Thames River Basin District Flood Risk Management Plan 2021 to 2027

December 2022

This is a joint plan prepared and developed under the [Flood Risk Regulations 2009] by the following risk management authorities:

Buckinghamshire Council

Central Bedfordshire Council

Crawley Borough Council

City of London Corporation

Essex County Council

Greater London Authority

Hampshire County Council

Harlow Council

Kent County Council

London Borough of Barking and Dagenham

London Borough of Barnet

London Borough of Bexley

London Borough of Brent

London Borough of Bromley

London Borough of Camden

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London Borough of Ealing

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Royal Borough of Kingston upon Thames

Royal Borough of Windsor and Maidenhead

Slough Borough Council

Surrey County Council

Thurrock Borough Council

West Berkshire Council

Westminster City Council

West Sussex County Council

If your LLFA does not appear in the above list, this LLFA has no statutory duty to develop a Flood Risk Management Plan. If your LLFA does not have a statutory duty to develop this plan it does not mean that your LLFA does not have its own set of measures to address flood risk. Please review your LLFAs ‘Local Flood Risk Management Strategy’ for further information on its action plan.

For more information about how flood risk is managed in your area please review the national level measures on the Flood Plan Explorer which covers the whole Thames River basin District.

The Preliminary Flood Risk Assessment for England has more information on how Flood Risk Areas were created.

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

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Foreword

The Thames River Basin District (RBD) covers over 16,200 square kilometres. It spans from northern Oxfordshire and Gloucester, southwards to the north of Hampshire, across to the Thames Estuary and northern Kent in the east. It also covers all of Greater London.

Over 15 million people live in the Thames River Basin District. There are approximately 1.7 million people at risk of flooding from rivers and the sea, and approximately 2.3 million people at risk of flooding from surface water in the Thames River Basin District. In England, for every person who suffers flooding, around 16 others are affected by a loss of services, such as transport and power. The combined effects of flooding from multiple sources presents complex challenges for all Risk Management Authorities (RMAs). This, combined with a rapidly changing climate, only increases the need to plan together and improve the resilience of our communities at risk. Partnerships are vital. The more we plan together, the more we can deliver together for local people, places and our environment.

Over the last 3 years, we have worked in partnership with relevant Lead Local Flood Authorities (LLFAs) and other partners to develop the Flood Risk Management Plan. This has been a challenging time with several major flood events and the impacts of coronavirus. These tests have reinforced how precious the environment around us is for our health and wellbeing, and the importance of protecting and enhancing it.

The Flood Risk Management Plans mark an important contribution towards helping to deliver the ambitions of the 'National Flood and Coastal Erosion Risk Management Strategy for England' and the government's 25-Year Environment Plan. They focus on the more significant areas of flooding and describe the risk of flooding now and in the future.

These plans will help us:

- identify measures (actions) that will reduce the likelihood and consequences of flooding from all sourcing focusing on rivers, the sea and surface water
- to improve resilience, which is the capacity of people and places to plan for, better protect, respond to, and to recover from flooding, whilst informing the delivery of existing flood programmes
- work in partnership with our stakeholders to explore wider resilience. These measures including a drive for more nature-based solutions, property flood resilience and sustainable drainage systems
- plan and adapt to a changing climate through developing longer-term, adaptive approaches

To support these plans, we have developed the Flood Plan Explorer. Our goal is that this will lead to further collaboration across all we do.

We recognise that there are areas at risk of flooding outside those detailed in the plan. Be assured that all RMAs will continue to plan and manage the risk of flooding to all communities.

Together with our partners, we have achieved so much already:

- we have made significant progress on the largest scheme in the country in the Thames Valley
- developing strong partnerships, achieving environment and sustainability ambitions for the Oxford to Cambridge (OXCAM) Arc
- and the publication of the 10-year Review of Monitoring from Thames Estuary 2100 provided more compelling evidence of the impacts of the Climate Emergency

We've listened to what you have told us during the consultation that we carried out in October 2021 and we value what you value too. The importance of partnerships to deliver actions, the need to strengthen a catchment approach so we work with and value our land and environment better and rising to the challenge of making infrastructure resilient to flooding whilst reducing carbon use.

These FRMPs have set us on a journey which will be both exciting and challenging. We need to innovate and adapt, making sure our thinking changes faster than our climate. The Flood and Coastal Erosion Risk Management Strategy Roadmap to 2026 (Strategy Roadmap) will help us do that by providing practical ways in which flood and coastal investments can contribute to wider priorities including local nature recovery, carbon reductions and more integrated water solutions that also help with drought resilience.

I'm pleased we can share this FRMP for the Thames River Basin, an important milestone on our journey. Let's keep looking ahead. We must continue to work in partnership and keep putting communities at the centre of what we do so they can adapt and thrive.

Sam Lumb, Director Operations South and East, Environment Agency

Contents

Introduction to the FRMP

You can find all the FRMP documents for the Thames River Basin District on GOV.UK. The plan is supported by the:

- Thames River Basin District Second Cycle Flood Risk Management Plan Habitats Regulations Assessment – a report on the findings of the habitats regulations assessment (HRA)
- Thames River Basin District Second Cycle Flood Risk Management Plan Habitats Regulations Assessment non-technical summary – a summary of the findings in the full HRA report
- Thames River Basin District Statement of Environmental Particulars (SOEP) – a report on the potential impacts on people and the environment when implementing the measures in the FRMP
- Annex 1 spreadsheet – a list containing the implementation status of each measure published in the first FRMP cycle

You can use Flood Plan Explorer, a new, interactive mapping tool that displays information about the measures included within this plan.

Approach to the FRMP

The second cycle Flood Risk Management Plans (FRMP) is a plan to manage significant flood risk in the Flood Risk Areas (FRAs) identified within the Thames River Basin District (RBD). Producing the plan for these areas is a requirement of the Flood Risk Regulations (2009). However, it is recognised that there are areas at risk of flooding outside of these FRAs. Therefore, the Environment Agency and other Risk Management Authorities (RMAs) will continue to plan for and manage the risk of flooding to all communities. This is regardless of whether they are in a FRA or not. For example, RMAs carry out flood risk management interventions such as warning and informing and capital investment and maintenance programmes.

This plan has been expanded to show what is happening across the RBD and in locally important areas, referred to as ‘Strategic Areas’. In the Thames RBD, Strategic Areas were put forward by the Environment Agency providing these were not already designated FRAs.

The Environment Agency and other RMAs, in particular Lead Local Flood Authorities (LLFAs), worked together to develop the first cycle FRMP. This created a plan to manage the risk from all sources of flooding. The second cycle FRMP will build on this approach. The ambition is that the FRMP is a strategic, place-based plan that shows what is happening in flood risk management across the Thames RBD. It is closely aligned with the Government's 25 Year Environment Plan and the National Flood and Coastal Erosion Risk Management Strategy for England (FCERM strategy).

The second cycle FRMP will encourage closer ways of working between RMAs that will help to achieve its revised objectives and measures. More information on the background to FRMPs, the Flood Risk Regulations, and how FRAs were identified, is in 'Part A: National Overview of Flood Risk Management in England for Second Cycle FRMPs'. The FRMP is also aligned with the River Basin Management Plan for the Thames RBD. Together, these plans set the strategic goals and approaches to managing water and flood risk within the RBD.

Contributors to the FRMP

Several Environment Agency areas have worked with relevant Lead Local Flood Authorities (LLFAs) and other RMAs to develop the FRMP as listed in table 1. The Environment Agency and those LLFAs with a Surface Water FRA within their administrative area must produce a FRMP. The second cycle FRMP for the Thames RBD identifies measures across the Thames RBD, for FRAs and Strategic Areas.

Strategic Areas are areas with a similar geography or strategic ambition where it is important to consider flood risk management across administrative boundaries and river catchments. There are four Strategic Areas within the Thames FRMP which are listed below.

Environment Agency Flood Risk Areas for main rivers and sea

Thames RBD Environment Agency Flood Risk Areas for main rivers and the sea are:

- Byfleet and Weybridge
- Chertsey
- Datchet
- Ditton
- East Peckham
- Egham
- Esher
- Five Oak Green
- Lee Valley, London
- London and Thames Estuary
- Maidenhead
- Marlow
- Oxford
- Reading
- Rochester
- Slough
- Smallfield
- Staines
- Tonbridge
- Walton-on-Thames

- Wokingham
- Wraysbury
- Yalding
- Yateley

There are several FRAs where the flood risk spans more than one RBD. These have been referenced to the relevant RBD FRMP in their individual chapters.

LLFAs with surface water FRAs within their administrative boundary

Lead Local Flood Authorities with surface water FRAs within their administrative boundary are listed in the table below.

Table 1: LLFA FRAs

Flood Risk Area name	LLFA name(s) / LLFA name (*leads)
Chesham	Buckinghamshire*
Canvey	Essex
Chatham	Medway
Crawley	West Sussex
Farnborough	Hampshire*, Surrey
Greater London	Barking and Dagenham, Barnet, Bexley, Brent, Bromley, Camden, City of London, Croydon, Ealing, Enfield, Greenwich, Hackney, Hammersmith and Fulham, Haringey, Harrow, Havering, Hillingdon, Hounslow, Islington, Kensington and Chelsea, Kingston upon Thames, Lambeth, Lewisham, Merton, Newham, Redbridge, Richmond upon Thames, Southwark, Surrey, Sutton, Tower Hamlets, Waltham Forest, Wandsworth, Westminster
Harlow	Essex
High Wycombe and the Wye Valley	Buckinghamshire*, Windsor and Maidenhead

Flood Risk Area name	LLFA name(s) / LLFA name (*leads)
Luton and Dunstable	Central Bedfordshire, Luton
Maidenhead	Windsor and Maidenhead
Newbury	West Berkshire
Rainham	Medway
Reading	Reading
Reigate	Surrey
Slough	Buckinghamshire, Slough*, Windsor and Maidenhead
Thurrock	Thurrock
Windsor	Windsor and Maidenhead

Thames RBD Environment Agency Strategic Areas for flooding from main rivers and the sea are:

- Colne Valley
- Middle Lee
- Roding Valley
- Oxford to Cambridge Arc

The Oxford to Cambridge Arc spans both the Thames and Anglian RBDs and is described in both FRMPs.

Strategic Areas

In the Thames RBD, Strategic Areas were put forward at the discretion of the Environment Agency providing they were not already designated as FRAs.

The Oxford to Cambridge Arc Strategic Area was put forward because it is a cross-government initiative that supports planning for up until 2050. It also represents a unique opportunity to put the Government's 25 Year Environment Plan into action.

The Colne Valley, Middle Lee and Roding Valley are Strategic Areas that each border a Rivers and Sea FRA. This is to support a catchment approach to managing flood risk.

Recognising that flood risk management should not be limited to the areas themselves at risk, the Strategic Areas help to identify opportunities to mitigate risk in nearby areas with higher risk. This is particularly true for urban areas at risk. This is because space and development pressures can limit options for managing and mitigating flood risk, so it can be helpful to look to other areas of the catchment to impact the risk of nearby areas. The Strategic Areas were formed using a higher scale method of spatial analysis than the FRAs. They are therefore larger and less detailed than the FRAs, which were determined using property-level data analysis.

Developing the FRMP

Developing the FRMP has been impacted by the extraordinary events of the past 2 years. Despite these challenges, the Environment Agency and RMA partners have set out measures for FRAs, ensuring that the requirements of the 'Flood Risk Regulations 2009' are met. Where we have been able to do so in the time available, we have taken a place-based approach when developing these measures for FRAs. For the rest of the RBD we have included new measures - mostly reflecting where we already had plans to work in the period 2021-2027.

Our ambition for the period 2021-2027 is to continue to drive catchment-based delivery in the Thames RBD that offers multiple benefits to communities and the environment. This catchment-based approach is a key part of the Environment Agency's ambition to meet net zero carbon, along with low carbon innovation and carbon offsetting. It is also integral to achieving the Environment Agency's biodiversity net gain targets which support the ambitions of the government's '25 Year Environment Plan'.

In preparing the FRMP, RMAs reviewed the first cycle FRMP objectives and measures with existing national and local plans and strategies.

For the Thames RBD FRMP, relevant plans and strategies include:

Environment Agency owned documents

- National Flood and Coastal Erosion Risk Management Strategy for England
- Thames Regional Flood and Coastal Committee 25-year strategy
- Thames River Basin Management Plan (RBMP 2022)
- Thames Valley Flood Scheme - Policy paper
- Thames Estuary TE2100 Strategic Plan (at the time of writing, we liased with other 100-year plans for tributaries of the river Thames, including the Lee2100, Brent2100 and Colne2100)
- Oxford to Cambridge Growth Arc
- Oxford Flood Scheme - Policy Paper
- Drought Management Plan
- Water Resources Management Plan
- Medway Estuary and Swale Shoreline Management Plan
- Medway Estuary and Swale Flood and Coastal Risk Management Strategy

Lead Local Flood Authority, Local Council owned or RMA documents

Local Flood Risk Management Strategies associated with each Lead Local Flood Authority (50) contributing to this plan can be found hosted on their website.

A local flood risk management strategy must:

- assess the local flood risk
- set out objectives for managing local flooding
- list the costs and benefits of measures proposed to meet these objectives, and how the measures will be paid for

Tools to support local flood risk management strategies:

- Multi-agency Flood Risk Plan
- Local Planning Authorities Mineral and Waste Plan
- Evolving Thames Water Drainage and Wastewater Management Plan
- Other supporting Risk Management Authority (RMA) documentation

Additional strategic plans in managing the water environment are in the Part A of the National Overview of Flood Risk Management in England for Second Cycle FRMPs.

The Environment Agency and our supporting RMAs value the contribution these partners make, including in:

- linking people and groups
- bringing in local knowledge, data and expertise
- developing and delivery of projects

Working in partnership is the most effective way to address the issues of flooding and climate change and to deliver multiple benefits. The Environment Agency intends to continue to develop and strengthen this partnership working to collaboratively identify, develop and deliver solutions to increase resilience to flooding and climate change in the River Basin District. The Flood Risk Management Plans are not intended to cover the detail of this partnership working.

For the second cycle of FRMPs, there is nationally consistent set of objectives which are closely linked to:

- Flood Risk Regulations 2009
- National Flood and Coastal Erosion Risk Management (FCERM) Strategy and Roadmap
- 25-year environment plan

The full list of these objectives is in the Part A of the National Overview of Flood Risk Management in England for Second Cycle FRMPs.

