – resistance measures

Measures designed to keep flood water out of properties and businesses.

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.

8.5 Flood risk management guidance – resilience measures

Measures designed to reduce the impact of water that enters property and businesses.

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent dame 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

8.6 Reducing flood risk from other sources

8.6.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk 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.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off the site. Developers should provide evidence and ensure that this will not be a significant risk.

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

8.6.2 Surface water and sewer flooding

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

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

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

More detailed guidance on surface water, drainage hierarchy and sewer flooding is providing in Section 9 and Essex County Council's SuDS Design **Guide**.

8.6.3 Sustainable Drainage Systems

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

The inclusion of SuDS within developments should be an opportunity to enhance ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

More detailed guidance on the use of SuDS is providing in Section 9 and Essex County Council's SuDS Design **Guide**.

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9 Surface water management and SuDS

9.1 What is meant by Surface Water Flooding?

For the purposes of this SFRA, the definition of surface water flooding is that set out in the Defra SWMP guidance. Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall in urban areas.

Surface water flooding includes

- **pluvial flooding:** flooding because of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- **sewer flooding:** flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood on the urban surface. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network; and
- **overland flows entering the built up area from the rural/urban fringe:** includes overland flows originating from groundwater springs.

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

From April 2015 local planning policies and decisions on planning applications relating to major development or major commercial development should ensure that sustainable drainage systems for management of run-off are put in place. The approval of sustainable drainage solution lies with the Local Planning Authority.

In April 2015 Essex County Council was made a statutory consultee on the management of surface water from major developments. They also provide pre-application advice on surface water drainage.

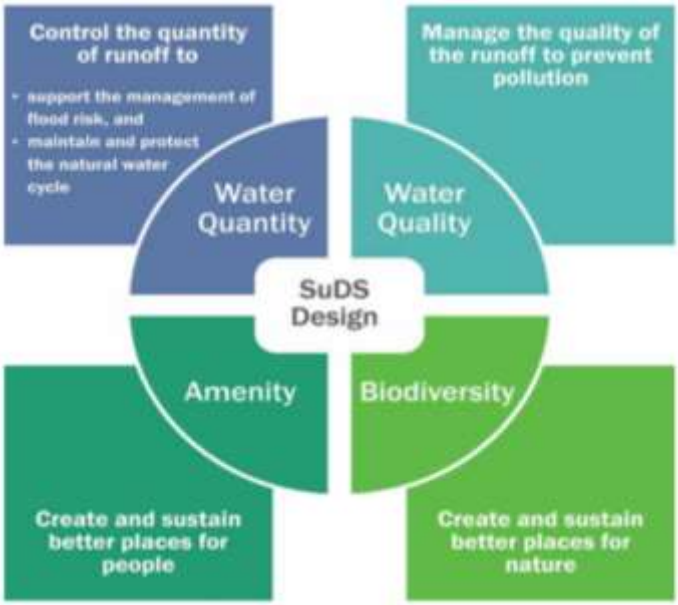
Major developments are defined as

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

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 technical standards and should consider design and construction costs, and additional local standards specified by the LLFA's adopted policy on SuDS Design.

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 9-1.

Figure 9-1: Four pillars of SuDS design



Source: The SuDS Manual (C753)

9.3 Sustainable Drainage Systems (SuDS)

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

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

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

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

All new major development proposals should ensure that sustainable drainage systems for management of run-off are put in place. 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.

9.3.1 Types of SuDS Systems

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 9-1). The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. the **CIRIA SuDS Manual C753 (2015).**

Essex County Council has produce **SuDS guidance**[11] which includes information on different types of SuDS systems detailing practical issues, solutions and design considerations.

Table 9-1: Examples of SuDS techniques and potential benefits

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

9.3.2 Treatment

A key part of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the SuDS management train. To maximise the treatment within SuDS, CIRIA recommends[12] the following good practice is implemented in the treatment process:

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

The number of treatment stages required should be based on the pollutions matrices within the CIRIA SuDS manual C753.

