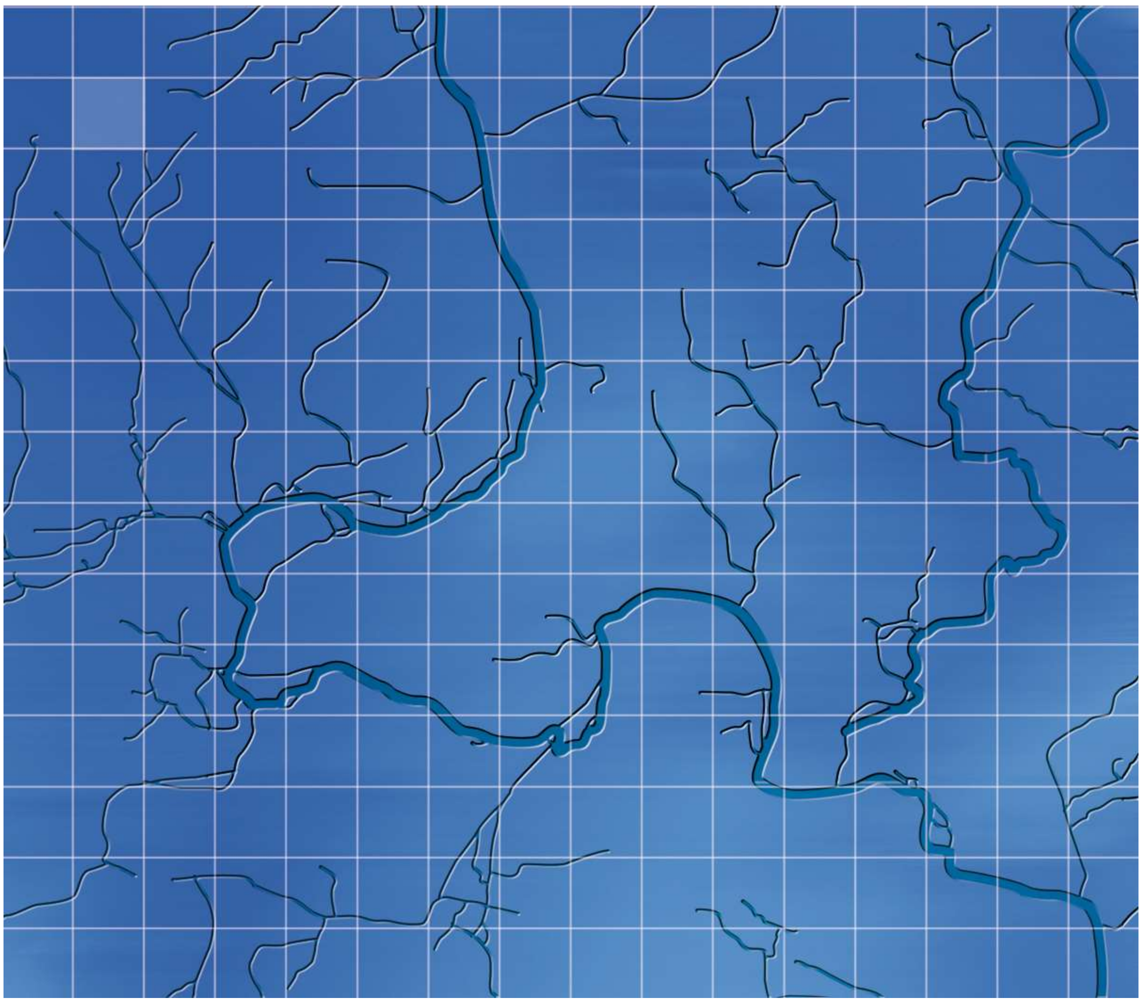
Reading Borough Council

November 2024

Reading Level 1 Strategic Flood Risk Assessment



Reading Borough Council

Reading Level 1 Strategic Flood Risk Assessment

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For and on behalf of Wallingford HydroSolutions Ltd.

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The WHS Quality & Environmental Management system is certified as meeting the requirements of ISO 9001:2015 and ISO 14001:2015 providing environmental consultancy (including monitoring and surveying), the development of hydrological software and associated training.

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1 Introduction

1.1 Scope of Assessment

Wallingford HydroSolutions (WHS) has been commissioned by Reading Borough Council (RBC) to undertake a Strategic Flood Risk Assessment (SFRA) to identify the extent of flood risk and to inform a partial update to the Reading Borough Local Plan.

The existing Reading Borough Local Plan was adopted in November 2019, however a partial update is necessary due to increased housing needs among other reasons. Large parts of Reading including much of the town centre are at risk of flooding, which is likely to mean increasing pressure on potential development sites where flood risk is an important consideration.

The level 1 SFRA will identify key flood risk constraints within the development plan area to enable RBC to assess the suitability of future development and inform land use policy with regards to flood risk.

1.2 SFRA Objectives

SFRAs are overarching technical studies that are used to guide development and inform the selection of sites in relation to flood risk.

A major part of this study will be to assess flood risk from all sources which will first involve the collation of available model data, historical information on flooding and details on flood risk management infrastructure. Flood risk will be assessed for the baseline and the future scenario, which will consider the latest climate change guidance.

In this context, we will i) identify and map flood risk from all sources, ii) assess existing and future flood management infrastructure and iii) outline measures to reduce the causes and impacts of flooding.

This information will enable RBC to make informed decisions on allocating sites for development in the local plan and identify sites where a further level 2 SFRA assessment is required.

Figure 1 shows the main watercourses within the Reading Borough Council's administrative boundary.

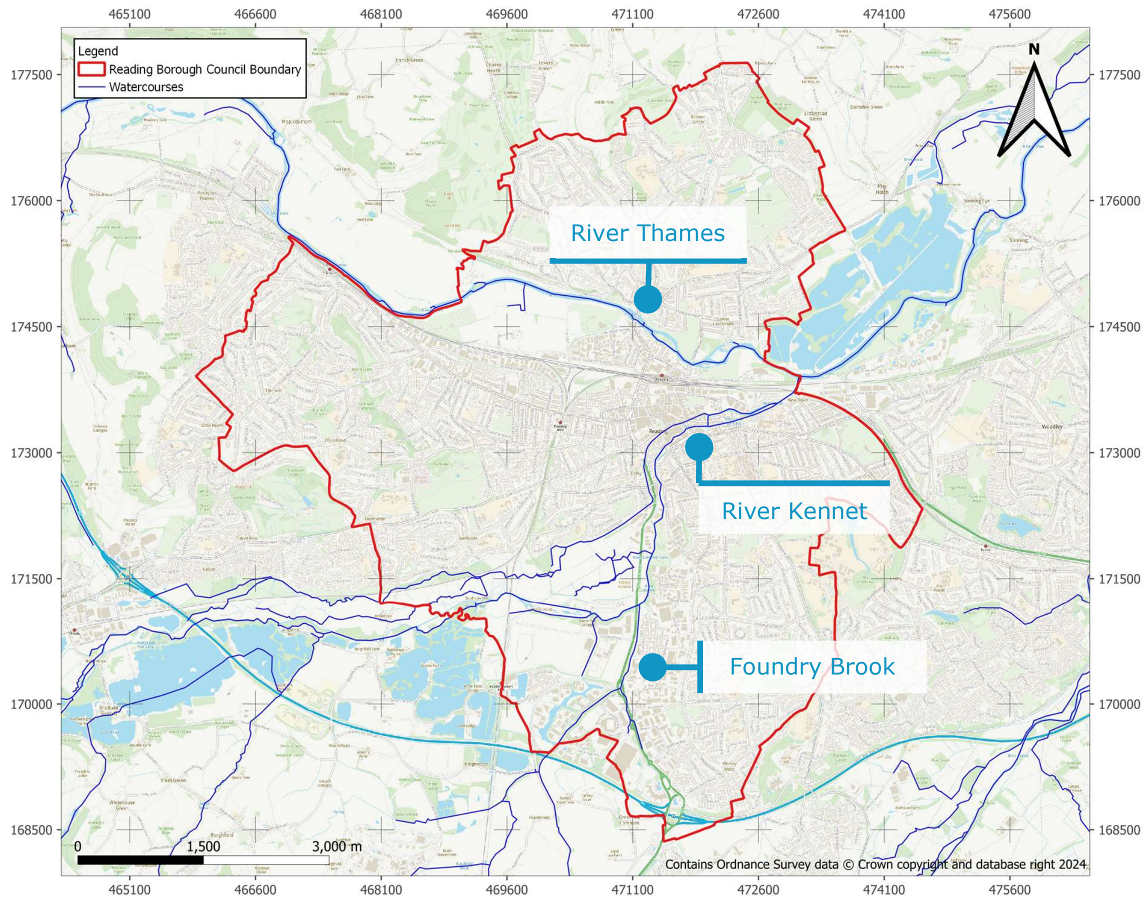

Figure 1- Overview of Study Area

1.3 Overview of National Planning Policy

1.3.1 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF)[1] sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced. The latest NPPF was updated in December 2023 and replaces the previous NPPF published in September 2023.

In terms of flood risk, NPPF states that a sequential risk-based approach (the sequential test) should be taken for development to ensure that it is directed away from areas at highest risk. Where development is necessary in such areas, an exception test should be applied ensuring development is i) made safe for its lifetime without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall and ii) provides wider sustainability benefits to the community (see section 3.2 for more details).

[1] Ministry of Housing, Communities & Local Government (2023) *National Planning Policy Framework*, https://assets.publishing.service.gov.uk/media/669a25e9a3c2a28abb50d2b4/NPPF_December_2023.pdf

To inform strategic development policies in the context of flood risk, NPPF specifies that an SFRA considers flood risk from all sources, the potential impacts of climate change and the effects of development on flood risk. The SFRA should take account of flood risk management policies and provides the basis for application of the sequential test.

1.3.2 NPPF Flood Zones

Flood risk is a function of the probability of a flood occurrence and the direct consequences to the community or a receptor. The NPPF categorises areas within the fluvial floodplain into zones of low, medium and high probability, as shown in Table 1.

Table 1- Flood Zones

Flood Zone	Definition
Flood Zone 1 (Low Probability)	Land having a less than 0.1% annual probability of river or sea flooding.
Flood Zone 2 (Medium Probability)	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding.
Flood Zone 3a (High Probability)	Land having a 1% or greater annual probability of river flooding; or land having a 0.5% or greater annual probability of sea flooding.
Flood Zone 3b (Functional Floodplain)	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

1.3.3 Planning Practice Guidance- Flood Risk and Coastal Change

The Planning Practice Guidance (PPG)[2] supports the NPPF. The PPG on flood risk and coastal change was last updated in August 2022 and advises how to take account of and address the risks associated with flooding and coastal change in the planning process. It supports and aligns with the principles espoused by the NPPF but sets out more specific guidance for developers and planners. The main areas covered by the PPG include:

- Taking flood risk into account in preparing plans
- Site-specific flood risk assessments
- The sequential approach & exception test
- The role of the Environment Agency (EA) and Lead Local Flood Authorities (LLFA)
- Addressing residual flood risk

[2] Ministry of Housing, Communities & Local Government (2022) *Flood risk and coastal change*, https://www.gov.uk/guidance/flood-risk-and-coastal-change

- The flood risk issues raised by minor developments & changes of use
- Permitted development rights and flood risk
- Proximity to watercourses and the need for a flood risk activity permit
- Sustainable drainage systems (SuDS)
- Flood resistance and flood resilience
- Planning and development in areas of coastal change
- Flood Zone and flood risk tables

In terms of taking flood risk into account in preparing plans, the document outlines how local planning authorities (LPAs) should use SFRAs to:

- Inform the sustainability appraisal of the Local Plan, so that flood risk is fully taken into account when considering allocation options and in the preparation of plan policies;
- Apply the sequential test and, where necessary, the exception test when determining land use allocations;
- Inform the allocation of land to safeguard it for flood risk management infrastructure;
- Inform policies for change of use and reducing the causes and impacts of flooding;
- Identify the requirements for site-specific flood risk assessments in particular locations, including those at risk from sources other than river and sea flooding;
- Determine the acceptability of flood risk in relation to emergency planning capability;
- Help demonstrate how the adaptation to climate change could be met.

1.3.4 Climate Change

The EA release guidance[3] on how local planning authorities, developers and their agents should use climate change allowances in flood risk assessments. Making allowances for climate change minimises vulnerability and provides resilience to flooding and coastal change.

The climate change allowances are predictions of anticipated change and are provided for:

- Peak river flow
- Peak rainfall intensity
- Sea level rise
- Offshore wind speed and extreme wave height

There are allowances for different climate scenarios over different epochs, or periods of time, over the coming century. For Reading Borough the peak river flow and peak rainfall intensity allowances are relevant and are covered in more detail below.

Peak river flow

Peak river flow allowances show the anticipated changes to peak flow by management catchment. Management catchments are sub-catchments of river basin districts. The range of allowances is based on percentiles, as follows.

- Central allowance is based on the 50th percentile
- Higher Central allowance is based on the 70th percentile
- Upper End allowance is based on the 95th percentile

[3] EA (2022), *Flood risk assessments: climate change allowances*, https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The Reading Borough administrative boundary crosses three management catchments in total. The Loddon and Tributaries management catchment covers only a small fraction of the east of the Borough (0.6%). The two other management catchments, the Kennet and Tributaries, and the Thames and South Chilterns, occupy a similar percentage area of the Borough (48.7% and 50.7% respectively). The appropriate climate change allowance should be used based upon the location of the development. In order to establish which of the three management catchment allowances should apply, the predominant fluvial flooding mechanism to the site should be established, whether that be from a watercourse from within the Kennet, Loddon or Thames and Southern Chilterns management catchment areas. The peak river flow allowances for the three management catchments are summarised in Table 2.

Table 2- Peak river flow allowances for Reading Borough Management Catchments

Allowance	Total Potential Change (2020s)	Total Potential Change (2050s)	Total Potential Change (2080s)
Kennet and Tributaries			
Central	10%	8%	21%
Higher	16%	16%	35%
Upper	32%	39%	76%
Thames and South Chilterns			
Central	12%	14%	31%
Higher	17%	22%	43%
Upper	30%	42%	76%
Loddon and Tributaries			
Central	7%	4%	14%
Higher	11%	10%	23%
Upper	23%	25%	46%

The guidance states that both the central and higher central allowances should be assessed as part of an SFRA. When applied at a site specific level for the purposes of a flood risk assessment (FRA), the flood risk vulnerability classification as defined in the NPPF should first be used to determine the vulnerability classification of the development. Subsequently the location of the development with respect to different flood zones should be determined. Following this exercise, the recommended allowances are summarised below:

In Flood Zones 2 or 3a for:

- essential infrastructure – use the higher central allowance;
- highly vulnerable – use central allowance (development should not be permitted in Flood Zone 3a); and
- more vulnerable, less vulnerable & water compatible – use the central allowance

In Flood Zone 3b for:

- essential infrastructure – use the higher central allowance;
- highly vulnerable, more vulnerable & less vulnerable – development should not be permitted; and
- water compatible – use the central allowance

The peak river flow allowances should also be applied to development that is currently located in Flood Zone 1 but where the Strategic Flood Risk Assessment shows an increased risk of flooding in the future such that the development could be in Flood Zone 2 or 3 in the future.

