Oxford City Council

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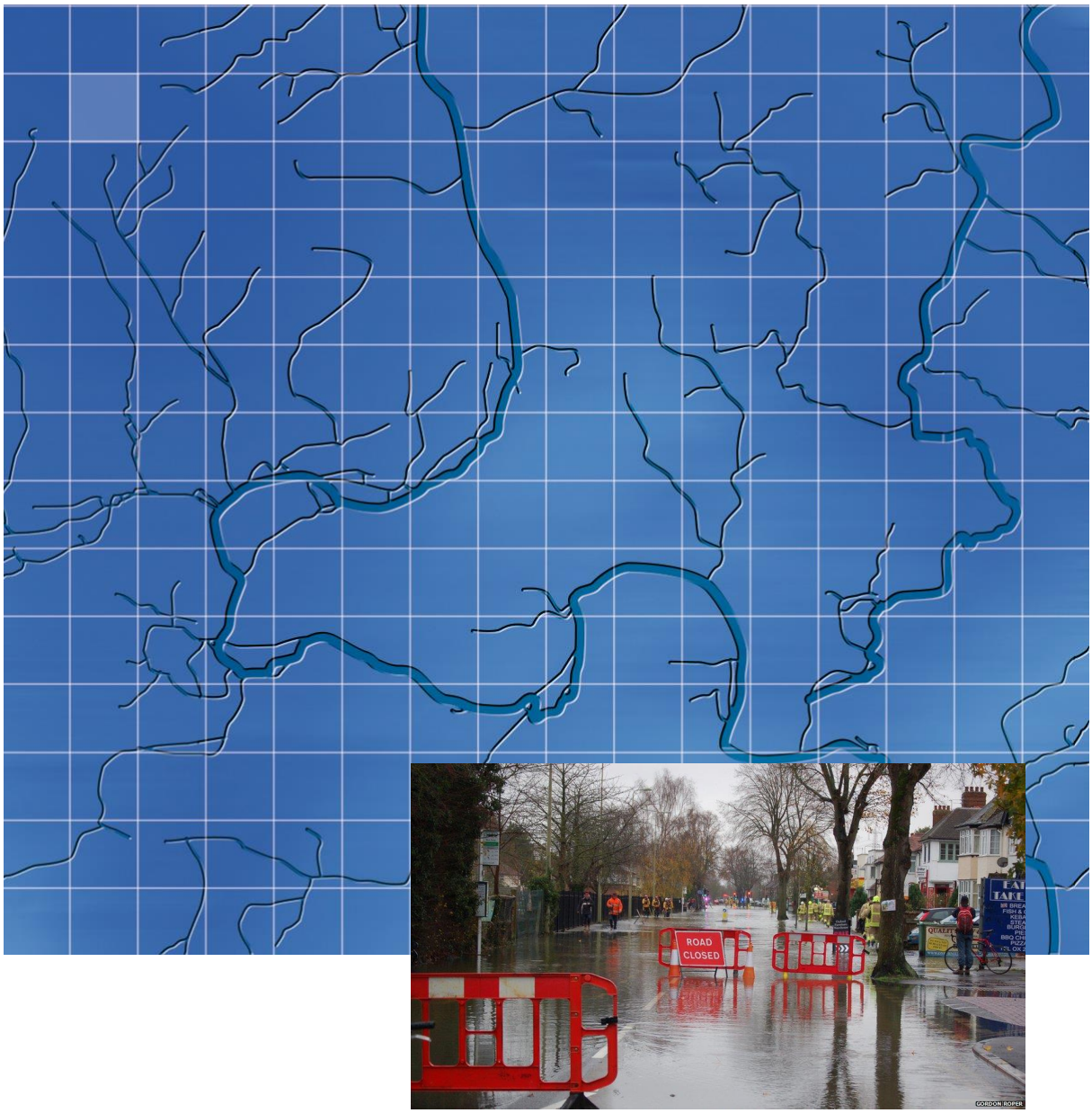
Level 1 Strategic Flood Risk Assessment



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Oxford City Council

Level 1 Strategic Flood Risk Assessment

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For and on behalf of Wallingford HydroSolutions Ltd.

The WHS Quality and Environmental Management system is certified as meeting the requirements of ISO 9001:2008 and ISO 14001:2004 for providing environmental consultancy, the development of hydrological software and associated training.

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1 Introduction

1.1 Scope of Assessment

1.1.1 General Overview

Wallingford HydroSolutions (WHS) Ltd has been commissioned by Oxford City Council to undertake a Level 1 Strategic Flood Risk Assessment (SFRA) in accordance with the National Planning Policy Framework (NPPF) and associated guidance from the Environment Agency (EA).

The main analysis and documentation on flood risk for Oxford City Council (OCC) currently comprises a Level 1 SFRA, completed in 2008 and subsequently updated in 2011, and a Level 2 SFRA completed in 2012, under Planning Policy Statement 25 (PPS25). Since publication of these reports, new national legislation, policies, and strategies have emerged with respect to both flood risk and planning, which have been supported by more robust hydrological and climate change science. The newly available data include:

- The introduction of the Flood Risk Regulations, 2009;
- The enactment of the Flood and Water Management Act, 2010;
- The introduction of the National Planning Policy Framework (2012) and its practice guidance (updated 2015);
- The availability of the EA's updated Flood Map for Surface Water, in 2013;
- Updates to EA river and coastal modelling; and
- New climate change guidance with respect to peak river flows and rainfall intensities (updated 2016)

In accordance with the national Government's development planning guidance, this report consolidates all of the existing data into one document, to provide a detailed evidence base on the nature of flood risk throughout the administrative area of Oxford City. The study area is provided in Appendix 1. In doing so this report will review the existing management of flood risk in Oxford, and support new policies in terms of flood protection, sustainable drainage and future development allocations.

1.1.2 Statement of the need for a Level 1 SFRA

Flooding is the most widespread and frequently occurring of natural hazards. Therefore flood risk plays a fundamental role in the spatial planning process, and will determine where it is appropriate to locate new development, and how the development should be designed. Any development of an area will change the land use and will subsequently influence runoff characteristics, storm responses and flooding mechanisms. This interdependency mean that flood risk must be monitored frequently and considered at all stages of the development process.

The NPPF sets out the government's planning policies for England and the tests to be applied to meet a wide range of planning criteria. The NPPF outlines the government's objectives, emphasising the importance of the planning system to help achieve sustainable development, economically, environmentally and socially. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

The NPPF is complemented by a number of other national planning policy documents. These include the Flood and Water Management Act (2010), which sets out legislation on the management of risks

in connection with flooding and coastal erosion, non-statutory technical standards for sustainable drainage systems (2015), which outlines national standards for Sustainable drainage (SuDS) design, Making Space for Water, a consultation exercise set up in 2004 investigating new approaches to flood management, and the Water Framework Directive (2000), a European Union (EU) directive which sets overarching targets for water quality for EU water bodies.

Oxford City Council is progressing a new Local Plan for Oxford, to guide future developments and support sustainable economic growth. The NPPF states that Local Plans should be supported by a Strategic Flood Risk Assessment, and develop policies to manage flood risk from all sources, taking into account advice from the EA and other relevant flood risk management bodies, including lead local flood authorities (LLFA) and internal drainage boards (IDB). Since 2015 LLFAs have taken on the role of statutory consultee for Ordinary Watercourses, and thereby have a greater influence on the planning process with regard to flood risk from this source.

The Flood and Water Management Act (2010) also highlights the need for an effective flood risk strategy, which must be developed, maintained, applied and monitored regularly to adequately manage flood risk. These guidelines mean that an up to date SFRA in a high flood risk area such as Oxford is a high priority.

Planning Practice Guidance, which should be read in conjunction with the NPPF, states that a Level 1 SFRA should be carried out in local authority areas 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 the location of development and to identify whether development can be allocated outside high and medium flood risk areas, based on all sources of flooding, without application of the Exception Test.

The overarching aims of the NPPF with regard to flooding are to ensure that both flood risk and climate change are taken into account through the adoption of proactive and risk-based strategies. Local plans should apply a sequential, risk based approach to the location of development, to direct development away from areas at risk of flooding, and manage any residual risk. Where new development is necessary in at risk areas, an exception test is required which aims to make the development safe without increasing flood risk elsewhere. A Level 1 SFRA provides the necessary information for the sequential and exception test to be suitably applied to support the initial allocation of sites for development.

Where development does take place, both the NPPF and Flood and Water Management Act highlight the need for it to be sustainable. A key facet of this is the requirement for sustainable drainage, which is designed to reduce the impact of new and existing development with respect to surface water discharges. As sustainable drainage systems (SuDS) are an important aspect of flood risk management this SFRA will provide advice on the requirements of SuDS and outline the guidance available to help planners.

1.2 SFRA Objectives and Scope

The SFRA has been prepared in accordance with the NPPF and presents the most recent update to the Oxford City SFRA since it was last published in 2011. It incorporates newly available information, most notably the latest modelling outputs available from the EA. It also takes account of recent flood events to provide a high level assessment of flood risk.

A Level 1 SFRA needs to provide sufficient information for the sequential test to be applied. If the Sequential Test identifies potential allocated sites to be within flood risk areas, an exception test will be needed and a Level 2 SFRA will be undertaken.

The objectives of this SFRA are to provide:

- An assessment of the risk of flooding from all sources, with existing information and model data collated and reviewed.
- Sufficient detail to enable OCC to apply the sequential test, and where necessary the exception test, and thus make informed decisions on allocating sites for development in the emerging Oxford Local Plan 2036.
- Identification of whether development can be allocated outside high and medium flood risk areas, based on all sources of flooding, without application of the Exception Test.
- Identification of the functional floodplain, providing delineation between Flood Zones 3a and 3b, to allow mapping of both separately
- Identification of areas where critical drainage problems exist and development areas which are likely to increase flood risk.
- A qualitative assessment on the potential increases in flood risk that may arise if new developments fail to meet their requirements of managing surface water run-off.
- Identification of any potential opportunities and constraints that may exist in Oxford for SuDS. Additional advice will be provided on calculation of surface water run-off rates and volumes.
- An assessment of flood risk management infrastructure in Oxford, including the Oxfordshire County LLFA Local Flood Risk Management Plan and the Thames Catchment Flood Management Plan.
- Evidence for OCC to determine the acceptability of flood risk in relation to emergency planning capability and existing flood defences
- Sufficient detail to enable planners to identify the level of detail required for site specific FRA's in particular locations.
- A robust and up-to-date document, which is easily amendable in the future.