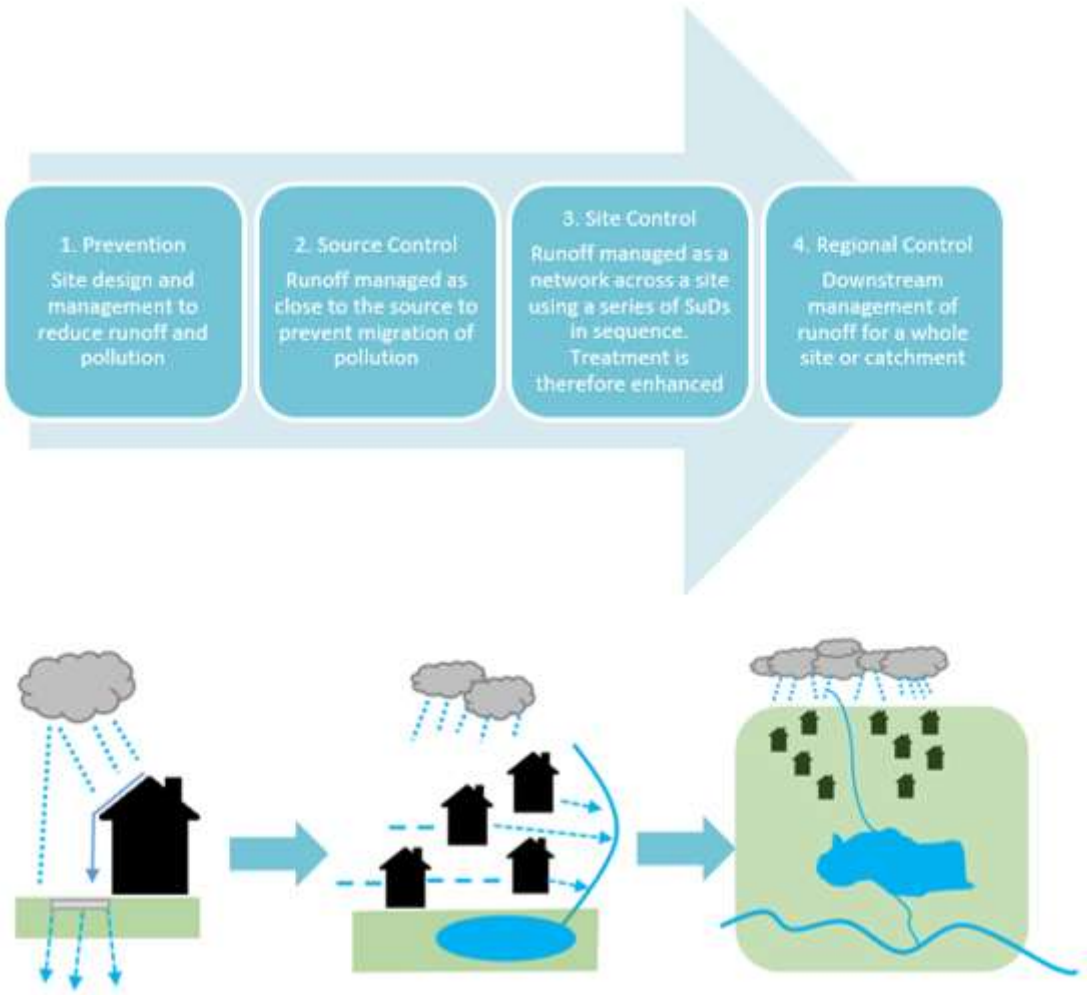
11 Essex County Council (2014) SuDS Design Guide

12 C753 CIRIA SuDS Manual (2015)

9.3.3 SuDS Management Train

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to discharge location. Collectively this concept is described as a SuDS Management Train (see Figure 9-2). 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 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.

Figure 9-2: SuDS management train



9.3.4 Overcoming SuDS constraints

The design of a SuDS system will be influenced by several physical and policy constraints. These should be considered and reflected upon during the conceptual, outline and detailed stages of SuDS design. Table 9-2 details some possible constraints and how they may be overcome and includes information from both the SuDS Manual (C753) and Essex County Council SuDS Guidance.

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

Table 9-2: Overcoming SuDS constraints

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

9.4 Sources of SuDS guidance

9.4.1 Essex County Council SuDS Design Guide (2016)

In 2014 Essex County Council produced the SuDS Design Guide which was subsequently updated in 2016. This was primarily intended to be used by developers, designers and consultants for implementing surface water drainage strategies including SuDS. The concept was for Essex County Council as the LLFA to provide guidance which complements national requirements but also includes localised needs.

The guide is formed of three key chapters:

1. A chapter which provides an overview of the design considerations, considering county issues such as the topography.
2. An overview of the standards expected of SuDS. This includes flood prevention but also amenity, ecology and water quality.
3. A number of case studies illustrating a number of worked examples for major type developments.

It is recommended that this guidance is used in conjunction with national guidance. The LLFA Guidance is designed to build on the national standards by outlining the local expectations within Essex. This national guidance includes **National Planning Practice Guidance**, **non-statutory technical standards for sustainable drainage schemes** and the **SuDS Manual** (C753).

9.4.2 Essex County Council Developer Checklists

As part of the LLFA duty as a statutory consultee on surface water drainage for major developments Essex County Council have developed checklists for an **outline application** and **detailed application**. The purpose of the document is to ensure that the necessary information is suppled to assess the suitability of the drainage system in line with NPPF. It is recommended that developers follow this guidance as failure to provide any of the requested information may result in the LLFA making the recommendation for refusal for the planning application based on insufficient information.