Peak rainfall

Increased rainfall affects surface water flood risk and the design of drainage systems. Peak rainfall allowances are provided for the central and upper percentile across two epochs. Allowances are specified for each management catchment, however the three management catchments spanning the city all have the same central and upper end allowances. These are summarised in Table 3.

Table 3- Peak rainfall allowances applicable to Reading Borough

Allowance	Total Potential Change (2050s)	Total Potential Change (2070s)
3.3% Annual Exceedance Probability (AEP)		
Central	20%	25%
Upper	35%	35%
1.0% Annual Exceedance Probability (AEP)		
Central	20%	25%
Upper	40%	40%

In terms of what allowances to apply, the guidance is based on the proposed lifetime of the development. For developments with a lifetime beyond 2100, FRAs should assess the upper end allowances for both the 1% and 3.3% annual exceedance probability (AEP) events, for the 2070s epoch (2061 to 2125).

For development with a lifetime between 2061 and 2100, the central allowance for the 2070s epoch (2061 to 2125) should be used.

For development with a lifetime up to 2060, the central allowance for the 2050s epoch (2022 to 2060) should be used.

1.3.5 Flood and Water Management Act 2010

The Flood and Water Management Act (FWMA) (2010)[4], sets out legislation on the management of risks in connection with flooding and coastal erosion for the United Kingdom. It highlights the need for an effective flood risk strategy, which must be developed, maintained, applied, and monitored regularly to adequately manage flood risk.

It gives a new responsibility to the EA for developing a National Flood and Coastal Risk Management Strategy and gives a new responsibility to local authorities (LAs), as LLFAs, to co-ordinate flood risk management in their area.

Duties for the LLFA include being the statutory consultee for ordinary watercourses, investigating significant flooding incidents (typically defined as five or more properties), maintaining a register of designated flood assets, provision of information, and the management of surface water and groundwater flooding.

[4] UK Parliament (2010) *Flood and Water Management Act*, https://www.legislation.gov.uk/ukpga/2010/29/contents

1.3.6 National Flood and Coastal Erosion Risk Management Strategy

The Flood and Water Management Act 2010 sets out how the EA must develop, maintain and apply a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England.

The most recent strategy was published in July 2020[5]. The strategy sets out how the EA will manage the risks from flooding and coastal erosion across England. It clarifies roles and responsibilities before setting out the policies and direction for all England's Flood Risk Management Authorities to follow, with measures to explain how targets will be achieved. The strategy highlights the importance of climate resilience in the development of future infrastructure.

1.3.7 Non-statutory guidance for SuDS

The non-statutory guidance[6] for SuDS published by DeFRA (2015), sets out the technical Standards for SuDS systems in England. 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.

1.3.8 Overview of Local Guidance and Past Studies

As the LLFA, the duties of Reading Borough Council relate to flooding from surface water, groundwater and ordinary watercourses. They are also required to develop and maintain a Local Flood Risk Management Strategy[7]. The strategy last published in 2015 sets a long-term programme for the reduction of flood risk, establishes how to identify areas where flood risk management will achieve multiple benefits and seeks to facilitate greater engagement with the community. The strategy is due for review and an update in the near future, however a date has not yet been set.

In a Supplementary Planning Document[8], the LLFA also sets out local standards and guidance on SuDS and drainage requirements within the Borough. This signposts to the CIRIA SuDS Manual (C753)[9] for technical guidance for developers.

Existing planning policy in Reading Borough includes the Local Plan 2019-2036[10], which is due for a partial update in 2024. The Local Plan 2019-2036 provides a framework for the development of new homes, jobs, community facilities and infrastructure within the city up to 2036. It was supported by a Level 1 SFRA[11] and Level 2 SFRA[12] completed in 2017. The plan sets out several polices relevant

[5] EA (2020) *National Strategy for Flood and Coastal Erosion Risk Management*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/920944/023_15482_Environment_agency_digitalAW_Strategy.pdf

[6] Department for Environmental, Food and Rural Affairs (2015) *Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

[7] Local Flood Risk Management Strategy. RBC. 2015. Available at: https://www.reading.gov.uk/crime-and-safety/emergency-planning/flooding/#strategy

[8] Reading Borough Council (2019). Sustainable Design and Construction SPD.

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

[10] Reading Borough Council (2019) Reading Borough Local Plan *https://images.reading.gov.uk/2019/12/Local_Plan_Adopted_November_2019.pdf*

[11] Peter Brett Associates (2017) *Reading Borough Council Level 1 SFRA* https://images.reading.gov.uk/2019/12/SFRA_main_June_17.pdf

[12] Peter Brett Associates (2017) *Reading Borough Council Level 2 SFRA* https://images.reading.gov.uk/2019/12/EV026_Strategic_Flood_Risk_Assessment_Level_2_Report_1217.pdf

to the management of flood risk. The most relevant is policy EN18 which is summarised below. Note, this policy is one of the policies being updated as part of the partial update to the local plan.

- Development will be directed to areas at lowest risk of flooding in the first instance, following the Sequential and Exceptions Test set out in the NPPF, and taking into account the effects of climate change.
- Where development in areas at risk of flooding is necessary, it will not in any way increase the risks to life and property arising from flooding. Wherever possible, development should be designed to reduce flood risk, both on- and off-site.
- All major developments must incorporate sustainable drainage systems (SuDS) as appropriate and in line with the Government's Technical Standards. Smaller schemes are encouraged to incorporate SuDS, where possible.
- Wherever possible, SuDS provision should maximise ecological benefits, link into the existing Green Network, incorporate tree planting and landscaping.

Reading Borough also falls within the Thames catchment so is subject to the Thames Catchment Flood Management Plan (CFMP) [13] developed by the EA in 2009. The CFMP seeks to establish the scale and extent of flooding now and in the future and sets policies for managing flood risk within the catchment. It should be used to inform planning and decision making by LPAs.

1.4 Data Sources

To inform the assessment of flood risk, existing information and model data have been identified and collated for different sources of flooding. Any recent and relevant studies on flood risk within the study area have also been incorporated into the SFRA, along with details on flood defences and flood management schemes. This information and the available model data have been used to assess flood risk across the study area and local plan sites. Detailed flood maps utilising the latest GIS software have also been created. The main sources of data utilised in this SFRA include:

- EA Fluvial Flood Maps[14] [15]– to quantify fluvial flood risk where detailed model data are not available.
- EA Surface Water Flood Maps[16] – to quantify the pluvial flood risk and flood risk from ordinary watercourses where appropriate.
- EA Reservoir Flood Mapping[17] – to quantify the risk of reservoir flooding
- EA Historical Flood Map[18] and Recorded Flood Outlines[19] – to review historical flood events

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[13] EA (2009) *Thames Catchment Flood Management Plan* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/293903/Thames_Catchment_Flood_Management_Plan.pdf

[14] EA (2024) *Flood Map for Planning (Rivers and Sea) – Flood Zone 2* https://www.data.gov.uk/dataset/cf494c44-05cd-4060-a029-35937970c9c6/flood-map-for-planning-rivers-and-sea-flood-zone-2

[15] EA (2024) *Flood Map for Planning (Rivers and Sea) – Flood Zone 3* https://www.data.gov.uk/dataset/cf494c44-05cd-4060-a029-35937970c9c6/flood-map-for-planning-rivers-and-sea-flood-zone-3

[16] EA (2024) *Risk of surface water flooding* https://environment.data.gov.uk/DefraDataDownload/?Mode=rofsw

[17] EA (2024) *Risk of Flooding from Reservoirs - Maximum Flood Extent* https://www.data.gov.uk/dataset/44b9df6e-c1d4-40e9-98eb-bb3698ecb076/risk-of-flooding-from-reservoirs-maximum-flood-extent-web-mapping-service

[18] EA (2024) *Recorded Flood Outlines,* https://www.data.gov.uk/dataset/16e32c53-35a6-4d54-a111-ca09031eaaaf/recorded-flood-outlines

[19] EA (2024) *Historic Flood Map,* https://www.data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map

- Canal and River Trust Overtopping and Breach data (2024)[20] [21]- to review flood risk from the Kennet and Avon Canal in the Borough
- Hydraulic modelling data for the River Kennet (Tyle Mill to Thames Confluence) (2018)[22] – to assess fluvial flood risk from the River Kennet and major tributaries
- Hydraulic modelling data from the Thames (Pangbourne to Sonning) (2021)[23] – to assess fluvial flood risk from the River Thames and major tributaries.
- EA flood defence structures[24] – to assess existing formal and informal flood defences present
- British Geological Survey (BGS) geoviewer[25] – To determine local bedrock and its expected permeability informing assessment of groundwater flood risk
- Soilscapes map[26] – To determine local soil and its expected permeability informing assessment of groundwater flood risk
- Thames Water sewer flooding data[27] – to determine risk of sewer flooding based on incidences of sewer flooding
- Previous flood risk studies previously completed by RBC (see section 1.3.8)

1.5 Limitations & Assumptions

1.5.1 Age and Extent of Modelling Data

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 carried out by the EA and/or external parties; or recorded flood extents following a flood event. Furthermore, real-world upgrades to flood defence infrastructure will also alter the degree of flood risk in a particular area. In this regard, this SFRA is a snapshot of flood risk based on data available at the time of publication, with the conclusions on flood risk presented subject to change in accordance with any updates to the EA Flood Map and existing flood defence infrastructure.

Detailed modelling data is available for the main watercourses running through Reading Borough (Kennet and Thames). Within these modelling studies, most open channel watercourses within the Reading Borough have been captured, with the exception of a few minor tributaries.

Those that have not been captured within these modelling studies, are likely to have their associated flood risk based on JFLOW mapping. JFLOW is appropriate for a strategic assessment of flood risk, however it is generally not advised for site-specific purposes. It should be noted, that the EA is currently updating its national generalised modelling, which will effectively replace JFLOW in areas where detailed modelling is not available. This modelling is due to be published in Spring 2025. Updated national surface water modelling is also due to be published by the EA in early 2025.

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[20] Canal and River Trust (2024) *Breach Archive* Breach archive.shp
[21] Canal and River Trust (2024) *Overtopping Archive* Overtopping archive.shp
[22] JBA (2018) Lower Kennet Hydraulic Modelling Study.
[23] Jacobs (2021) Reading and Caversham Flood Alleviation Scheme Baseline Modelling
[24] EA(2024) AIMS Spatial Flood Defences (inc. standardised attributes) https://www.data.gov.uk/dataset/cc76738e-fc17-49f9-a216-977c61858dda/aims-spatial-flood-defences-inc-standardised-attributes
[25] BGS (2024) *BGS Geology Viewer*, https://geologyviewer.bgs.ac.uk/
[26] Cranfield Soil and Agrifood Institute (2024) *Soilscapes map*, http://www.landis.org.uk/soilscapes/
[27] Thames Water (2024) *DG5 Sewer Flooding Records for Reading Postcode Areas* Reading SFHD_Sep24.xlsx

1.5.2 Flood Zone 3b (Functional Floodplain)

In the EA flood map, the functional floodplain or Flood Zone 3b (FZ3b) is not distinguished from Zone 3a. As part of their SFRAs, LPAs should identify areas of functional floodplain and its boundaries accordingly.

As shown in Table 1, the flood extents for the 3.3% AEP (30-year) event and/or any land that is designed to flood is generally considered the basis for the delineation of FZ3b. Therefore, as a starting point it is proposed that land which naturally floods during a 30-year event or is designed to flood be classified as FZ3b.

As mentioned, detailed modelling is not available for all watercourses within the study area, however the two models available, covering the Thames, Kennet and tributaries include a 3.3% AEP event. Where detailed modelling data is not available, the Flood Zone 3a extent is used as a conservative proxy for the FZ3b.

The approach outlined above is suitable for the purposes of a level 1 SFRA. However, where detailed modelled outlines for 3.3% AEP event are unavailable for sites at risk of fluvial flooding, further detailed modelling will need to be undertaken to refine the assessment of the latest allowances. This should be carried out as part of a site-specific FRA.

1.5.3 Assessing the impacts of Climate Change

As part of SFRAs, LPAs should assess and map the effects of climate change on flood risk to identify areas where flood risk will increase and ensure that future development is sustainable.

The modelling results predate the latest climate change allowances for each management catchment. Instead, both models apply the old allowances for the Thames River Basin of 25%, 35% and 70% for the 1.0% AEP event (tiered from central, higher to upper end).

For the Kennet and Tributaries management catchment, the 25% allowance has been used as a proxy for the current central allowance for the management catchment which is 21%. In terms of the higher central allowance, the old 35% allowance matches the current higher central allowance and is applied.

For the Thames and Southern Chilterns management catchment the 35% allowance has been used as a proxy for the current central allowance for the management catchment which is 31%. The current higher central allowance for the management catchment is 43%. In this case rather than reapply the old central allowance, the old 70% allowance has been applied as a conservative proxy.

Where detailed modelling data is unavailable, the Flood Zone 2 extent shown in the EA's fluvial flood map is used to assess the impacts of climate change in general.

The approach outlined above is suitable for the purposes of a level 1 SFRA. However, where detailed modelled outlines for new climate change scenarios are unavailable for sites at risk of fluvial flooding, further detailed modelling will need to be undertaken to refine the assessment of the latest allowances. This should be carried out as part of a site-specific FRA.

2 Summary of Flood Risk in Reading Borough

2.1 Review of Flooding Sources

The following sections provide a detailed summary of baseline flood risk from all relevant sources across Reading Borough. They identify where flood risk is most significant and is likely to pose a risk to people or property. Where data is available, the future scenario considering the impacts of climate change is also considered. A series of supporting GIS maps offer a visual representation of the risks outlined and are provided in Appendix 1-7 of this report.

The assessment of flood risk has been based on the collation of available model data, historical information on flooding and details on flood risk management infrastructure.

2.1.1 Fluvial Flood Risk

The risk of fluvial flooding has been assessed using the mapped flood extents through the Reading Borough area, as shown by existing hydraulic modelling data and the EA's Fluvial Flood Map. Flood risk from the main rivers running across the district is summarised below. Larger watercourses are usually designated as main rivers. The EA carries out maintenance, improvement or construction work on main rivers to manage flood risk.

River Thames

The EA flood maps for the River Thames within Reading Borough are based on an existing 1D/2D model which was completed in 2021 for the Reading and Caversham Flood Alleviation Scheme. The modelling built upon previous work during the Outline Business Case stage for the scheme (2017), which itself made use of a Thames model from 2011 from Mapledurham to Hurley[28]. The model uses Flood Modeller and TuFLOW to represent the 1D and 2D domains respectively, and uses hydrological inflows derived from the Lower River Thames Flood Modelling Study (JBA, 2017).

In terms of flood risk, the river enters the Borough from the west, the floodplain is relatively extensive for higher order events, though at Tilehurst this is generally confined to the undeveloped north banks of the Thames, with flooding within the developed area to the south limited by the railway embankment at this location. As the Thames runs south of Caversham Heights district, the floodplain is generally constrained to the south with the exception of properties along The Warren, and some developed areas to the south of the railway embankment. Floodwater crosses this embankment by way of access roads under this line. This specifically affects residential and commercial developments, including those off Portman and Loverock Roads.