1.3 Overview of Local Planning Policy

A wide range of local planning documents developed by OCC exist related to development policy, flood risk, environmental standards and surface water management.

Existing planning policy in the city includes the Local Plan 2001-2016, which is to be superseded by the emerging 2016-2036 Local plan. The Local plan 2001-2016 has provided a framework for the development of new homes, businesses, jobs, and infrastructure within Oxford up to 2016. The plan sets out several polices relevant to the management of flood risk which remain applicable. These include the following:

NE.6- Oxford's Watercourses: Planning permission is only to be granted for waterside development proposals that complement and enhance the waterside setting, whilst protecting wildlife habitats and maintaining public access

NE.11- Land Drainage and River Engineering Works: Planning permission will only be granted for river management, flood protection works and land drainage schemes that are designed to protect the flora and fauna of Oxford's flood meadow and other wetland habitats.

Planning permission will not be granted for proposals to culvert watercourses or ditches. As part of new development proposals the City Council will, in suitable locations, seek opportunities to remove existing culverts and restore the watercourse to a more natural state

NE.12- Groundwater Flow: Planning permission will not be granted for developments that will have an adverse impact on groundwater flow. Where necessary, effective preventative measures will be implemented to ensure that groundwater flow is not obstructed.

NE.13- Water Quality: Planning permission will only be granted for development that will not cause a deterioration in surface or ground water quality. Appropriate measures to prevent pollution will be required, and site investigation details along with precautionary measures will need to be submitted by the applicant.

NE.14- Water and Sewerage Infrastructure: Planning permission will only be granted for developments that would increase the demand for on and off-site service infrastructure where:

a. Sufficient capacity already exists; or
b. Extra capacity can be provided in time to serve the development that will ensure that the environment and the amenities of local residents is not adversely affected

Certain elements of the local plan have already been superseded by Oxford City Council's Core strategy which was adopted by the council in March 2011. The core strategy is the Council's overarching strategy for future development in the city up to 2026. It identifies areas for potential development, as well as areas requiring regeneration and new housing.

In terms of flood risk the core strategy sets out a series of guidelines which are related to the now superseded planning policy statement 25 (PPS25). The main guidelines include:

- no development in the Functional Floodplain (Flood Zone 3b), with the exception of water compatible structures;
- a full flood risk assessment for any development in excess of 1 hectare which is sited in Flood Zone 2 or above; and
- the integration of SuDS into the design of all new developments to limit runoff to acceptable rates.

Once adopted, the Oxford Local Plan 2036 will replace the Local Plan 2001-2016, and the Core Strategy 2026. The 2016-2036 local plan for Oxford will shape how Oxford grows, guiding new developments whilst looking to improve the environment and people's quality of life.

Even though work is commencing on a new Local Plan, the existing planning policies remain strong and will continue to be used for determining planning applications while the new Local Plan is being drafted.

1.4 Sources of Information and Methodology

This SFRA presents an assessment of the risk of flooding from all sources. To inform this, existing information and model data has been identified and collated for different sources of flooding. Any recent and relevant studies on flood risk within the Thames catchment have also been incorporated into the SFRA, along with details on flood defences, flood warning systems and flood management schemes. This information and the available model data has been used to identify potential developable areas, and produce detailed flood maps utilising the latest GIS mapping software.

The main sources of data used to inform this SFRA include;

- The 2016 Oxford 1D/2D model including the River Thames and River Cherwell to assess fluvial flood risk, and define functional floodplain for the majority of the city
- Outputs from the 1D model of the Boundary Brook to assess fluvial flood and define functional flood plain in areas near the Boundary Brook
- EA Surface Water Flood Mapping to quantify the pluvial flood risk, and flood risk from ordinary watercourses
- EA's Ground Water Flooding Register- To quantify the risk of groundwater flooding
- EA Reservoir Flood Mapping- To quantify the risk of reservoir flooding

- Breach analysis data and historical flooding records from the Canal and River Trust (CRT) to assess the potential of flooding from the Oxford Canal
- EA and OCC information on historic flood events to review historical flooding including the recent winter floods of 2013 and 2015.
- EA flood warning systems within the study area to assess the suitability of existing flood warning systems
- Emergency Flood Plans produced by OCC and/or the LLFA to assess existing emergency plans
- EA flood defence structures to assess existing formal and informal flood defences
- EA National Receptors Database to identify key infrastructure including major transport links, public building and energy infrastructure
- The Oxfordshire County LLFA Local Flood Risk Management Plan and the Thames Catchment Flood Management Plan to assess the performance of local flood risk management infrastructure
- Joint Cherwell and West Oxfordshire SFRA to identify the potential impacts of the activities of neighbouring upstream authorities on Oxford City

The EA regularly review and update the Flood Map, with any amendments to the Flood Zone mapping being informed by more detailed information as and when it becomes available. This can either be as a result of more detailed hydraulic modelling and hydrological analysis carried out by the EA and/or external parties; or recorded flood extents following a flood event. Therefore, this SFRA should be considered as a living document, and the flood zone mapping will be subject to change in accordance with any changes to the EA Flood Map.

2 Flood Risk in Oxford City

2.1 Consultation with statutory bodies

The NPPF and associated guidance requires that a Strategic Flood Risk Assessment be prepared by local planning authorities in consultation with the EA and lead local flood authorities, as well as the local sewerage undertaker and Internal Drainage Boards where relevant.

In order to inform this SFRA, the EA and OCC were immediately contacted to confirm the most up to date information available. This was followed up by a series of meetings, along with proactive engagement to agree the structure, methodology and mapping required for this SFRA. In addition, consultation with Thames Water and the Canal and River Trust established what information/data was available to inform the SFRA. As stated above, the SFRA is a living document. Therefore, in the first instance, any developer and planner should contact the EA and/or OCC in order to confirm whether there have been any subsequent revisions to the flood zone mapping.

2.2 Review of Flooding Sources

2.2.1 Fluvial Flood Risk

The risk of fluvial flooding has been assessed using the mapped flood extents through the Oxford City administrative area, as shown by the EA's Fluvial Flood Map. The EA have confirmed that the predicted flood extents for the River Thames and River Cherwell are based on an existing 1D/2D model for Oxford which was undertaken as part of the Thames (Eynsham to Sandford) 2016 study The EA Flood Map is also informed by modelled outputs from a separate 1D hydraulic model of the Boundary Brook, Northfield Stream, and Littlemore Brook. This data originates from 2011 and there have been no subsequent updates to the output data.

The 2016 study includes modelled sections of the River Thames, River Cherwell, Castle Mill Stream, Osney Ditch, Hinksey Stream, Wytham Stream, Bulstake Stream, and the Oxford Canal. The principal model inflows are from the River Thames, River Cherwell and River Evenlode. Inflows are represented elsewhere by minor lateral inflows further downstream.

Fluvial flooding is the primary source of flood risk in Oxford in terms of both flooding extent and the number of properties at risk. Located at the confluence of the River Thames and River Cherwell, the city is vulnerable from both watercourses independently, as well as concurrently in large flood events.

The River Thames is the largest river running through Oxford. It flows from the north to the west, passing through Wolvercote before entering the City Centre from the west near New Botley. To the north of the city the main flood risk is to Wolvercote. South of Wolvercote the river flows through a wide and flat floodplain corridor in the form of Port Meadow. In this area the flood plain consists of mostly farmland with few properties at risk. This area is also served by a network of smaller watercourses and drainage channels which are not explicitly modelled by the EA hydraulic model.

As the river flows south east towards the River Cherwell, the model outputs show out of bank flows impacting the urban areas of New Botley and Osney. Both areas have in the past been subject to regular flooding. The EA model incorporates the principal rivers at this location including the Botley Stream, Fiddler's Island Stream, Wytham Stream, Bulstake Stream, Osney Ditch, Castle Mill/Wareham Stream, Mill Stream, and Hinksey Stream. The majority of flooding from the main River Thames is constrained to the west of the raised railway embankment which carries the mainline railway service between London Paddington and Hereford. Castle Mill Stream which joins the Thames in the centre of Oxford between New Osney and Jericho, it poses a risk to properties in both these areas, although damage to properties is rare.

The River Cherwell originates from the north east and passes between Marston and Summertown, entering the city centre to the east before it flows into the River Thames near Christ Church Meadow. The floodplain of the River Cherwell is mostly characterised by farm and recreational land as it flows between Marston and Summertown. The overall risk to properties and infrastructure is low, with only small areas of Summertown and New Marston shown to be at risk based on the model outputs.

The River Cherwell adds a significant discharge to the River Thames in the city centre, and as the River Thames flows southwards out of the city boundary, it poses a significant flood risk to the suburbs of Grandpont and New Hinksey. In these areas, the floodplain contains a number of housing estates which are at significant flood risk and are known to have flooded in the past. The modelled outputs show this with the majority of these area located in Flood Zone 3.

In these areas Hinksey Stream also poses a significant flood risk. It flows to the west of the city and along the western boundary of the built-up area of New Hinksey, joining the River Thames south of New Hinksey. Flood mapping indicates that this watercourse poses a significant flood risk and has in the past caused widespread flooding to the area west of New Hinksey.

For the Boundary Brook in Headington, the outputs from the existing 1D model of the watercourse, as supplied by the EA, were used to assess it as a source of fluvial flood risk. The brook flows from west to east from Headington through Cowley and Iffley before joining the River Thames south of New Hinksey. It is culverted at various locations along its length, including immediately upstream of the B480/Cowley Road. The main culvert structures are incorporated into the 1D model, which is modelled using HEC-RAS. The Flood Map shows that in its upper reaches, the flood extent is minimal and the floodplain comprises mostly of recreational land. The main flood risk is further downstream in Cowley and Iffley, associated with the culverted section of channel. Significant flooding is predicted within the surrounding residential areas for both the 100 year and 1000 year events.