9.4.3 Essex County Council SuDS Adoption Policy (2015)

Essex County Council has the dual function of being both the LLFA and the Highway Authority. The Highway Authority is duty bound to adopt associated drainage from highways and manage risk of flooding to highways. In order to provide clarity and align the approach a **SuDS Adoption Policy** has been developed to outline when Essex County Council would consider the adoption of SuDS.

Typically, Essex County Council has the policy of not adopting SuDS unless under exceptional circumstances. The developer must demonstrate that that it is not possible for the SuDS to be adopted by a water company, even if design changes are necessary. Exceptional circumstances are considered to be where a developer as incorporated alleviation measures within their site and significantly improve flood risk and also fulfil one of the following requirements:

- There are known existing highway and/or property flooding problems
- There is a flood investigation for the area
- The site or area adjacent to the site is in a Critical Drainage Area defined by a Surface Water Management Plan
- Significant areas are shown to be at risk in the RoFSW map.

It should be noted that the context of a significant improvement in flood risk by incorporated alleviation measures is something that would be judged on a site by site basis by the LLFA.

As part of the SuDS Adoption Policy Essex County Council outline the process which developers should follow to obtained approval for SuDS to be adopted. This process also includes information on fees, key design principles and specific adoption requirements. If further information is required, it is recommended that the developer contact Essex Highways via their contact **highway.enquiries@essex.gov.uk**.

9.4.4 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 Essex County Council's SuDS Guidance.

9.5 Other surface water considerations

9.5.1 Groundwater Vulnerability Zones

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

- Basic groundwater vulnerability map: this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability

- Combined groundwater vulnerability map: this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps should be considered when designing SuDS

9.5.2 Nitrate Vulnerable Zones

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

The whole of Chelmsford is classed as a surface water NVZ. In addition, the area north of Chelmsford City is classed as a groundwater NVZ.

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10 Flood warning and emergency planning

10.1 Flood emergencies

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 respond to, and recover from, flooding. In development planning, several these activities are already **integrated** with national building control and planning policies e.g. the NPPF.

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. It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels)[13] and for essential ancillary sleeping or residential accommodation for staff. Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

Emergency planning and flood risk management links

- 2004 Civil Contingencies Act: **http://www.legislation.gov.uk/ukpga/2004/36/contents**
- DEFRA (2014) National Flood Emergency Framework for England: **https://www.gov.uk/government/publications/the-national-flood-emergency-framework-for-england**
- Government guidance for public safety and emergencies is available at: **https://www.gov.uk/topic/public-safety-emergencies/emergencies-preparation-response-recovery**

10.2 Existing flood 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. The different levels of warning are shown in Table 10-1.

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

There are currently five Flood Alert Areas and seven Flood Warning Areas (FWAs) covering parts of Chelmsford. Appendix F shows the FWA coverage for Chelmsford.

The Environment Agency only provide a limited groundwater alert service and this does not currently cover Chelmsford.

[13] NPPG: Flood Risk and Coastal Change (paragraph 056, Reference ID: 7-056-20140306) March 2014

Table 10-1: Environment Agency Flood Warnings Explained

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

10.3 Managing flood emergencies

The **Essex Resilience Forum** brings together agencies involved in preparing for, and responding to, emergencies in the county to develop efficient and effective responses to a range of situations and major emergencies. The forum is made up of a **number of partner organisations** including the Environment Agency, health providers, Essex County Fire and Rescue Service, Essex Police, ambulance service, Coastguard, local authorities and the voluntary sector. The Forum's website contains a range of information to assist individuals, businesses and communities prepare for emergencies including flooding.

The forum has produced a multi-agency flood plan that outlines the arrangements that should be put in place to ensure an efficient and effective multi-agency response to major flooding emergencies in Essex.

Essex Prepared is the website of the Essex Resilience Forum. Contained on this website is information on the risks facing Essex (as informed by the Community Risk Register) as well as guidance on 'preparing yourself', 'preparing your business' and 'preparing your community'. There is also an **interactive community map** which displays the locations of community workshops and events, community resilience plans, district emergency planning officers and hospital A&E departments.

Chelmsford City Council – leaflets on emergencies

- **Home emergency plan: a guide to writing an emergency plan for your family**
- **Flooding: a self-help guide**
- **Coping with a major incident**
- **In case of emergency**

Chelmsford City Council has also published general guidance and advice for **residents** and **business** on preparing for emergencies (not exclusive to flooding) on its website, as well as list of **emergency contacts**.

10.4 Sandbag policy

Local councils do not have a legal obligation to store or provide the public with sandbags and note that these are relatively ineffective when compared to bespoke property level protection products. Chelmsford City Council have published guidance on **flooding and sandbags**, including where sandbags can be obtained.