There is more extensive risk to development north of the railway, downstream of this location near Reading Train Station, Cardiff Road, Richfield Avenue and along Vastern Road. This is most pronounced during the 0.1% AEP event (Flood Zone 2).

The River Thames bifurcates downstream of this location around Fry's Island and then View Island, with water levels controlled by Caversham Weir and Sluice. There is also a small navigation bypass (Caversham locks) to the south of the main channel. Much of Lower Caversham at this location is at risk from fluvial flooding, which is immediately upstream of the confluence between the River Thames and River Kennet.

[28] Jacobs. 2011. Thames Mapledurham to Hurley hydraulic model.

River Kennet

The EA flood maps for the River Kennet within Reading Borough are based on an existing 1D/2D model completed by JBA in 2018. It runs from Tyle Mill to the River Thames confluence. This was based upon an earlier model developed in 2007 of the Lower Kennet and tributaries. Several tributaries are modelled as part of this study within the Reading Borough, including the Foudry Brook and the Holy Brook.

Entering the Borough from the southwest, the floodplain associated with the Kennet is extensive, covering the segment between the Kennet main channel and Foudry Brook tributary to the south. The area is topographically relatively flat, with an extensive network of ponds and drainage channels feeding the Kennet and tributaries. This area serves as a large flood storage area during significant flood events and consists mostly of farm and parkland with few properties at risk. This is with the exception of a small mixed residential and commercial development around Reading Green Park Station. The development to the south of this station is generally only at risk for the most extreme modelled event (Flood Zone 2), with the Foudry Brook appearing to be the dominant mechanism of flooding, rather than the Kennet main channel. The raised railway embankment provides some separation between the Foudry Brook and Kennet floodplains at this location. A complex interconnecting series of online ponds and ditch network run between the development, the Select Car Leasing Stadium and Green Park Station.

To the north of this location, the district of Southcote is partially at risk from the Holy Brook, which is a tributary of the River Kennet. The floodplain for this watercourse affects properties along Brunel and Hatford Road. Floodwater is constrained by a railway embankment to the south of these locations. The Holy Brook passes under the railway before Southcote Linear Park and there is a significant flooded area within the park downstream of this location, however this does not affect properties.

The floodplain from the River Kennet and Holy Brook remains extensive in the region of Fobney Meadow, which includes again a large network of interconnecting drains in the region. The area is generally undeveloped, however there are areas of commercial and industrial development at risk between the two watercourses, including Reading Trade Centre, Reading Industrial Estate and the Link Retail Park.

The floodplain significantly contracts around the Coley District near to the centre of Reading, with flooding from the Holy Brook and Kennet generally contained within their respective riverbanks. This is except for small areas of development around Crane and Highbridge Wharf. The Kennet bifurcates and joins the Holy Brook immediately after this location. One part of the bifurcation is the Kennet and Avon navigation canal. There are a series of weirs and locks connecting the two channels before they rejoin shortly before the confluence with the Thames. Immediately before the confluence, there is some flood risk to the north of the Kennet, with some hydraulic connection to the Thames floodplain close to Oscar Wilde Road.

A borough-wide map showing modelled flood outlines in the affected areas for the main rivers in Reading Borough are provided in Appendix 1.

2.1.2 Climate change

River Thames

When considering the central allowance for the 1.0% AEP event (35% used as proxy in absence of a 31% design run), there are significant increases to inundated areas north of Reading Station and upstream of this location to the south of the railway embankment. This aligns with the same risk areas for the 0.1% AEP event. Lower Caversham is also at increased risk, with a significant increase in flooding for the central climate change scenario. For the Higher Central allowance, (here the much greater 70% is used as proxy in absence of a 43% design run) the incremental changes above the central allowance are relatively small, with some increases to the floodplain extent within the developed area northwest of Reading Station and then to small areas south of the embankment near this location.

Kennet

When considering the central allowance for the 1.0% AEP event (25% proxy in absence of a 21% design run), there are generally only minor increases to the floodplain extent within the Borough boundary. The exception to this is for properties south of Hatford Road (Southcote district) and for the Water Treatment Works and immediate area south of Fobney Meadow. Small areas are now at risk in this scenario around the industrial/commercial development off the A33, to the north of Fobney Meadow. For the Higher Central allowance, the pattern is similar, with minor incremental changes from the central climate change allowance. The only region greatly affected is the undeveloped floodplain south of Southcote Mill, on the southwestern boundary of the Reading Borough.

Appendix 1 also shows the fluvial flood mapping when accounting for climate change.

2.1.3 Surface Water Flooding

Surface water flooding is often the result of high peak rainfall intensities, and/or insufficient capacity in the sewer network. Surface water flooding is a significant flood risk in urban areas 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 has produced the Risk of Flooding from Surface Water (RoFSW) map 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.

The surface water flood map show areas of high risk which relates to land estimated to flood in a 3.3% AEP pluvial event, medium risk which relates to land estimated to flood in a 1.0% AEP pluvial event and low risk which relates to land estimated to flood in a 0.1% AEP pluvial event.

The maps are currently based on several assumptions, and only indicate where surface water flooding would occur as a result of local rainfall. Caution should be exercised when reviewing the RoFSW map as it may show an over or under-estimation of the surface water flood risk in certain areas. Furthermore, due to the modelling techniques used, the mapping picks out depressions in the ground surface and simulates some flow along natural drainage channels and rivers. Where this is the case, the dominant flooding mechanism is considered to be fluvial and these areas are therefore ignored in the assessment of surface water flooding throughout Reading Borough.

Based on the assumptions and limitations listed above, the maps should only be used at the strategic planning level. In this regard, the analysis has sought to identify broad areas at significant risk of surface water flooding. The at-risk areas are summarised below:

- **Emmer Green, Caversham Heights and Lower Caversham** – There are a number of significant flow routes during the 0.1% AEP event, which follow preferential pathways along major roads within these districts. Several of these flow routes emanate from outside of the Reading Borough boundary, the most prominent two being from the direction of Tokers Green and from Chambers Copse. These then traverse mainly down main roads within the borough, including Hemdean Road, Church Street, Woodcote Way, Upper Woodcote Road and Boundary Lane. There is also flooding along the periphery of the residential developments around Milestone Wood to the southeast of Emmer Green. These impact both roads and properties. More dispersed flood risk is observed in Lower Caversham, affecting properties more widely across this district, with notable ponding observed off Micklands Road, around Ardler Road Allotments and north of Queen Anne's School.

- **Tilehurst, Churchend, Southcote and Horncastle** – There are significant flow routes during the 0.1% AEP event, along Lower Elmstone Drive within Tilehurst, Pottery Road and Rodway Road. The latter may be connected to the minor watercourse emerging within Blundells Copse. There is significant ponding affecting properties to the north and south of Manor Primary School and also to the north of these districts, to developments around Portman and Oxford Road.
- **Central Reading, Coley and Newtown** – During the 0.1% AEP event there are areas above the Coley Recreation Ground and particularly southeast of Coley Primary School which are at risk. To the north there are large areas of ponding along Oxford Road and Great Knollys Street, with some accumulation of surface water also observed along the railway embankment. Much of the surface water flooding shown through Central Reading is thought to be fluvial in origin relating to the River Kennet. However, there are areas, such as along the A329 near the intersection with Bridge Street, which appear to be at surface water risk, unconnected to the fluvial floodplain.
- **The Mount, Whitley and Whitley Wood** – Areas of note in these areas include flow routes emanating from the John Rabson Recreation Ground, which affect industrial developments along Acre Road and Bennet Road before discharging to the Foudry Brook. To the south of this location, there is another band of surface water originating from outside the Borough boundary from Crosfields School, directing westwards towards Geoffrey Field School, affecting properties along Blandford Road, Byworth Close and Whitley Wood Lane. A significant area of ponding is also seen to housing development south of Goddards Farm Allotments. There are also areas north of Reading Girls School along Hexham Road, Canterbury Road and Cradock Road which are affected, this includes a number of residential and industrial units.

Maps showing the extent of the flood outlines for the surface water flood maps in the Reading Borough are provided in Appendix 2.

2.1.4 Ordinary Watercourses

Ordinary watercourses include every river, stream, ditch, drain, cut, dyke, surface water sewer (other than public sewers) and passage through which water flows, above ground or culverted, which is not designated as a main river.

To assess flood risk from these watercourses the EA's flood maps are used. The EA's fluvial flood map does not always show flood extents for smaller catchment sizes, therefore the EA's surface water flood map can also be used to help determine flood risk from these watercourses.

The surface water maps, accounting for local rainfall patterns and topography, show the majority of ordinary watercourses. It should be noted that not all the conveyance area of ordinary watercourses is explicitly modelled nor structures such as culverts in most cases. Therefore, they usually provide a conservative assessment of the flood risk from ordinary watercourses and should not be used as definitive mapping. This said they remain a valuable tool when combined and validated against local experience and knowledge. The key ordinary watercourses have been identified as follows:

- Unnamed Watercourse in Whitley: A stream running through the playing fields below the Acre Business Park, westwards towards the A33, joining the Foudry Brook. Significant flooding in the surface water flood maps is estimated in the Worton Grange Industrial Estate, which may be connected to this feature.

- Unnamed watercourse at Blundell's Copse, Churchend: A small unnamed watercourse runs through Blundell's Copse for approximately 400m, however is untraceable beyond this point, assumed to be culverted and discharge directly to the River Thames. A major surface water flow route is observed both up-and-downstream of this feature, which will not have accounted for the culvert network.
- Unnamed watercourses around Newcastle Road Allotments, The Mount: Various interconnecting watercourses and ditches are present around this location including an extended channel running behind properties on Stanhope Road. It is assumed that this channel is culverted eventually discharging directly to the River Kennet. Surface water mapping does indicate flood risk around this location, with a flow route heading due west from the aforementioned channel. Which again will not have accounted for the culvert network.

Maps showing the location of main rivers and ordinary watercourses are provided in Appendix 3.

2.1.5 Groundwater Flooding

Groundwater flooding is defined as the emergence of groundwater at ground level. There are limited local data with respect to groundwater flooding. However, for a strategic level assessment of the potential for groundwater flooding, the BGS UK Geology Viewer has been used to determine the bedrock geology and hydrogeology across the study area respectively, with the Landis Soilscapes map used to determine the soils present.

BGS mapping shows that the geology of Reading is characterised by distinct formations across different regions. In the north, the Seaford Chalk Formation and Newhaven Chalk Formation dominate, comprising primarily of chalk. This encompasses the following areas; New Town, Lower Caversham, Hemdean Bottom, Emmer Green and Caversham Heights. These chalky formations, due to their high groundwater recharge, can potentially lead to high groundwater levels and an increased risk of groundwater flooding during wet periods.

In contrast, in the east, west and south of the Borough, the Lambeth Group and London Clay Formations are dominant. These are composed mainly of clay, silt and sand. This encompasses the areas of Whitley, The Mount, Whitley Wood, Tilehurst, Churchend, Southcote, Coley, and Horncastle. These formations have lower permeability and are largely underlain by non-productive aquifers, which reduces the risk of groundwater flooding. However, it should be noted that in the central and western areas specifically there may be some potential for groundwater flooding, due to low to moderately productive aquifers which could have significant intergranular flows.

In terms of the soils across the Borough the Soilscapes map shows the urban areas across the Borough to be unclassified, however elsewhere soils tend to be either clayey soils with high groundwater over the Lambeth and London Clay formations or freely draining acid soils over the chalk areas. In both cases these have the potential to increase groundwater flood risk.

Maps showing the bedrock geology, hydrogeology, and soils across Reading are provided in Appendix 4.

2.1.6 Sewer Flooding

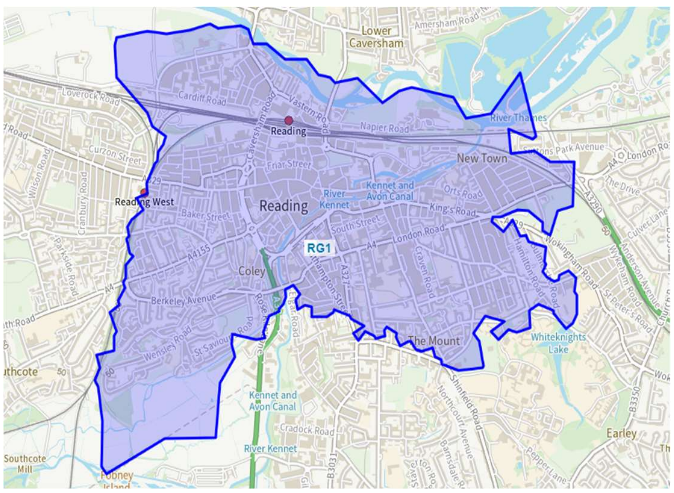
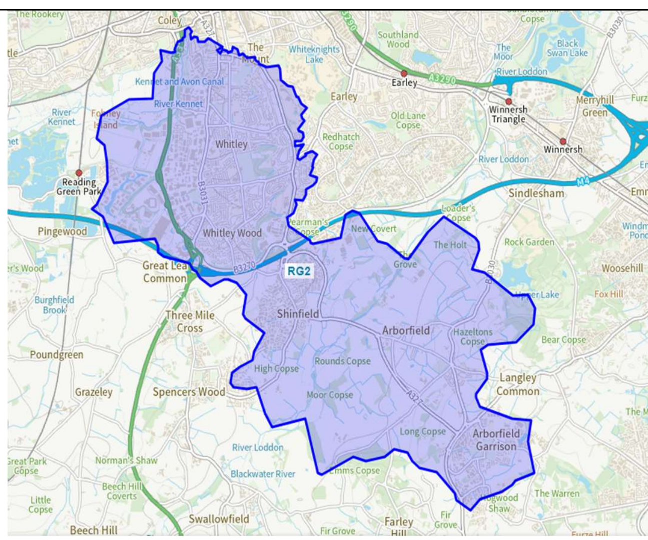
Sewer flooding often occurs because of an existing drainage system having insufficient capacity to drain rainfall, consequently causing the release of water at manholes. Sewer flooding can also occur should there be a fault/failure at an existing drainage system.