In drawing the objectives and measures together, RMAs have:

- revisited the priorities mainly in the FRAs

- ensured there is a shared understanding of the main flood risks and how best to manage them mainly in the FRAs

The Thames River Basin District

Overview of the Thames RBD

The Thames River Basin District (RBD) covers over 16,200 km2. It encompasses all of Greater London and extends from north Oxfordshire down to the north of Hampshire, and from Gloucester in the west to the Thames Estuary and parts of Kent in the east. In total, over 15 million people live in the Thames RBD and many enter it daily to work or visit. In addition to Greater London, other urban centres in the RBD include Luton, Reading and Guildford.

Flooding can occur in the Thames RBD from rivers, the sea, surface water, groundwater, storm water drainage (including highways), sewer systems and the failure or overtopping of water control structures. These different types of flooding rarely happen in isolation.

Extensive, catchment-wide river flooding in the Thames RBD tends to happen when heavy and prolonged rainfall occurs, and the catchment is either frozen or saturated. This usually happens between the autumn and spring. Extensive flooding history can be found in the first cycle Flood Risk Management Plan (FRMP) (2015-2021). This includes details of the 2013/2014 prolonged and widespread flooding along the whole River Thames catchment. It also includes several smaller but devastating flood events that took place across the RBD because of sudden and exceptionally high or prolonged rainfall on often saturated grounds.

The Thames RBD has a rich diversity of wildlife and habitats. It supports many species of global and national importance, from chalk streams such as the River Kennet to the Thames Estuary and salt marshes. The management catchments that make up the RBD include many interconnected rivers, lakes, groundwater, estuarine and coastal waters. These catchments range from chalk streams and aquifers to tidal and coastal marshes. The River Basin District is mostly rural to the west and urban to the east where it is dominated by Greater London. About 17% of the RBD is urbanised and the rural land is mainly arable, grassland and woodland. Rural areas face specific challenges in relation to flood risk management. Agriculture and horticulture are economically significant land uses that are vulnerable to extreme weather and climate change. Significant flooding, particularly on land used for arable farming and horticulture can have potential to affect food production.

The Thames RBD is in an area of significant water stress. Affinity Water, Anglian Water and Thames Water are all companies classified within ‘Serious’ Water Stressed areas, using the ‘2013 Groundwater and rivers supply water for local people’ classification.

Our rivers, lakes, canals, coasts, and groundwater – and the essential services that they provide society – are worth billions of pounds to the UK economy. Our actions should strive to protect and improve our waters and find a better balance that meets the needs of people and nature. Within the Thames RBD there are:

- 24 Flood Risk Areas (FRAs) at significant risk of flooding from main rivers and the sea (Figure 1)
- 17 FRAs at significant risk of flooding from surface water (Figure 2)
- Four Strategic Areas (SAs) as locally important areas

Each of these defined areas are discussed in more detail in the FRA chapters within this FRMP.

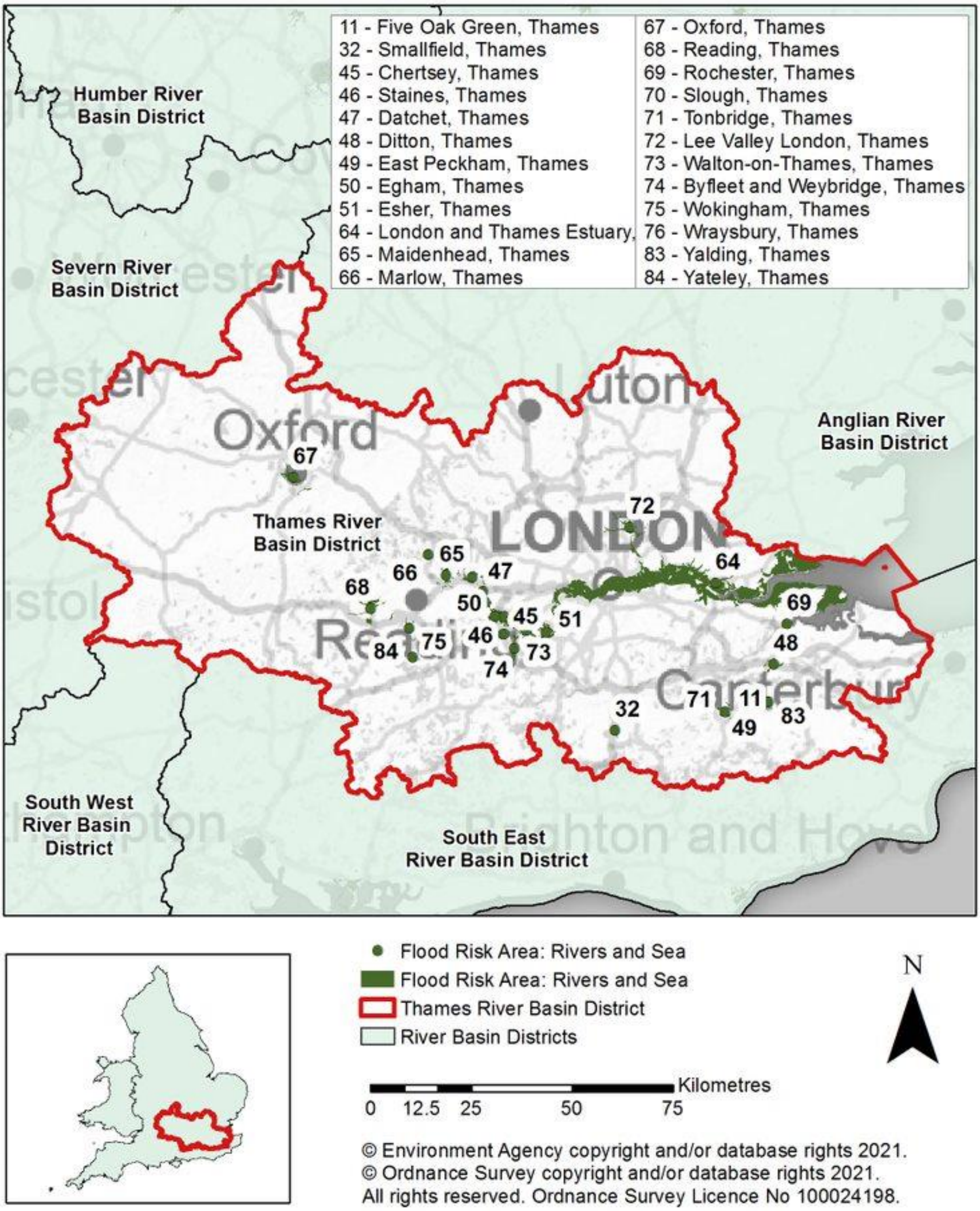


Figure 1: Thames RBD FRAs at risk from flooding from rivers and sea

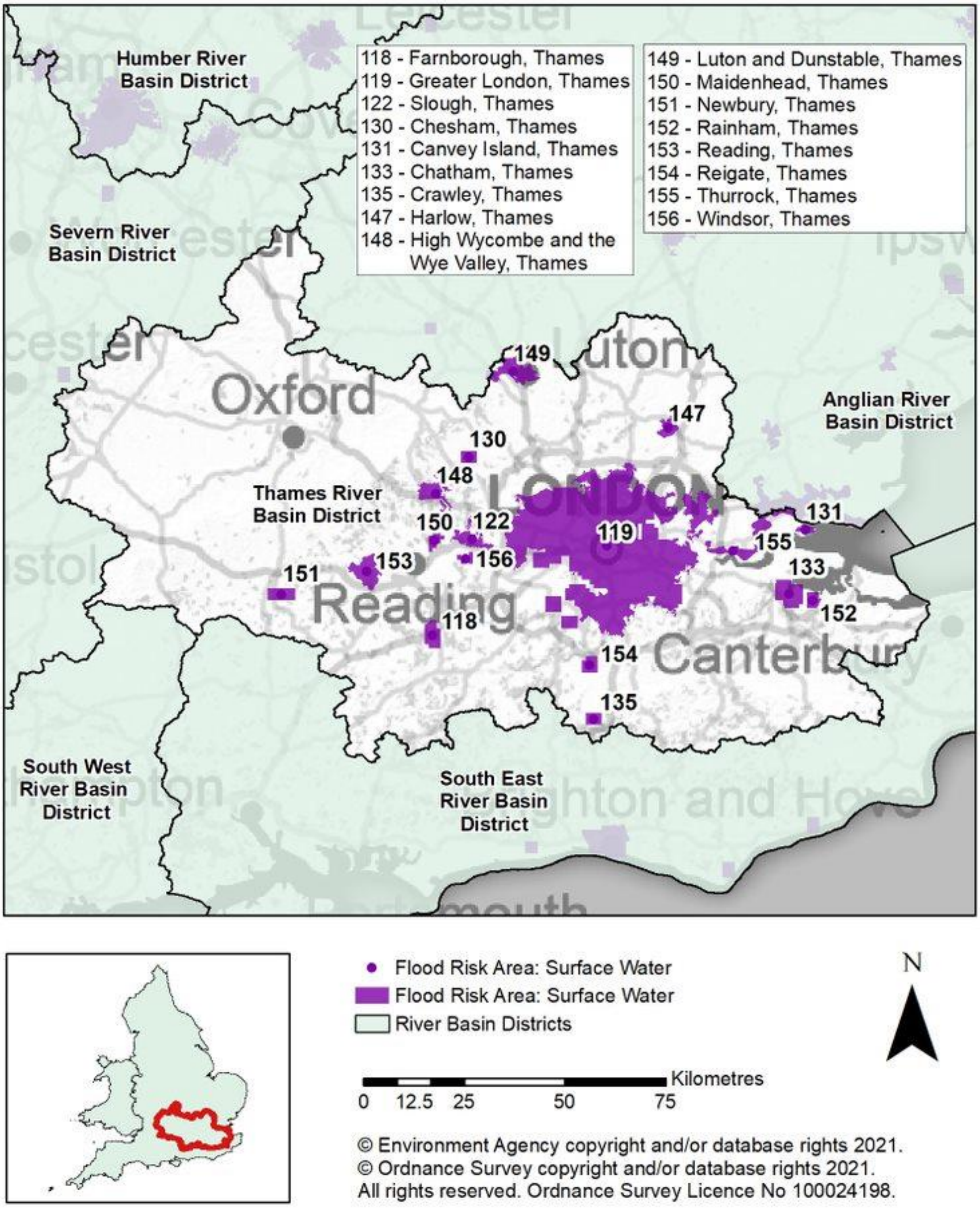


Figure 2: Thames RBD FRAs at risk from flooding from surface water

For more information about the Thames RBD, read the accompanying Strategic Environmental Assessment (SEA) Report. This includes information on topics such as the landscape, geology, and cultural heritage of the Thames RBD.

The main flood risk issues and changes in the Thames River Basin District

Rivers, coastal, and tidal flood risk

River flooding, known as ‘fluvial flooding’, usually occurs when a river cannot cope with the amount of water draining into it. This is likely to be caused by intense or prolonged rainfall within the catchment. Blockage or restriction to flow within the river channel can exacerbate this.

The River Thames is slow to rise and fall so properties and businesses can remain flooded for days or even weeks. The estimated economic impact of a major flood is currently about £1 billion. Due to the impact of climate change, damage from such events could become twice as bad by 2055.

The River Thames and the lower reaches of some of the rivers that flow into the river are affected by tides. When discussing flooding from ‘Rivers and Sea’ within this FRMP, the tidal impacts on the River Basin are taken into account. The River Thames has a large tidal range: over 7 metres on spring tides.

The natural geology and topography of the Thames River Basin District (RBD) strongly influences its hydrological system. The Thames RBD is made up of rolling hills and a wide, flat river floodplain which combine to make most rivers respond slowly to rainfall.

In chalk areas, river flows are generally low, filled slowly by groundwater. Across the river basin scale, there is a long lag time before rainfall affects water levels in the rivers. Exceptions are in the steeper parts of the tributaries and within urban areas where water reaches the rivers quickly. This causes a more rapid rise in water levels. These differences affect the way flood risk is managed across the RBD.

The underlying gravels across much of the River Thames floodplain mean that, overall, there are very few lengths of raised defences. Instead, defences tend to provide additional storage in the upper reaches (for example in Aylesbury), or additional conveyance of water in the lower reaches (for example in the Lower Lee, Wandle and Maidenhead).

Most of the main rivers across the Thames RBD remain in a natural or semi-natural state. They are generally unconstrained and run in an earth channel through relatively flat undefended rural floodplains. The standard of protection is provided by the capacity of the river channels and the natural storage within the floodplains. Maintenance is important in these areas to make sure that the channel has no obstructions and can accommodate high flows.

However, in urban areas such as London, the rivers are heavily modified for flood risk management. These modifications have increased the conveyance of rivers by straightening them, artificially lining the beds and banks and erecting structures to manage blockages and water levels. The River Thames is one of the most intensely used and managed rivers in Europe. Between Lechlade and Teddington, it is heavily controlled by a series of weirs, sluices and locks. During times of normal flow, this section of the Thames acts like a series of ponds that are fed via upstream locks, with water levels controlled by downstream structures. At times of high flow, the Thames floods its large rural floodplain.

The Thames Estuary converges freshwater from the River Thames and its many tributaries with the North Sea. Tidal influence reaches to Teddington Lock on the Thames and up several of its tributaries. The River Thames is a a non-tidal river system upstream of Teddington Lock.

Without the current river walls, many areas of London along the River Thames and along the tidal stretches of the tributaries would be inundated twice a day through the normal tidal cycle. River walls, mostly in Greater London, have been steadily raised to give increasing levels of flood protection and to enable urban development.

About 500,000 properties in the Thames region are at risk from a tidal flood event in central London (without taking defences into consideration). This could occur because of ‘surges' flowing upstream from the Thames Estuary, caused by the combined effects of atmospheric pressure, high tides and high winds. Also, sea levels around the UK are about 10cm higher than they were in 1900.

Tide-locking is complex, this usually occurs when the fluvial system cannot drain into the tidal estuarine section of the River Thames. This occurs in those fluvial rivers where structures are in place to prevent (temporary) interaction between the fluvial river and the tidal Thames. If tide-locking coincides with high fluvial flows and the fluvial system does not have enough capacity, fluvial flooding can happen upstream of the barrier or impoundment. Climate change, ageing flood defences and population growth mean tidal flood risk will increase over time, unless this risk is carefully managed. The Thames Estuary 2100 Plan will ensure the Environment Agency continues to protect 1.4 million people, £320 billion worth of property and critical infrastructure from increasing tidal flood risk.

The above information summarises flood risk from rivers, tidal and coast risk. The Thames RBD is large and made up of several and varied catchments. For area specific information, refer to the Flood Risk Area and Strategic Area sections below.