10.5 Emergency planning and development

10.5.1 NPPF

NPPF seeks to avoid inappropriate development in areas at risk from all sources of flooding. It is essential that any development which will be required to remain operational during a flood event is in the lowest flood risk zones to ensure that, in an emergency, operations are not impacted on by flood water. All flood sources should be considered. Sites should be also considered in relation to the critical drainage areas and problems highlighted in the Chelmsford SWMP (see section 2.5.1).

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

10.5.2 Safe access and egress

The NPPG outlines how developers can ensure safe access and egress to and from development to demonstrate that development satisfies the second part of the Exception Test[14]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development. The NPPG sets out that:

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

[14] **NPPG: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014**

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

10.5.3 Potential evacuations

During flood incidents, evacuation may be considered necessary. The Environment Agency and DEFRA's standing advice for undertaking flood risk assessments for planning applications states that details of emergency escape plans are required for any parts of the building that are below the estimated flood level. The plans should show

- single storey buildings or ground floors that do not have access to higher floors can access a space above the estimated flood level, e.g. higher ground nearby;
- basement rooms have clear internal access to an upper level, e.g. a staircase; and
- occupants can leave the building if there is a flood and there is enough time for them to leave after flood warnings[15].

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

Flood warning and evacuation plans

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

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

Guidance documents for preparation of flood response plans

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

It is recommended that emergency planners at Chelmsford City Council are consulted prior to the production of any emergency flood plan.

[15] EA and DEFRA (2012) Flood Risk Assessment: Standing Advice: https://www.gov.uk/flood-risk-assessment-standing-advice

11 Strategic flood risk solutions

11.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in Chelmsford. The two main Policies under the North Essex CFMP assigned to Chelmsford are Policy 5 and Policy 6, which means further actions can be taken to reduce flood risk.

The Anglian Flood Risk Management Plan, published by the Environment Agency in March 2016, sets out a series of measures to manage flood risk across the Anglian River Basin, in line with the policies set out in the CFMP. Chelmsford falls within the Combined Essex catchment in the Plan; the measures for this catchment that are relevant to Chelmsford are:

- Upstream online flood storage as well as walls and bunds in Chelmsford city centre
- Implement the recommendations from the Chelmer Flood Risk Study and Chelmsford Flood Alleviation Scheme Viability Study. These studies will investigate creating/developing storage on the River Wid CFMP policy unit.
- Partnerships to prioritise critical drainage areas where further scheme development is required
- Working with the community at Little Waltham to raise awareness of flood risk as ways to reduce the risk of flooding

The first two measures are already being implemented through the Chelmsford Flood Alleviation Scheme, discussed in Section 7.

Further details on how flood storage schemes and floodplain restoration can help towards achieving these policies and actions are provided in the following sections.

11.2 Flood storage schemes

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[16]:

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

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

11.2.1 Promotion of SuDS

By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. SuDS should be promoted on all new developments to ensure the quantity and quality of surface water is dealt with sustainably to reduce flood risk. Given the detailed policies and guidance produced by Essex County Council (summarised in Section 9), this should actively promote developers to use this information to produce technically proficient and sustainable drainage solutions.

11.3 Catchment and Floodplain restoration

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

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

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

- 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 watercourse and the floodplain. There are several culverted sections of watercourse located throughout the district which if returned to a more natural state would potentially reduce flood risk to the local area
- Apply the Sequential Approach to avoid new development within currently undefended floodplain.

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

11.3.1 Upstream natural catchment management

Essentially, opportunities to work with natural processes to reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes should be sought, requiring integrated catchment management and involving those who use and shape the land. It also requires partnership working with neighbouring authorities, organisations and water management bodies.

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

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

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

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

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

Further information is provided in the 'Trash and Security Screen Guide 2009'[17], published by the Environment Agency/ Defra, which should be used as evidence for any culvert assessment, improvement or structure retention.

11.3.3 Bank Stabilisation

It is generally recommended that bank erosion is avoided where possible and all landowners are encouraged to avoid using machinery and vehicles close to or within the watercourse.

17 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291172/scho1109brhf-e-e.pdf

There are several techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow 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.

11.3.4 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.

An assessment of formal flood defences has been undertaken as part of this SFRA. All formal defences have a role in reducing flood risk, and therefore opportunities for bank removal, set back and / or increased easement will be limited. However, there may be informal artificial structures (embankments, walls) or defences within the district which are now redundant.

11.3.5 Re-naturalisation

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

11.4 Flood defences

There are several formal flood defences within Chelmsford (see Chapter 7 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.

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12 Level 1 assessment of potential development sites

12.1 Introduction

A number of potential development sites were provided by Chelmsford City Council. These sites were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site. Indication is provided on the proportion of a given site affected by levels and types of flood risk, along with whether historic incidences of flooding have occurred, and any watercourses with a catchment less than 3km^2 flow through the site.