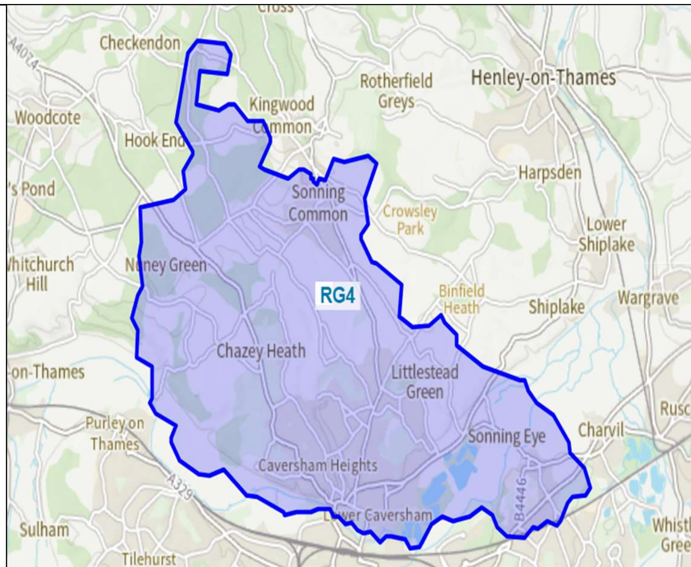
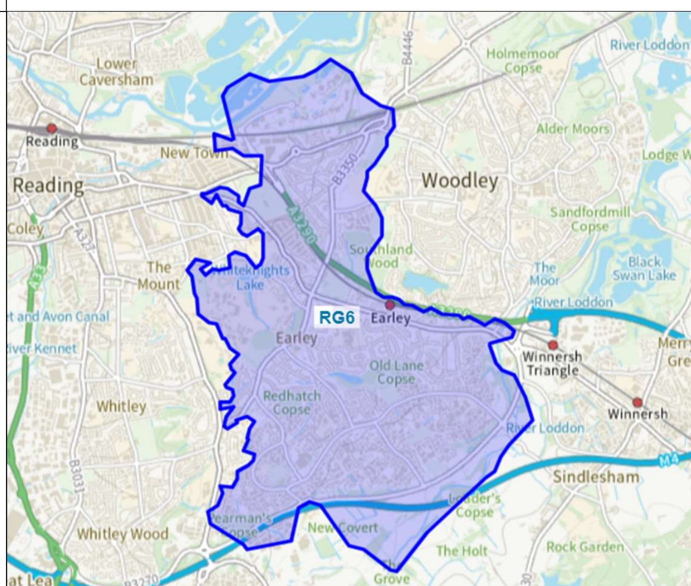
The responsible authority for sewer flooding across the study area is Thames Water who act as the sewerage undertaker. They were contacted to gather available data on sewer flooding. A total of 106 historic records of sewer flooding have been recorded for the study area since records began in 1989 with privatisation of the water industry.

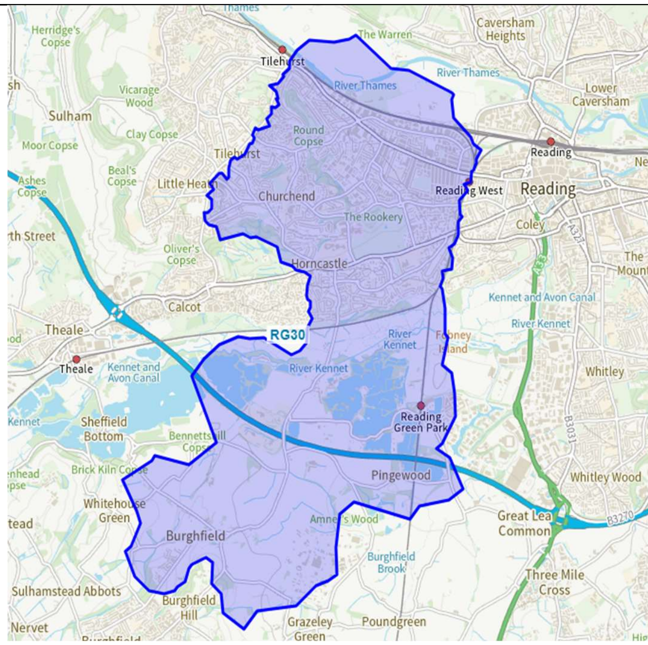
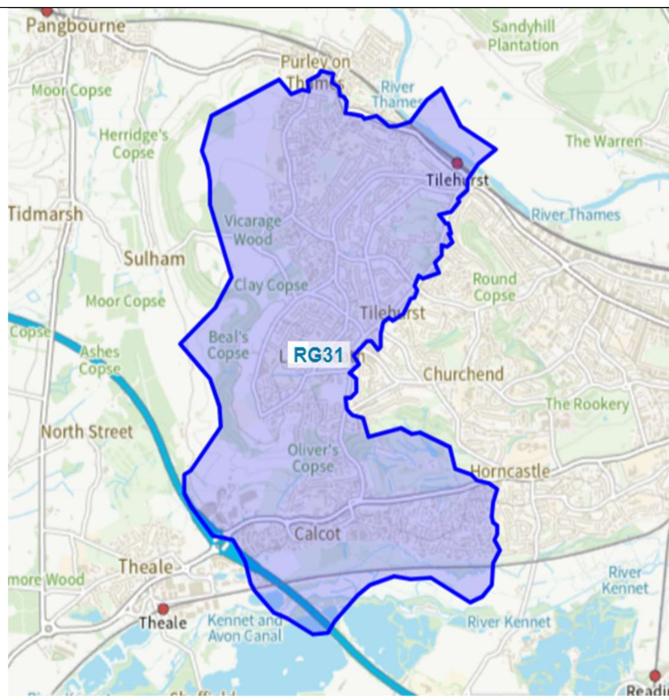
It should be noted that the records are somewhat dependent on reporting and are given for broad post code areas. In this regard, caution should be exercised when ascribing sewer flood risk to a particular location.

A summary of the spatial distribution of incidents of sewer flooding by post code area is provided in Table 4. These predominantly show as expected that built up areas have the most incidents with incidents less common where more rural land use is prevalent. Note some of the areas shown lie partially outside of the Borough area.

Table 4 - Sewer Flooding Incidents by Post code area

Post Code	Post Code Area	External Flooding	Internal Flooding	Total
RG1		7	7	14
RG2		2	13	15

RG4		6	16	22
RG6		0	1	1

RG30		5	29	34
RG31		2	18	20
Total		**22**	**84**	**106**

2.1.7 Reservoir Flooding

In 2021 the EA published updated maps showing the flood risk associated with reservoirs. Dam breach and flood modelling techniques were used to produce a new national set of reservoir flood maps for England. The maps show two flooding scenarios, including a 'dry-day' and a 'wet-day'. The 'dry-day' scenario predicts the flooding that would occur if the dam or reservoir failed when rivers are at normal levels. The 'wet day' scenario predicts how much worse the flooding might be if a river is already experiencing an extreme natural flood.

The main reservoirs which could impact Reading Borough include the following:

- Whiteknights Lake (grid reference SU7380072300) Owner: The University of Reading
- Farmoor No.1 (grid reference: SP4450006800) Owner: Thames Water Limited
- Farmoor No.2 (grid reference: SP4450006000) Owner: Thames Water Limited

The modelled extents tend to lie along the River Thames and an area in central Reading close to the River Kennet and the Kennet and Avon Canal. The two Farmoor reservoirs impact the River Thames whilst the Whiteknights Lake effects the area in central Reading.

In the wet day scenario, the areas affected within the Thames floodplain include parts of Tilehurst, and Lower Cavensham. Parts of central Reading are also affected by the Farmoor reservoirs however this mostly remains to the North of the railway line. Areas affected by a dam breach at Whiteknights Lake lie south of the railway line and in the central Reading include the areas around the University of Reading, the River Kennet and the Kennet and Avon Canal. Areas further west including Portman Rd are also affected.

Whilst these areas are shown to be at risk, reservoir failure is a rare event with a very low probability of occurrence. Current reservoir regulation, which has been further enhanced by the FWMA, aims to ensure that all reservoirs are properly maintained and monitored to detect and repair any problem.

Maps showing the reservoir flood extents in Reading Borough are provided in Appendix 5.

2.1.8 Canal Flooding

The Kennet and Avon Canal is 87 miles long and links London with the Bristol channel. In Reading specifically, the River Kennet was made navigable in the 18th century. Known as the Kennet Navigation, this stretch of the river is administered by the Canal & River Trust as part of the Kennet and Avon Canal. Throughout the navigation, stretches of natural riverbed alternate with 11 miles of artificially created lock cuts, and a series of locks from High Bridge in Reading town centre (NGR: 471763, 173298) to Tyle Mill approximately 4 miles to the southwest of the Borough (NGR: 462641, 169289). These overcome a rise of 40m between Reading and Newbury. Due to its intrinsic connection with the River Kennet, the route of the Canal primarily follows the base of the Kennet Valley. However, there are isolated areas where it is elevated above surrounding ground levels

The Canal and River Trust has recorded incidents of overtopping, when water rises above the top of the canal. Table 5 shows the overtopping incidents recorded in the Reading Borough. A total of 11 incidents have been recorded in Reading Borough during floods in 2008 (1), 2012 (1) 2014 (6) and 2018 (2). For one of the incidents near Southcote lock no date was provided. In general, the events have occurred in rural areas in the southwest of the borough. No events have been recorded in Reading town centre.

Table 5 – Overtopping Incidents recorded for Kennet and Avon Canal and River Trust

Location	Eastings	Northings	Date	Description
U/S of Southcote lock	469095	171243	30/12/2012	Caused by prolonged heavy rain. No visible damage.
Fobney Island	469911	171222	23/01/2008	Reasons unknown
U/S of Southcote lock	468953	171152	Not stated	5m of towpath affected.
Fobney Island	469910	171221	13/01/2014	Caused by rainfall. Led to deep scouring of towpath.
U/S of Reading-Basingstoke railway	469609	171329	13/01/2014	Caused by prolonged heavy rainfall. 6m of towpath affected.
Fobney Island	470251	171163	15/01/2014	Caused by rainfall. Led to scouring of towpath.
D/S of A33	471176	171197	24/01/2014	Caused by rainfall. Overtopping towpath from channel.
Fobney Island	470329	171149	05/02/2014	Caused by rainfall. Overtopping along 20m section.
Waterloo Meadows Allotments	471339	171804	05/02/2014	Caused by rainfall. Approximately 200m section with depth of 0.4m.
Fobney Island	470116	171185	25.01.2018	Caused by rainfall. Overtopping along 0.75m section to depth of 0.025m.
Fobney Island	470107	171183	30.03.2018	Caused by rainfall. Overtopping along 0.50m section to depth of 0.010m.

The Canal and River Trust also record breach incidents, where the banks of the canal fail causing water to spill onto surrounding land. No breach incidents have been recorded in the Borough.

Despite the lack of overtopping and breach incidents within the urban areas of the Borough, given the proximity of the canal to other watercourses (the River Kennet and River Thames) in the centre of the town, flooding from the canal should still be recognised as a potential risk.

Overall, the likelihood of these potential events are rare and canal flooding should not unduly influence spatial planning decisions. However, ongoing maintenance and management of the canal is important and any potential future development in the proximity of the structure should consider the residual risk of failure as part of a site-specific flood risk assessment (FRA).

2.2 Review of Historic 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 recorded flood outlines map, which shows the extent of all individual recorded flood outlines. Information provided by RBC as part of the previous SFRA has also been used to identify any events not shown in the EA records.

In Reading, twenty flood events have been identified dating back to Autumn 1894, ten of which are shown in the EA recorded flood outlines mapping. Table 6 shows a list of the notable flood events identified, including their start and end dates, the source of flooding and the cause.

Based on all the available records, flooding associated with the River Thames and River Kennet affects the majority of the area. Areas within Reading that have been affected include large parts of Lower Caversham and Southcote located in the north and south-east of the Borough. During all of the events, the open rural areas along the River Thames and River Kennet (e.g. Fobney Meadow), are regularly subject to inundation and act to store large volumes of flood water.

Some properties and roads have also been reported to flood during the listed events. This includes Stockton Road, William Street, Stone Street, Queens Road, Coldicutt Street, George Street, and Island Road.

The most recent widespread flood event was in January 2024 which was caused by three months of extremely wet weather followed by intense rainfall on saturated ground during Storm Henk. This event led to the River Thames at Reading gauge reaching its highest recorded level, as well as causing rising water levels in River Kennet. This event resulted in 24 properties being flooded, particularly in Lower Caversham and parts of Southcote. Appendix 6 shows the recorded flood outlines for Reading.

Table 6- Summary of Historic Flood Events in the Reading District

Event	Start Date	End Date	Source	Cause
Autumn 1894	Oct/Nov 1984	Nov/Dec 1984	River Thames and River Kennet	Prolonged rainfall
Summer 1910	June 1910	June 1910	Surface water	Intense rainfall
Spring 1947	March 1947	March 1947	River Thames	Snow melt
Summer 1971	June 1971	June 1971	River Kennet	Intense rainfall
Winter 1974	November 1974	November 1974	River Thames	Prolonged rainfall
Summer 1977	August 1977	August 1977	Surface water	
Autumn 1992	September 1992	September 1992	River Kennet	
Autumn 1993	October 1993	October 1993	Holy Brook	
Summer 1999	August 1999	August 1999		
Winter 2000	December 2000	December 2000	River Thames	Prolonged rainfall
Autumn 2000	September 2000	November 2000	River Thames	Prolonged rainfall
Winter 2002	January 2002	January 2002		
Winter 2002/3	23rd December 2002	12th January 2003	River Thames	Prolonged rainfall
Summer 2007	July 2007	July 2007	Brooks	Prolonged rainfall
Autumn 2012	November 2012	November 2012	River Thames	Prolonged rainfall
Winter 2013/14	23rd November 2013	28th February 2014	River Thames, River Kennet, and Holy Brook	Prolonged rainfall
Winter 2024	January 2024	January 2024	River Thames, River Kennet, and Holy Brook	Prolonged rainfall

2.3 Review of Flood Defences

The EA national AIMS flood defence layer provided by the EA for Reading has been used to identify significant flood defence infrastructure across the Borough.

Most areas along the River Thames and River Kennet have no flood defence. It is mainly protected by natural high ground. Natural High Ground (NHG) covers all extents along watercourses that are not defined as any other Defence Asset Type. It covers situations where the only defence is the ground itself, rather than anything manmade. Examples include the top of a riverbank adjacent to a watercourse.

For the defence structures identified, the majority are located along the Kennet near Reading town centre, Newtown, Green Park, and Coley Park. This includes a series of embankments and retaining walls, which serve as flood protection as the river approaches its confluence with the Thames. For the majority of defences identified, the standard of protection tends to be low, generally offering protection for a 1 in 5-yr flood event (20% AEP). The defence structures identified below do not include flood storage schemes.

The AIMS database lists a condition grade for some defences as defined below:

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

Table 7 provides a summary of the flood defences including where available their condition, extent and standard of protection. The majority of the defence structures identified have unknown owners with the exception of the embankment near Reading Link Retail Park and A33 Bridge, which the EA flood defence layer identifies as being held by private owners. Maps showing the location of flood defences in Reading are provided in Appendix 7.

Table 7- Flood Defences in Reading

Location	Defence Type	Length (m)	Condition	Design SOP
River Kennet, US of Kenavon Bridge (NGR: 472624, 173491)	Embankment (Unknown)	121	3-Fair	5
River Kennet, US of Watlington Bridge (NGR: 472086, 173331)	Wall (Unknown)	55	2-Good	5
River Kennet, US of Yield Hall Place Bridge (NGR: 471599, 173198)	Wall (Unknown)	100	2-Good	5
Holy Brook, near Reading Link Retail Park (NGR: 471075, 172201)	Embankment (Private owned)	383	3-Fair	5
River Kennet, US of A33 Bridge (NGR: 470836, 171030)	Embankment (Private owned)	512	3-Fair	5
Foudry Brook, near Reading Gate Retail Park (NGR: 471062, 169824)	Embankment (Unknown)	181	3-Fair	2

Note, RBC undertook clearance work (completed April 2024) on the Christchurch Ditch, also known as the Danall, which runs through the Christchurch and Hills Meadows. The ditch is fed by a pipe from the River Thames and provides minor flood alleviation.