Surface water flood risk

Surface water flooding happens when rainfall overwhelms the drainage system or is so intense that it flows overland. This can happen in localised areas as a result of particularly intense storms, particularly in urban areas, which have a faster rate and greater percentage of run-off. It is very hard to predict. While sustainable drainage systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible, legacy and/or poorly maintain systems are limited by design to handle local, intense rainfall events. Other areas can be inundated by flow from adjacent farmland or parkland after periods of prolonged rainfall when the ground is saturated and natural (undeveloped) areas react to rainfall in a similar way to paved areas.

Lead Local Flood Authorities (LLFAs) are responsible for managing the risk of flooding from surface water.

Surface water run-off can exacerbate fluvial (river) flooding by increasing the volume of storm run-off, reducing travel times to watercourses and increasing flood peaks. This type of flooding happens when rainfall overwhelms the drainage system or is so intense that it flows overland. It is therefore inevitable that the capacities of sewers, covered urban watercourses and other piped systems will sometimes be exceeded.

Lower lying areas of many London boroughs are at risk from surface water flooding. Given the complexity of the landform, topography and the drainage network, it is impossible to predict precisely where the risks will lie. Details like the height of kerbs or the level and construction of boundary walls can determine which way surface water will flow.

The greatest likelihood of surface water flooding is in London, but also in other densely urbanised areas, for example Swindon, Reading and Oxford.

Managing the risk of flooding from surface water is the responsibility of LLFAs. More information about surface water management can be found in each LLFA Local Flood Risk Management Strategy.

The Environment Agency has produced some surface water flood risk maps using information and input from LLFAs. The maps indicate an area's flood risk, particularly the likelihood of surface water flooding. They cannot be used to find out whether an individual property will flood, and they do not include the flood risk from sources like blocked drains and burst pipes.

The above information gives a general overview of flood risk from surface water risk. The Thames RBD is large and made up of several and varied catchments. For area specific information, refer to the Flood Risk Area and Strategic Area sections below.

Groundwater flood risk

Groundwater flooding is associated with fluctuations in the water table. Flooding from groundwater can happen when the level of water within the rock or soil that makes up the land surface (known as the water table) rises. LLFAs are responsible for managing the risk of flooding from groundwater. It can occur in low lying areas that are a long way from any watercourse. The onset of flooding from this source can be linked to fluvial events but can also occur independently.

In permeable catchments (such as the chalk in areas of the Thames RBD), significant fluctuations in groundwater can lead to long-duration, small scale flooding. Flooding happens when groundwater levels rise high enough to reach the ground surface and the local drainage network cannot cope with the volume of water. Groundwater flows out of the ground at the point where the water table meets the surface. Heavy rainfall can infiltrate the ground, causing saturation. Surplus water will then flow out to rivers or onto land, potentially causing flooding.

Groundwater responds slowly to rainfall, so when groundwater flooding happens it can persist for some time. Flooding from groundwater can also happen in locations with sand and gravel in the river valleys. Marlow, Datchet, Runnymede and Guildford are all examples within the River Thames catchment. For more information on the underlying geomorphology of the river Thames RBD, see the British Geological Society's mapping.

The Environment Agency has a strategic overview for all sources of flooding including groundwater. They supply information in the form of monitored groundwater levels. In some areas that have historically experienced groundwater flooding, the Environment Agency provide a groundwater alert or warning service. The Environment Agency also produces monthly water situation reports based on data provided by themselves, the Met Office and water companies.

The above information has been created as a general overview of flood risk from groundwater risk. The Thames RBD is large and made up of several and varied catchments. For area specific information, refer to the Flood Risk Area and Strategic Area sections below.

Sewer flood risk

Water companies are responsible for managing sewer flooding and maintaining their network of foul and surface water sewers.

Sewers are the main channels for conveying surface-water runoff in the urban areas of the UK. Flooding from sewers can occur when the network becomes blocked or overloaded. This often affects basement flats, many of which are based in low lying areas like London. Sewer flooding is generally a mixture of raw sewage and stormwater and has two main causes. One cause is hydraulic overload through a lack of system capacity. Another cause is the impact of wider fluvial flooding from rivers and watercourses.

Very heavy rain can result in severe, but localised flooding, often made worse by surface run-off over impermeable urban environments. Some sewerage systems such as the old Victorian system can be easily overloaded in heavy rain.

Sewer flooding is particularly unpleasant and distressing as its contents are highly contaminated. Thames Water estimates that there are currently over 10,000 properties vulnerable to sewer flooding across the whole of Thames Water's operational area.

In most of central and inner London the surface water and sewerage networks are contained within 'Combined Sewers'. During periods of heavy rain, the combined sewage and rainwater is diverted to the River Thames via combined sewer overflows to prevent significant flooding of homes, businesses, streets and gardens. In parts of London where these combined sewers are still present, there are historical flooding issues, particularly due to the foul sewerage system backing up from being overloaded with surface water. This piped or culverted surface water drainage system is unable to handle the volumes of water. When under pressure, it forces surface water into the foul sewerage system through informal cross-connections. This has led to several flooding incidents in parts of London over the past 30 years.

This type of flooding has got worse when surface water drains are wrongly connected to the foul system. Climate change is expected to increase the intensity of storm events and therefore increase the likelihood of sewer flooding. Similarly, within the combined sewer area, increases in rainfall will trigger additional combined sewer discharges to the River Thames. In central London, Thames Tideway Tunnel will intercept, store and ultimately transfer sewage waste away from the River Thames.

Thames Water is developing its [Drainage and Wastewater Management Plans (DWMP)] alongside Local Authorities and the Environment Agency to manage wastewater and drainage issues. The plans will also ensure the Thames catchment is better prepared for the impact of climate change and population growth. This FRMP aims to align and integrate with the DWMP and workshops are being held to ensure a more joined up approach. For example, in the Maidenhead FRA, Thames Water is working with the LLFA in Ockwells catchment.

The above is a general overview of flood risk from sewerage flood risk. The Thames RBD is large and made up of several and varied catchments. For area specific information, refer to the Flood Risk Area and Strategic Area sections below.

Canal flood risk

Canals within the Thames River Basin are a combination of man-made cut canals and river navigations (where the river flow maintains navigable levels via a series of weir/sluice structures). Flood risk can arise if an embankment breaches where a canal is above ground level or an asset, such as when a culvert fails. Canal flooding needs to be considered alongside the whole hydrological and drainage system along with the potential interaction with other sources of flooding.

In some locations canals are managed locally by navigational authorities, the Environment agency or other organisations. The Canal & River Trust (‘the Trust’) is one of the main asset owners of canals in the Thames RBD. The Trust is not a designated Risk Management Authority (RMA) within the Flood and Water Management Act (2010). However, the Trust has responsibility for managing their infrastructure to minimise risk to others. The Trust aims to manage water levels within a ‘normal operating zone’ that is specific to a certain location. Water resource and flood risk assets are operated to keep water levels within the normal operating zone and thus reduce the risk of overtopping. The Trust also manages and maintains its network to minimise the risk of asset failure.

The location and timing of flooding from canal is highly variable. Monitoring of levels and flows on main rivers by the Environment Agency is used to inform flood alerts and warnings.

The above information has been created as a general overview of flood risk from canal flood risk. The Thames River Basin District is large and made up of several and varied catchments. For area specific information, refer to the Flood Risk Areas and Strategic Areas section below.

Reservoir flood risk

Several large reservoirs are in the Thames RBD and could impact Flood Risk Areas and Strategic Areas falling in it. The chances of a reservoir failing and causing flooding are very low and reservoir flooding is an extremely unlikely source of risk. There has been no loss of life in the UK from reservoir flooding since 1925. As a result, the Environment Agency have not explicitly detailed the risk from reservoirs further.

Specific reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the Environment Agency ensures that reservoirs are inspected regularly and essential safety work is carried out. In the unlikely event that a reservoir dam fails, a large volume of water would escape at once and flooding could occur with little or no warning. The extent of flooding from a reservoir can be up to 50 miles from its source. This is because the local geography, such as valleys, can channel flood water for long distances. This means they are an important consideration when managing flood risk within the Thames RBD. The potential consequence of reservoir flooding means that, although unlikely, the risk should be considered in Strategic Flood Risk Assessments to inform local plans.

There are many people and properties at risk of flooding from reservoirs in the Thames RBD, including:

- 940,050 people
- 2,000 non-residential properties
- 1,100 key services
- 400 Special Areas of Conservation
- 3,010 listed buildings

These numbers are only precautionary due to the low likelihood of reservoir flooding in the area. The Preliminary flood risk assessment for England explains this in more detail. The reservoir flood maps published on the Environment Agency website show the largest areas that might flood if a reservoir were to fail. You can also check the long term flood risk for an area in England.

The above information has been created as a general overview of flood risk from reservoirs. The Thames River Basin District is large and made up of several and varied catchments. For area specific information, refer to the Flood Risk Areas and Strategic Areas section below.

Land management and flooding

It is important to consider land use within the floodplain for flood risk management. Changes in the way the land is used could affect both flooding and flood risk management measures.

The landscape of the Thames region varies considerably. The western parts of the region are mainly rural, with mostly arable land, grassland, woodland and some dispersed urban areas. The north and the south-east also have very large areas of rural land, with relatively large amounts of forest and woodlands in the south-east part of the region.

However, urban land use is increasing due to urban expansion and new development. The land in the north is mainly arable, with some urban areas. In the eastern part, the heavily urbanised Greater London dominates the land use, constrained by the Green Belt (an area of rural land use).

The floodplain in the Thames region is mainly natural. Almost 70% of the 0.1% AEP fluvial floodplain is arable, grassland or woodland, and this is mainly in the northern and western parts of the region. However, 10% of the floodplain is suburban or rural development. About 15% of the floodplain area is continuous urban land use, mainly located in the Greater London area.

Changes in land management can reduce the amount of surface runoff at a local scale. Within the built environment, local drainage systems (for example Sustainable Urban Drainage Systems, commonly referred to as SUDS) can have a positive impact on the quantity, quality and timing of runoff entering the river system. In rural areas, initiatives such as the Defra environmental stewardship scheme, encourage landowners to adopt practices that benefit the environment as well as reducing localised flooding.

Decisions about the use and management of land have the potential to radically change the consequences of flooding. Further information on land management and flood risk can be found within the [Thames River Basin Management Plan].

History of flooding

Within the River Thames Catchment, as a whole, there has been extensive, fluvial floods, this tends to happen when heavy and prolonged rainfall occurs when the catchment is either frozen or saturated between the autumn and spring. Because of the size of the Thames region, flooding is sometimes confined to sub-catchments because of storms and depressions that only affect part of the region.

This section of the FRMP provides a summary of significant flood events and their consequences since the first cycle FRMP in 2015. ‘Significant’ is defined as an event that affected more than 20 residential properties. The [first cycle FRMP for the Thames RBD] contains information on historic flood events and their consequences before this date. More detailed information about why flood records and evidence are important and how they are used is in [Part A of the National Overview of Flood Risk Management in England for Second Cycle FRMPs].

There has been some but no major flooding impacting the Thames RBD as a whole, between 2015 – 2021.

Thames RBD Flood Events between 2015 – 2020

Table 2 shows flood events from all sources that have impacted the Thames RBD from January 2015 to December 2020. The number has been rounded to the nearest 10. Internal flooding has been included only when it has affected 20 properties or more.

Table 2 is not exhaustive and does not include the July 2021 flooding events. Information about the July 2021 flooding in London and actions to reduce future flooding has been included in the Greater London Surface Water Flood Risk Area section.

The Environment Agency, Lead Local Flood Authorities and supporting Risk Management Authorities, such as Thames Water, will work together to ensure that this level of flooding affects fewer homes in the future.

Table 2: Historical flood events from all sources since January 2015 – December 2020. Number of properties rounded to the nearest 10. This table is not exhaustive and does not include the July 2021 flooding events.

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
July 2015	Stevenage (20)	Fluvial: Stevenage Brook
August 2015	Fleet (30)	Main river, sewer and drainage, surface water
August 2015	Barnet / Harrow (30)	Fluvial: Brent Brook - Silk Stream, Edgware and Wealdstone
May 2016	Maybury and Rive Ditch, Woking (50)	Main river, surface water, foul flooding
June 2016	Epping Forest, Havering, Barking and Dagenham, Redbridge (140 affected – 48 affected from main rivers)	Fluvial: Rom, Roding, Seven Kings Water, Mayes Brook and Ingrebourne, Hillmans Brook, Loxford Water

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
June 2016	Dunstable (20) including sheltered accommodation, Kingsbury Court	Surface water flooding
June 2016	Newham (70 dwellings + 27 highways)	Fluvial
June 2016	Harrow (100)	Fluvial
June 2016	Hillingdon (90)	Surface water
June 2016	Southwark (30)	Surface water, multiple sources
June 2016	Caterham Hill and Caterham Valley (140)	Surface water, foul flooding
August 2016	Hengest Avenue and wider Elmbridge East (30)	Surface water
September 2016	Harrow (30)	Fluvial
September 2016	Maybury and Rive Ditch, Woking repeat flooding	Main river, surface water, foul flooding
July 2017	Tunbridge Wells (60)	Surface water, Sewer, Fluvial
May 2018	Sittingbourne and the surrounding area (60), Nelson Terrace in Chatham (30)	Fluvial, Surface water
December 2019	Horley and Smallfield area (50)	Combination
June 2019	Bromley (40)	Fluvial, surface water
June 2019	Vigo and Culverstone, Gravesend (60)	Surface water, Fluvial, Sewer

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
January 2020	Hillingdon (30)	Surface water
February 2020	Five Oak Green (30)	Surface water, fluvial, Sewer
February 2020	Horley and Smallfield area (60)	combination
February 2020	West Byfleet (50)	Main river, surface water
February 2020	Old Woking (20)	Main river, surface water
June 2020	Romford, Colliers Row (over 20)	Surface Water
August 2020	Barking and Dagenham (50)	Groundwater / Surface water
August 2020	Burgh Heath and Kingswood (30)	Surface water
August 2020	Great Burgh and Nork (20)	Surface water
August 2020	Merstham (40)	Surface water
October 2020	Harrow (20), Aylesbury (40)	Main River
December 2020	Witney (80), Bicester (50), Chipping Norton (40)	Main River

Climate change and the Thames RBD

The Thames region

This section sets out what we know are likely to be the implications of climate change in the Thames RBD. We use allowances for different climate scenarios over different epochs or periods of time, over the coming century.

A percentile describes the proportion of possible scenarios that fall below an allowance level. The:

- 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

An allowance based on the 50th percentile is exceeded by 50% of the projections in the range. At the 70th percentile it's exceeded by 30%. At the 95th percentile it's exceeded by 5%. The 'H++' allowance is an extreme climate change scenario which applies up to the year 2100 for sea level rise.