In 2010 the Littlemore and Northfield Brooks catchment was modelled as part of the EA Littlemore and Northfield Brooks Flood Risk Mapping Study. This utilised a 1D/2D ISIS TUFLOW model based on survey data of the river channels and key floodplain features. The model outputs were used to derive the predicted flood extents. It can be seen that Littlemore Brook poses a flood risk to areas in Blackbird Leys and Littlemore in the south east of the city.

The Bayswater Brook flows along the north eastern boundary of the OCC administrative boundary in a south-east to north-west direction. It flows into the River Cherwell approximately 475m upstream of the A40/Northern By-pass Road and just beyond the study area. At Barton, the Bayswater Brook forms the boundary of the OCC administrative area, and the floodplain on the left bank is shown to affect some parts of this residential area. No hydraulic model was supplied in order to inform this updated SFRA. As part of the planning application for the Barton Strategic Development Site (Ref. 13/01383/OUT) a detailed 1D ISIS model was constructed to inform the site-specific FRA. This assessed flood risk associated with the Bayswater Brook for a modelled reach of approximately 1.8km. The outputs from this study however have not been used to update the EA Flood Map.

A city-wide map and local maps showing modelled flood outlines in the affected areas for the main rivers in Oxford are provided in Appendix 2.

2.2.2 Ordinary Watercourses

Ordinary watercourses with catchments less than 3km^2 are not represented in the fluvial flood maps provided by the EA. The risk of flooding from ordinary watercourses has therefore been assessed by reviewing the updated Flood Map for Surface Water (uFMfSW) published by the EA in 2013.

The uFMfSW was developed by the EA using information and inputs from Lead Local Flood Authorities (LLFAs), to develop a map which accounted for local rainfall patterns and topography. By combining appropriate local mapping from LLFAs with national mapping, the uFMfSW provides an improved and consistent picture of surface water flood risk. The maps show water following typical drainage routes and incorporate the majority of ordinary watercourses.

The uFMfSW is designed to show flooding that takes place from the 'surface runoff' generated by rainwater which a) is on the surface of the ground, and b) has not yet entered a drainage system or public sewer. Although the maps appear to show flooding associated with ordinary watercourses, the conveyance effect of ordinary watercourses is not explicitly modelled. Therefore they should not be used as definitive mapping of the flood risk from ordinary watercourses, however are a valuable tool when combined and validated against local experience and knowledge.

There are a number of ordinary watercourses in Oxford City which are not included in either the EA's fluvial flood maps or the existing hydraulic models for Oxford and the surrounding area. However, they still have the potential to contribute to overall flood risk in Oxford, and thereby represent a separate flood risk.

OCC have supplied a map of the ordinary watercourses and assets within Oxford City, which identifies the majority of the watercourses in the area, together with culverted stream lengths, in-line structures and instances of reported flooding. Using this local knowledge and data from Oxford City Council, combined with the outputs from the uFMfSW, the key ordinary watercourses have been identified as follows:

- Marston Brook: A small stream which runs towards Old Marston from the Northern Bypass road. This appears to be a potential flood risk for a number of properties in Old Marston, which are designated as being at medium to high risk of flooding in the uFMfSW.
- Peasmoor Brook: A small stream to the south east of Marston Brook which poses a potential flood risk, to properties to the east of Marsh Lane in New Marston. A new Flood Alleviation Scheme is in progress to address flood risk associated with flooding from this watercourse.
- Unnamed watercourse at Cutteslowe: A small unnamed watercourse and drainage ditch, both running through Cutteslowe Park towards Cutteslowe. Based on the surface water flood maps the flooding appears to originate from the River Cherwell to the east, with the two channels acting as a conveyance route for flood water. This puts many parts of Cutteslowe at medium to high risk of flooding based on the uFMfSW.
- East and west branches of the Boundary Brook: Two upstream branches of the Boundary Brook near the Churchill Hospital which flow from east to west downslope towards Cowley Road; no properties appear to be at risk based on the UFMfSW
- Northfield Brook West; A small stream which flows east to west through Blackbird Leys before it joins the Littlemore Brook; flooding is predicted along the majority of its length, posing a significant risk to properties in Blackbrid Leys.

The uFMfSW indicates that there is potential for the capacity of these watercourses to be exceeded during large fluvial flood events, with overland flow possibly routed through established residential areas and developed areas. In order to quantify the risk associated with the highlighted watercourses, the mapped flood extents for the 0.1% AEP pluvial event have been overlaid onto the National Receptors Database (NRD) dataset. Only those areas not covered by fluvial mapping have been interrogated. The number of properties deemed to be at risk of flooding associated with each watercourse have been summarised in Table 1 below. There are a number of properties at risk and it is clear that there is potential for the understanding of flood risk at these locations to be refined It should be noted that the uFMfSW does not account for the conveyance capacity of watercourses, and

therefore is likely to provide a conservative assessment of flood risk for the ordinary watercourses identified.

Table 1- Properties at risk of flooding from Ordinary Watercourses

Watercourse	Number of residential dwellings "at risk"	Number of sensitive sites at risk	Key structures
Northfield Brook	118 (incl flats)	1 School (Horspath)	A number of culverts convey the watercourse from the eastern boundary of OCC to the Littlemore/Northfield Brook confluence.
Unnamed OW in Cutteslowe	163 (incl flats)	0	
Marston Brook	302 (incl flats)	1 School (Marston)	2 no. culverts
Peasmoor Brook	687 (incl flats)	1 School (Peasmoor Piece)	Approx. 550m long culvert (inlet adj. to Peasmoor Piece); OCC data indicates recorded flooding upstream of culvert inlet (NGR 453401, 208344). Some flooding recorded at bottom of Oxford Road, Beechey Avenue and Rippington Drive NGR (452766, 207927)
Boundary Brook	Not calculated as fluvial mapping is available for this watercourse		OCC data indicates a number of reported instances of flooding along Boundary Brook corresponding with culverted section of watercourse along Marsh Road. Possible under-capacity of culverts

Appendix 3 provides a map showing the location of ordinary watercourses within Oxford City supplied by OCC, and a map showing the areas where infrastructure is at risk of flooding from ordinary watercourses.

2.2.3 Surface Water Flooding

Surface water flooding is often the result of high peak rainfall intensities, and insufficient capacity in the sewer network. Surface water flooding is a significant flood risk in an urban area like Oxford, due to the high proportion of impermeable surfaces, which cause a significant increase in runoff rates and consequently the volume of water that flows into the sewer network.

Although managing the risk of flooding from surface water is the responsibility of LLFAs, the EA have produced the updated Flood Map for Surface Water (uFMfSW) under their strategic role in England. This combines the EA's nationally produced surface water flood mapping and appropriate locally produced maps from LLFAs. The map is intended to be the best single source of information on surface water flooding, incorporating the latest EA modelling techniques and local data. In the future LLFAs will be able to update the uFMfSW with any new information they have in relation to surface water flooding.

The maps are currently based on a number of assumptions, and only indicate where surface water flooding would occur as a result of local rainfall. Caution should be exercised when reviewing the uFMfSW as it may show an over or under-estimation of the surface water flood risk in certain areas. Therefore the maps should only be used at the strategic planning level.

Due to the modelling techniques used, the mapping picks out depressions in the ground surface and simulates some flow along natural drainage channels, rivers, low areas in floodplains, and flow paths between buildings. In areas where the surface water flood maps show flooding near rivers, the dominant flooding mechanism is considered to be fluvial these areas are therefore ignored in the assessment of surface water flooding throughout Oxford City.

Areas at significant risk of surface water flooding include parts of Jericho, Headington, Summertown and the Woodstock Road. Surface water flooding is mainly isolated to the individual road network, rather than large areas. These areas are above the floodplains of the River Thames and River Cherwell, meaning that the main source of flooding in these areas is likely to be pluvial.

In 2016, a planning application was approved for a Flood Alleviation Scheme (FAS) within the Headington Hill and Northway and Marston areas of Oxford. The FAS incorporates various measures to manage fluvial and surface water flooding originating from Peasmoor Brook and Headington Hill Tributary. The work is to be undertaken in two phases:

- Phase 1 will construct a flood storage area on the Northway Community Field and associated works to Westlands Drive and Saxon Way to direct flood flows to the storage area. This will be combined with road re-profiling at Westlands Drive and Saxon Way alongside flood resilience measures at Oxford Boxing Academy.
- Phase 2 will create an additional flood storage area adjacent to Court Place Farm Nature Park alongside channel realignment to form flood storage and the installation of a small earth bund at Peasmoor Brook and Peasmoor Piece respectively.

The proposed FAS was supported by the findings of the 2012 Flood Feasibility Study, which indicated that the source of flood risk in the area is out of bank flow at the inlet structure of the Headington Hill Tributary culvert to the rear of the Saxon Way Boxing Academy. The water then flows around the side of the property and flows down Saxon Way, Westlands Drive, Maltfield Road and finally pools in Stockleys Road. The FAS will provide a reduction in flood risk to 110 properties in the Northway and Marston area, with 91 residential properties protected from flooding up to the modelled 1 in 75 year (1.33% AEP) event (*Planning Reference 16/01320/CT3 and 16/01549/CT3*).

There are several high risk areas near the city centre also where surface water pools, these include large parts of St Aldates and Speedwell Street to the south of the city, and George Street to the west. Ground levels to the west and south of the city in particular are lower than those in the city centre, which may explain why water is shown to pool in these locations.

A map of surface water flooding across the Oxford area is provided in Appendix 4.

In an attempt to verify the dataset, Thames Water were contacted to find information on past flooding from the surface water and foul sewer systems in addition to the records of surface water flooding available from Oxford City Council and the Environment Agency. The data supplied by Thames Water was reported at a postcode area basis and therefore provided limited data to verify against.