2.4 Review of Flood Warning

The EA is responsible for issuing flood warnings in the Reading area. In regularly monitoring the river network they aim to give the public notice of any local main river overtopping its bank (flood alert) or flooding properties (flood warning).

Water levels are monitored at a number of locations, and this information is used to inform flood warnings at the five flood warning areas within the Borough. Flood warning areas are geographical areas where the EA expect flooding to occur and where the EA provide a flood warning service. A flood warning is issued when there is a risk of property flooding. The flood warning areas for the Borough are listed below:

- Foudry Brook from Stratfield Mortimer to Green Park
- Properties closest to the River Kennet at the Burghfield, Southcote, Coley and Holybrook areas
- Properties closest to the River Thames from Scours Lane, Reading to Caversham Lakes
- River Kennet from Theale down to Reading
- River Thames at Reading and Caversham

Gauges along watercourses are also used to issue flood alerts across wider flood alert areas. Flood alert areas are geographical areas where it is possible for flooding to occur. A flood alert is issued to warn people of the possibility of flooding. For Reading there are three flood alert areas, these are listed below. Figure 2 shows the alert areas relative to the flood warning areas.

- River Enborne and Foudry Brook
- River Kennet from Thatcham down to Reading
- River Thames at Reading and Caversham

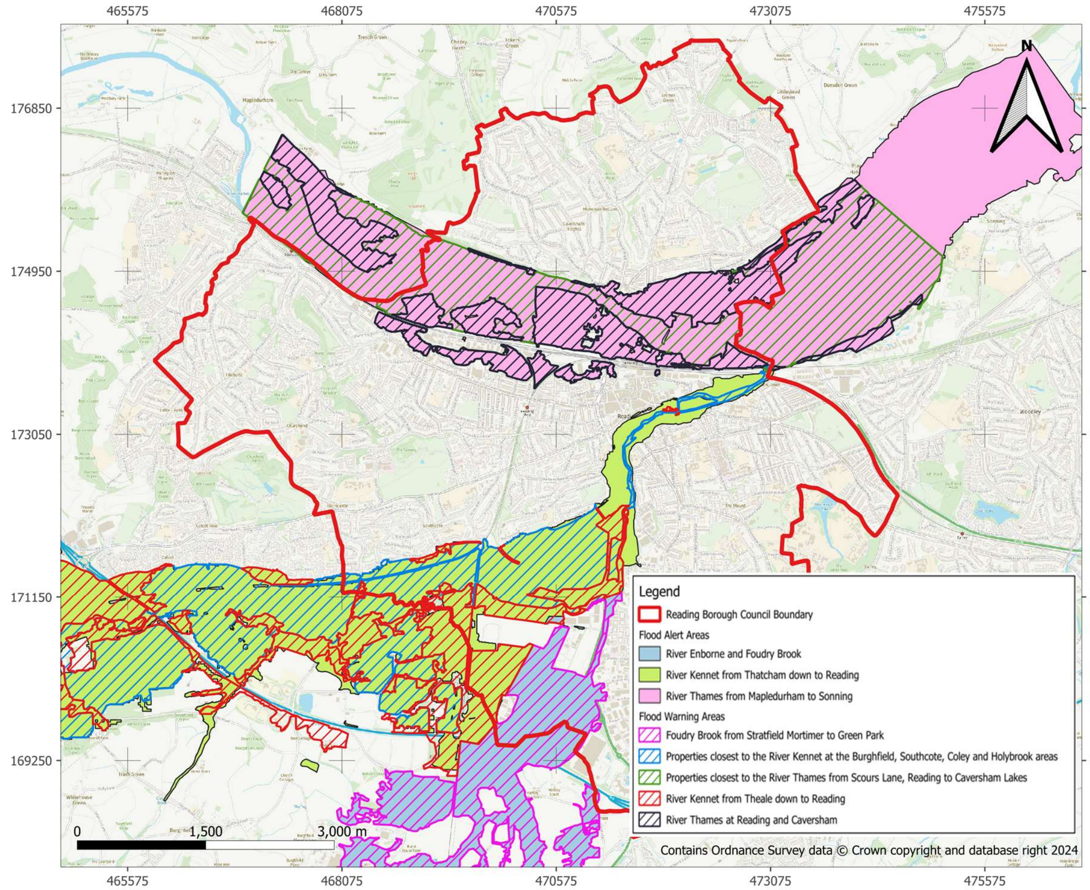


Figure 2 – Flood Warning Areas and Flood Alert Area

The timings of flood alerts and warnings are typically determined by trigger levels at the gauges which relate to the following:

- **FAL – Flood Alert Level**
  The level where flood waters first come out of bank if there were no defences. Flooding is possible.
- **FW – Flood Warning**
  Flooding is expected.
- **SFW – Severe Flood Warning**
  Flooding may present a risk to life and significant disruption to communities.

Flood alerts and warnings are available from the EA by a preferred contact method e.g. by phone or email. It is recommended that landowners/property owners in flood risk areas sign up to this service.

The relatively permeable geology of the Thames catchment means that it tends to be relatively slow when responding to rainfall. This can mean that there is a significant amount of time for flood warning procedures to be implemented. The same does not apply for some of the smaller watercourses within the Borough, which due to the size of their catchments and urbanisation may elicit faster runoff responses and reduced lead in times making it difficult or impossible to provide an alert or warning in sufficient advance of flooding.

3 Flood Risk at Site Allocations (Reading Local Plan 2040)

3.1 Sequential Test

This SFRA provides information to support application of the sequential test to the individual development sites identified by RBC.

The sequential test ensures that a sequential, risk-based approach is followed to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account. Where it is not possible to locate development in low-risk areas (Flood Zone 1), the sequential test should go on to compare reasonably available sites:

- Within medium risk areas (Flood Zone 2); and
- Within high-risk areas (Flood Zone 3), only where there are no reasonably available sites in low and medium risk areas

The sequential test should then consider the spatial variation of risk within medium and then high flood risk areas to identify the lowest risk sites in these areas.

Site specific FRAs should apply the sequential test at a site level locating the most vulnerable infrastructure in lower risk areas. To support such an assessment information on flood depth, velocity, hazard and speed-of-onset should be considered, along with the role of flood management infrastructure and the potential impacts of climate change.

3.2 Exception Test

In situations where sites at lower risk of flooding are not available following application of the sequential test, potential development may be located in medium to high-risk areas. In these cases, it may be necessary to apply the exception test.

The exception test requires two additional elements to be satisfied before allowing development to be allocated or permitted. It should be demonstrated that:

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

Table 8 sets out the circumstances when the exception test will be required. More guidance on application of the sequential and exception test is provided in the NPPF and flood risk and coastal change PPG.

Table 8- Flood risk vulnerability and flood zone 'incompatibility'

Flood Zones	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	x	Exception Test required	✓	✓
Zone 3b	Exception Test required	x	x	x	✓

3.3 Development Sites for Local Plan Update

A total of 148 sites have outstanding planning permission and/or are expected to be included in the local plan update, many of which were allocated in the local plan adopted in November 2019. A significant number of sites have been granted planning permission and some are already under construction. The SFRA seeks to provide sufficient information to allow RBC to apply the sequential test to sites not yet granted permission focusing on those being considered in the local plan process. The SFRA has also outlined any requirements for the exception test. In this way, the SFRA will help RBC to implement national policy to direct development away from areas of flood risk through assessing these sites and helping inform strategic decisions on future development.

Table 9 summarises the sites expected to be allocated in the local plan process and those which have been allocated with no permission yet granted. Figure 3 shows the location of all local plan sites across the Reading Borough area including those already granted planning permission. Appendix 8 provides a full list of all local plan sites.

Table 9 – List of Development Sites for Local Plan Update

Reference	Address	Development	Status
CR11a	Friar Street and Station Road	Mixed	Allocated, no permission
CR11b	Greyfriars Road Corner	Residential	Allocated, no permission
CR11d	Brunel Arcade and Apex Plaza	Mixed	Allocated, no permission
CR12a	Cattle Market	Residential	Allocated, no permission
CR12b	Great Knollys Street and Weldale Street	Residential	Allocated, no permission
CR12c	Chatham Street, Eaton Place and Oxford Road	Residential	Allocated, no permission
CR12e	Hosier Street	Mixed	Allocated, no permission
CR13a	Reading Prison	Mixed	Allocated, no permission
CR13b	Forbury Retail Park	Residential	Allocated, no permission
WR3i	Part of Battle Hospital (remainder)	Residential	Allocated, no permission
WR3k	784-794 Oxford Road	Residential	Allocated, no permission
WR3l	816 Oxford Road	Residential	Allocated, no permission
CA1f	Rear of 1 & 3 Woodcote Rd & 21 St Peter's Hill	Residential	Allocated, no permission
WR3f	4 Berkeley Avenue	Residential	Allocated, no permission
WR3g	211-221 Oxford Road	Residential	Allocated, no permission
CR1c	Land at Lowfield Road	Residential	Allocated, no permission
CA1d	Rear of 200-214 Henley Rd, 12-24 All Hallows Rd	Residential	Allocated, no permission
CA1e	Rear 13-14a Hawthorne Rd & 282-292 Henley Rd	Residential	Allocated, no permission
CA2	Caversham Park	Residential	Allocated, no permission
CR14i	Enterprise House, 89-97 London Street	Residential	Allocated, no permission
CR14j	Corner of Crown Street and Southampton Street	Residential	Allocated, no permission
SR3	South of Elgar Road Major Opportunity Area	Residential	Allocated, no permission
SR4a	Pulleyn Park, Rose Kiln Lane	Residential	Allocated, no permission
SR4c	169-173 Basingstoke Road	Residential	Allocated, no permission
WR3r	Charters Car Sales, Oxford Road	Residential	Allocated, no permission
WR3s	Land at Kentwood Hill	Residential	Allocated, no permission
WR3t	Land at Armour Hill	Residential	Allocated, no permission
ER1i	261-275 London Road	Mixed	Allocated, no permission
ER1k	131 Wokingham Road	Mixed	Allocated, no permission
SR4b	3-29 Newcastle Road	Residential	Allocated, no permission
ER1b	Dingley House, 3-5 Craven Road	Residential	Allocated, no permission
ER1c	Land rear of 8-26 Redlands Road	Residential	Allocated, no permission
ER1d	Land adjacent to 40 Redlands Road	Residential	Allocated, no permission
CR11f	West of Caversham Road (remainder)	Residential	Allocated, no permission
CR11i	Napier Court	Residential	Allocated, no permission
CR11g	Riverside (remainder)	Residential	Allocated, no permission
CR13c	Forbury Business Park and Kenavon Drive	Residential	Allocated, no permission
CR14l	187-189 Kings Road	Residential	Allocated, no permission
CA1a	Reading University Boat Club, Thames Promenade	Residential	Allocated, no permission
WR3b	2 Ross Rd and Part of Manrose Manufacturing	Residential	Allocated, no permission
WR2	Downing Road Playing Field	Residential	Allocated, no permission
SR2	Land North of Manor Farm Road	Residential	Allocated, no permission

ER1e	St Patricks Hall, Northcourt Avenue	Employment	Allocated, no permission
SR1a	Land south of Island Road	Employment	Allocated, no permission
SR1c	Island Road A33 frontage	Employment	Allocated, no permission
SR4d	16-18 Bennet Road	Employment	Allocated, no permission
CR11e	North of Station (remainder)	Mixed	Allocated, part permitted
None	Rose Kiln Court, Rose Kiln lane	Mixed	Considered in LP process
None	Crowne Plaza Reading, Richfield Avenue	Residential	Considered in LP process
None	Part of car park, Tesco Extra, Napier Road	Residential	Considered in LP process
None	2 Norman Place	Residential	Considered in LP process
None	Reading Bridge House, George Street	Residential	Considered in LP process
None	Kennet Place, Kings Road	Residential	Considered in LP process
None	Part of Reading College, Kings Road	Residential	Considered in LP process
None	Land west of Milford Road	Residential	Considered in LP process
None	Land at Drake Way (south)	Residential	Considered in LP process
None	Land at Drake Way (north)	Residential	Considered in LP process
None	Formner Marketing Suite, Drake Way	Residential	Considered in LP process
None	Site at Green Park Village, Flagstaff Way	Residential	Considered in LP process
None	51 Church Road, Earley	Residential	Considered in LP process
None	Part of Tesco car park, Portman Road	Residential	Considered in LP process
None	20-22 Duke Street	Residential	Considered in LP process
None	Reading Central Library, Abbey Square	Residential	Considered in LP process
None	Former Debenhams, The Oracle	Residential	Considered in LP process
None	Vue Cinema, The Oracle	Residential	Considered in LP process
None	Aquis House, Forbury Road	Residential	Considered in LP process
None	33 Blagrave Street	Residential	Considered in LP process
None	Sapphire Plaza, Watlington Street	Residential	Considered in LP process
None	Royal Court, Kings Road	Residential	Considered in LP process
None	Reading Link Retail Park, Rose Kiln Lane	Residential	Considered in LP process
None	72 Berkeley Avenue	Residential	Considered in LP process
None	John Lewis Depot, Mill Lane	Residential	Considered in LP process
None	Tunbridge Jones, Cradock Road	Residential	Considered in LP process
None	11 Basingstoke Road	Residential	Considered in LP process
None	Royal Berkshire Hospital, London Road	Employment	Considered in LP process
None	132-134 Bath Road	Residential	Considered in LP process
None	Southcote Library, Coronation Square	Residential	Considered in LP process