The information provided is intended to enable a more informed consideration of the sites using the sequential approach.

12.2 Sequential testing

Table 12-1 summarises the flood risk to the supplied development sites. Most the sites are predominantly located within Flood Zone 1 or have a relatively small proportion of the site area within Flood Zones 2 and 3. Surface water flooding is shown to be a risk to most sites.

Inclusion of these 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. NPPG Flood Risk and Coastal Change describes how the **Sequential Test** should be applied in the preparation of a Local Plan. The assessments undertaken for this SFRA will assist the council when they undertake the Sequential Test.

Table 12-1: Summary of flood risk to Chelmsford potential development sites

Site name	Site Code	Area (ha)	Proportion of site shown to be at risk (%)									Ordinary Watercourse with catchment less than 3km² flowing adjacent or through site
			Flood Zones					Risk of Flooding from Surface Water map			Historic Flood Map	
			FZ3b	FZ3a	FZ2	FZ1	Combined FZ3 and 2	30yr	100yr	1,000yr		
NORTH OF SOUTH WOODHAM FERRERS	7	121.38	0%	<1%	<1%	99%	1%	9%	16%	35%	0%	YES
NORTH EAST CHELMSFORD	4	373.13	1%	<1%	<1%	99%	0%	1%	3%	8%	0%	YES
NORTH OF BROOMFIELD	6	29.30	0%	0%	0%	100%	0%	1%	1%	3%	0%	NO
WEST CHELMSFORD	2	45.64	0%	4%	1%	95%	5%	1%	1%	4%	0%	YES
EAST OF BOREHAM	EC4	7.05	0%	0%	0%	100%	0%	<1%	1%	3%	0%	NO
EAST CHELMSFORD - MANOR FARM	3a	27.45	0%	<1%	3%	97%	3%	0%	0%	3%	0%	NO
EAST CHELMSFORD - LAND NORTH OF MALDON ROAD	3b	10.76	0%	0%	0%	100%	0%	<1%	<1%	3%	0%	NO
EAST CHELMSFORD - LAND NORTH OF MALDON ROAD	3d	2.83	0%	0%	0%	100%	0%	0%	0%	0%	0%	NO
BICKNACRE NORTH	8	0.69	0%	0%	0%	100%	0%	0%	<1%	9%	0%	NO
BICKNACRE SOUTH	8	0.73	0%	0%	0%	100%	0%	0%	<1%	38%	0%	NO
GREAT LEIGHS - LAND AT MOULSHAM HALL	5a	46.67	3%	<1%	1%	96%	0%	2%	2%	6%	0%	YES
GREAT LEIGHS - LAND EAST OF LONDON ROAD	5b	12.56	0%	0%	0%	100%	0%	3%	4%	7%	0%	NO
NORTH OF GLOUCESTER AVENUE (JOHN SHENNAN)	SGS1c	6.49	0%	0%	0%	100%	0%	<1%	<1%	12%	0%	NO
EASTWOOD HOUSE CAR PARK, GLEBE ROAD	SGS1h	0.66	0%	0%	0%	100%	0%	0%	<1%	1%	0%	NO
ASHBY HOUSE CAR PARKS NEW STREET	GS1j	0.85	0%	0%	0%	100%	0%	0%	5%	16%	0%	NO
FORMER CHELMSFORD ELECTRICAL AND CAR WASH, NEW STREET	GS1m	0.32	0%	0%	0%	100%	0%	0%	0%	1%	0%	NO
BT TELEPHONE EXCHANGE COTTAGE PLACE	GS1n	0.97	0%	0%	0%	100%	0%	0%	1%	3%	0%	NO
CHELMSFORD SOCIAL CLUB AND PRIVATE CAR PARK 55 SPRINGFIELD ROAD	GS1i	0.74	13%	44%	38%	5%	95%	10%	29%	72%	23%	NO
NAVIGATION ROAD	CW1f	0.42	0%	0%	14%	86%	14%	<1%	<1%	12%	0%	NO
TRAVIS PERKINS, NAVIGATION ROAD	CW1e	0.88	1%	18%	64%	17%	83%	2%	8%	29%	4%	NO
CAR PARK R/O BELLAMY COURT, BROOMFIELD ROAD	GS1v	0.08	0%	0%	0%	100%	0%	0%	0%	12%	0%	NO
BRITISH LEGION NEW LONDON ROAD	GS1r	0.12	0%	0%	0%	100%	0%	0%	0%	<1%	0%	NO
LOCKSIDE, NAVIGATION ROAD	CW1c	2.25	1%	56%	24%	19%	81%	9%	18%	45%	23%	NO
BADDOW ROAD CAR PARK	CW1d	1.15	6%	92%	2%	0%	100%	5%	13%	82%	83%	NO
WATERHOUSE LANE DEPOT AND NURSERY	GS1p	0.85	0%	0%	0%	100%	0%	0%	5%	29%	0%	NO
ESSEX POLICE HQ AND SPORTS GROUND NEW COURT ROAD	SGS1b	7.81	0%	0%	0%	100%	0%	1%	2%	9%	0%	NO