OCC supplied a drawing which indicated recorded instances of flooding within the City centre. These reported instances are generally located along the smaller watercourses which are largely culverted along their length. The uFMfSW shows surface water flooding along the 'original' course of these watercourses, where urban development has now constrained their capacity and conveyance underground. The limited number of reported surface water flood incidents and lack of detail

regarding the cause/source of flooding means that the data is not sufficient to verify the uFMfSW data.

It is considered that the greatest risk of surface water flooding is located around Florence Park and the St Gregory the Great School grounds. This appears to be predominantly pluvial flooding from the wider catchment. The uFMfSW also indicates extensive pluvial flooding to the south of Cowley. However, the culverted length of the Boundary Brook in this location will serve to convey some of this overland flow.

2.2.4 Reservoir Flooding

In 2010 the EA published maps showing the flood risk associated with reservoirs. Dam breach and flood modelling techniques were used to produce a national set of reservoir flood maps for both England and Wales. The maps were created showing how far flood water would spread from a reservoir in a worst case scenario so that emergency services and councils have all the information they need to put plans in place to protect people.

Based on the EA's reservoir flood maps, Oxford is located within an area considered to be at risk from reservoir flooding. This flood zone is associated with failure of the Farmoor Reservoir, approximately 6 miles to the west of Oxford. It sits close to the left bank of the Thames, and in the event of the reservoir failing water is likely to spill directly into the Thames valley, and flow downstream. As a result the areas affected in Oxford are those on the River Thames floodplain, including Wolvercote, New Botley, New Osney, Grandpont, and New Hinksey. Large parts of all these areas would be inundated.

However this is considered to be a rare event with a very low probability of occurrence. Current reservoir regulation, which has been further enhanced by the Flood and Water Management Act, aims to make sure that all reservoirs are properly maintained and monitored in order to detect and repair any problem. Therefore the risk of reservoir flooding is not thought to be of major significance.

Appendix 5 shows the flood risk associated with reservoirs.

2.2.5 Oxford Canal

The Oxford Canal is 78-mile-long (126 km) and links Oxford with Coventry via Banbury and Rugby. Running adjacent to port meadow in the north of Oxford, the canal joins the River Thames near the centre of the city, between the Jericho area and New Osney.

As the canal approaches the city centre, it runs parallel to the Castle Mill Stream for approximately 800m, before it terminates.

At this location the Oxford canal, Castle Mill Stream and the River Thames are linked through a series of locks and spills which manage water levels near the centre, and allow safe passage for boats in the area.

Whilst there have been some isolated breaches north of the city, British waterways have not identified any historical occurrences of flooding or flood risk within the city limits.

However given the proximity of the canal to other watercourses in the centre of the town, flooding from the canal should still be recognised as a potential risk.

Upstream of Hythe Bridge Street, the canal and Castle Mill Stream are separated by as little as 5m in places. Whilst water levels in the canal tend to sit 1m above those in Castle Mill Stream, failure of the canal bank and subsequent spill into the stream could drain a large volume of the canal up to Wolvercote lock, 3.5 km upstream.

A further potential flood risk comes from raised water levels in Castle Mill Stream. Should any of the water control assets located upstream near Jericho cricket ground fail, water within the stream could rise and overtop into the canal, which would form a conveyance route for flood water into Oxford city centre, thereby increasing flood risk.

Aforementioned the canal currently terminates at Hythe Bridge Street, however there are potential plans to extend the canal into Worcester street car park.

2.2.6 Groundwater Flooding

Groundwater flooding is an issue within the Thames Valley through parts of Oxfordshire. The floodplain is often characterised by buried gravels which act as underground storage reservoirs. When their capacity is exceeded, they can overspill into the floodplain. The majority of the sites at risk from groundwater flooding tend to be in the low lying areas, subject also to fluvial flood risk.

The Environment Agency and British Geological Survey (BGS), amongst others have worked to investigate the nature and mechanisms behind groundwater flooding in Oxford. In the majority of cases it has been found that local ground water is linked to river flows and has an independent response to rainfall. There is a lack of reliable data however, therefore a system of water level measurement points for future monitoring purposes has been established.

In addition to the work being undertaken by the BGS and the Environment Agency, a groundwater flooding register identifying the locations and nature of specific groundwater flooding events is held and updated by the Environment agency.

For Oxford the groundwater register identifies 21 records of suspected ground water flooding. These occurred between 2000 and 2003 inclusive and 2007 and 2009 inclusive. 15 of the incidents occurred within the city, whereas 6 were located just outside the city's boundary.

Based on the register there is a tendency for groundwater flooding to occur in low lying areas with clusters of incidents in New Hinksey, Grandpont and New Botley. However there have also been isolated incidents in higher areas such as in Sunnymead, and Headington. One of the incidents in Headington however, north of hospital, has been confirmed to be a mains water leak rather than groundwater.

Typically the incidents reported is associated with cellar and sub floorboard flooding of property and the emergence of groundwater in gardens and garages.

The 3 groundwater incidents located within New Hinksey, in the south of the city are all located within Flood Zone 3, the incident in New Botley occurred in Flood Zone 3; the 2 incidents in the vicinity of Grandpont were also located within Flood Zone 3. The register reports that these 6 locations have underlying gravels, associated with the Thames floodplain. It is therefore thought that the groundwater incidents reported in these areas are partly associated with fluvial flooding.

The 4 incidents reported immediately to the west of the Cherwell-Thames confluence are within Flood Zone 1.

The sites are located on gravels like those within the floodplain. Although the incidents took place within Flood Zone 1, the proximity of the Rivers Cherwell and Thames means that groundwater emergence is likely, especially during periods of high water level in the two rivers.

All remaining incidents in Headington, Sunnymead and Iffley are located within Flood Zone 1. Appendix 6 provides a map showing the spatial distribution of incidents recorded by the EA's groundwater registrar.

2.2.7 Thames Water

The sewerage undertaker for Oxford is Thames Water. No new information regarding historical data was available since publication of the previous Level 1 SFRA. Therefore, this SFRA retains the assumption that the surface water flood risk from the surface water sewer network within the city, as reported by Thames Water, is low.

Thames Water have confirmed that they are working to reduce the risk of sewer flooding in Oxford as part of a £9 million project to undertake 5 catchment studies to investigate sewer flooding, sewer capacity and loss of service.

The Oxford drainage system comprises, almost exclusively, separate foul water and surface water sewers. Despite this, Thames Water have observed storm responses within the foul network suggesting that the network is not completely separate. In addition to this it is widely known that Oxford suffers from fluvial flooding and ground water flooding both of which can have an impact on sewerage system through infiltration and direct ingress. Thames Water are working closely with the EA and the councils to understand and quantity the benefits of schemes that may impact on their network, such as the Marston FAS and Oxford FAS.

Thames Water maintain that, with regards to the performance of the foul sewers, flooding is primarily a result of operational issues such as sewer blockages. However there are areas where Thames Water sewers are overloaded during significant rainfall events - for example the Campbell Road area of Iffley. Investigations are ongoing to investigate the potential to increase the sewer capacity to address flood risk in this area. This includes the completion of a hydraulic model of the catchment utilising survey data of over 200 sewer and river flow monitors, asset surveys, CCTV surveys and impermeable area surveys. This network model has been combined with the EA hydraulic model of the River Thames to produce a single integrated model.

In addition to this, the Thames Water study will also assess the impact of proposed future development trends (up to 2040) in order to assess and mitigate any detriment on the performance of the sewerage system.

A trunk sewer investigation is also being undertaken, which includes assessment of the impact of Littlemore SPS on the network aiming to improve the performance of the pumping station and better utilise the capacity of the trunk sewers.

It is anticipated that the Thames Water catchment study will be completed in early 2017, when a drainage strategy for the catchment will be devised.

2.2.8 Critical Drainage Area

A Critical Drainage Area (CDA) is an area that has critical drainage problems and which has been notified to the Local Planning Authority as such by the Environment Agency in line with the National Planning Policy Framework (NPPF). In these locations there is a need for surface water to be managed to a higher standard than normal to ensure any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

OCC and the EA have confirmed that there are no designated CDAs within the OCC administrative boundary.

2.2.9 Adjoining Local Authorities

The Oxford City Council administrative boundary is adjoined by Cherwell District Council, West Oxfordshire District Council, Vale of White Horse District Council, and South Oxfordshire District Council. When assessing flood risk to Oxford City, the potential impacts to local flooding issues as

a result of development and planning policy within the neighbouring upstream authorities needs to be considered. Therefore the SFRAs of neighbouring authorities are reviewed.

Joint Cherwell District and West Oxfordshire SFRA

A Level 1 SFRA was undertaken jointly for the Cherwell District Council and the West Oxfordshire District Council and was published in April 2009. This was followed by a Level 2 SFRA published in 2015, which assessed the suitability of an area of land north of Witney for potential development.

The Cherwell District is located upstream of Oxford City on the River Cherwell. As a result, development in the District has the potential to impact flood risk further downstream in Oxford. The Level 1 SFRA identified the main areas for strategic development, with employment and related infrastructure being located in parts of Banbury and Bicester. A significant proportion of residential growth has taken place in Banbury, Bicester and Upper Heyford.

In West Oxfordshire, the majority of new business and housing development is focused in the large service centres of Witney, Carterton, Eynsham and Chipping Norton; major developments elsewhere are limited.

The upstream developments in Cherwell and West Oxfordshire could potentially have significant impacts on the hydrological regime and subsequent level of flood risk within Oxford City. However, provided that new developments are regulated and the NPPF guidance is adhered to, these risks should be mitigated. The Environment Agency and District's planning officers should ensure that any new development does not increase flood risk elsewhere, thereby ensuring that there is no increased flood risk to Oxford.

Joint South Oxfordshire and Vale of White Horse SFRA

A joint Level 1 and 2 SFRA was undertaken by South Oxfordshire District Council and Vale of White Horse District Council and was published in 2009. Both districts are predominantly downstream of Oxford, however small areas of each drain into the River Thames upstream of Oxford City.