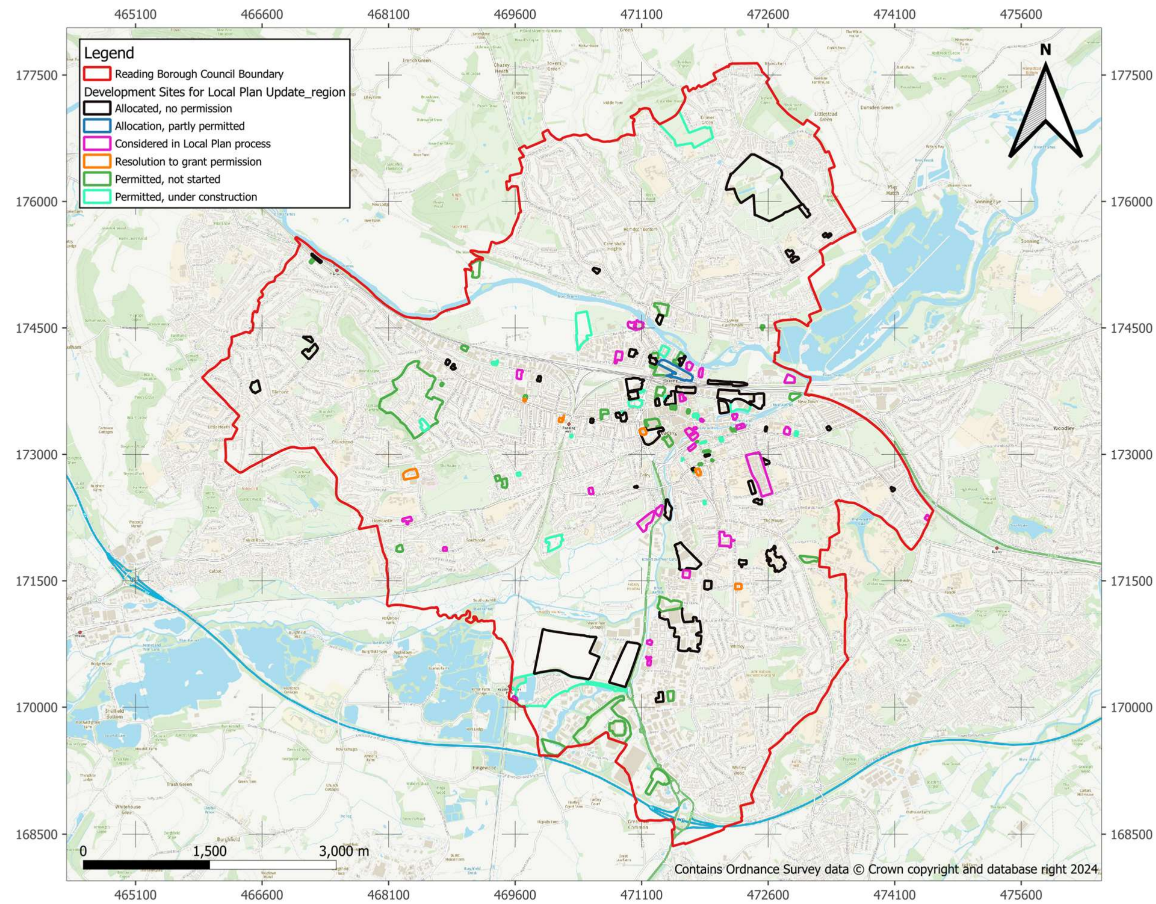


Figure 3- Map of Development Sites for Local Plan Update

Based on the information and mapping provided as part of this SFRA, RBC will undertake a sequential test of new allocations within the Local Plan Update as well as existing allocations where flood risk has increased. To inform this assessment, the proportion of each site falling within Flood Zone 2, Flood Zone 3a and Flood Zone 3b has been estimated. Table 10 displays the results of this analysis for all local plan sites across the Borough apart from those lying exclusively in Flood Zone 1. Whilst the sequential test will not be undertaken at sites already granted planning permission and existing allocations with no change in flood risk, the analysis at these sites is used to inform the assessment of cumulative development impacts in section 3.4.

Table 10 – Proportion of sites at fluvial flood risk (FZ2, FZ3a, FZ3b)

Site Name	Area (ha)	FZ2 (%)	FZ3a (%)	FZ3b (%)
Allocated, no permission				
Reading University Boat Club, Thames Promenade	0.56	100.00	64.32	33.91
Pulleyn Park, Rose Kiln Lane	1.29	5.96	4.46	4.18
Land south of Island Road	32.15	43.21	3.91	2.65
Riverside (remainder)	0.41	52.28	2.05	1.97
Napier Court	1.62	53.28	7.35	1.27
Island Road A33 frontage	9.74	0.12	0.04	0.02
Part of Battle Hospital (remainder)	0.21	100.00	0.00	0.00
West of Caversham Road (remainder)	0.57	100.00	0.00	0.00
Cattle Market	2.47	57.19	0.00	0.00
Great Knollys Street and Weldale Street	0.92	50.19	0.00	0.00
784-794 Oxford Road	0.22	17.92	0.00	0.00
Forbury Business Park and Kenavon Drive	2.08	9.29	0.00	0.00
2 Ross Road and Part of Manrose Manufacturing	0.60	4.58	0.00	0.00
Brunel Arcade and Apex Plaza	1.51	0.65	0.00	0.00
Land North of Manor Farm Road	13.74	0.55	0.00	0.00
Allocated, partly permitted				
North of Station (remainder)	3.92	73.41	0.00	0.00
Considered in Local Plan Process				
Former Debenhams, The Oracle	0.56	4.96	4.96	4.96
Vue Cinema, The Oracle	0.53	4.65	4.65	4.51
Reading Central Library, Abbey Square	0.10	4.02	4.02	4.02
20-22 Duke Street	0.08	4.21	2.84	2.84
Crowne Plaza Reading, Richfield Avenue	1.29	86.64	27.14	2.55
Reading Bridge House, George Street	0.40	98.09	3.08	1.84
Royal Court, Kings Road	0.16	1.47	0.47	0.47
2 Norman Place	0.55	20.50	3.50	<0.01
Reading Link Retail Park, Rose Kiln Lane	2.12	5.43	0.04	<0.01
Land west of Milford Road	0.86	100.00	0.00	0.00
Part of car park, Tesco Extra, Napier Road	0.88	100.00	0.00	0.00
Site at Green Park Village, Flagstaff Way	0.20	97.81	0.00	0.00
Part of Tesco car park, Portman Road	0.59	66.79	0.00	0.00
Former Marketing Suite, Drake Way	0.25	7.05	0.00	0.00
Sapphire Plaza, Watlington Street	0.25	0.21	0.00	0.00
Rose Kiln Court, Rose Kiln lane	0.66	<1.00	0.00	0.00
Permitted, not started				
Unit 1, Paddock Road	0.14	100.00	100.00	59.42
Land at Chazey Farm	1.70	100.00	37.29	34.83
Plot 8, 600 South Oak Way	3.17	100.00	33.09	25.55
Land at Select Car Leasing Stadium, Shooters Way	16.39	100.00	9.95	8.12
Gas Holder, Alexander Turner Close	0.71	57.20	3.30	2.92
55 Vastern Road	0.78	50.30	4.07	0.56
127a Loverock Road	0.36	68.10	37.02	0.00
71-73 Caversham Road	0.17	100.00	0.00	0.00
97a-117 Caversham Road	0.49	100.00	0.00	0.00
Select Car Leasing Stadium, Royal Way	2.72	100.00	0.00	0.00
80 Caversham Road	3.92	96.87	0.00	0.00
St Martin's Precinct, Church Street	1.61	25.14	0.00	0.00
Brunel Retail Park, Rose Kiln Lane	3.22	19.65	0.00	0.00
Station Hill	0.89	0.46	0.00	0.00
Permitted, under construction				
Green Park Village	22.81	98.38	13.82	11.06
Richfield Driving Range, Richfield Avenue	5.52	100.00	20.96	8.90
Green Park Village Phase 6A	1.62	97.3	4.45	2.85
Kenavon Drive	2.67	0.04	0.03	0.03
Great Brighams Mead, Vastern Road	1.02	99.86	86.34	0.00
45 Caversham Road	0.15	21.2	0.00	0.00

If following application of the sequential test, it is found that a number of sites need to be located in Flood Zone 2, Flood Zone 3a and/or Flood Zone 3b a level 2 SFRA will be required. This will include a detailed assessment of flooding at each of the relevant sites and review the appropriateness of development.

It should also be noted, that whilst sites in Flood Zone 1 are not included in the table above, a site-specific FRA will still be required where developments are:

- More than 1 hectare (ha)
- Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and the sea (for example surface water drains, reservoirs)
- In an area within Flood Zone 1 which has critical drainage problems as notified by the EA

It is noted that based on NPPF all plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk. Fluvial flood risk is the primary consideration for future development allocations across the Borough, however surface water flood risk is also important. To inform the plan process, the proportion of each site falling within the low risk (0.1% AEP), medium risk (1.0% AEP) and high risk (3.3% AEP) surface water flood zones (based on the EA Surface Water Floop Map) has been estimated. The results of this analysis are shown in Table 11. Sites lying exclusively outside of the low-risk zone and considered not to be at surface water flood risk are not shown.

Table 11 – Proportion of sites at surface water flood risk (High, Medium, Low)

Site Name	Area (ha)	Low (%)	Med (%)	High (%)
Allocated, no permission				
Part of Battle Hospital (remainder)	0.21	68.10	62.10	13.57
Great Knollys Street and Weldale Street	0.92	93.18	32.33	13.18
16-18 Bennet Road	0.75	74.40	69.76	11.85
Enterprise House, 89-97 London Street	0.11	48.46	38.36	8.49
Rear 200-214 Henley Rd, 12-24 All Hallows Rd	0.86	14.87	10.69	6.61
169-173 Basingstoke Road	0.80	22.53	8.50	3.83
Brunel Arcade and Apex Plaza	1.51	6.56	5.46	3.51
Greyfriars Road Corner	0.36	6.28	4.62	3.45
Land North of Manor Farm Road	13.74	18.00	5.64	3.03
Forbury Business Park and Kenavon Drive	2.08	11.46	3.22	1.95
Hosier Street	3.42	11.92	3.49	1.86
Pulleyn Park, Rose Kiln Lane	1.29	6.40	2.10	1.58
784-794 Oxford Road	0.22	52.31	15.13	1.09
South of Elgar Road Major Opportunity Area	5.42	20.66	3.90	1.04
Rear of 1 & 3 Woodcote Rd & 21 St Peter's Hill	0.33	4.36	1.65	1.03
Island Road A33 frontage	9.74	15.63	3.38	0.94
211-221 Oxford Road	0.16	51.56	3.53	0.92
Friar Street and Station Road	1.36	7.99	2.19	0.91
St Patricks Hall, Northcourt Avenue	3.41	8.48	0.99	0.49
Land south of Island Road	32.15	22.55	0.62	0.40
Forbury Retail Park	4.34	13.99	2.45	0.30
Caversham Park	38.42	1.53	0.33	0.13
261-275 London Road	0.16	16.56	0.11	0.06
Cattle Market	2.47	82.49	5.21	0.03
Reading University Boat Club, Thames Promenade	0.56	30.06	2.68	0.01
Downing Road Playing Field	1.18	0.03	<0.01	<0.01
Land adjacent to 40 Redlands Road	0.43	31.21	11.73	0.00
Dingley House, 3-5 Craven Road	0.33	24.51	4.13	0.00
816 Oxford Road	0.23	8.09	1.34	0.00
Reading Prison	1.44	9.68	0.92	0.00
Corner of Crown Street and Southampton Street	0.08	4.47	0.41	0.00

Site Name	Area (ha)	Low (%)	Med (%)	High (%)
West of Caversham Road (remainder)	0.57	23.14	0.18	0.00
Land at Lowfield Road	0.93	5.33	0.02	0.00
Chatham Street, Eaton Place and Oxford Road	0.84	12.73	<0.01	0.00
Riverside (remainder)	0.41	5.25	0.00	0.00
131 Wokingham Road	0.15	3.87	0.00	0.00
2 Ross Road and Part of Manrose Manufacturing	0.60	2.78	0.00	0.00
Napier Court	1.62	2.11	0.00	0.00
Charters Car Sales, Oxford Road	0.33	0.36	0.00	0.00
Allocated, partly permitted				
North of Station (remainder)	3.92	21.57	5.54	2.61
Considered in Local Plan Process				
132-134 Bath Road	0.51	45.33	26.47	16.43
Vue Cinema, The Oracle	0.53	12.96	7.55	4.05
Royal Berkshire Hospital, London Road	7.76	20.26	6.67	2.76
11 Basingstoke Road	1.93	9.31	0.78	0.75
Former Debenhams, The Oracle	0.56	8.20	1.40	0.45
20-22 Duke Street	0.08	62.40	13.44	0.05
Rose Kiln Court, Rose Kiln lane	0.66	60.97	26.54	0.00
John Lewis Depot, Mill Lane	0.37	17.70	10.16	0.00
Land west of Milford Road	0.86	38.09	9.26	0.00
Aquis House, Forbury Road	0.35	4.81	1.48	0.00
Royal Court, Kings Road	0.16	6.49	0.55	0.00
Reading Central Library, Abbey Square	0.10	3.62	0.51	0.00
Sapphire Plaza, Watlington Street	0.25	27.45	0.03	0.00
Tunbridge Jones, Cradock Road	0.69	0.52	0.03	0.00
2 Norman Place	0.55	5.78	<0.01	0.00
Crowne Plaza Reading, Richfield Avenue	1.29	0.59	<0.01	0.00
Former Marketing Suite, Drake Way	0.25	33.17	0.00	0.00
Land at Drake Way (south)	0.22	29.2	0.00	0.00
Part of Tesco car park, Portman Road	0.59	5.01	0.00	0.00
Reading Link Retail Park, Rose Kiln Lane	2.12	4.22	0.00	0.00
Southcote Library, Coronation Square	0.17	0.23	0.00	0.00
Permitted, not started				
Land at Battle Street	0.55	87.38	32.71	18.87
127a Loverock Road	0.36	57.1	22.33	13.78
Dee Park, Spey Road	35.45	29.2	20.74	6.58
Plot 8, 600 South Oak Way	3.17	7.44	3.17	2.86
Land at Select Car Leasing Stadium, Shooters Way	16.39	17.39	7.94	2.75
Amethyst Lane	0.57	29.34	6.89	2.44
97a-117 Caversham Road	0.49	16.65	4.10	2.22
University of Reading, Chancellors Way	1.17	5.00	2.29	2.02
Station Hill	0.89	19.92	6.57	1.83
Select Car Leasing Stadium, Royal Way	2.72	9.59	4.40	1.40
80 Caversham Road	1.96	34.91	8.81	0.87
St Martin's Precinct, Church Street	1.61	24.42	5.09	0.87
Brunel Retail Park, Rose Kiln Lane	3.22	1.05	0.79	0.73
Reading International Business Park	3.68	52.08	4.50	0.63
Bennet Court, Bennet Road	0.75	55.32	52.51	0.35
Central Club, London Street	0.05	1.43	0.63	0.24
Civic Offices, Bridge Street	0.85	14.67	0.19	<0.01
173-174 Friar Street	0.10	18.53	10.00	0.00
138-144 Friar Street	0.13	10.16	7.80	0.00
Land at 362 Oxford Road	0.16	40.61	3.83	0.00
Gas Holder, Alexander Turner Close	0.71	11.46	2.61	0.00
Land at Chazey Farm	1.70	7.65	1.32	0.00
Land at Weldale Street	1.21	2.90	1.19	0.00
Alexander House, 205-207 Kings Road	0.16	27.56	0.97	0.00
Broad Street Mall	1.78	0.60	0.58	0.00
Land rear of 8-26 Redlands Road	0.74	21.57	0.22	0.00
75-81 Southampton Street	0.08	2.29	0.12	0.00
Soane Point, 6-8 Market Place	0.27	7.37	0.12	0.00

Site Name	Area (ha)	Low (%)	Med (%)	High (%)
55 Vastern Road	0.78	0.58	<0.01	0.00
71-73 Caversham Road	0.17	78.68	0.00	0.00
Clarendon House, 59-75 Queens Road	0.16	62.11	0.00	0.00
Unit 1, Paddock Road	0.14	44.02	0.00	0.00
Unit 16 North Street	0.04	32.02	0.00	0.00
Alice Burrows Home, Dwyer Road	0.49	3.55	0.00	0.00
1025-1027 Oxford Road	0.20	1.65	0.00	0.00
12-18 Crown Street	0.09	0.23	0.00	0.00
Permitted, under construction				
18 Parkside Road	0.14	60.85	34.55	17.68
Kenavon Drive	2.67	10.36	2.61	1.60
Reading Golf Club, Kidmore End Road	12.13	11.07	1.16	0.63
Wensley Road	2.37	17.67	4.04	0.62
Green Park Village	22.81	6.49	0.61	0.23
Richfield Driving Range, Richfield Avenue	5.52	1.73	1.23	0.00
45 Caversham Road	0.15	77.21	0.99	0.00
54-58 Queens Road	0.16	16.04	0.49	0.00
Station Hill Plot F	0.18	0.65	0.07	0.00
Green Park Village Phase 6A	1.62	0.90	<0.01	0.00
42 Portman Road	0.22	9.36	0.00	0.00
53-55 Argyle Road	0.07	5.25	0.00	0.00
Great Brighams Mead, Vastern Road	1.02	2.71	0.00	0.00
103 Dee Road	0.89	0.30	0.00	0.00
34-38 Southampton Street	0.03	0.19	0.00	0.00
Resolution to Grant permission				
Meadway Precinct, Honey End Lane	1.58	59.12	29.46	11.78
2 Hexham Road	0.46	36.05	19.74	8.33
Rear of 303-315 Oxford Road	0.22	53.05	2.00	0.28
The Hexagon, Queens Walk	0.48	25.28	0.04	0.04
20 Greyfriars Road	0.12	16.70	8.67	0.00
Land at 9 Upper Crown Street	0.35	26.23	3.80	0.00

3.4 Cumulative Impacts of Development and Land Use Change

Land use and land management influences the characteristics of how rainwater runs off land into local water networks such as drains, streams and rivers. Localised changes in land use can alter the pre-existing baseline behaviour of an individual area, and when this occurs collectively over multiple areas within a catchment, it can cause a change in flooding characteristics for the area. As such, this may incur detrimental impacts downstream on a catchment-wide scale.