As the data that is used to predict the impact of climate change is constantly changing, the most up to date information has been used at the time of publishing. Over the next 6 years this information is likely to change so the most up-to date information should be used.

Coastal flood risk

As sea levels rise, coastal flooding will become more frequent. This is because higher water levels will be seen more often. Predicting coastal flooding is complicated because it's a combination of:

- a still water level
- a surge component
- wave conditions

Future changes in sea levels are primarily accounted for by increases to the mean sea level. Changes in storminess and wave conditions are not as well understood or are not likely to change significantly. Future changes in wave conditions are thought to be heavily variable by geographical area and are an area of further research. Table 3 sets out how we expect mean sea levels to rise along the coastline by 2125. As the Thames RBD does not have its own sea level rise allowances, the South East RBD allowances are applied.

Table 3: cumulative mean sea level rises between 2000 and 2125 (metres) for the South East River Basin District*

Allowance	Sea level rise
Extreme (H++)	1.90m**
Upper end	1.60m
Higher central	1.20m

* Data source: flood risk assessments: climate change allowances.
** This applies up to the year 2100.

Fluvial (river) flood risk

Rainfall intensity is expected to increase in the future, which will cause river flows to increase. Flood risk assessments: climate change allowances set out how much we expect peak river flows might increase by 2115 across the management catchments. A 'Management Catchment' is a designated river catchment designated under the Water Framework Directive (The Water Environment (Water Framework Directive) Regulations 2017); this subdivides river catchment areas for easier management within the River Basin District.

As river flows increase, fluvial flooding will become more frequent. This is because higher river flows will be seen more often.

Surface water flood risk

In winter, more rainfall and 'wet days' are projected. In summer less rainfall and fewer 'wet days' are projected. For all seasons, rainfall intensity is projected to increase.

Intense rainfall can cause surface water flooding, particularly when the ground is already wet or following a prolonged dry spell. This is when clay soils can form an impermeable crust. As rainfall intensity increases, surface water flooding will become more frequent, because higher rainfall totals will be seen more often.

Flood risk assessments: climate change allowances set out how much we expect rainfall intensity might increase by the 2125 for management catchments in the Thames RBD.

How our understanding of the impact of climate change on flood risk might change

Our understanding of the impact of climate change on flood risk will evolve as more climate modelling and research is undertaken. The climate change allowances provided are based on the latest UK climate change projections in UKCP18 and UKCP Local

(2.2km). We will review, and where needed update, the climate change allowances as new climate change projections and research is published, working with the Met Office and other experts such as at universities.

Traditional methods used to estimate the likelihood and size of floods assume ‘stationarity’ of extreme events. This means that flooding in the past is assumed to represent the behaviour of future flooding.

Due to recent large-scale flood events on our rivers and coasts, many hydrologists are now considering ‘non-stationarity’. This recognises statistically significant changes over time.

More information on climate change considerations in the FRMPs is in Part A of the National Overview of Flood Risk Management in England for Second Cycle FRMPs.

Progress review of implementing the first cycle FRMP

This section covers what has happened across the Thames River Basin District (RBD) and what has been achieved since the first cycle Flood Risk Management Plan (FRMP) was produced in 2015. It describes how the first cycle FRMP was reviewed. The first cycle FRMP showed which objective categories each measure would help to deliver. The following describes measures under the objective category that they primarily benefit. It reports on the status of the measures and a summary of progress made towards achieving the objectives in the 2015 FRMP. If progress has not been made, it gives reasons why not.

How we assessed progress

The Flood Risk Regulations 2009 (FRR) require that the Environment Agency and Lead Local Flood Authorities (LLFAs) review the first cycle FRMP. The FRRs state that this review must include:

- an assessment of the progress made towards implementing the measures
- include a statement of the reasons why any measures proposed in the previous FRMP have not been implemented

The Environment Agency and LLFAs followed the following steps to complete the review within the Thames RBD:

- review the status of each measure and assign an estimated implementation status as of 31 March 2021
- give reasons why any measures assigned an implementation status of 'not started' or 'superseded' have not been progressed
- identify additional measures implemented since 2015 that have made a material difference to achieving the first cycle FRMP objectives

- assess how well the measures have contributed towards achieving the first cycle FRMP objectives

The review of first cycle FRMPs is presented in this section by:

- summary statistics to show an overview of measure implementation
- a selection of case studies to demonstrate what has been achieved since 2015
- a summary of additional measures implemented since 2015
- an overview of how well first cycle FRMP objectives have been met

Summary of progress of implementing the measures since 2015

Table 4 shows a summary of the implementation status of all the measures in the Thames RBD since 2015, as of 31 March 2021. Chart 1 presents this information as a doughnut chart, showing the proportion of measures by implementation status.

Table 4: implementation status of measures for the Thames RBD

Progress	Number of measures (%)
Ongoing	832 (55.8%)
Ongoing construction	2 (0.1%)
Completed	322 (21.6%)
Superseded	249 (16.7%)
Not started – proposed	75 (5%)
Not started – agreed	11 (0.7%)

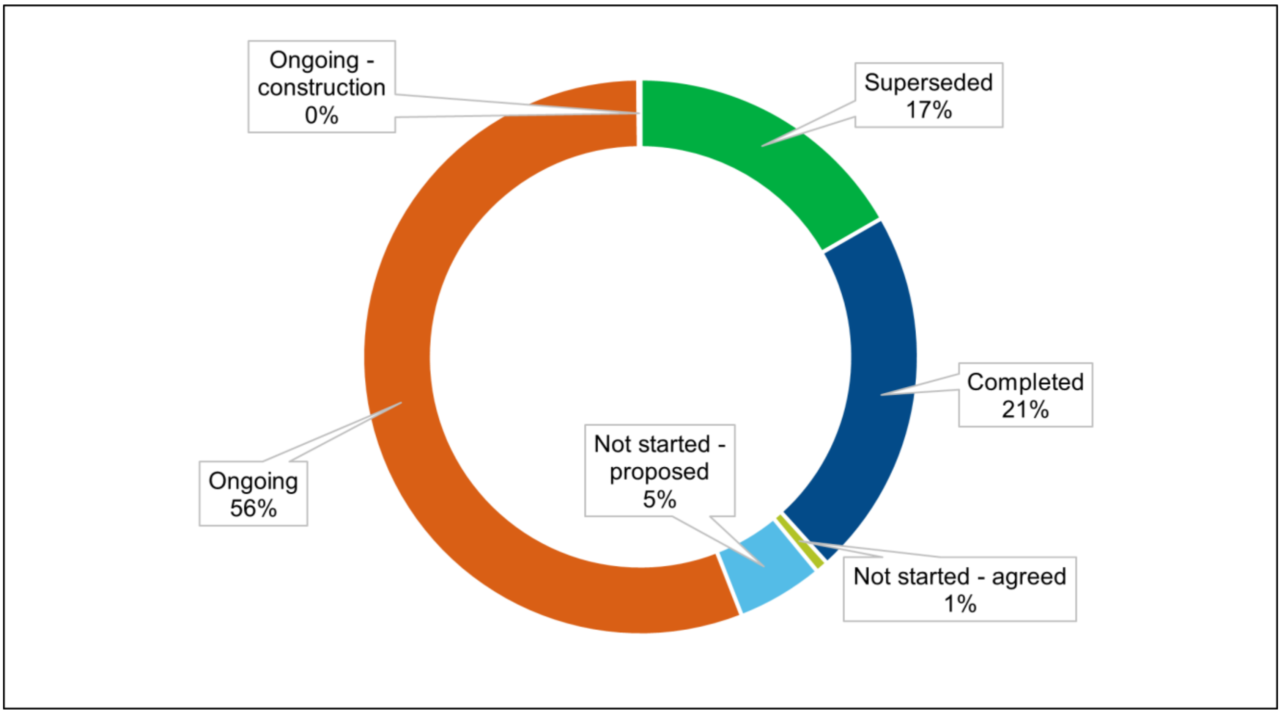


Chart 1: shows the implementation status of measures for the Thames RBD

21.6% of the measures published in the first cycle FRMP have been completed. 0.1% of the measures are ongoing/under construction. 55.8% of the measures are ongoing. Most of these ongoing measures are day to day activities carried out by Risk Management Authorities (RMAs) in 2015-2020.

These activities will be continuing in the period 2021-2027 and have been transitioned into the national level measures. These national level measures can be found in the interactive mapping tool – Flood Plan Explorer. 16.7% of the measures proposed in the first cycle FRMP have been superseded. These include either duplications, for example 'clean XX Trash screen', 'clean YY Trash screen' or multiple measures all focusing on one watercourse, which have been combined into one second cycle measure. 22.5% of the measures proposed in the first cycle FRMP have not been implemented. The reasons for this are:

- further work showed it was not viable
- it has been postponed
- it has been included in another piece of work
- it has been replaced by another measure
- it does not yet have funding

Table 5 shows a breakdown of the reasons for not progressing measures in the Thames RBD. Chart 2 presents this information as a doughnut chart, showing the proportion of measures that have not been progressed by reason.

Table 5: reasons for not progressing measures in the Thames RBD

Reason for not progressing measures	Number of measures
Not viable	50
Postponed	7
Included elsewhere	109
Replaced	7
No funding	89
Other	73

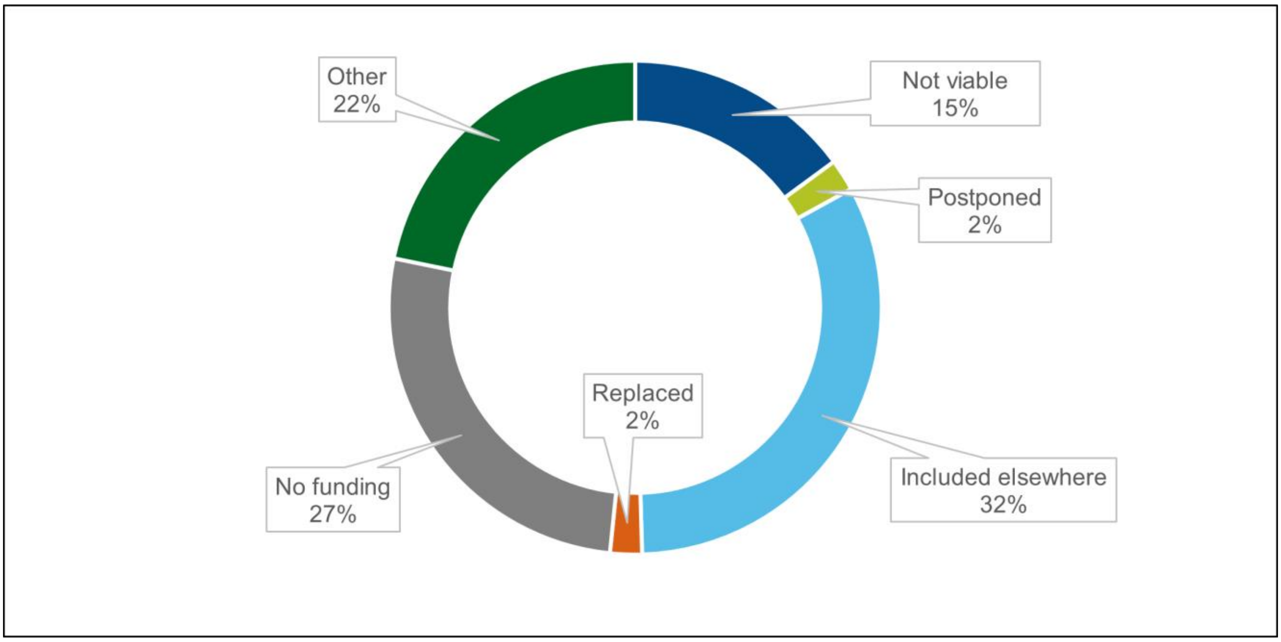


Chart 2: shows the reasons for not progressing a measure in the Thames RBD

Each measure included in the published first cycle FRMP and its implementation status at the end of March 2021 can be found in Annex 1. Annex 1 also provides information on which measures from the first cycle FRMP have been transitioned to this second cycle FRMP.

How these measures were implemented, and the main outcomes achieved

The Flood Risk Regulations (FRR) state that the FRMP must include measures relating to the:

- prevention of flooding
- the protection of individuals, communities and the environment against the consequences of flooding
- arrangements for forecasting and warning

In order to meet the requirements of the FRR, measures included in the first cycle FRMP were grouped into themed approaches:

- preventing flooding
- protecting against flooding
- preparing for flooding
- recovery and review following flooding

The case studies below provide a few examples of completed measures across the Thames RBD that have protected people and places from flooding.

ACT4606 - Houghton Regis Flood Storage Area

The flood storage on the Houghton Brook is operational, the scheme was completed in spring 2021. Houghton Regis Flood Storage Area reduces the risk of flooding to 600 residential and commercial properties in Luton, as well as key roads and other infrastructure. It will hold over 100,000 cubic metres of water during high-risk flood events.

To reduce the risk of flooding, a stretch of the Houghton Brook was realigned through the new flood storage area under the close supervision of geomorphologists because of its rare chalk stream status. A new public footpath and cycleway was also created, and native trees, diverse grassland and wildflowers were planted. New benches and information boards were also installed. 249 OM2s were recognised by the scheme, totalling £8.5m. The cost of the project was funded through partnership funding from the Thames Region Flood & Coast Committee levy, SEMLEP (South East Midlands Local Enterprise Partnership) and Luton council.

ACT3559 - Look for future opportunities Godalming. Godalming flood alleviation scheme, Surrey

Figure 3: aerial photograph of the Godalming flood alleviation scheme, Surrey

A £5.8 million flood alleviation scheme for Godalming in Surrey opened on 11 October 2019. The scheme was run collaboratively by several organisations including the Environment Agency and Surrey County Council.

The project was funded by Flood and Coastal Erosion Risk Management grant-in-aid with supporting investment from:

- Surrey County Council
- Waverley Borough Council
- Godalming Town Council
- Thames Water
- Thames Regional Flood & Coastal Committee (RFCC)

This scheme will help reduce the risk of flooding to approximately 90 homes. It comprises:

- 525 metres of flood wall
- a small section of removable temporary flood barrier across the Catteshall Road Bridge
- 2 pumping stations

The scheme also incorporates important environmental enhancements. These include an area to attract spawning fish and a wetland area.

The scheme was put to the test during Storm Dennis in February 2020 when it successfully protected the local community from rising flood water.

ACT 3499 - Making Space for Water Pang

The Pang Valley Natural Flood Management (NFM) project was created to reduce the response of the River Pang to rain events. This would therefore reduce the flood risk to properties in Pangbourne using natural techniques within the Pang Valley. The Pang Valley Flood Forum worked in collaboration with Englefield Estates, Reading University and the Environment Agency. The project consisted of the installation of 64 leaky wooden structures or leaky dams since 2018. It also involved bank reinforcement along tributaries of the River Pang, mainly along the River Bourne on Englefield Estates and Elmwood in West Berkshire. These locations are fast reacting clay tributaries, chosen based on local knowledge of the geology, topography and history of flooding.