In South Oxfordshire, potential new development is focussed around Didcot, approximately 12 miles south of Oxford. Development elsewhere is expected in Henley, Thame and Wallingford.

Within the Vale of White Horse District, the Council's preferred locations for housing growth includes Abingdon, Wantage Grove, Botley, and the western edges of Didcot and Faringdon. Apart from Botley, none of these locations are upstream of Oxford, and are therefore not expected to have any impact on flood risk in the city.

2.3 Review of Historical Flood Events

Historical flood events are recorded by the EA and subsequently documented in the form of reports, photographs and maps. This information is used to update the historical flood map, which shows the maximum extent of all individual recorded flood outlines.

In Oxford nine flood events have been recorded dating back to Spring 1947. Since 2000, there have been four events, with the most recent in 2014. Table 2 shows the recorded flood events identified from the EA's records.

Table 2- Recorded Flood Events in Oxford

Date of Flood Event
Spring 1947
Summer 1977
Winter 1979
Autumn 1992
Autumn 1993
Easter 1998
Winter 2000
Winter 2003
Summer 2007
Winter 2012
Winter 2014

The two most recent events have occurred since the publication of the previous SFRA for Oxford in 2009. These were both large events which flooded significant areas of land adjacent to many of the watercourses running through Oxford.

In the 2012 event, significant rainfall throughout Autumn led to a continued rise in groundwater levels. By December, the cumulative effect of rainfall resulted in topping up of aquifers across the region. A series of Atlantic depressions in late December in combination with the already saturated ground led to a rapid response in the water levels in the rivers running through the region.

Whilst the event flooded large areas of New Hinksey, Osney and New Botley, only three properties were recorded as having flooded. These were in New Botley near the Bulstake stream. According to the EA records, the source of flooding was from groundwater emergence from nearby fluvial gravels.

The 2014 flood was largely as a result of a spell of extreme weather from late-January to mid-February as a succession of major storms brought widespread impact and damage across the UK. Eighteen properties were recorded as flooding during this event, many of which were in New Hinksey, with overtopping of both the River Thames and Hinksey Stream. Flooding was also recorded along the Bulstake Stream in a similar location to the 2012 event, with two further properties flooded on Bridge Street in Osney.

Based on all the available records, flooding associated with the River Thames affects the largest number of areas. Areas within Oxford that have been affected include large parts of North Hinksey, New Hinksey, New Botley, Osney, and in the 1947 flood, Wolvercote. During all of the events, the open area between Wolvercote and the city centre was subject to inundation, and acts regularly to store large volumes of flood water.

Historically, the area surrounding the confluence to the River Cherwell and River Thames has experienced the greatest extent and frequency of flooding. Records indicate that this area has the greatest number of recorded instances of properties having flooded; with the flood events in 1947 and 2003 having the largest flood extents.

Flooding along the River Cherwell is mainly isolated to the open areas of recreational land which characterise the flood plain as it flows towards the city centre. Very few properties have been reported as having flooded during the listed events. Those properties which do appear in the

floodplain are predominantly sporting facilities, where finished floor levels are expected to have been set above the 1947 flood level which is the largest recorded event on record.

Appendix 7 shows the historic flood map for Oxford, revealing the maximum recorded flood outline across all recorded flood events.

2.4 Review of Flood Defences

The EA have confirmed that they do not own or maintain any formal flood defences within Oxford City. However they are responsible for deploying demountable flood defences at Osney Island and New Hinksey, which are erected during significant flood events. It is understood that these demountable defences are available across the region and therefore their availability is not guaranteed. The EA also control a sluice gate and 8 overflow pipes set in a stone headwall either side of an earth bank walkway upstream of Hythe Bridge Street. They also operate a number of pumps.

OCC have confirmed that they and any riparian landowners do not own or maintain formal flood defences within their administrative boundary. However OCC are responsible for a series of small scale demountable flood defences at Bulstake Close in New Botley, and also operate a number of pumps.

Although no formal defences were identified by the EA or OCC as part of this SFRA reporting, there are a number of informal defences within the city limits. These are identified in a mapping table which has been provided by the EA, and include structures in New Botley, Osney, St Clements, Barton, New Marston, Grandpont, New Hinksey and Iffley.

For the majority of these informal defences the standard of protection is unknown and unlikely to be no greater than for the 1 in 25 year event. The defences in many cases are also discontinuous in their defended line. It is therefore considered that whilst some of these informal defences offer flood protection, this is often localised and inadequate for larger flood events. Private defences can also exacerbate flood risk elsewhere, and should in all cases be used with caution. Therefore a residual risk of flooding remains associated both with an event that may exceed the design capacity of the defences, and/or structural failure.

Table 3 lists the flood defences for each developed area, a map showing the spatial distribution of both temporary and informal flood defences is provided in Appendix 8.

Table 3- Flood Defences in areas of Oxford

Area	Flood Defences	Location	Description
Osney & New Botley	Yes	Osney Stream and Osney Ditch	Osney Stream- Retaining wall Osney Ditch- Bank protection Likely privately built to protect individual properties.
North Hinksey	No	-	-
St Clements	Yes	River Cherwell	A masonry wall and a stone retaining wall is sited in the Water Meadow in Magdalen College Grounds. Bank protection is provided to the north of St. Clements where the River Cherwell splits. Unclear how extensive.
Headington	No	-	-
Barton	Yes	Bayswater Brook	Bank protection located along the Bayswater Brook along the northern bank

New Marston	Yes	River Cherwell	Available data indicates that at the confluence of Peasmoor Brook and the River Cherwell, bank protection for high velocity flows from an upstream weir is present. In addition, data shows that a retaining wall to the east of Masrton Road and south of King's Mill Lane is present along the eastern bank of the River Cherwell.
Iffley	Yes		Bank protection along the River Thames is present at Iffley. In addition, a small concrete maintained channel is present on the western bank of the river next to Mill Lane and Churchway
Grandpont	Yes	River Thames/River Cherwell	Available data indicate informal bank protection along the River Thames at Grandpont. Data also indicates a stone retaining wall present at the Cherwell/Thames confluence.
New Hinksey	Yes	River Thames	Bank protection continues from Grandpont to New Hinksey. In addition, available data indicates naturally high banks along the Thames, and weirs in Mill Stream near Cold Harbour may control flow through this reach in some way.
Summertown & Cutteslowe	No	-	-

This table does not include the proposed FAS at Headington and Northway and Marston, as detailed in Section 2.2.3.

There is a residual risk of flooding due to the lack of quantitatively designed flood defences, especially in some of the most at risk locations that have been identified. The Oxford Flood Alleviation Scheme which is currently in development should help manage some of this risk.

Investigations have confirmed that a flood relief channel will bring significant flood relief benefits to Oxford. The Oxford Flood Alleviation Scheme project team have developed a series of options to construct new channels and enlarge existing channels in the western floodplain. The proposed new channel is likely to run from the Botley Road to downstream of Sandford Lock, sited south west of the City administrative boundary.

The western floodplain is still to be utilised in extreme weather as the channel would fill up and be over-topped. Before its construction river modelling techniques are to be used to assess the most effective way to manage flood water. Once constructed it is hoped that the scheme will help protect at least 1000 homes and businesses, reducing flood impacts on road, rail and utility infrastructure, whilst maintaining local habitats.

2.5 Climate Change

The National Planning Policy Framework (NPPF) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and supporting planning practice guidance on Flood Risk explain how flood risk will be managed now and over the development's lifetime, taking climate change into account.

The latest climate change guidance released in February 2016 updates previous climate change allowances to support the NPPF.

The peak river flow allowances show the anticipated changes to peak flow by river basin district. The range of allowances is based on percentiles. The central allowance is based on the 50th percentile, the higher central the 70th percentile, and the upper end the 90th percentile. Table 4 shows the

allowances for the Thames River Basin District, when considering the total potential change up to 2115.

Table 4- Peak river flow allowances for the Thames River Basin District

Allowance	Total Potential change (2015-2039)	Total Potential change (2040-2069)	Total Potential change (2070-2115)
Upper end	25%	35%	70%
Higher central	15%	25%	35%
Central	10%	15%	25%

When deciding which allowances to apply to a particular development site, EA guidance states that the flood zone and the appropriate flood risk vulnerability classification should be considered. For example, for highly vulnerable infrastructure the higher central and upper end allowances are applied, whereas for less vulnerable developments, the central allowance is normally applicable.

As well as the effects of climate change on peak river flows, the guidance also provides allowances for the peak rainfall intensity in small and urban catchments. These are not river basin specific, and consist of an upper end allowance of 40%, and a central allowance of 20%. An increase in peak rainfall intensity is likely to lead to an increase in flooding from thunderstorms in urban areas.

The updated climate change guidance has been used in the latest hydraulic modelling study for the main rivers through Oxford. The required allowances presented in Table 4 are not yet implemented within hydraulic models for the Boundary Brook, Littlemore Brook, and Bayswater Brook, where modelling predates the latest guidance. Therefore, for the purposes of this SFRA, climate change flood outlines are shown for the watercourses modelled as part of the 2016 study, which make the largest contribution to flooding in the city boundaries. For the remaining watercourses the 1000 year flood extent is used as a proxy for the 100 year plus central allowance climate change event.

In the 2016 study, the model was ran for all three climate change allowances listed for total potential change (2075-2115).

In general there is an increase in flood extent, these are mostly within areas already at risk of flooding including New Hinksey, Grandpont, and Botley. Flood depths are also increased in these areas. Notable increases in flood extents are also predicted along Castle Mill Stream as it runs through the city centre, with additional areas at fluvial flood risk shown near Hollybush Row and Oxpens Road. Elsewhere changes in flood extent are mostly isolated to open floodplain, which is void of development.

Based on this analysis there are no significant additional areas at risk of flooding when accounting for climate change, however hazard maps show a significant increase in flow velocities and depths in already at risk areas. Appendix 9 shows the fluvial flood map when accounting for climate change, and Appendix 13 and 14 show hazard and depth mapping respectively for the modelled events.