The impact of development on previously rural land tends to be greatest with greenfield land replaced with impermeable surface. If insufficient measures are taken to mitigate this, surface runoff following rainfall can increase in volume and velocity. When instances of this happen repeatedly across a catchment, this can result in a catchment experiencing shorter amounts of time between rainfall events and peak flood levels resulting in greater magnitude floods and making effective flood response more difficult. To mitigate against this developers should always have a suitable surface water drainage strategy that manages surface water. This should demonstrate there is no increase in surface water flood risk as a result of any new impermeable surfaces that may be present within a development. Furthermore, where possible opportunities to reduce flood risk should be sought. Surface water drainage design should be in line with Local Plan policy EN18 and follow the guidance provided in RBC's Sustainable Design and Construction Supplementary Planning Document[29] and the CIRIA SuDS Manual (C753)[30].

Viewing all of the local plan sites across the Reading Borough area including those already granted planning permission, it appears that the majority are located on brownfield land in urban areas. Redeveloping these areas generally presents less of a risk than new development on greenfield land. For brownfield sites, typically a betterment on existing brownfield surface water runoff rates is required especially in areas where drainage is poor. This is particularly important when considering that of the 148 sites with outstanding permission, likely to be included in the local plan update and adopted previously, 118 of the sites lie partially within areas at low surface water flood risk, 96 sites lie within areas at medium surface water flood risk and 59 sites lie within areas at high surface water flood risk. Therefore, a reduction in runoff rates provides an opportunity to reduce surface water flood risk in a number of areas.

It should be noted that windfall sites and urban creep can also contribute to the forms of flood risk outlined above via the same mechanism. Urban creep should be considered in the design of any surface water management scheme.

In addition, the development of pre-existing open land may result in loss of floodplain area, causing reduced floodplain storage capacity which could have a detrimental impact on flood risk on immediately neighbouring land as well as downstream. Open areas of rural land use are most vulnerable, however changes in areas of urban land use could also impact upon available floodplain storage. Instances of practices that may cause this include the raising of land levels above the existing floodplain which may interfere with storage and floodwater conveyance. Blockage or constriction of existing flow routes can also have an impact on flood risk.

Of the 148 sites with outstanding permission, likely to be included in the local plan update and adopted previously, 51 of the sites lie partially or wholly within Flood Zone 2, 27 sites lie partially within Flood Zone 3a, and 25 sites lie partially within Flood Zone 3b. Generally, at these sites the majority of the site areas lie outside of Flood Zone 3 apart from some exceptions. It should therefore be possible to locate development outside of areas at highest flood risk or if necessary, locate less vulnerable ancillary infrastructure in these areas. This should safeguard against loss of floodplain areas.

Where site infrastructure does need to be located in floodplain areas, for allocated and non-allocated sites, developers must follow advice provided by the EA and LLFA to mitigate against flooding onsite and detriment to downstream areas. FRAs supporting developments must incorporate evidence that the cumulative effects of development in the area – both in terms of past and present developments – have been considered and shown to be sufficiently mitigated. A further cumulative impact of development that should be considered is the impact on sewer capacity, Thames Water should be consulted in this regard.

More detail is provided in section 4 on the requirements for site specific FRAs and how development impacts can be mitigated.

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[29] Reading Borough Council (2019) *Sustainable Design and Construction Supplementary Planning Document* https://images.reading.gov.uk/2019/12/Sustainable-Design-and-Construction-SPD-Adopted-December-19.pdf
[30] CIRIA (2015). *The SuDS Manual C753*

4 Flood Risk Management

SFRAs should include information on i). opportunities to reduce the causes and impacts of flooding and ii). recommendations on how to address flood risk in development. This section focuses on these two areas and details the specific requirements for site-specific FRAs.

Both these areas are closely tied into the requirements of the exception test in ensuring development is safe and provides wider sustainability benefits that outweigh the flood risk incurred by it, and where possible, the development will reduce flood risk overall.

As outlined in PPG[31], developers should refer to the SFRAs and site-specific FRAs to identify opportunities to reduce flood risk overall and to demonstrate that the measures go beyond just managing the flood risk resulting from the development.

In terms of future flood risk management infrastructure there are currently no plans in place across Reading Borough including flood alleviation schemes and land safeguarded for flood stor

4.1 Opportunities to Reduce Flood Risk

This section identifies at a strategic level how a proposed development has the potential to improve the water environment via the use of SuDS and Natural Flood Management (NFM), in addition to remedial work on structures (i.e. culverts and bridges) and the provision of green spaces. Some of the potential measures and key benefits are outlined below:

- Runoff control using SuDS - SuDS slow the rate of surface water run-off and where viable use infiltration to mimic 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. Runoff is controlled at or near source and typically, greenfield rates are maintained or there is betterment on brownfield rates at existing development sites. This minimises excess runoff to third party land, thereby managing and reducing flood risk where possible. Provided SuDS is correctly implemented it should safeguard against the cumulative impact of development causing an increase of flood risk within Reading Borough.
- Promoting the use of rainwater re-use – In accordance with the drainage hierarchy contained in Approved Document H of the Building Regulations, PPG[32] and the need to mitigate against water scarcity surface water runoff should consider rainwater re-use (e.g. rainwater harvesting, greywater recycling) before discharge to the ground, a watercourse or a sewer. This approach recognises water as a valuable resource with rainwater collected (harvested) for non-potable use where practicable. This not only reduces potable water demand, but it can also reduce the volume of surface water runoff requiring disposal.
- Promoting the use of infiltration SuDS –Water re-use can be used for small rainfall events but for larger order events typically water will need to be discharged elsewhere. The PPG sets out the hierarchy of drainage to promote the use of SuDS, by aligning modern drainage systems with natural water processes. The most sustainable option is considered to be infiltration of surface water run-off into the ground as it aligns closely with natural processes. This generally requires i) soils and/or bedrock to be permeable ii) groundwater levels to be a significant distance below the surface reducing the risk of groundwater emergence, iii) minimal land stability issues and iv)

[31] Ministry of Housing, Communities & Local Government (2022) Paragraph: 037 Flood risk and coastal change, https://www.gov.uk/guidance/flood-risk-and-coastal-change
[32] HM Government (2010) *Approved Document H- Drainage and waste disposal* https://www.gov.uk/government/publications/drainage-and-waste-disposal-approved-document-h

sites to be flat or gently sloping. Where infiltration is proposed, infiltration rates should be confirmed through BRE Digest 365 Soakaway Tests. Additional groundwater monitoring may also be required where there is a risk of groundwater emergence.

- Increasing flood storage and attenuation using natural flood management (NFM) - NFM involves techniques that aim to work with natural hydromorphological processes, features and characteristics to manage the sources and pathways of flood waters. Examples include the introduction of storage/conveyance features such as water meadows along with incorporation of riverside vegetation or leaky barriers to help slow overland flows and increase interception. This in turn prevents a flashy catchment response and serves to attenuate peak flows; mainly for lower order rainfall events and in smaller catchments.
- Land management using NFM - Incorporating good practice into the management of land for the purpose of increasing infiltration of water and sediments into soils and reducing surface runoff. Woodland creation is also encouraged in some cases. The former relates to encouraging the use of infiltration SuDS where feasible at new development sites, but also improving management on existing land.
- River and floodplain restoration using NFM - The stabilisation of excessively eroding riverbanks in order to reduce deposition of sediment downstream and works that restore an altered river to a more appropriate shape and in turn reconnect the river with its floodplain. These options could be considered at the catchment scale and at the site scale. For example, where future development is located in the vicinity of an eroding riverbank or altered river, restoration could be considered as part of the scheme to bring wider benefits.
- Maintaining and removing existing structures/channels - developments can serve to adapt problem structures within a watercourse/floodplain, which can improve conveyance and reduce impact of flooding. Diverting and daylighting of culverted watercourses can also provide more effective flow routing through an area as well as environmental benefits.
- Managing water quality using SuDS - incorporation of SuDS features which provide filtration and capture of pollutants. These can include features such as permeable pavements and swales within the surface water system, which can settle and filter contaminants to provide treatment of surface water before being discharged. The level of treatment provided can be set relative to the risk index of the site. Particular attention should be applied to sites in groundwater source protection zones (SPZs) where additional measures may be necessary to protect the water environment. In sites where waterbodies are proximal, the EA and LLFA should be consulted to determine local sensitivities and any specific requirements.
- Enhancing biodiversity & amenity - developments can improve the quality of existing habitats and help create new habitats through landscape change. Sites offer an opportunity to establish green corridors and create coherent ecological networks. Development sites can also provide amenity benefits in the form of publicly accessible green spaces and improved access networks. SuDS and NFM often create new water features which can, if correctly implemented, bring associated educational benefits. For the allocated sites and for future development in general, biodiversity and amenity should always be factored into site design and the provision of SuDS/NFM.

4.2 SuDS

This section provides more detail on SuDS design considerations and requirements at a site-level. The NPPF states that any development should give priority to their use, and local authorities assess planning proposals based on their ability to mitigate the impacts that development has on surface water runoff rates and volumes.

In Reading, all major developments (10 or more dwellings or equivalent non-residential developments) must incorporate SuDS as appropriate and in line with the Government's Standards[33]. Smaller schemes are encouraged to incorporate SuDS, where possible. All new developments in areas of flood risk should give priority to SuDS.

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 which can be defined as follows:

- 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 is 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 developing an interconnected system, the layout and function of drainage systems should be considered at the start of the design process for a new development. This will help ensure better integration with road networks and other infrastructure which can maximise the availability of developable land. This in turn can lead to the provision of multi-functional benefits and reduced land-take. Maintenance requirements and adoption arrangements should also be incorporated into the

[33] Department for Environmental, Food and Rural Affairs (2015) *Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

planning process for any SuDS systems proposed. These should consider and encompass the lifetime of the development.

In terms of guidance for SuDS design, the SuDS Manual published in 2007 and updated in 2015 incorporates research, industry practice and construction methods for a range of SuDS components. In delivering SuDS there is also a requirement to meet the framework set out by the Government's 'non statutory technical standards' and the SuDS Manual complements these.

When determining SuDS design it is necessary to estimate runoff rates and volumes for a development site. These 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[34]. 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.

Note, when considering Brownfield sites specifically, these often coincide with critical drainage areas (CDAs), and the incorporation of SuDS is seen as key opportunity that may benefit existing hardstanding areas at flood risk.

In addition to runoff control, developers are encouraged to utilise SuDS to provide water quality inputs. Schemes should ensure that the movement of water through vertical infiltration as well as horizontal run-off does not worsen contamination effects. Wherever possible, SuDS provision should maximise ecological benefits, link into the existing green network, incorporate tree planting and landscaping and avoid damage to existing significant trees, including through changes to the site hydrology. Again, this should be conducted in adherence to the CIRIA SUDS Manual.

At the time of writing Schedule 3 of the Flood and Water Management Act 2010 is expected to be implemented in England following the January 2023 review[35] of its proposed implementation. Schedule 3 will make SuDS mandatory on all developments exceeding 100m^2 and provides a framework for the approval and adoption of drainage systems. A sustainable drainage system approving body (SAB) will be formed within unitary and county councils, and national standards on the design, construction, operation, and maintenance of sustainable drainage systems for the lifetime of the development should be published.

4.3 Flood Resilience

Property Flood Resilience (PFR) is another flood risk management option available for new and existing development. It is an approach to building design which aims to reduce flood damage and speed up recovery and reoccupation following a flood. It uses a combination of flood resistance and recovery measures.

It is described in the industry-developed CIRIA Property Flood Resilience Code of Practice[36], which provides advice for both new-build and retrofit. PFR is also now a key consideration in the NPPF (paragraph 173b) for new developments in flood risk areas. This states that all new development in areas at risk of flooding should be appropriately flood resistant and resilient such that, in the event

[34] CIRIA (2015) *The SuDS Manual (C753)*
[35] DeFRA (2023) The review for implementation of Schedule 3 to The Flood and Water Management Act 2010 *https://assets.publishing.service.gov.uk/media/63bc504dd3bf7f263846325c/The_review_for_implementation_of_Schedule_3_to_The_Flood_and_Water_Management_Act_2010.pdf*
[36] CIRIA (2021) *Code of practice for property flood resilience (C790)*
https://www.ciria.org/CIRIA/Resources/Free_publications/CoP_for_PFR_resource.aspx

of a flood, it could be quickly brought back into use without significant refurbishment. The associated PPG for Flood Risk and Coastal Change also identifies flood resilience in new developments as a way of ensuring that developers can adapt to the challenges of a changing climate. The latest EA national strategy on flood risk and coastal change, also identifies flood resilience measures as a key means to adapt to the threats from flooding and coastal change, enabling growth in a sustainable and climate resilient way.

The NPPF is supported by the PPG for Flood Risk and Coastal Change, this states that the first preference is to apply the avoidance measures set out in the sequential approach to planning. Where this is not possible, flood resistance and flood resilience measures may need to be incorporated into the design of buildings and other infrastructure, including behind flood defence systems.