The function of the leaky dams is to allow the passage of some water through but also hold floodwater back during times of high river levels and slow the flow down the river. Reading University have installed flow and level monitoring equipment and some time lapse cameras in order to understand the outcomes of these interventions during high flow events. They were constructed of locally sourced fallen trees and have the added environmental benefit of providing habitat for deadwood invertebrates, and therefore a food source for other wildlife such as birds and bats.

The Pang NFM project has created trusting, effective relationships between the local delivery team, landowners, and the community, leading to greater belief in and willingness to try out NFM. Since the landowner at Englefield Estate used their own company to build the woody dams, there is now trusted local expertise to use NFM and other landowners are more at ease trying this natural approach.

Figure 4: Leaky dam on River Bourne during installation in April 2019

Additional measures implemented since 2015

Measures have been implemented which have emerged since the publication of the first cycle FRMP. A few examples are described below.

Several Lead Local Flood Authorities have updated their Local Flood Water Management Strategy and Surface Water Management Plan.

Hampshire Council is also looking to strengthen its strategic place-based planning by evolving its Surface Water Management Plans into Catchment based water management plans covering 18 catchments. These include several projects completed by Risk Management Authorities (RMAs) as part of the six-year capital investment programmes across the Thames RBD.

As an example, Hampshire County Council has been working closely with Rushmoor Borough Council, the Environment Agency, Thames Water and Network Rail to identify and implement affordable flood risk mitigation measures to address surface water flooding at Rectory Road and Sycamore Road. Both areas have a record of vulnerability to:

- surface water
- groundwater flooding after certain prolonged rainfall events

The estimated cost of the scheme is about £475,000. This was funded by central government, the Thames Regional and coastal Committee and Hampshire County Council.

Several RMAs have produced a robust and aspirational Sustainable Drainage Supplementary Planning Document (SPD) to strengthen their ability to make sure new developments follow best practice in sustainable drainage design.

The Sustainable Drainage Systems (SuDS) Supplementary Planning Document (SPD) makes the case for the use of sustainable drainage, for considering their design early in master planning, and for ensuring that they are providing benefits not just in terms of water quantity, but also water quality, amenity, and biodiversity. The Council wanted to encourage imaginative and innovative designs, which bring sustainable drainage into all new development. They also want to improve the number of developments that store water where it falls within the site and make water part of the landscape. They are strengthening the national non-statutory technical standards and making it clear that more is expected of developers at a local level. The SPD was adopted in December 2018.

It is also worth noting there are several ongoing flood risk projects which have been carried out and identified outside of the FRMP Cycle 2 FRAs. The projects and schemes described in this FRMP are only part of the work the Environment Agency and our supporting Risk Management Authorities carry out to reduce, mitigate and alleviate the risk of flooding. There have been some projects which do not fall into the new FRAs. The Environment Agency does not deem these projects any less significant, however they do not fall under the specific criteria in this FRMP. An example of this is the Middle Medway Flood Resilience Scheme.

The Middle Medway Flood Resilience Scheme provided Property Flood Resilience (PFR) to 256 properties at very significant risk to fluvial flooding. It was the first project to use the National PFR Framework in 2019. An excellent working relationship was developed between the contractor, the project team and the community, meaning the community is better equipped to deal with future flood events. ‘Lessons learnt’ and recommendations from the project were used to inform future PFR projects. Figure 5 below shows an example of a barrier installation.

Figure 5: Middle Medway PFR Scheme

Natural Flood Management (NFM) was trialled on Littlestock Brook in the Evenlode catchment during a 5-year project (2016-2021) aiming to reduce flood risk to a small rural community and enhance the river environment. The Environment Agency collaborated with Wild Oxfordshire, the Evenlode Catchment Partnership and local community to deliver agricultural land management changes and NFM measures. These included constructing field corner bunds, leaky woody dams and de-culverting a watercourse.

Hydraulic modelling results show that the new measures reduce the severity of flooding to 12 properties for a range of flood events. As one of the first NFM projects in the region, it helps us understand the effectiveness of working with natural processes for flood risk management in this setting. As part of the project, environmental improvement was considered alongside NFM. To reduce diffuse phosphate and sediment entering Littlestock Brook and improve wildlife habitats, the project created 10 nutrient retention ponds and 1.1km field margin sediment/nutrient traps, as well as planting 14.4ha of riparian woodland and constructing a new path for recreation. A key to the success of the project was its integrated delivery with local community and partners to address multiple local environmental issues and to empower the local community to invest in catchment-based solutions.

Figure 6: Field corner storage areas and riparian woodland planting as part of the Evenlode NFM project

How well these measures have achieved the FRMP1 objectives

The Flood Risk Regulations (FRR) require the FRMP to include details of the set objectives and how these have created flood risk measures. This is used to help realise how the objectives will be achieved. The FRMP1 objectives were grouped into categories: social, economic and environmental. Information about these objectives for the Thames RBD FRMP cycle 1 can be found in [Part B of the FRMP1](#).

The objectives set out in the FRMP Cycle 1 contain key goals for managing flood risk and were agreed by RMAs. These objectives help to deliver the main ways to make a difference and reduce flood risk. They cover people, the economy and the environment. They were split into the 3 categories to help demonstrate the balance of objectives across the plans, but the categories were not assigned a weighting in the FRMP1.

The objectives were used to plan and prioritise investment programmes to target investment towards the ‘most at risk’ communities. This risk prioritisation was done at a wider national level and considered other factors such as cost benefits, the level of investment to date and other aspects such as the potential for external funding opportunities.

An example of where this has been achieved over the last 5 years is across numerous Lead Local Flood Authorities (LLFAs) within the Thames RBD. These LLFAs have written and produced flood risk documentation including Local FRMPs and Surface Water Management Plans. These documents hold benefits which cross multiple objectives set out in the FRMP1.

Overall, the measures included in the FRMP Cycle1 have successfully achieved the objectives set out across most of the objective categories, improving the social, economic and environmental well-being of the Thames RBD.

As some of the measures created within Cycle 1 are still on-going, these measures have been incorporated into the second cycle.

Second cycle summary of flood risk for the Thames River Basin District

This section summarises flood risk in the Thames River Basin District (RBD) from:

- rivers and sea
- surface water

The data in tables 6 to 11 has been calculated from data available in December 2019. This data considers the presence and condition of defences.

1. High risk means that each year, an area has a chance of flooding of greater than 3.3%.
2. Medium risk means that each year, an area has a chance of flooding between 1% and 3.3%.
3. Low risk means that each year, an area has a chance of flooding of between 0.1% and 1%.
4. Very low risk means that each year, an area has a chance of flooding of less than 0.1%.

Table 6 summarises the risk of flooding from rivers and the sea to people in the RBD.

Table 6: summary of river and sea flood risk to people in the Thames RBD

Risk to people	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of people in RBD	15,795,924	78,167	241,652	402,225	981,995
Number of services	95,490	893	2,241	3,441	4,944

There are 15,795,924 people in the RBD. Of these:

- 10.8% are in areas at risk of flooding from rivers and the sea
- 0.5% are in areas at high risk of flooding

There are 95,490 services in the RBD. Of these:

- 12% are in areas at risk of flooding from rivers and the sea
- 0.9% are in areas at high risk

Table 7: summary of river and sea flood risk to economic activity in the Thames RBD

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	585,572	5,610	15,266	22,010	44,211
Number of airports	8	4	0	0	1
Length of road (kilometres (km))	3,095	22	91	87	79
Length of railway (km)	3,177	49	101	114	186
Agricultural land (hectares (ha))	1,013,747	21,950	25,093	13,556	2,964

There are 585,572 non-residential properties in the RBD. Of these:

- 14.9% are in areas at risk of flooding from rivers and the sea
- 1% are in areas at high risk of flooding

There are 8 airports in the RBD. Of these:

- 5 airports (62.5%) are in areas at risk of flooding from rivers and the sea
- 50% are in areas at high risk of flooding

There are 3,095 km of roads in the RBD. Of these:

- 9% are in areas at risk of flooding from rivers and the sea
- 0.7% are in areas at high risk of flooding

There are 3,177 km of railways in the RBD. Of these:

- 14.1% are in areas at risk of flooding from rivers and the sea
- 1.5% are in areas at high risk of flooding

There are 1,013,747 hectares of agricultural land in the RBD. Of these:

- 6.3% are in areas at risk of flooding from rivers and the sea
- 2.1% are in areas at high risk of flooding

Table 8: summary of river and sea flood risk to the natural and historic environment in the Thames RBD

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of EU designated bathing waters within 50 metres (m)	10	1	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	391	33	20	42	48
Area of Special Area of Conservation (SAC) within area (ha)	20,566	398	275	57	0.2
Area of Special Protection Area (SPA) within area (ha)	47,667	10,481	186	3,912	210
Area of Ramsar site within area (ha)	22,956	10,023	69.5	4,643	210.5
Area of World Heritage Site within area (ha)	4,262.8	266.3	78.9	30.1	122.15
Area of Site of Special Scientific Interest (SSSI) within area (ha)	70,522	12,516	1,278	5,235	763
Area of parks and gardens within area (ha)	43,537.6	1,279	932	333	312
Area of scheduled ancient monument within area (ha)	6,336	400	458	404	71
Number of listed buildings within area	77,153	1,118	2,381	1,588	2,684
Number of licensed water abstractions within the area	3,854	736	266	200	215

Some of the environmentally designated sites at risk in the RBD are reliant on flooding to some degree to maintain their protected features such as a wetland.

There is one EU designated bathing waters site in this RBD in an area of high risk of flooding from rivers and the sea due to its fundamental features.

There are 391 Environmental Permitting Regulations (EPR) installations in the RBD. Of these:

- 36.6% are in areas at risk of flooding from rivers and the sea
- 8.4% are in areas at high risk of flooding

There are 20,566 hectares of Special Area of Conservation (SAC) in the RBD. Of these:

- 3.5% are in areas at risk of flooding from rivers and the sea
- 1.9% are in areas at high risk of flooding

There are 47,667 hectares of Special Protection Area (SPA) in the RBD. Of these:

- 31% are in areas at risk of flooding from rivers and the sea
- 22% are in areas at high risk of flooding

There are 22,956 hectares of Ramsar sites in the RBD. Of these:

- 65% are in areas at risk of flooding from rivers and the sea
- 43% are in areas at high risk of flooding

There are 4,262.8 hectares of World Heritage Site in the RBD. Of these:

- 11.7% are in areas at risk of flooding from rivers and the sea
- 6.2% are in areas at high risk of flooding

There are 70,522 hectares of Site of Special Scientific Interest (SSSI) in the RBD. Of these:

- 28% are in areas at risk of flooding from rivers and the sea
- 17.7% are in areas at high risk of flooding

There are 43,537.6 hectares of parks and gardens in the RBD. Of these:

- 6.5% are in areas at risk of flooding from rivers and the sea
- 2.9% are in areas at high risk of flooding

There are 6,336 hectares of scheduled ancient monument in the RBD. Of these:

- 21% are in areas at risk of flooding from rivers and the sea
- 6.3% are in areas at high risk of flooding

There are 77,153 listed buildings in the RBD. Of these:

- 8.77% are in areas at risk of flooding from rivers and the sea
- 1.4% are in areas at high risk of flooding

There are 3,854 licensed water abstractions in the RBD. Of these:

- 36.8% are in areas at risk of flooding from rivers and the sea
- 19.1% are in areas at high risk of flooding

Table 9: shows the summary of surface water flood risk to people in the Thames RBD

Risk to people	Total in RBD	High risk	Medium risk	Low risk
Number of people in RBD	15,795,924	259,636	386,199	1,750,601
Number of services	95,490	1,048	1,506	7,243

There are 15,795,924 people in the RBD. Of these:

- 15.2% are in areas at risk of flooding from surface water
- 1.6% are in areas at high risk of flooding

There are 95,490 services in the RBD. Of these:

- 10.26% are in areas at risk of flooding from surface water
- 1.1% are in areas at high risk

Table 10: shows the summary of surface water flood risk to economic activity in the Thames RBD

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk
Number of non-residential properties	585,572	10,890	16,319	71,837
Number of airports	8	7	0	1
Length of road (kilometres (km))	3,095	141.6	139.5	414.5
Length of railway (km)	3,177	254.2	233.8	489.5
Agricultural land (hectares (ha))	1,013,747	19,941	15,023.5	58,217

There are 585,572 non-residential properties in the RBD. Of these:

- 16.9% are in areas at risk of flooding from surface water
- 1.8% are in areas at high risk of flooding

There are 8 airports in the RBD. Of these:

- 8 airports (100%) are in areas at risk of flooding from surface water

- 87.5% are in areas at high risk of flooding

There are 3,095 km of roads in the RBD. Of these:

- 22.5% are in areas at risk of flooding from surface water
- 4.6% are in areas at high risk of flooding

There are 3,177 km of railways in the RBD. Of these:

- 30.8% are in areas at risk of flooding from surface water
- 8% are in areas at high risk of flooding

There are 1,013,747 hectares of agricultural land in the RBD. Of these:

- 9.2% are in areas at risk of flooding from surface water
- 2% are in areas at high risk of flooding

Table 11: shows the summary of surface water flood risk to the natural and historic environment in the Thames RBD

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Number of EU designated bathing waters within 50 metres (m)	10	1	0	1
Number of Environmental Permitting Regulations (EPR) installations within 50m	391	165	84	79
Area of Special Area of Conservation (SAC) within area (ha)	20,566	297.5	189.9	963.2
Area of Special Protection Area (SPA) within area (ha)	47,667	248.7	273.94	1,477.6
Area of Ramsar site within area (ha)	22,956	120.5	160.1	901.5
Area of World Heritage Site within area (ha)	4,262.8	4.9	17.5	139
Area of Site of Special Scientific Interest (SSSI) within area (ha)	70,522	1,166.2	911.7	3,925.1
Area of parks and gardens within area (ha)	43,537.6	1,006.1	689.7	2,952.8
Area of scheduled ancient monument within area (ha)	6,336	100	75.1	318.9

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Number of listed buildings within area	77,153	844	774	3,239
Number of licensed water abstractions within the area	3,854	420	162	625

There are 10 EU designated bathing waters in this RBD. Of these:

- 2 are in areas at risk of flooding from surface water
- 1 is in an area at high risk of flooding

There are 391 Environmental Permitting Regulations (EPR) installations in the RBD. Of these:

- 84% are in areas at risk of flooding from surface water
- 42.2% are in areas at high risk of flooding

There are 20,566 hectares of Special Area of Conservation (SAC) in the RBD. Of these:

- 7% are in areas at risk of flooding from surface water
- 1.4% are in areas at high risk of flooding

There are 47,667 hectares of Special Protection Area (SPA) in the RBD. Of these:

- 4.2% are in areas at risk of flooding from surface water
- 0.5% are in areas at high risk of flooding

There are 22,956 hectares of Ramsar sites in the RBD. Of these:

- 5.1% are in areas at risk of flooding from surface water
- 0.5% are in areas at high risk of flooding

There are 4,262.8 hectares of World Heritage Site in the RBD. Of these:

- 3.8% are in areas at risk of flooding from surface water
- 0.1% are in areas at high risk of flooding

There are 70,522 hectares of Site of Special Scientific Interest (SSSI) in the RBD. Of these:

- 8.5% are in areas at risk of flooding from surface water
- 1.6% are in areas at high risk of flooding

There are 43,537.6 hectares of parks and gardens in the RBD. Of these:

- 10.6% are in areas at risk of flooding from surface water
- 2.3% are in areas at high risk of flooding

There are 6,336 hectares of scheduled ancient monument in the RBD. Of these:

- 7.8% are in areas at risk of flooding from surface water
- 1.6% are in areas at high risk of flooding

There are 77,153 listed buildings in the RBD. Of these:

- 6.3% are in areas at risk of flooding from surface water
- 1.1% are in areas at high risk of flooding

There are 3,854 licensed water abstractions in the RBD. Of these:

- 31.3% are in areas at risk of flooding from surface water
- 10.9% are in areas at high risk of flooding

Second cycle flood risk summary

This FRMP sets out the way in which the Environment Agency will manage flood risk for the next 6 years. As an RBD we, the Environment Agency and associated Lead Local Flood Authorities (LLFAs), have proposed measures to seek and embed the use of new approaches and work collaboratively with our partners to achieve wider environmental outcomes and benefits.