2.6 Identification of Flood Zone 3B

Flood Zone 3b comprises land where water has to flow or be stored in times of flood, also known as functional floodplain. As part of an SFRA, local planning authorities are required to identify areas of functional floodplain and its boundaries. This should be conducted in agreement with the Environment

Agency. The identification of functional floodplain should take account of local circumstances and should not be defined solely on rigid probability parameters.

As a starting point for consideration, functional floodplain can be designated as land which would naturally flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% annual probability) flood. The area identified as functional floodplain should account for the effects of defences and other flood risk management infrastructure. Areas which would naturally flood, but which are prevented from doing so by existing defences and/or infrastructure, will not normally be identified as functional floodplain.

Following consultation with the EA and OCC areas subject to flooding in events up to (and including) the 5% AEP[1] (1 in 20) design event have been designated as areas of functional floodplain. A review of Oxford City and the existing development within the OCC administrative boundary confirmed that there is substantial built development located within the modelled 5% AEP flood extent. Where the 1 in 20 year model extent data were not available, the 1 in 100 year output was used to define areas of functional floodplain. This included the Boundary Brook, where the existing data was not provided and a number of small watercourses including the Bayswater Brook, where no data existed.

The delineation of functional floodplain has significant implications in terms of planning policy and guiding development. Developed areas are not generally part of the floodplain and only water compatible and essential infrastructure are considered appropriate development types in the functional floodplain.

After consideration of Oxford City and the existing development constraints, this SFRA has taken the approach of sub-delineating the 5% AEP outline on the basis of current land use such that:

- Areas of existing open space have been defined as *Zone 3b Functional Floodplain;*
- Areas that are 'previously developed' have been defined as *Zone 3b Developed.*

'*Zone 3b Developed'* relates to sites within which there are existing buildings that are considered to be mostly impermeable to floodwaters. The flood outline for Flood Zone 3b Developed is limited to the built footprint of buildings, and does not include land surrounding these buildings where floodwater may flow. This sub-delineation is in accordance with the recommendations from the Environment Agency, and has been agreed by OCC.

'*Zone 3b Functional Floodplain*' and '*Zone 3b Developed*' are both areas subject to relatively frequent flooding, and may be subject to fast flowing and/or deep water. No development is permissible in *Zone 3b Functional Floodplain* apart from water compatible uses and essential infrastructure, and only then if the Exception Test can be passed. There are clear sustainability implications to be considered in regard to building in the functional flood plain, and it is highly questionable whether insurance against flooding related damages will be available in the longer term.

It is intended that development within *Zone 3b Developed* will be regulated through the application of stringent policies prepared by OCC as part of the emerging LDP. This will ensure that existing development is not blighted by flood risk whilst ensuring that all future development is appropriate and sustainable in terms of flood risk.

The hydraulic models supplied by the EA for this SFRA were interrogated to extract the 5% AEP model output data or 1.0% model output data where available. The data source for extracting this outline for each watercourse is summarised in Table 5 below:

[1] Annual Exceedance Probability (AEP)

Table 5- Data Sources for delineation of Flood Zone 3b

Watercourse	Model	Comments
River Thames, including Seacourt Stream, Botley Stream, Bulstake Stream, Castle Mill Stream, Osney Stream, Mill Stream, Wareham Stream, Wytham Stream and Hinksey Stream	EA 1D/2D hydraulic model Thames (Eynsham to Sandford) 2016	5% AEP model outputs supplied and used to derive Flood Zone 3B
River Cherwell	EA 1D/2D hydraulic model Thames (Eynsham to Sandford) 2016	5% AEP model outputs supplied and used to derive Flood Zone 3B
Bayswater Brook	N/A - FZ3B is based on the 1 in 100 year flood extent.	N/A - FZ3B is based on the 1 in 100 year flood extent.
Boundary Brook	EA 1D HEC-RAS model, 2010	1 in 20 year levels available only (un-georeferenced). Flood extent not made available for SFRA so FZ3B is based on the 1 in 100 year flood extent.
Littlemore Brook	EA Littlemore and Northfield Brooks Flood Risk Mapping Update 2011	5% AEP model outputs supplied and used to derive Flood Zone 3B
Northfield Brook	EA Littlemore and Northfield Brooks Flood Risk Mapping Update 2011	5% AEP model outputs supplied and used to derive Flood Zone 3B

The 5% AEP flood extent was overlaid onto OS mapping data in order to assess the dominant land use and likely impact on flood storage and conveyance. OS MasterMap data was provided by OCC to facilitate this process. Satellite and Aerial Imagery were also used to provide additional information.

Flood Zone 3b Developed has not been mapped at this stage as mapping of building footprints could leave room for interpretation, especially in location where properties are bounded by walls and other external boundaries.

Appendix 10 details the extent and delineation of Flood Zone 3b within Oxford City.

3 Development Pressures in Oxford

3.1 Summary

Oxford is an international city, and is the focus of a world-class knowledge economy. It is important nationally as well as internationally with one of the most important concentrations of high-value businesses in Europe. However, the city's continuing housing crisis through the lack of housing availability, choice and affordability, is a significant challenge for its future development.

Oxford needs between 24,000 and 32,000 new homes over the period 2011 to 2031 to meet the City's growing need for housing.

Recruitment by the city's businesses, universities, hospitals and schools is difficult, because of a lack of housing choice and affordability. This has had adverse effects on the local economy, and the quality of services.

With over half the city's workforce travelling into Oxford and commuting distances increasing, the pressure on the existing infrastructure is not sustainable, even with improvements to roads and public transport.

Therefore an urgent response is needed to manage future development, and allocate potential sites for development. This is focussed both within the city's administrative boundary, and potentially in Oxford's Green Belt immediately beyond its boundaries.

A key requirement of this SFRA is to enable OCC to make informed decisions on allocating sites for development in the Oxford Local Plan 2036, which will ultimately shape future development in Oxford.

3.2 Identification of key sites

The city's existing Area Action Plans (AAPs) for its strategic sites have not changed. They include 2 large greenfield sites in Barton and Northern Gateway, a potential site in Summertown, and a series of smaller development sites throughout the West End of Oxford.

The council's preferred option is to largely keep the existing strategic allocations for the AAPs and not re-visit these, this is with the exception of the site in Summertown, which they have singled out as requiring a reassessment in relation to the latest model data.

Summertown

The site in Summertown is located on a 17 hectare site adjacent to the River Cherwell. Approximately 90% of the proposed land is located within Flood Zone 1, and is at low risk from fluvial flooding. Only very small sections of land are located within '*Flood Zone 3b-Functional Floodplain'*, in total these equate to an area of approximately 0.09 ha and is located in the eastern corner of the development site. In line with NPPF and local planning policy only water compatible structures should be considered here. The remaining area is divided equally between flood zones 2 and 3a.

The EA's surface water flood map shows only minor pooling of surface water in three small areas distributed across the site. The majority of the site remains flood free up to and including the 1 in 1000 year pluvial flood event. It is therefore considered that the site is at very low risk of pluvial flooding, although it is suggested that further investigation be carried out during the detailed planning stage.

No groundwater flooding issues have been identified in close proximity to this site. However, the wide spread of gravels throughout Oxford would suggest some further investigation of groundwater flooding be carried out as part of site planning.

Given 90% of the site lies within Flood Zone 1, it should be possible to avoid development within flood risk areas altogether. In any case the site is larger than 1 hectare so a site specific FRA will still be necessary.

Should development be required on an area of land considered at risk of flooding then a sequential approach should be adopted, guiding land uses of higher vulnerabilities to lower risk areas, and more water compatible structures to higher risk areas. If highly vulnerable or essential infrastructure is to be sited in high risk areas an Exception Test will be required. Appendix 11 shows flood risk at the Summertown site.

3.3 The Sequential Test

The primary objective of NPPF is to steer vulnerable development towards areas of lowest probability of flooding, i.e. Flood Risk Zone 1 Low Probability. NPPF advocates a sequential approach that will guide the planning decision and the allocation of potential development sites. Planners should seek to allocate sites for future development within areas of lowest flood risk. Only if it can be demonstrated that there are no suitable sites within these areas should alternative sites at greater risk of flooding be considered. This is referred to as the Sequential Test.

Following the application of the Sequential Test, NPPF stipulates permissible development types within each flood zone. This considers both the probability of flooding within a site, and the likely vulnerability of the proposed development to damage, as well as the risk of life to occupants should a flood event occur.

This SFRA provides the information required to carry out the Sequential Test. It identifies flood risk zones, and accounts for the impact of climate change on fluvial flooding, along with a summary of other sources of flood risk.

The SFRA will be used by the relevant planning teams and developers to inform the Sequential Test for site allocations. Where there are too few sites in Flood Zone 2 to meet the development requirements of the city flood, Flood Zone 3 will be considered. Sites will be assessed based on the highest flood risk on the site, but, where this is only a small area that can be avoided by the development, a methodology should be agreed for taking this into account in the Sequential Test.

3.4 The Exception Test

Many towns like Oxford are situated adjacent to rivers, and are at risk of flooding. The future sustainability of these communities relies heavily upon their ability to develop sustainably. The NPPF recognises that by restricting residential development in areas within Flood Zone 3a, development can be compromised significantly.

For this reason, NPPF provides an Exception Test, which follows the application of the Sequential Test. Where a local planning authority has identified that there is a strong planning based argument for a development to proceed within an area that may be at risk of flooding, it is essential that the Council demonstrate that the Exception Test can be satisfied.

For the Exception Test to be passed 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.

- 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 overall

Both elements of the test will have to be passed for the development to be allocated or permitted. It should also be noted that it is encouraged that development take place on previously developed land.

This SFRA provides sufficient information to apply the exception test, if potential allocated sites are within flood risk areas, an exception test will be applied and a Level 2 SFRA undertaken.

3.5 Surface Water Run-off

A requirement of new developments is to not increase flood risk elsewhere. This is primarily achieved by controlling the increase in surface water runoff that may result from increased impermeable areas associated with future development.