Site name	Site Code	Area (ha)	Proportion of site shown to be at risk (%)									Ordinary Watercourse with catchment less than 3km² flowing adjacent or through site
			Flood Zones					Risk of Flooding from Surface Water map			Historic Flood Map	
			FZ3b	FZ3a	FZ2	FZ1	Combined FZ3 and 2	30yr	100yr	1,000yr		
FORMER ST PETERS COLLEGE FOX CRESCENT	SGS1d	11.19	0%	0%	0%	100%	0%	1%	2%	6%	0%	NO
CIVIC CENTRE LAND	SGS1g	1.93	0%	0%	0%	100%	0%	0%	<1%	4%	0%	NO
CHURCH HALL SITE WOODHALL ROAD	GS1q	0.37	0%	0%	0%	100%	0%	0%	0%	3%	0%	NO
GARAGE SITE ST NAZAIRE ROAD	GS1t	0.24	0%	0%	0%	100%	0%	0%	0%	0%	0%	NO
GARAGE SITE AND LAND MEDWAY CLOSE	GS1u	1.28	0%	24%	6%	70%	30%	38%	61%	90%	0%	YES
LAND SURROUNDING TELEPHONE EXCHANGE ONGAR ROAD WRITTLE	EC2	0.55	0%	0%	0%	100%	0%	0%	0%	4%	0%	NO
LAND NORTH OF GALLEYWOOD RESERVOIR	EC1	0.76	0%	0%	0%	100%	0%	0%	0%	0%	0%	NO
SAINT GILES MOOR HALL LANE BICKNACRE	EC5	2.89	0%	0%	0%	100%	0%	13%	25%	59%	0%	YES
GREAT LEIGHS - LAND EAST OF MAIN ROAD	EC3	4.58	0%	0%	0%	100%	0%	2%	4%	10%	0%	NO
RIVERSIDE ICE AND LEISURE	SGS1f	1.13	<1%	51%	49%	0%	100%	23%	42%	60%	4%	NO
EAST CHELMSFORD - LAND SOUTH OF MALDON ROAD	3c	7.24	0%	0%	0%	100%	0%	<1%	1%	8%	0%	NO
FORMER ROYAL MAIL PREMISES, VICTORIA ROAD	SGS1e	1.42	0%	0%	70%	30%	70%	7%	15%	39%	0%	NO
RIVERMEAD, CHELMSFORD	OS1a	1.61	6%	42%	52%	0%	100%	<1%	3%	8%	96%	NO
RAILWAY SIDINGS, BROOK STREET	OS1b	1.01	0%	0%	0%	100%	0%	1%	14%	64%	1%	NO
FORMER GAS WORKS, WHARF ROAD	CW1a	3.29	1%	93%	6%	0%	100%	1%	3%	55%	100%	NO
PENINSULA WHARF ROAD	CW1b	4.10	12%	27%	61%	0%	100%	<1%	3%	24%	97%	NO
RECTORY LANE EAST	GS1o	0.23	0%	0%	0%	100%	0%	0%	0%	<1%	0%	NO
RECTORY LANE WEST	GS1k	0.73	0%	0%	0%	100%	0%	0%	0%	<1%	0%	NO
CAR PARK WEST OF THE COUNTY HOTEL	GS1l	0.26	0%	0%	0%	100%	0%	0%	0%	<1%	0%	NO
LAND REAR OF 17-37 BEACH'S DRIVE	GS1s	0.67	0%	91%	5%	4%	96%	39%	69%	98%	0%	NO
GREAT LEIGHS - LAND NORTH AND SOUTH OF BANTERS LANE	5c	7.76	0%	0%	0%	100%	0%	<1%	1%	3%	0%	NO
DRAKES LANE GYPSY AND TRAVELLER SITE	GT1	0.96	0%	0%	0%	100%	0%	11%	18%	31%	0%	YES

13 Level 2 assessment of potential development sites

13.1 Introduction

The SFRA forms an integral part of Chelmsford City Council's evidence base, in terms of identifying locations for development and preparation of flood risk policies in the Local Plan, with one of the objectives of an SFRA being to help inform site allocations so they are in accordance with the NPPF. Proposed sites have been provided by the Council for assessment. Following the Level 1 screening assessment, a site was brought forward for a Level 2 assessment if was within Flood Zone 2 and/or 3.