The Flood Risk Areas (FRA) highlighted are areas of the highest risk and the Environment Agency have used these to identify and enable us to target our effort in the areas where there will be the most impact. Based on this information, it is concluded that the Environment Agency should take further action to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment both now and in the future.

The RMAs responsible within the FRMP have a considerable challenge to work with the general public to change their perceptions of flood risk, mitigation and resilience. Together, we need to create a more holistic approach to deliver flood risk management. Successful delivery will be dependent on many partners working together to achieve our overall goal which is the sustainable management of flood risk in the Thames RBD.

Second cycle objectives and measures

A full list of the objectives is in the Part A of the National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans (FRMPs).

In developing the FRMP, the Risk Management Authorities (RMAs) have:

- drawn **conclusions** from the hazard and risk maps and other sources of information - this helps us all to understand the risks or opportunities
- **taken account** of the likely impact of climate change on the occurrence of floods

- selected appropriate **objectives** from the national list to reduce the adverse consequences of flooding for human health, economic activity and the environment (including cultural heritage), and reduce the likelihood of flooding
- identified the likely approach (the measures) to achieve these objectives using the categories: **preparing**, **preventing**, **protecting** and **recovery and review**

Some measures have an implementation status of ‘not started’. This will be because funding is not yet in place or it is due to start later in the planning cycle.

Measures differ in terms of environmental outcomes, and this will be monitored through FPE.

Not all measures in the FRMPs have secured funding and so they will not definitely be implemented. For some of these measures, RMAs can apply for Grant-in-Aid to help pay for the work. The Environment Agency administers this funding and allocates it in line with government policies and priorities.

In determining the proposed measures for the FRMP, the RMAs considered several different factors. The main ones are outlined in the Part A of the National Overview of Flood Risk Management in England for Second Cycle FRMPs.

Finding the second cycle measures

For this second cycle of flood risk management planning, the Environment Agency has developed a new interactive mapping tool called Flood Plan Explorer. You can use this tool to discover information about all the measures proposed as part of this plan. You can find out:

- where the measure is
- a description of the measure and what it is aiming to achieve
- which objectives the measure will help to achieve
- who is responsible for implementing the measure
- when the measure is planned to be implemented

National level objectives and measures

There are some measures applicable to every Flood Risk Area (FRA) in England. The Environment Agency will seek to implement these national-level measures as part of its routine work as a Risk Management Authority. The Environment Agency is responsible for the national-level measures that apply to every FRA for main rivers and the sea.

LLFAs are responsible for the national-level measures that apply to every FRA for surface water. Some of these measures are statutory (the work is required by law) and others are optional. LLFAs implement their work in different ways depending on local priorities and resources.

LLFA websites and their local flood risk management strategies have more information about how they carry out their work.

You can find information about each of these measures in the Flood Plan Explorer tool.

It should be noted that the national level objectives and measures described above apply to the whole of the Thames RBD area, including those areas outside of the identified FRAs.

River Basin District level objectives and measures

There are eight measures applicable to managing flood risk in the Thames River Basin District (RBD) or apply to areas within the RBD. This is 1.4% of the total number of measures in this FRMP. These measures have been developed in addition to the specific FRA measures. You can find information about all the measures which apply to the wider Thames RBD in the interactive mapping tool - Flood Plan Explorer.

West Northamptonshire-wide measures that apply to the area of West-Northamptonshire that is in the Thames RBD have been included in the Anglian RBD FRMP.

Gloucestershire-wide measures that apply to the area of Gloucestershire that is in the Thames RBD have been included in the Severn RBD FRMP.

It should be noted that the RBD level objectives and measures described above apply to the whole of the Thames RBD area, including those areas outside of the identified FRAs.

FRA level objectives and measures

There are 504 measures applicable to managing flood risk in the nationally identified Flood Risk Areas (FRAs) in the Thames RBD. This is 94% of the total number of measures in this Thames FRMP. The full list of FRAs in the Thames RBD can be found in the introduction of this plan. More information on how FRAs were identified can be found in the 'Part A: National Overview of Flood Risk Management in England for the Second Cycle FRMPs'. The FRAs are described below.

In addition to the measures developed for the FRAs, measures have also been produced for areas covering a wider geographic area (the whole Thames River Basin), these measures have been put forward at the discretion of the Environment Agency as River Basin District measures.

The Byfleet and Weybridge Rivers and Sea Flood Risk Area

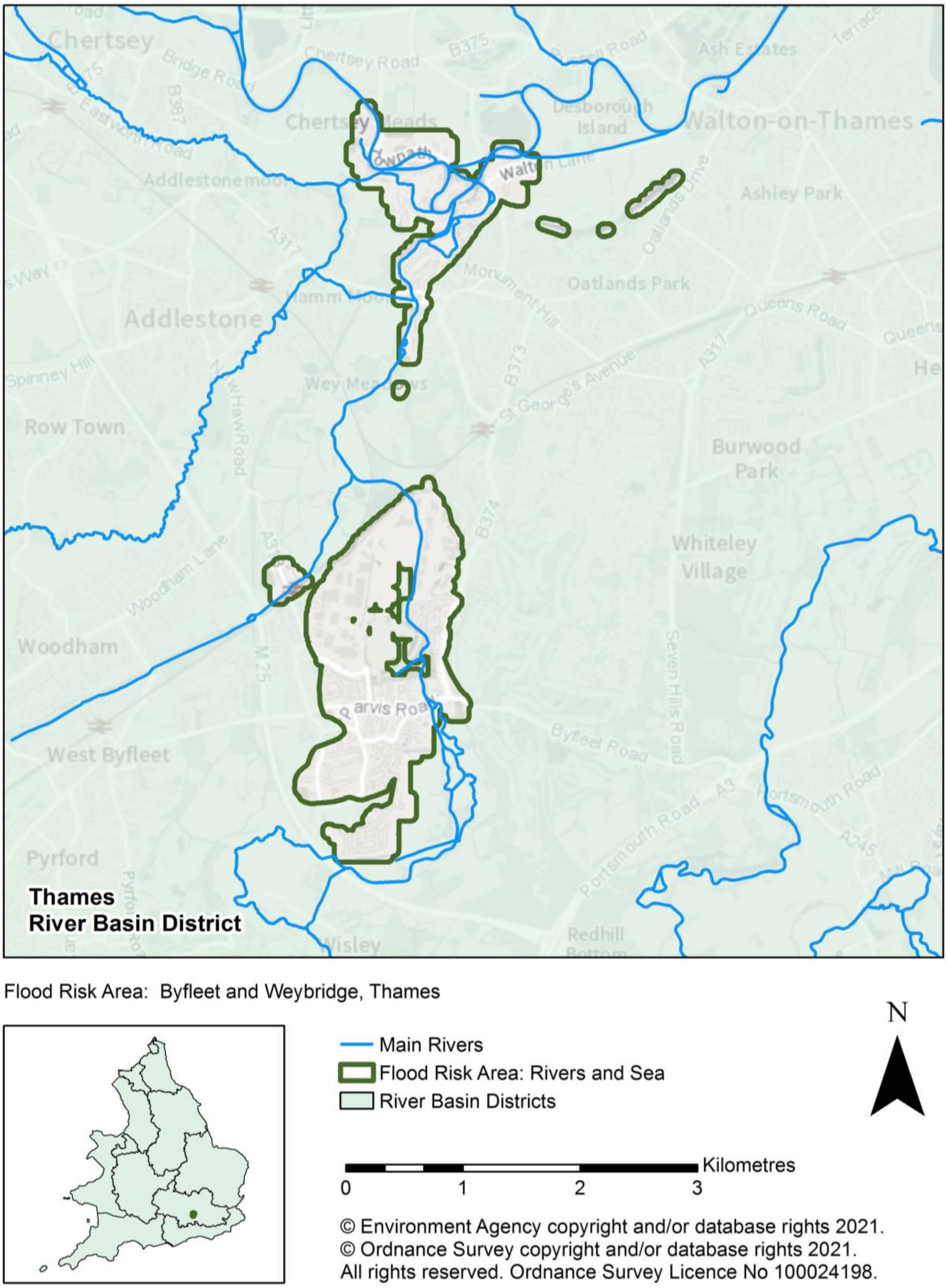


Figure 7: Map showing the Byfleet and Weybridge Flood Risk Area Boundary and its location in England

The Byfleet and Weybridge Rivers and Sea Flood Risk Area (RS FRA) is in the South East of the country and to the centre of the Thames RBD. This RS FRA will be reported solely by the Thames RBD. The Byfleet and Weybridge RS FRA has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Byfleet and Weybridge RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Byfleet and Weybridge RS FRA is in the boundaries of several local authorities:

- Woking Borough Council
- Elmbridge Borough Council
- Runnymede Borough council
- Spelthorne Borough Council

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Risk Management Authorities (RMAs) operating in the Byfleet and Weybridge FRA include:

- Environment Agency
- Lead Local Flood Authority (LLFA) - Surrey County Council
- Four district councils - Woking Borough Council, Elmbridge Borough Council, Runnymede Borough council, Spelthorne Borough council
- Regional flood and coastal committee - Thames
- Two Highways Authorities - National Highways and Surrey County Council
- Water and sewerage company - Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the FRA is strongly influenced by its underlying geomorphology. In the South East of England, there are 3 main types of underground rock (geology) that can impact permeability and infiltration rates. The underlying geology in Byfleet and Weybridge is sand. The porosity of sand is high, which can result in high infiltration rates. A section towards the north-east of Weybridge is made up from silt and clay. The porosity of clay is low, which can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

Byfleet tends to slope towards the River Wey to the east of the town. Weybridge slopes towards the west where the River Wey is, and north towards the Thames.

The FRA is a heavily populated urban area on the outskirts of London. It is therefore subject to considerable development pressures.

Key urban areas include:

- Byfleet
- Weybridge
- Hamhaugh Island
- Pharaohs Island

Partnership working

The Environment Agency is working collaboratively with other RMAs and partners. This is through the Surrey Nature Partnership hosted by Wey Landscape Partnership and Wey Catchment Partnership hosted by Surrey Wildlife Trust. It is made up of a group of organisations working together through a Catchment Based Approach (CaBA). This is to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment, the ideas and commitment of our partners makes it more likely that the issues identified can be collaboratively resolved.

For information on how risk from other sources will be managed, this chapter should be read in conjunction with other sections of this plan as well as the Surrey Local Flood Risk Management (LFRM) Strategy 2017.

Current flood risk

The primary source of flood risk within this FRA is from main river. The River Wey and the River Thames are the main rivers of importance in the Byfleet and Weybridge Rivers and Sea FRA. The Addlestone Bourne also enters the FRA to the west of Weybridge, where it meets the River Wey.

The River Wey flows from the south to the north through Byfleet and Weybridge meeting the River Thames at Hamhaugh and Lock islands. The River Wey and Wey Navigation are located to the east of Weybridge. They have their confluence with the Thames, north of the town centre. In some areas, the Navigation is an artificial channel managed by the National Trust which bypass sections of rivers. The Wey is described as heavily modified, where some stretches have been straightened to take Navigation traffic. Most of the River Wey typically flows in open channels. The Thames flows in an easterly direction, north of Weybridge.

Historically, flooding events have affected the FRA, but since 2015 there has not been any significant flooding. A significant event is when 20 or more properties were affected by flooding.

Fluvial flood risk: description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps, which were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment, which could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered, as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the Flood Risk Areas. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Byfleet and Weybridge Rivers and Sea FRA, 7,669 people (79%) are in areas at risk of flooding from main river. Of these people, 15.3% are in areas of high risk. There are also services that have been built within FRAs. There are 12 services (16%) that are in areas at risk of flooding from the main river.

Also shown to be at risk of flooding from main rivers in Byfleet and Weybridge:

- 227 non-residential properties (70%)
- a small proportion of the railway (4%)
- A large proportion (81%) of agricultural land
- A large proportion of listed buildings (91%)
- 56.5% of the Parks/Gardens
- 61.7% of Scheduled Ancient Monuments

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Byfleet and Weybridge FRA is currently managed through a series of approaches, including:

- development planning and adaptation
- flood risk assets
- flood warning systems
- flood risk modelling

In Surrey, the Environment Agency are part of the Surrey Flood Risk Partnership Board, a working group which aims to implement a joined-up approach to flood risk reduction.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

The Environment Agency is working in partnership with Woking Borough Council and Surrey County Council to plan a scheme to reduce the risk of flooding, present and future, to the Sanway-Byfleet and Brooklands areas.