The Northern Gateway development lies entirely within the Thames catchment, the proposed development in Summertown is sited within the River Cherwell's catchment, and the Barton development in the smaller catchment of the Bayswater Brook. All of the sites are currently situated on grassland, replacing this with impermeable urban surfaces will increase runoff rates into the River systems, leading to a flashier storm response and a potential increase in third party flood risk.

Therefore unless shown to be unfeasible, all developments should incorporate sustainable drainage systems or techniques to limit runoff rates to existing levels. This prevents an increase in flood risk elsewhere. It is especially important for the Northern Gateway and Summertown developments, which are located upstream of the areas already at significant risk of flooding.

Appropriate design, situation and location of future development can all contribute to reducing the risk of flooding. Steering developments outside of the floodplain ensure that the new development is not at significant risk, but also means that flood plain storage is not diminished.

In Oxford flood corridors including Port Meadow provide significant flood storage in extreme events, therefore care should be taken when siting developments within or near to these areas to avoid losses of storage and potential flooding problems downstream. The Oxford meadows also depend on regular flooding to sustain their habitats. It is therefore important that favourable water level conditions are maintained.

Developments can also inhibit the flow of groundwater, changing its distribution and potentially leading to groundwater emergence elsewhere. This should be considered in the detailed planning stage, and monitored if required. Infiltration SuDS techniques should only be used where the risk of groundwater flooding is low, and where geotechnical investigation has confirmed suitable infiltration rates.

In terms of existing drainage across the city no areas have been identified as having critical drainage problems. The EA has also confirmed that no critical drainage areas exist in the area. Surface water flooding is mainly isolated to small individual streets rather than the major roads running into the city, and is largely intermittent. It is recommended at the detailed planning stage that these localised areas be assessed to identify development areas which are likely to have the potential to increase flood risk.

4 Flood Risk Management

4.1 Flood Risk Management Overview

Oxford Area Flood Partnership (OAFP) was formed after the floods in 2003, with a view to reduce flood risk in the Oxford Area. The partners include the Environment Agency, Network Rail, Oxford City Council, Oxfordshire County Council, Vale of White Horse District Council and Thames Water PLC.

The partners each look after different parts of the vast network of pipes, culverts, ditches and rivers that carry water through Oxford.

The EA has a statutory responsibility for main river flood management and defence in England. It assists the planning and development control process through the provision of information and advice regarding flood risk and flooding related issues. It is responsible for managing the Main Rivers and the statutory consultee with regard to sustainable drainage systems. In Oxford specifically it manages the large scale temporary demountable defences and is responsible for issuing flood warnings.

The EA published the Thames Catchment Management Plan (CFMPs) in 2009. The CFMP seeks to understand the scale and extent of flooding now and in the future, and sets out strategic policies for managing flood risk. The main policy applicable for Oxford identified in the CFMP is Policy 5, which is relevant to areas of moderate to high flood risk where further action could be taken to reduce flood risk. The CFMP states the need for appraisals to assess whether actions taken to reduce flood risk are socially and environmentally sustainable, technically viable and economically justifiable.

The Lead Local Flood Authority (LLFA) for Oxford is Oxfordshire County Council. The Flood Water Management Act 2010 requires county councils to lead the coordination of flood risk management for surface water, groundwater and smaller watercourses in their area. Main river flooding remains the responsibility of the Environment Agency.

Oxfordshire County Council has produced a local flood risk management strategy and an action plan. The main high level objectives of which are to improve understanding of the flood risk in Oxfordshire, and to take a sustainable and holistic approach to flood risk management, seeking to provide wider environmental and social benefits. The document also outlines procedures to prevent flooding.

Oxfordshire as a whole largely falls within areas of low to moderate flood risk. In these areas the flood risk management strategy states that there may be opportunities in some locations to reduce flood risk locally or more widely in the river catchments by storing water or managing runoff.

The Oxford City Council, as the local planning authority is responsible for future development, development control policies, planning approval and sustainability appraisals within its boundaries. It has also published a series of flood response plans for a number of areas across Oxford in conjunction with the Oxford Area Flood Partnership. These describe the nature of flooding in these areas, and outlines the response of the regulatory agencies. Further detail is provided in section 4.3.

As well as local councils and national organisations riparian owners (whose land includes or adjoins waterways) are also responsible for keeping waterways open. The EA published the 5th edition of Living on the edge in 2014 which outlines Riverside ownership rights and responsibilities. It sets out the following guidelines:

- You must let water flow through your land
- You must accept flood flows through your land
- You should maintain the bed and banks of the watercourse
- You should leave the bank edge development free

- You should not cause obstructions
- You must keep any structure clear of debris
- You are responsible for protecting your property
- You have a legal obligation to notify the EA and the relevant authority if you would like to build a structure that acts as an obstruction

To reduce flood risk all associated parties must work in conjunction to ensure that schemes can be implemented sustainably, as well as new developments without increasing flood risk elsewhere.

4.2 Sustainable Drainage Systems

The latest non-statutory guidance for SuDS published by DeFRA (2015), sets out the technical standards. For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year and 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event. For developments which were previously developed, the peak runoff rate from the development must be as close as reasonably practicable to the equivalent greenfield runoff rate over the same area; never exceeding the rate of discharge from the development prior to redevelopment for any event.

Sustainable drainage systems slow the rate of surface water run-off and improve infiltration, by mimicking natural drainage in both rural and urban areas. This reduces the risk of "flash-flooding" which occurs when rainwater rapidly flows into the public sewerage and drainage systems. When implemented successfully they also negate any third party flood risk associated with a development. These measures support the NPPF aim, in ensuring that development never increases flood risk, and where possible reduces it.

Sustainable drainage systems are a vital part of the planning process, the NPPF states that any development should give priority to their use, and local authorities often assess planning proposals based on their ability to mitigate the impacts that development has on surface water runoff rates and volumes.

The Water Framework Directive sets out targets for improving water quality, and local planning policy also require appropriate measures to prevent pollution. Sustainable drainage systems are considered to be environmentally beneficial, causing minimal or no long-term detrimental damage. They are often designed to intercept and remove pollutants at the source, managing a development's impact on the water quality of local water bodies.

There are many types of SuDS component, which means that sustainable drainage can be tailored to a range of sites. They are generally split into two categories; infiltration systems and attenuation systems.

- Infiltration Systems- Infiltration components facilitate the infiltration of water into the ground. These often consist of temporary storage zones which allow for the slow release of water into the soil. They include permeable surfaces such as gravel, grassed areas, swales and permeable paving, and sub-surface components such as filter drains, geocellular systems and soakaways.

- Attenuation Systems- Attenuation SuDS capture runoff and control its subsequent discharge off-site. They are divided into conveyance systems which convey flows to downstream storage systems, and storage systems, which control the flows being discharged from a site

by storing water and slowly releasing it. Examples of attenuation SuDS include detention basins, wetlands, ponds and swales.

The use of both systems tends to be determined by the permeability of the soil, and a site's topography. Relatively flat or gently sloping sites are often necessary for infiltration SuDS, and geotechnical investigations required to determine whether infiltration rates are sufficient. If ground conditions cannot support infiltration systems, surface water may need to be attenuated using measures to capture surface water. Attenuation systems do not offer the same range of sustainability benefits as infiltration systems and therefore infiltration SuDS are always preferred where viable.

At a number of sites SuDS designs often include a combination of infiltration and attenuation systems. A central design component for SuDS is the SuDS management train. SuDS should not be thought of as individual components, but as an interconnected system designed to manage, treat and make best use of surface water. The use of a sequence of components that collectively provide the necessary processes to control runoff and water quality is therefore often encouraged.

In terms of guidance the SuDS manual published in 2007 and updated in 2015, is highly regarded. It incorporates the very latest research, industry practice and guidance. In delivering SuDS there is a requirement to meet the framework set out by the Government's 'non statutory technical standards' and the revised SuDS Manual complements these.

Runoff rates and volumes for a development site can be derived using the FEH methods specifically the rainfall runoff method implemented in ReFH 2. This is the current recommended method outlined in the CIRIA SuDS manual[2]. Existing run-off rates are estimated by extracting point or catchment data. This data includes variables which describe rainfall and runoff characteristics in a particular area. For a development site the runoff characteristics derived can be linearly scaled based on the site area, yielding runoff rates and volumes for that area. The rates derived either need to be maintained or bettered depending on if the site is on green or brownfield land.

WinDes micro drainage tends to be used at the detailed design stage to size and design specific SuDS drainage features.

To assist with the management of surface water, OCC and Oxfordshire County Council are currently jointly producing a Sustainable Drainage Systems (SuDS) Evaluation Guide. This guide will be aimed at providing easy to read non-technical guidance for applicants who want to undertake development from minor extensions up to large scale developments.

4.3 Emergency Planning

Jurassic limestone and chalk characterise much of the Thames catchment upstream of Oxford leading to a significant base flow component in the catchment's storm response. A large proportion of the River Cherwell's catchment is rural and it is also slow to respond to rainfall. Due to this there is potentially a lead time of 20 hours between peak rainfall in the upstream parts of the catchment and peak water levels through Oxford City. This means there is significant amount of time for flood warning procedures to be implemented throughout Oxford.

[2] CIRIA (2015). *The SuDS Manual.*C753

The Environment Agency (EA) aim to give the public at least two hours' notice of any local main river overtopping its bank (flood alert) or flooding properties (flood warning). In regularly monitoring the river network through Oxford, flood response organisations will normally be prepared at least one day ahead of a major flood event.

Flood Warnings apply to flooding caused by rivers and streams, not to flooding from other sources, such as sewer flooding, surface water flooding, and burst water mains. For fast responding catchments (particularly in urban areas) it may be necessary to issue Flood Warnings (or even Severe Flood Warnings) directly without issuing a Flood Alert first.

Oxford City Council have the responsibility of checking critical river levels several times a day once they have been alerted by the EA.

The OAFP work in combination to assess variations in the timing, rate, location and total amount of rainfall, along with experience of previous floods to enable a response based on the developing situation. As the flood develops incident coordination centres are set up which liaise with regional and national centres, enabling a rapid and targeted response.