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

13.2 Site summary tables

As part of the Level 2 SFRA, detailed site summary tables have been produced for the potential development sites listed below. The summary tables can be found in Appendix G.

- Baddow Road Car Park
- Chelmsford Social Club and Private Car Park, 55 Springfield Road
- East Chelmsford – Manor Farm
- North East Chelmsford
- Former Gas Works, Wharf Road, Chelmsford
- Former Post Office Sorting Office, Victoria Road, Chelmsford
- Garage Site and Land, Medway Close
- Lockside, Navigation Road
- Navigation Road Sites
- North of South Woodham Ferrers
- Peninsula Wharf Road
- Rivermead Industrial Estate, Bishop's Hall Lane, Chelmsford
- Riverside Ice and Leisure
- Travis Perkins, Navigation Road
- West Chelmsford
- Great Leighs – Land at Moulsham Hall

Where available, the results from detailed hydraulic models (River Chelmer and Rettendon Brook models) were used in the assessment to provide depth and velocity information. No hazard information was available for the detailed models.

Using the model information combined with the Flood Zones, climate change and Risk of Flooding from Surface Water (RoFfSW) extents produced for the Level 1 assessment, detailed site summary tables have been produced for the potential development sites (see Appendix G). Each table sets out the following information:

- Site area
- Current land use
- Existing drainage features
- Proportion of the site in each Flood Zone and description of fluvial flood risk
- Proportion of the site in the three RoFfSW events and description of surface water flood risk
- Whether the site would be at risk of inundation in the event of reservoir failure
- Whether the site is shown to have flooded in the past

- Description of the defence type, standard of protection and condition as well as any residual risk considerations
- Emergency planning information including whether the site is covered by a flood warning area and whether there any potential access and egress issues for the site
- What the 2080s climate change allowances are for the area and the climate change implications for the site, including the increase in the proportion of the site at risk compared to Flood Zone 3a
- A broad scale assessment of suitable SuDS techniques and considerations, including whether the site is in a source protection zone or a historic landfill site
- Information on whether the Exception Test will be required
- Requirements and guidance for site-specific flood risk assessments

13.2.1 Important note on data sets used for the summary table maps

It is important to recognise that for the SFRA several different sets of data have been used to clarify the extent, depth, hazard and velocity for each site.

Flood zones

The extent of flooding, which determines the proportions of the site falling into the different flood zones, were determined from several sources

- Flood Zone 2: based on Flood Zone 2 of the Environment Agency's Flood Map for Planning
- Flood Zone 3a: based on Flood Zone 3 of the Environment Agency's Flood Map for Planning
- Flood Zone 3b: has been derived from the 1 in 20-year results from Environment Agency detailed hydraulic models

Depth, velocity and hazard

Depth, velocity and hazard mapping for the 1 in 100-year event (Flood Zone 3a) have been taken from the Environment Agency's detailed hydraulic models of the River Chelmer and the Rettendon Brook.

Climate change

Climate change allowances extents are taken from the outlines produced for the Level 1 assessment.

14 Summary

14.1 Overview

This Level 1 SFRA delivers a strategic assessment of risk from all sources of flooding in Chelmsford. It also provides an overview of policy and provides guidance for planners and developers.

14.2 Key policies

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

14.3 Sources of flood risk

- Flood history shows that Chelmsford has been subject to flooding from several sources of flood risk, including a significant fluvial event affecting Chelmsford City in 1947 and South Woodham Ferrers significantly affected by the 1953 North Sea storm surge.
- The primary fluvial flood risk is associated with the River Chelmer and its tributaries. The main urban areas at risk is Chelmsford City. Other areas that are shown to be at risk include Margaretting, Bicknacre and Writtle.
- The primary tidal flood risk is associated with the tidal River Crouch, Fenn Creek and Clements Green Creek. The main urban area at risk is South Woodham Ferrers. However, much of the area benefits from defences consisting of sea walls and embankments.
- The Risk of Flooding from Surface Water map (RoFSW map) shows several prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. In addition, several these follow local road infrastructure. Surface water flooding is shown to be a risk to most towns and villages within Chelmsford.
- The sewers are managed by Anglian Water. The DG5 register of recorded historical sewer flooding was requested but not provided at the time of publication.
- 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.

14.4 Development and flood risk

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

14.5 Defences

A review of existing flood defences was undertaken and found several formal defences in the study area. Defences mainly consist of sea walls and embankments providing protection against tidal sources for South Woodham Ferrers, and walls and embankment providing protection against fluvial sources for Chelmsford City.

14.6 Flood warning and emergency planning

A review of the flood warning coverage in Chelmsford was undertaken as well as emergency planning provision.

14.7 Strategic flood risk solutions

Potential options for strategic flood risk solutions have been documented.