To reduce flood risk from the River Thames, the Environment Agency are committed to working closely with partners and stakeholders to design the River Thames Scheme, to provide the most benefit to communities. The scheme is expected to reduce flood risk to communities including 11,000 homes and 1,600 businesses in Surrey and south-west London. Road, rail, power and water networks are also expected to be more resilient throughout the scheme footprint.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. The Environment Agency is constantly reviewing its local modelling programme to ensure its flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Byfleet and Weybridge FRA is covered by the Environment Agency flood warning service, for both alerts and warnings. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Byfleet and Weybridge FRA

Measures have been developed which apply specifically to the Byfleet and Weybridge FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Byfleet and Weybridge FRA.

You can find information about all the measures that apply to the Byfleet and Weybridge FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Canvey Island Surface Water Flood Risk Area

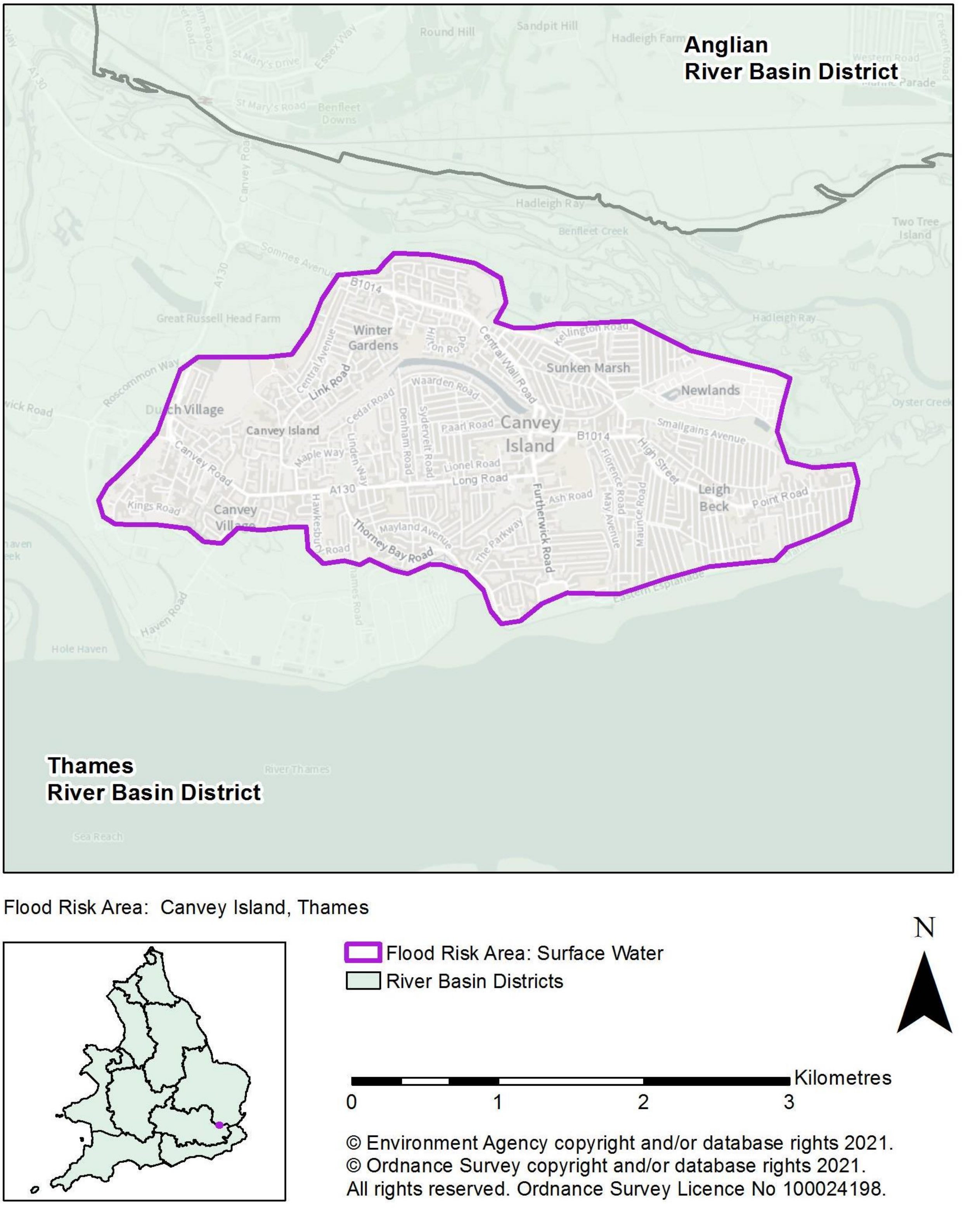


Figure 8: Map showing the Canvey Island Flood Risk Area Boundary and its location in England

Canvey Island Surface Water (SW) Flood Risk Area (FRA) is in the South East of the country and to the north-east of the Thames RBD. This FRA falls across the Thames and Anglian RBDs and can be found in both plans.

The Canvey Island SW FRA has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

This helps to assess which areas are, nationally, the most significantly affected by flooding. Areas within this Flood Risk Management Plan (FRMP) can be classified as an area at risk from 'Rivers and Sea' (RS) or 'Surface Water' (SW) to help distinguish the risk, but this does not negate other types of flood risk. The main source of flood risk in this FRA is surface water, but there is also a risk from coastal, fluvial (river) and groundwater flooding.

The Canvey Island FRA was not identified in the first cycle of FRMPs (2011) but was later identified in the Preliminary Flood Risk Assessment (PFRA) (2017) as an area with significant risk of flooding from the Coast, Main River and Surface Water.

The Canvey Island FRA sits within Castle Point District Council in the administrative area of Essex County Council (ECC). ECC is the Lead Local Flood Authority (LLFA) responsible for the district of Castle Point. ECC will take the lead on developing and delivering the FRMP measures in this area.

The Risk Management Authorities (RMAs) operating in this FRA include:

- Environment Agency
- Lead Local Flood Authority (LLFA): Essex County Council
- District Council: Castle Point District Council
- Regional Flood and Coastal Committee (RFCC): East Anglia RFCC
- Three Highways Authorities: Essex Highways, Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980) and National Highways manage major motorways
- Water and sewerage company: Anglian Water
- Department of Communities and Local Government through local planning authorities

Environmental designations

The areas that hold environmental conservation designations located within this FRA are:

- Harlow Woods (Site of Special Scientific Interest)
- Parndon Wood (Local Nature Reserve)

Topography, geology, hydrogeology, land use

Canvey Island is the largest town in Castle Point with a population of around 40,000 people. It has the borough's largest town centre and largest employment estate (Charfleets Industrial Estate). The Island has a healthcare centre, two secondary schools, a vocational college and the Waterside Farm Leisure Centre.

There are significant levels of commuting off the Island and many residents rely on private cars to access jobs and services. East-west routes across the Island are heavily congested, and there are only two single carriageway routes on and off the Island which converge at a single junction (Waterside Farm) resulting in significant peak time congestion. It is therefore an aspiration of the District Council to provide a third access to the district in order to provide resilience to the road network. The Council also seeks to complete an extension to Roscommon Way (Phase 3), from Haven Road to Western Esplanade to provide an alternative east-west route on the island, alleviating congestion on Long Road and Somnes Avenue.

Canvey Island has two port facilities, Oikos and Calor Gas. Both are registered as upper tier Control of Major Accident Hazards (COMAH) Installations and are of national significance. Due to their proximity to the resident population, there are constraints on development, with defined consultation zones around these sites.

The western part of Canvey Island is largely undeveloped and covered by environmental designations. These include:

- the Holehaven Creek Site of Special Scientific Interest (SSSI)
- Canvey Wick SSSI
- Local Wildlife Sites (LoWS)
- the Greater Thames Marshes Nature Improvement Area (NIA). The area is covered by the Metropolitan Green Belt and Tidal Flood constraints

The Castle Point Local Plan (2018 – 2033) seeks to provide about 5,300 homes, of which 900 have been completed or have planning permission. Of the strategic allocations in the Plan, some 1,150 are on brownfield sites in urban areas, and around 2,750 outside urban areas, of which 1,300 homes are on Canvey Island, on primarily Green Belt land. The Plan allocates some 24 hectares (ha) of new employment land. 20.2ha of this is allocated at Charfleets Industrial Estate and Northwick Road.

The underlying geology within the FRA is mostly clay. The porosity of clay is low, which can result in reduced infiltration rates and increased surface water run-off. In urban areas, this can exacerbate potential issues related to surface water flooding.

As the Highways Authority, Essex County Council are responsible for maintaining an effective highway drainage system including kerbs, road gullies and pipes which connect road gullies to the trunk sewers and soakaways. The water and sewerage company, in this case Anglian Water, is responsible for maintaining the trunk network, including sewers (mixture of combined and separated), manholes, pumping stations and outfalls.

Current flood risk

Surface water flood risk

The main source of flood risk within this FRA is from surface water. Surface water flooding occurs when high intensity rainfall (often of short duration) is unable to infiltrate into the ground, or exceeds the capacity of local drainage networks, causing water to flow overland.

The Canvey Island SW FRA has been identified as being at significant risk of flooding due to the relatively flat topography of the area and location within a river valley. This topography, in addition to impermeable urban land cover, can cause surface water ponding and run-off. Roads can convey water as a secondary channel within a flood event and flooding tends to be centred in areas where sewer and fluvial flood risk are also likely.

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered, as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the Flood Risk Areas. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Canvey Island FRA, some 10,082 of the 39,401 people live in areas at risk of flooding from surface water, of these 5% are considered high risk.

Also shown to be at risk of flooding from surface water in Canvey Island SW FRA are:

- 461 non-residential properties
- ~16.32 ha of agricultural land, of which around 2.72 ha is at high risk
- small areas of Special Protection Area (SPA)
- small areas of Scheduled Ancient Monument
- small areas of Sites of Special Scientific Interest (SSSI)
- small areas of Ramsar sites

Conclusions based on risk statistics

It is clear from the above, that flooding within the Canvey Island SW FRA is a complex system with many differing factors impacting the flood risk. 39,401 people living in the Canvey Island SW FRA are at risk from surface water flooding. Based on this information, further steps should be taken to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment, both now and in the future.

Historic flood events (2015 – present)

Before the second cycle of the FRMPs, it is worth noting that Canvey Island has experienced widespread surface water flooding which affected up to 1000 properties (2014). Although the Lead Local Flood Authority (LLFA) has not seen any events of this magnitude in the period 2015-present, isolated incidents of local highway flooding continue to occur. Standing water on the highway often threatens to flood properties as vehicles pass through and create bow waves.

The underlying geology within the FRA is mostly clay. The porosity of clay is low, which can result in reduced infiltration rates and increased surface water run-off. Gradients within the drainage system on Canvey Island are also minimal, which can cause water difficulty in draining away from street level to the pumping stations. There are many known defects within privately owned culverts, linked to historic development and poor service installations. In urban areas, this can exacerbate potential issues related to surface water flooding.

How the risk is currently managed

Surface water flood risk within the Canvey Island SW FRA is currently managed through a series of approaches. These include development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

Essex County Council lead the management of surface water flood risk, in collaboration with other RMAs and stakeholders. These include:

- the Environment Agency
- Anglian Water
- Essex Highways
- Castle Point Borough Council

Critical Drainage Areas

A Critical Drainage Area (CDA) is defined as a discrete geographic area (usually a hydrological catchment) where multiple or interlinked sources of flood risk cause flooding during a severe rainfall event, affecting people, property, or local infrastructure.

The South Essex Surface Water Management Plan (SWMP) (2012) and associated SWMP update (2018) identifies 2 CDA's within the Canvey Island FRA. These areas will be prioritised by the LLFA for targeting potential flood risk management measures, as outlined in the SWMP Action Plan (2018):

Table 12: Residential Properties at Risk within CDA's (2018)

CDA Ref.	CDA Name	Residential properties at risk (Greater than 0.1m internal flooding in areas with a chance of flooding of 1% each year))	People at risk
NCAST_002	North Canvey Island	75	176
NCAST_003	Leighbeck	14	33

Flood risk asset management

As a LLFA, Essex County Council have a duty to maintain a register of assets that are likely to have an impact on flood risk in the County. This is publicly available on request. Essex County Council have 10,176 records on its register to date. It also has in policy for designating assets, although there were no 'designated' assets at the time of compiling this report (May 2021).

Any capital flood management schemes delivered by Essex County Council are subject to third party maintenance agreements. The assets are added to the register and maintained through an annual inspection regime to ensure the condition of assets is reasonably maintained.

Measures implemented to reduce flood risk

Under the Flood and Water Management Act 2010 and Flood Risk Regulations 2009, as a LLFA, Essex County Council is required to carry out statutory and partnership roles. These roles could be considered measures to reduce flood risk.

The roles include the need to:

- oversee local flood risk such as groundwater flooding, surface water run-off and ordinary watercourses
- prepare and maintain a strategy for local flood risk management
- maintain a register of assets. These are physical features that influence flooding
- look into flooding incidents and make the results from these investigations public
- play a lead role in emergency planning and recovery after a flood event
- commission works to manage flood risk from surface runoff or groundwater
- request information from any person in connection with the authority's flood and coastal erosion risk management functions
- give permission for any changes to ordinary watercourses
- record, investigate and publish reports on floods in the county

- manage any assets and features which have an impact on flood risk so they cannot be removed or replaced without permission
- work with organisations such as the Environment Agency and water companies to develop a local flood risk management strategy for managing surface runoff, groundwater and ordinary watercourses throughout Essex
- make sure that any developments/projects drain run-off water in a way which does not increase the risk of flooding anywhere else
- manage surface water flooding. This includes flooding from rainfall run-off from surfaces such as roads, roofs, and patios
- respond to major planning applications in relation to sustainable drainage systems

Essex County Council has also provided a successful Property Flood Resilience Grant for individual homeowners and a Flood Capital Programme for wider flood alleviation schemes.

There is a strong partnership between flood RMAs working on Canvey Island. Since the 2014 flood event, a Multi-Agency Partnership (MAP) has evolved, previously chaired by ECC and subsequently the CEO of Castle Point BC. A 6-point plan was put together. This plan included requirements for more maintenance and investment for existing infrastructure and improvements, and a resilient community programme with continued Property Level Flood Protection Grants.

Essex Highways, Anglian Water and the Environment Agency have taken special measures to provide more services and improvements for Canvey Island. The Action List includes additional gully maintenance, surface water drainage scheme appraisals and delivery, pumping station upgrades and additional inspection of private systems. Property Flood Resilience Grant uptake on Canvey Island continues to be high in concentration in relation to the rest of Essex County with over 100 installations since the scheme began in 2015.

A ‘Make Rain Happy’ pilot scheme on Park Avenue is nearing completion (May 2021). It is hoped to provide a template for local street level improvements which could help improve the existing flood situation. The scheme makes space for water within reto-fitted Sustainable Drainage Systems (SuDS) including rain gardens, filter strips and swales.