Flood Warning areas are drawn to the extent of Flood Zone 2 and cover all properties that fall within this boundary. Oxford City is currently covered by 4 Flood Warning Areas, three of these relate the Thames and its tributaries. They consist of a flood warning area in Wolvercote, a second encompassing Binsey and Osney, and a third covering New Botley, New Hinskey, Grandpont and North Hinkey. The fourth area relates to the River Cherwell and covers parts of New Marston and Summertown. Appendix 12 shows the four flood warning areas pertaining to Oxford.

For the flood warning system to alert as many people as possible the Environment Agency recommends all residents sign up to Floodline Warnings Direct (FWD). This is a multimedia flood warning system used to issue flood warnings to specific areas by text, phone or email. It seeks to increase awareness of flood risk and provides advice on how the damage can be limited.

Based on the national receptors database, historical flooding and modelled flood extents, the major infrastructure at risk of flooding in a large flood event have been identified.

The main transport links impacted in a large flood event are the Botley Road in New Botley, and the Abingdon Road in New Hinksey, these run into the city centre from the west and south respectively. Parts of both roads lie in Flood Zone 3b Developed, and are prone to regular flooding. There is also a potential flood risk along the Cowley Road associated with the Boundary Brook.

In terms of energy infrastructure, the main flood risk is to a substation to the south of Osney, which is located within Flood Zone 3b Developed. It is expected that its major assets are set above the predicted flood level for the majority of storm events.

The two largest hospitals in Oxford, the John Radcliffe and the Churchill Hospitals are located on higher ground in Headington, and are therefore not at risk of flooding. The majority of medical practices are also not at risk of flooding, with the exception of South Oxford Health Centre in New Hinksey which lies in Flood Zone 3b Developed.

The main secondary Schools in Oxford are located outside of the floodplain, and are not considered to be at risk of flooding in a major flood event. However primary schools including New Hinksey Primary School, and West Oxford Community Primary School in New Botley are at risk. The City of Oxford College on Oxpens Road is also at risk of flooding from the Castle Mill Stream. None of the major assets in the City Centre are at risk of flooding in all events up to and including the 1 in 1000 year event. Although there may be a residual risk due to surface water flooding.

5 Conclusions and Recommendations

5.1 Conclusions

5.1.1 A collation of potential sources of flood risk has been carried out in accordance with NPPF, developed in close consultation with both the Council and the Environment Agency. The functional flood plain (flood zone 3b) has been identified providing the basis for the application of the NPPF Sequential Test.

5.1.2 If after having undertaken the Sequential Test it has been identified that there are no reasonably available sites in areas not at risk of flooding, specific recommendations have been provided to assist the Council and the developer to apply the Exception Test

5.1.3 A considerable proportion of Oxford City is at risk of flooding. The dominant flooding mechanism is fluvial, although flood risk to properties also arises from a number of other sources including surface water, sewer and groundwater flooding.

5.1.4 The River Thames flows north to south through Oxford and is a major source of flood risk to properties within the city, including Wolvercote, New Botley, Osney, Grandpont and New Hinksey.

5.1.5 The main tributary to the River Thames is the River Cherwell, it floods large areas of land to the north east of the city centre, and poses a flood risk to a small number of properties in New Marston and Summertown.

5.1.6 In terms of surface water flooding there are several high risk areas near the city centre, in parts of Jericho, Headington, Summertown and along the Woodstock Road.

5.1.7 Ground Water flooding is an issue in many parts of Oxfordshire. The floodplain is often characterised by buried gravels which act as underground storage reservoirs. When their capacity is exceeded, they can overspill into the floodplain. The majority of the sites at risk from groundwater flooding tend to be in the low lying areas, subject also to fluvial flood risk.

5.1.8 Existing flood management practices and defences have been provided by the EA and OCC, and have been reviewed to identify any residual risk within the city boundary.

5.1.9 No formal flood defences are present in the city, with flood defences mainly comprising of informal privately owned defences, and temporary defences mounted during high flow events.

5.1.10 For the majority of informal defences the standard of protection is unknown, and unlikely to be no greater than for the 1 in 25 year event. The defences in many cases are also discontinuous in their defended line. It is therefore considered that they are inadequate for larger flood events.

5.1.11 The Oxford Flood Alleviation scheme currently being developed will help convey water away from development infrastructure and will help greatly in reducing flooding in the most at risk areas

5.1.12 Flood management in the city is primarily managed by the Oxford Area Flood Partnership (OAFP) which includes the Environment Agency, Network Rail, Oxford City Council, Oxfordshire County Council, Vale of White Horse District Council and Thames Water PLC.

5.1.13 The partners each look after different parts of the network of pipes, culverts, ditches and rivers that carry water through Oxford.

5.1.14 The EA are primarily responsible for the flood warning systems within the city, the slow response of the two major rivers in the catchment, allow for clear and timely warning to be addressed before the majority of flood events.

5.1.15 This SFRA has built on the finding of the previous SFRA, updating specific planning recommendations for the four development sites already identified, and providing further interpretation where necessary.

5.1.16 Since the 2009 SFRA, there have been subtle changes to the flood risk associated with each development site following refinement of the flood map in relation to the 2016 model build, as well as the release of the surface water flood maps in 2013.

5.2 Recommendations

5.2.1 There is a residual risk due to the lack of quantitatively designed defences, especially in some of the most at risk locations, however the Oxford Flood Alleviation scheme currently in development should help reduce this significantly in providing an extra conveyance route for flood water away from local infrastructure. It is recommended that the construction of private and informal flood defences is appropriately assessed to ensure they do not increase flood risk elsewhere.

5.2.2 In terms of the development sites, vulnerable developments should be steered away from the small areas predicated to be affected by flooding in accordance with the NPPF Sequential Test.

5.2.3 Consideration should be given to the proportion of sites located within specific Flood Zones and the implications of this upon the development layout of the site. Higher vulnerability uses should be placed on the higher ground.

5.2.4 This SFRA does not replace the need for site specific flood risk assessments. A greater level of detail should be provided such assessments with respect flood risk and any existing protection not identified at the strategic planning level.

5.2.5 It may be necessary for the Council (and the developer) to apply the Exception Test at some locations. This will involve adherence to development control recommendations as set out in section 3.4, and the clear demonstration that the proposed development will provide sustainability benefits to the community that outweigh the identified flood risks

5.2.6 Site specific FRAs are required for all sites over 1 hectare in size and for all sites located with Flood Zones 2, 3a and 3b. FRAs for sites within Flood Zone 1 may be required to assess surface water and non-fluvial forms of flood risk.

5.2.7 In undertaking site specific FRAs, developments should ensure that surface water drainage systems negate any residual risk of flooding for events in excess of the return period for which the sewer system on the site is designed.

5.2.8 For greenfield development sites runoff rates should be controlled to be no greater than the existing (greenfield) rate of runoff from the site.

5.2.9 For developments on previously developed (brownfield) sites the rate of runoff should not exceed the runoff of the site in its previously developed condition, and in some cases achieve a betterment on pre-existing rates, especially in locations where drainage is poor.

5.2.10 Emergency planning is crucial for the minimisation to the risk to life posed by flooding within Oxford City. The OAFP should use this SFRA as a guide for risk identification, supporting the already available flood plans published by the EA, LLFA and City council.

6 A Living Document

This SFRA has been developed with reference to existing data and knowledge with respect to flood risk within Oxford City. The flood maps informing this SFRA are regularly updated with new information, and modelling software. This, in addition to observed flooding that may occur throughout a year, will improve the current knowledge of flood risk within the City. Subsequently, the predicted flood extents may be altered in some locations. Furthermore, future amendments to the NPPF are anticipated. Given that this is the case, a periodic review of the Oxford City Level 1 SFRA is imperative.

6.1 Future updates of the Level 1 SFRA

In updating the Oxford SFRA a number of key areas should be reviewed and updated. These are listed below;

6.1.1 For any historical flood event subsequent to this SFRA, the dates of flooding should be noted, with the perceived cause and mapped extent also provided. If possible, the indicative statistical probability of the observed flooding event should also be estimated.

6.1.2 Any amendments to NPPF released since the previous review should be accounted for, including any alteration to the definition of flood zones presented within this SFRA, and any revision of the Sequential and Exception Tests. The effect of these changes on the categorisation of land use vulnerability should also be considered.

6.1.3 If the Environment Agency have issued any amendments to their flood risk mapping and/or standing guidance since the previous policy review, then any changes to the 1 in 20 year, 1 in 100 year or 1 in 1000 year flood outlines should be updated and measured in detail at potential development locations.

6.1.4 Changes in climate change guidance will likely have impacts upon rainfall and/or river flows, and therefore a review of the impacts that climate change may have upon Oxford City is required.

6.1.5 If the development control recommendations provided in this SFRA in any way contradict emerging EA advice with respect to (for example) the provision of emergency access, the setting of floor levels and the integration of sustainable drainage techniques, then a discussion with the EA is required to ensure an agreed suite of development control requirements are in place.

6.1.6 Where the implementation of the SFRA within the spatial planning and/or development control functions of the Council, has raised any particular issues or concerns, then these need to be reviewed as part of the SFRA process.

Appendix 1 Oxford City Council Administrative Boundary

Appendix 2 Fluvial Flood Map for Oxford City

Appendix 3 Flood Risk for Ordinary Watercourses in Oxford City

Appendix 4 Surface Water Flood Maps for Oxford City

Appendix 5 Reservoir Flood Map for Oxford City

Appendix 6 Groundwater Register Locations for Oxford City

Appendix 7 Historic Flood Map for Oxford City

Appendix 8 Informal and Temporary Flood Defences in Oxford City

Appendix 9 Climate Change Flood Maps for Oxford City

Appendix 10 Flood Zone 3b

Appendix 11 Flood Risk at Summertown Site

Appendix 12 Flood Warning Areas for Oxford City

Appendix 13 Hazard Maps

Appendix 14 Depth Maps