Resistance and resilience measures are unlikely to be suitable as the only mitigation measure to manage flood risk, but they may be suitable in some circumstances, such as:

- Water-compatible and less vulnerable uses where temporary disruption is acceptable, and the development remains safe;
- Where the use of an existing building is to be changed and it can be demonstrated that the avoidance measures set are not practicable, and the development remains safe;
- As a measure to manage residual flood risk from flood risk management infrastructure when avoidance measures have been exhausted.

In these cases, and where existing development is already in flood risk areas, flood resilience measures could be considered. These are typically defined as sustainable measures that can be incorporated into the building fabric, fixtures and fittings to reduce the impact of floodwater on property. They allow for easier drying and cleaning, ensure that the structural integrity of the building is not compromised and reduce the amount of time until the building can be re-occupied. Flood repairability should also be considered which involves the design and construction of building elements, to ensure the ease of replacement and repair, should they suffer flood damage.

As part of being resilient, buildings should be structurally sound and remain in situ during the worst case flooding effects (depth and velocity). Any measures in place to ensure structural soundness during a flood should not cause a hazard to people.

Some of the main measures to ensure structural safety and resilience are outlined below:

- Flood doors and windows - These can prevent water from entering a property by creating a watertight seal during a flood.
- Flood barriers - These can be fitted to external doorways, windows, across driveways, garage doors and gardens. It is recommended that they are not fitted higher than 600mm in order to prevent structural damage to walls.
- Flooring - Concrete floors with damp proof membranes can be used in properties which are at particular risk of groundwater flooding as they prevent water rising up through the floors.
- Walls - Pointing which is in poor condition should be repaired with a water-resistant mortar and any cracks or holes in brickwork can be repaired with a waterproof silicone sealant.
- Drains and pipes - Fitting non-return valves to pipes will prevent backflow from toilets, sinks, drains and manholes when drains and sewers become overwhelmed with flood water.
- Airbricks and vents - There are a number of products available, examples include automatic (self-closing) air bricks which allow ventilation but prevent flood water coming in when needed. Alternatively, air brick covers can be placed over airbricks.

- Adaption measures - Where flooding does occur waterproof plaster, solid concrete floors and tiled floor coverings, can reduce flood damage and greatly shorten the recovery time after a flood. Other steps include raising electric sockets to preserve electricity supply and moving paperwork and valuables to higher levels to minimise potential damage.

Planning and building standards have a complementary role in flood management and the use of flood damage resistant and mitigation measures could be considered at the proposed preferred sites where appropriate. These may be required as part of ensuring that consequences of flooding are acceptable.

It should be noted that mitigation and flood resilience measures are not sufficient justification to permit a development if the tolerable conditions are exceeded during an extreme flood event. High velocities and/or depths of floodwater pose a potential risk to life, may cause structural damage to buildings and could impact on human health and wellbeing.

4.4 Site Specific FRA Considerations

An FRA is required for the following development scenarios:

- In Flood Zone 2 or 3 including minor development and change of use.
- More than 1 hectare (ha) in Flood Zone 1.
- Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and the sea (for example surface water drains, reservoirs).
- In an area within Flood Zone 1 which has critical drainage problems as notified by the EA.

In general, FRAs should address the points below, full advice is available within the EA's FRA guidance[37]:

- The proposed site's address.
- Description of the proposed development.
- An assessment of the flood risk from all sources of flooding for the proposed development, including consideration for an allowance for climate change.
- The estimated flood level for the proposed development which takes into account the impacts of climate change over the proposed development's lifetime.
    - The estimated flood level is the depth of flooding predicted on a proposed development site in either a 1 in 100-year river flood plus an allowance for climate change.
    - It should also be noted that if a proposed development is in an area with flood defences present, that the estimated flood level should account for residual flood risk if they breached or were overtopped.
    - The design flood level (1 in 100 year river flood plus an appropriate allowance for climate change) should be calculated using detailed computer modelling of the relevant watercourse[38]. The EA holds modelling for many of the watercourses in the Borough, which is available on request. However, it is the responsibility of the developer to review whether such modelling is suitable for a site-specific FRA and carry out any necessary updates. Where the EA does not hold detailed modelling for a watercourse, the developer may need

[37] DeFRA & EA (2017) *Flood risk assessments if you're applying for planning permission* https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications
[38] DeFRA & EA (2023) *Using modelling for flood risk assessments* https://www.gov.uk/guidance/using-modelling-for-flood-risk-assessments

to commission modelling from a suitably qualified consultant. Any modelling undertaken should be reviewed by the EA before it is deemed appropriate to use in an FRA. More detail is provided in the guidance for using modelling for flood risk assessments[39].

- Details of the finished floor levels; these should be a minimum elevation of the design flood level plus a freeboard.
- Safe access and egress; with consideration of hazard ratings on the site and its routes of escape.
- Details of flood resistance and resilience plans.
- All supporting plans and drawings.
- All other information for example planning correspondence.

As indicated, liaison should be sought when making a planning application and it is also recommended that the LLFA and local authority be contacted for area specific advice on flood risk requirements. The following sections provide more detail on some of the areas mentioned above.

4.5 Residual Risk

Residual risk should be minimised at each stage of the planning process. Residual risks include those that result from the failure or overtopping of flood defences, the blockage of drainage systems, failures in flood forecasting or flood warning issue, receipt or response, and failure of active measures such as demountable flood barriers. It can be minimised by taking a sequential approach to development. For example, in locating the buildings in areas at lowest risk, raising floor levels, managing site levels (where appropriate), raising vulnerable uses to upper floors and ensuring that appropriate passive flood resistant/resilient and recovery measures have been incorporated.

Where an assessment shows that flood risk and residual risks are a consideration for a plan or development proposal, the Avoid, Control, Mitigate, Manage residual risk process should be followed. More detail is provided in paragraph 4 of the Flood Risk and Coastal PPG.

To determine the level of risk and safety implications for development proposed in a site allocation or planning application, the following should be considered:

- the characteristics of a possible flood event,
- the safety of people within a building if it floods,
- the safety of people around a building and in adjacent areas,
- the structural safety of buildings; and,
- the impact of a flood on the essential services provided to or from a development.

More detail is provided in paragraph 5 of the Flood Risk and Coastal PPG.

4.6 Emergency Planning

Another consideration to ensure that development is safe is whether adequate flood warnings would be available to people using the development. An emergency plan will be needed wherever emergency flood response is an important component of making development safe. Emergency plans will need to take account of the impacts of climate change on escape routes. Residual risk mitigation measures may also include the provision of a safe refuge above the extreme (0.1% with climate change AEP) residual risk flood levels with a freeboard. Emergency flood plans should follow the

[39] EA(2023) *Using modelling for flood risk assessments* https://www.gov.uk/guidance/using-modelling-for-flood-risk-assessments

ADEPT and EA guidance[40]. More detail is provided on managing residual risk and emergency planning in paragraph 42-48 of the Flood risk and Coastal PPG.

Across the Borough as a whole, the Civil Contingencies Act 2004[41] is one of the most relevant pieces of legislation to emergency planning for flooding. It lists local authorities, the EA and emergency services as 'Category 1' responders to emergencies. It places duties on these organisations to:

- Undertake risk assessments
- Manage business continuity
- Carry out emergency planning
- Warn and advise the public during times of emergency.

The EA has a key role in relation to flooding. It is the lead agency for warning those at risk and maintaining and improving flood defences.

Local resilience forums (LRFs) – of which the EA is a member in all regions – have developed multi-agency flood plans (MAFPs). These cover various elements associated with a flood. The LRF applicable to Reading is the Thames Valley Resilience Forum[42]. All the organisations that make up the Thames Valley Resilience Forum work together to ensure that preparations and plans are in place for major emergencies and incidents affecting the county. These are regularly reviewed, tested and updated so that agencies can respond immediately and effectively to any threat or incident.

4.7 Finished Floor Levels

As mentioned in section 4.4, details of the finished floor levels should be included within an FRA. These need to consider design flood levels and climate change in view of the nature and lifetime of the development. More detail on the design event and climate change allowances applicable to different development types is provided in the PPG on climate change allowances[43]. Development should be set at a floor level to provide an appropriate freeboard above the design flood level which should be calculated with climate change considered. A freeboard is defined as an additional amount of height above the design flood level which is used as a factor of safety to account for any uncertainty. Typically, it is set to 300 or 600mm above the design flood level. The freeboard allowance should be agreed with the EA, LLFA and/or local authority depending on the scale of the development and flood risks present. More detail is provided in the PPG for preparation of an FRA.

4.8 Third Party Impacts

Development or the cumulative impacts of development may result in an increase in flood risk elsewhere as a result of impacts such as the loss of floodplain storage, the deflection or constriction of flood flow routes or through inadequate management of surface water. Floodplain storage can also be lost where finished floor levels are raised above the design flood level or where the built footprint of an existing site is increased during redevelopment.

Where a loss in floodplain storage is caused, mitigation is required and can be accomplished via compensatory storage. This refers to a practice of offsetting the effects of a development that

[40] Adept and EA (2019) Flood risk emergency plans for new development https://www.adeptnet.org.uk/system/files/documents/ADEPT%20%26%20EA%20Flood%20risk%20emergency%20plans%20for%20new%20development%20September%202019....pdf
[41] UK Parliament (2004) Civil Contingencies Act https://www.legislation.gov.uk/ukpga/2004/36/section/1/enacted
[42] Thames Valley Local Resilience Forum (2024) https://www.thamesvalleylrf.org.uk/
[43] EA (2022), *Flood risk assessments: climate change allowances*, https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

encroaches into floodplain storage by providing a hydraulically equivalent, excavated floodplain storage capacity onsite. The preferred method for flood plain compensation is level-for-level compensation. This is where the lost floodplain storage volumes are matched with a new floodplain storage volume gained through the reduction of ground levels.

The EA and LLFA should be contacted to confirm the requirements for assessing 3rd party impacts (e.g. hydraulic modelling), mitigation and compensatory storage. The EA recommend that level for level floodplain storage calculations are provided in a table that sets out the change in volumes across the site using 100mm or 200mm slices (dependent on site specific considerations). The location of the changes in floodplain storage should also be clearly identified in a plan or drawing, demonstrating that the scheme would be hydraulically connected for each slice.

4.9 Flood Risk Activity Permits

Applicants may need an environmental permit for flood risk activities if they want to do work in, under, over or within 8 metres from a fluvial main river and from any flood defence structure or culvert or 16m from a tidal main river and from any flood defence structure or culvert. If works are required close to an ordinary watercourse, ordinary watercourse consent may be required.

Further information regarding flood risk permits can found in the EA guidance for permits[44]. RBC should be contacted regarding any requirements for ordinary watercourse consent.

[44] EA (2024) *Flood risk activities: environmental permits* https://www.gov.uk/guidance/flood-risk-activities-environmental-permits

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 and associated legislation and guidance. The SFRA has been developed in consultation with RBC, the EA and TW.

5.1.2 The dominant flooding mechanism in Reading tends to be fluvial in origin associated with flooding from the River Thames and the River Kennet along with associated tributaries.

5.1.3 A number of properties lie within the Thames' fluvial flood extents. This mainly includes properties in Caversham and Central Reading,

5.1.4 A number of properties lie within the Kennet's fluvial flood extents. This mainly includes properties in Reading's Green Park area, Southcote and central Reading.

5.1.5 Flood risk also arises from surface water flooding with areas affected including Emmer Green, Caversham, Tilehurst, Churchend, Southcote, Horncastle, Central Reading, Coley, Newtown and Whitley. In these areas, few properties are at risk however many roads are.

5.1.6 In terms of groundwater flood risk, areas in the north of the Borough are considered to be most at risk. These areas are underlain by chalk and lie within the Thames floodplain. In this regard the groundwater table is likely to be mobile.

5.1.7 In contrast, in the east, west and south of the borough, the Lambeth Group and London Clay Formations are dominant. These formations have lower permeability and are largely underlain by non-productive aquifers, which reduces the risk of groundwater flooding.

5.1.8 Sewer flooding incidents have been recorded across the Reading Borough area. These predominantly show that built up areas close to the town of Reading have the most incidents.

5.1.9 Reservoir flooding has been assessed using EA's reservoir flood maps. Large areas within the floodplain of the River Thames and in central Reading are shown to be at risk of reservoir flooding, however such an event is rare with very low probability of occurrence.

5.1.10 Overtopping incidents have been recorded along the Kennet and Avon canal however these have primarily affected rural areas. There have been no recorded breach incidents within the Borough boundary. The canal does offer a potential conveyance route for floodwater from the River Thames and River Kennet through central Reading.

5.1.11 Flood defences are present alongside the River Thames and River Kennet, however these are mostly privately owned and offer a low standard of protection (maximum 1 in 5-year event).

5.1.12 There are a total of five flood warning areas and three flood alert areas within Reading Borough. The Thames catchment tends to be relatively slow when responding to rainfall. This means there is a significant amount of time for flood warning procedures to be implemented.

5.1.13 The same does not apply for some of the smaller watercourses within the Borough which due to the size of their catchments and urbanisation may elicit faster runoff responses and reduced lead in times, which increases the need for efficient flood warning systems.

5.2 Recommendations

5.2.1 In general, development should be located in Flood Zone 1 wherever possible. In cases where this is not possible, a sequential approach should be taken by locating developments with the highest vulnerabilities at areas of lowest flood risk.

5.2.2 Where flood risk is significant and access may be compromised in extreme events, a comprehensive Emergency Flood Plan must be provided to help manage any residual risk.

5.2.3 Sustainable drainage principles should be followed at every site to safeguard against increasing flood risk both onsite and to third party land downstream.

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

5.2.5 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 should seek a betterment on pre-existing rates, especially in locations where drainage is poor.

5.2.6 The northern part of the Borough offers good potential for infiltration SuDS given its geology and topography. The use of infiltration SuDS should be encouraged where possible, although groundwater may be too high in some areas.

5.2.7 Where possible, opportunities to reduce flood risk at sites and downstream should be identified, for example through the creation of wetland features, encouraging vegetation growth and use of NFM practices. The limited rural spaces in the Borough prevent NFM being implemented in some areas.

5.2.8 This SFRA does not replace the need for site specific FRAs. A greater level of detail should be provided by such assessments. FRAs should factor in the latest climate change guidance where sites are at risk.

5.2.9 Site specific FRAs are required for all sites over 1 hectare in size and for all sites located within Flood Zones 2 and 3. FRAs for sites within Flood Zone 1 may be required to assess surface water and non-fluvial forms of flood risk. FRAs should factor in the latest climate change guidance. More guidance on FRAs is provided in the PPG for FRAs.

This SFRA has been developed with reference to existing data and knowledge with respect to flood risk within Reading Borough. 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 any given year, will improve the current knowledge of flood risk within the Borough. 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 Reading Borough Level 1 SFRA is imperative when considering its contents.

Appendix 1 – Baseline and Climate Change Fluvial Flood Maps

Appendix 2 – Surface Water Flood Maps

Appendix 3 –Watercourse Classification Maps

Appendix 4 –Geology and Soils Mapping

Appendix 5 –Reservoir Flood Maps

Appendix 6 – Recorded Flood Outlines Maps

Appendix 7 –Flood Defences Maps

Appendix 8 – Site Allocations