14.8 Level 1 assessment of proposed allocation sites

Proposed allocation sites within the study area were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site. Indication is provided on the proportion of a given site affected by levels and types of flood risk, along with whether historic incidences of flooding have occurred, and any watercourses with a catchment less than 3km^2 flow through the site.

Of the 48 potential development sites provided by Chelmsford City Council for assessment, ten were at risk in Flood Zones 3b, 3a and 2, five were at risk in Flood Zones 3a and 2, and two were at risk in Flood Zone 2. Most the sites at risk are in Chelmsford City. Of the remaining sites, all but three were shown to be at risk of surface water flooding.

14.9 Level 2 assessment of proposed allocation sites

As part of the Level 2 SFRA, detailed site summary tables have been produced for each of the potential development sites taken forward from the Level 1 assessment. These sites are ones which are shown to be at risk of fluvial flood risk from watercourses running either through or adjacent to the site.

The summary tables set out the flood risk to each site, including maps of extent, depth and velocity of flooding as well as hazard mapping. Each table also sets out the flood risk implications for the site as well as guidance for site-specific FRAs. A broad scale assessment of possible SuDS constraints has also been provided giving an indication where there may be constraints to certain sets of SuDS components.

15 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA,

15.1 Development management

15.1.1 Sequential approach to development

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

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 using SuDS, as informed by national and local guidance
- Relocating development to zones with lower flood risk
- Creating space for flooding
- GI should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

15.1.2 Cumulative impact of development and cross-boundary issues

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

Development control should ensure that the impact on receiving watercourses from development in Chelmsford has been sufficiently considered during the planning stages and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality, both within Chelmsford and the wider area.

15.1.3 Sequential and Exception tests

The SFRA has identified that areas of Chelmsford are at risk of flooding from both fluvial, tidal and surface water sources. Therefore, potential development sites for the Local Plan will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

Developers should consult with the Council, Essex County Council, the Environment Agency, and Anglian Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

15.1.4 Site-specific flood risk assessments

The 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.

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

15.1.5 Residual risk

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage. They should seek to contact the reservoir owner to obtain information and should apply the sequential approach to locating development within the site.

Developers should also consult with relevant authorities regarding emergency plans in case of reservoir breach

Developers should include an assessment of the residual risk where developments are in areas benefitting from defences. They 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.

15.1.6 Safe access and egress

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

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

15.2 Drainage assessments and promotion of SuDS

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

- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration. If infiltration results are poor, a hybrid approach should be considered.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration, and the LLFA's SuDS guidance and requirements.
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems.
- SuDS proposals should contain an adequate number of treatments stages based on the pollutions matrices within the CIRIA SuDS manual C753.
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure.
- Development in CDAs should conform with the preferred options for the CDA, as set out in the Chelmsford SWMP.

15.2.1 Council review of planning applications

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

- Will the natural watercourse system which provides drainage of land be adversely affected;
- Will a minimum 8m width access strip be provided adjacent to the top of both banks of any Main River for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits;

- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up;
- Have SuDS been given priority as a technique to manage surface water flood risk;
- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk; and
- Is the application compliant with the conditions set out by the LLFA?

Councils should also consult the LLFA as the statutory consultee on surface water. Consideration should also be given to consultation with sewerage and water companies who are key stakeholders when considering flood risk from new development and play a key role in the adoption and maintenance of flooding measures put in place as part of any development.

15.3 Future flood management in Chelmsford

15.3.1 Flood defences

Any improvements to defences should ensure they are in keeping with wider catchment policy.

15.3.2 Strategic catchment-wide solutions

- It is preferential that developments take a sequential approach to site layout, with the development being placed furthest away from the source of flood risk and outside of the Flood Zones if possible
- The construction of upstream storage schemes on watercourses within Chelmsford may 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. However, site assessments have shown that most sites are too small, or are on urbanised watercourses, to provide opportunities for storage.

15.4 Flood warning and emergency planning

- It is essential that any development which will be required to remain operational during a flood event is in the lowest flood risk zones to ensure that, in an emergency, operations are not impacted on by flood water. All flood sources should be considered. Sites should be considered in relation to the areas of drainage critical problems highlighted in the Chelmsford SWMP.
- The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements within Chelmsford. This includes the nominated rest and reception centres (and prospective ones), to ensure evacuees are outside of the high-risk flood zones and will be safe during a flood event.

15.5 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. New information on flood risk may be provided by Chelmsford City Council, Essex County Council (in its role as LLFA), the Highways Authority, Anglian Water or the Environment Agency. It is recommended that the SFRA is reviewed regularly, followed by checking with the above bodies for any new information to allow a periodic update.

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Appendices

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A Watercourses in Chelmsford

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B Flood Zone mapping

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C Climate change mapping

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D Surface water mapping

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E Groundwater mapping

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F Flood warning coverage

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G Level 2 detailed site summary tables

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