In 2021 it was also announced that Canvey Island would form part of the two-year Building Resilience in Flood Disadvantaged Communities (BRIC) project. This is designed to build networks between individuals, community organisations, NGOs and public authorities in the UK and France, to find better ways to tackle flooding and test flood risk management.

SuDS are used to mitigate the impact of new development on flood risk and water pollution, while providing additional benefits such as amenity and biodiversity net gains. Examples of SuDS features include swales, rain gardens and detention basins but can also include engineered solutions, such as vortex separators, permeable paving and flow control devices as part of a scheme.

When assessing a new development site, the LLFA will look to mitigate any negative impacts that a development may have on the surrounding environment. However, where necessary, as indicated by the SWMP documents, CDAs and any other surface water flood mapping, the LLFA may also request that existing flood risk issues are considered as part of the application process. Where possible, Essex County Council would like to negotiate with the developer to deliver flood risk improvement schemes as part of the new development.

While the LLFA is not currently statutory consultee on minor planning applications recommendations are still given to the Local Planning Authorities that the principles of the Essex SuDS Design Guide are implemented on smaller sites to ensure that the cumulative effect of multiple smaller developments do not lead to a significant increase in downstream flood risk.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Essex Green Infrastructure Strategy

Essex County Council have published the Essex Green Infrastructure Strategy (2020) setting out its Green Infrastructure (GI) ambitions. This defines the different types of GI across Greater Essex and aims to encourage stakeholder collaboration and a coordinated approach to delivering and managing a GI network across Essex.

The GI covers 782 km2 or 21% of Greater Essex. There is a wide and varied amount of green space in Greater Essex that represents a GI network of green, blue and sometimes brown components. These lie within and between towns and villages and can cross local authority areas. Green Spaces are any vegetated areas of land or water within, or adjoining, an urban area. The types of green space (both publicly accessible and non-accessible) covers 49% of the Castle Point authority area. Of their total green space, 9% (4.1km2) is blue infrastructure of ponds, lakes and reservoirs, and coastal features, and 10% (4km2) of natural and semi natural open green space.

Castle Point’s emerging Local Plan aims to support the Thames Gateway South Essex Green Grid Strategy by focusing on the amenity and biodiversity benefits of GI and its potential to reduce pollution. It proposes working in partnerships to extend the GI network through multi-functional projects that encourage existing habitats to be managed and enhanced, and new ones to be created. It aims to provide links to the Greater Thames Marshes Nature Improvement Area for people and wildlife, to support species migration.

These projects will focus on:

- preserving and enhancing ecological and heritage assets and nature conservation areas
- a net increase in biodiversity through priority habitats and species
- managing and reducing pollution to air, water and soil
- managing flood waters consistent with their Local Plan policy 6
- recreational benefits and access to coast

The South Essex Green and Blue Infrastructure Study (2020) sets a vision for an integrated green and blue infrastructure network across South Essex. It provides high-level objectives, strategic opportunities, and policies driven by a coordinated approach.

The vision is for one single park system to be created which encompasses all of South Essex and comprises 5 project areas. One of these is Central Marshlands, which includes Canvey Island and Canvey Wick, a designated SSSI at the site of the partially built and abandoned oil refinery. The Central Marshlands is situated in the heart of South Essexand is a rich zone of habitats, flood alleviation, watercourses and reclaimed industrial sites. Juxtoposing and joining up designated habitats and iconic heritage sites creates opportunities for leisure, culture, and passive recreation, while simultaneously providing flood mitigation and protecting habitats.

This vast marshland is already being created through the Turning the Tide: The South Essex Marshland Landscape Partnership scheme (2011), produced by Essex County Council. Connectivity will be key to bringing this vast landscape together, which spans numerous local authorities. Habitats will be seamlessly linked and provide adequate space for restoration. At the same time, a plan will be prepared to encourage better access for people in appropriate areas. Central Marshlands offers a green and blue infrastructure solution that enhances current flood defence proposals, provides flood storage, complements and improves existing habitat sites, and aligns with developing coastal path plans. Castle Point is also promoting the regeneration of Canvey seafront area, protection and improvements to Canvey Wick, including public access and environmental flood management, and the regeneration of Hadleigh Town Centre.

Through good design - in both existing GI and in new GI, created as part of the wider landscape - GI network can help make areas less vulnerable to flood risk and improve water management. It can also help ensure development does not increase flood risk to third parties.

This is achieved through GI’s important role in delivering:

- sustainable drainage
- drought mitigation
- flood and water stress reduction
- opportunities for attenuation or infiltration that can help recharge Aquifers
- retained water levels in watercourses or other blue infrastructure features
- increased water quality through limiting diffuse pollution in watercourses

Essex Climate Action Commission

The Essex Climate Action Commission (ECAC) was established in 2019 in response to the challenges of climate change and increased flood risk. It recommends a multifunctional GI approach to build resilience into 75% of schemes developed by 2050 to include integrated water management, Natural Flood Management and Nature based measures. Such schemes will need to provide biodiversity net gain and open space provision, which will enhance the aesthetic, amenity value and safe public access. These designs should draw on national and local best practice guidance and must comply with requirements set out in the Essex SuDS Guide and national policy. GI should be integral to all stages of the planning process and can play an important part in place-making and place-keeping.

One of the agreed actions of the ECAC is to address the resilience of Essex to extreme weather and flooding. A key focus throughout is land use and GI.

The formal remit of the ECAC is:

1. Year one: identify ways in which Essex County Council can mitigate the effects of climate change, improve air quality, reduce waste across Essex and increase the amount of green infrastructure and biodiversity in the county by drawing on in-house expertise, commissioning research and forming new external partnerships.
2. Year two: explore how to attract investment in natural capital and low carbon growth. The Commission will be provided with regular updates on the status of the year one recommendations so that it can monitor progress.

Emerging recommendations from the ECAC will Essex County Council to manage the predicted sea level rise and increased rainfall intensity due to climate change in this area, and to become more resilient to future flood risk.

Essex County Council's work, as the LLFA, will be directly influenced by the emerging recommendations of the ECAC.

Objectives and measures for the Canvey Island SW FRA

Measures have been developed which apply specifically to the Canvey Island SW FRA.The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed alongside measures covering a wider geographic area (Thames River Basin) but that also apply to the Canvey Island SW FRA.

You can find information about all the measures that apply to the Canvey Island SW FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Chatham Surface Water Flood Risk Area

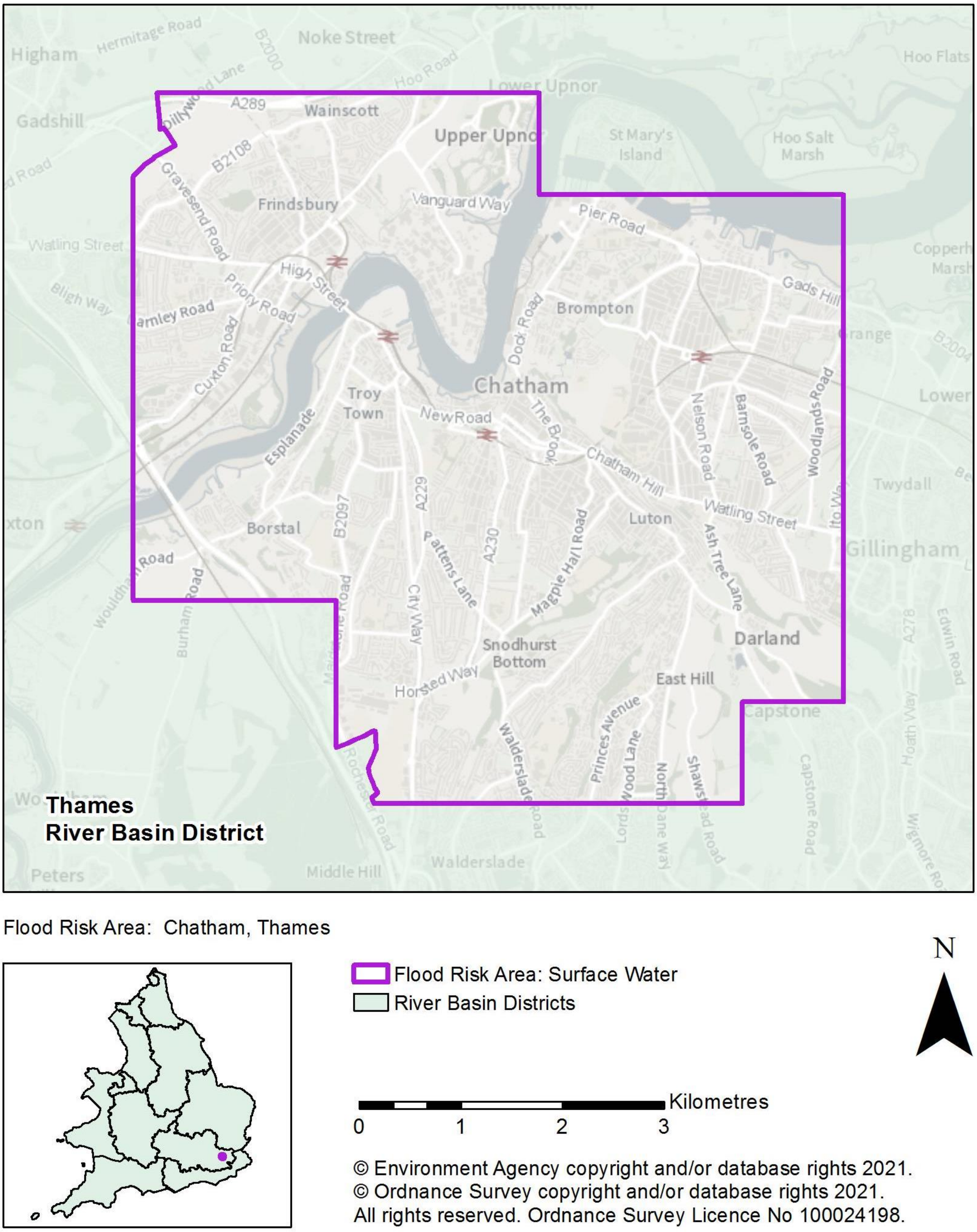


Figure 9: Map showing the Chatham Flood Risk Area boundary and its location in England

The Chatham Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the south-east of the Thames RBD. It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Chatham Surface Water FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The main sources of flood risk within the Crawley FRA are surface water and fluvial.

The relevant Lead Local Flood Authority (LLFA) leads on the development and delivery of the FRMP, as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMAs) operating in Chatham SW FRA. These include:

- Environment Agency
- Lead Local Flood Authority (LLFA): Medway Unitary Authority
- Unitary District/Borough Council:
- Regional Flood and Coastal Committee: Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and sewerage company: Southern Water
- Department of Communities and Local Government through local planning authorities

Environmental designations

In the Chatham SW FRA, there are two sites with a special environment designation. Part of the Tower Hill to Cockham Wood lies within Chatham FRA and is a site of special scientific interest (SSSI). It sits just at the northern edge of the FRA. A part of the Medway Estuary and Marshes also sits on the north-east side of the FRA and is also a SSSI. There are also many designated local wildlife sites and ancient woodlands within the Chatham FRA.

The full detail of the designations can be found in the Defra Magic map database.

Topography, geology, hydrogeology, land use

Chatham is an urbanised area with dispersed green space. The existing Medway Local Plan (2003) and the emerging Local Plan characterises the area as important to the prosperity of the Medway District.

Policies within the Local Plan restrict inappropriate development and ensure that properties or areas of brownfield land which are vacant or deteriorating are redeveloped over using the limited greenfield sites within Chatham.

Medway must significantly boost its supply of housing to meet national standards but it is important for the area to preserve its green space. It should encourage developers to promote landscaping, ecology and sustainable drainage within developments to ensure that there are suitable measures to minimise and mitigate surface water flooding within the region.

The underlying geology of the catchment is Lewes Nodular Chalk formation and the Seaford Chalk formation. Part of the Newhaven Chalk formation and the Thanet formation also sits in the Chatham FRA.

Watercourses

The main watercourse in the Chatham FRA is the river Medway.

There have been flood events attributed to surface water flooding and highway flooding within the Chatham FRA. The LLFA keeps records of all flood events which occur within the Medway region. Large events have occurred at Nelson Terrace, Haig Avenue and Wilson Avenue.

Current flood risk

The main source of flood risk within this FRA is from surface water.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present in the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at the local and wider level.

The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Chatham FRA, 25,703 (16.5%) people live in areas at risk of flooding from surface water.

Also shown to be at risk of surface water flooding in the Chatham FRA are:

- 71 services (8.3%)
- 1572 non-residential properties (25.8%)

- Critical Infrastructure: 5.32 km of railway (25.7%), 0.43 km of motorways, primary and trunk routes, as classified by National Highways (16.7%). Disruption to transport routes as a result of flood risk can have an impact at both local and larger scales. The lengths of road or railway at risk only provide part of the picture of transport network flood risk, as the duration of possible flooding has wider implications due to closure or restriction of routes or services
- 98.82 hectares of agricultural land (12.1%)
- Natural environment: 1 Environmental Permitting Regulation installation (100%, 18.3 hectares of Sites of Special Scientific Interest (SSSI) (51%), 0.04 hectares of parks and gardens (4%)
- Historic environment: 4.99 hectares of Scheduled Ancient Monument (10.1%) and 56 listed buildings (11.4%)
- 2 licensed water abstraction sites (50%)

Conclusions

Based on this information, RMAs have concluded that more steps should be taken to reduce the likelihood of flooding and its potential impact on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding happens when heavy rainfall exceeds the capacity of the local drainage network and water flows over the ground. The Chatham FRA has been identified as being at risk of flooding due to a combination of factors.

These factors include:

- impermeable urban land cover
- low lying areas that are conducive to surface water ponding
- culverted watercourses
- kerb and boundary wall heights
- ageing drainage infrastructure that is often overwhelmed

Due to the complex nature of these factors, it can be very difficult to predict surface water flooding and gauge precise locations for the risk.

Groundwater flood risk

Groundwater flooding happens when water overflows from the underlying aquifer or flows from springs at times of surplus and inundates the surrounding area. This tends to occur after long periods of sustained and high levels of rainfall, and the areas most at risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although it is increasingly associated with more localised floodplain sands and gravels. The Defra Magic map highlights that this area ranges from medium to high groundwater flooding.

How the risk is currently managed

Surface water flood risk within the Chatham SW FRA is currently managed through a series of approaches, including:

- development planning and adaptation
- sustainable drainage systems
- maintenance
- flood awareness

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Chatham FRA

Measures have been developed that apply specifically to the Chatham FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Chatham FRA.

You can find information about all the measures that apply to the Chatham FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Chertsey Rivers and Sea Flood Risk Area

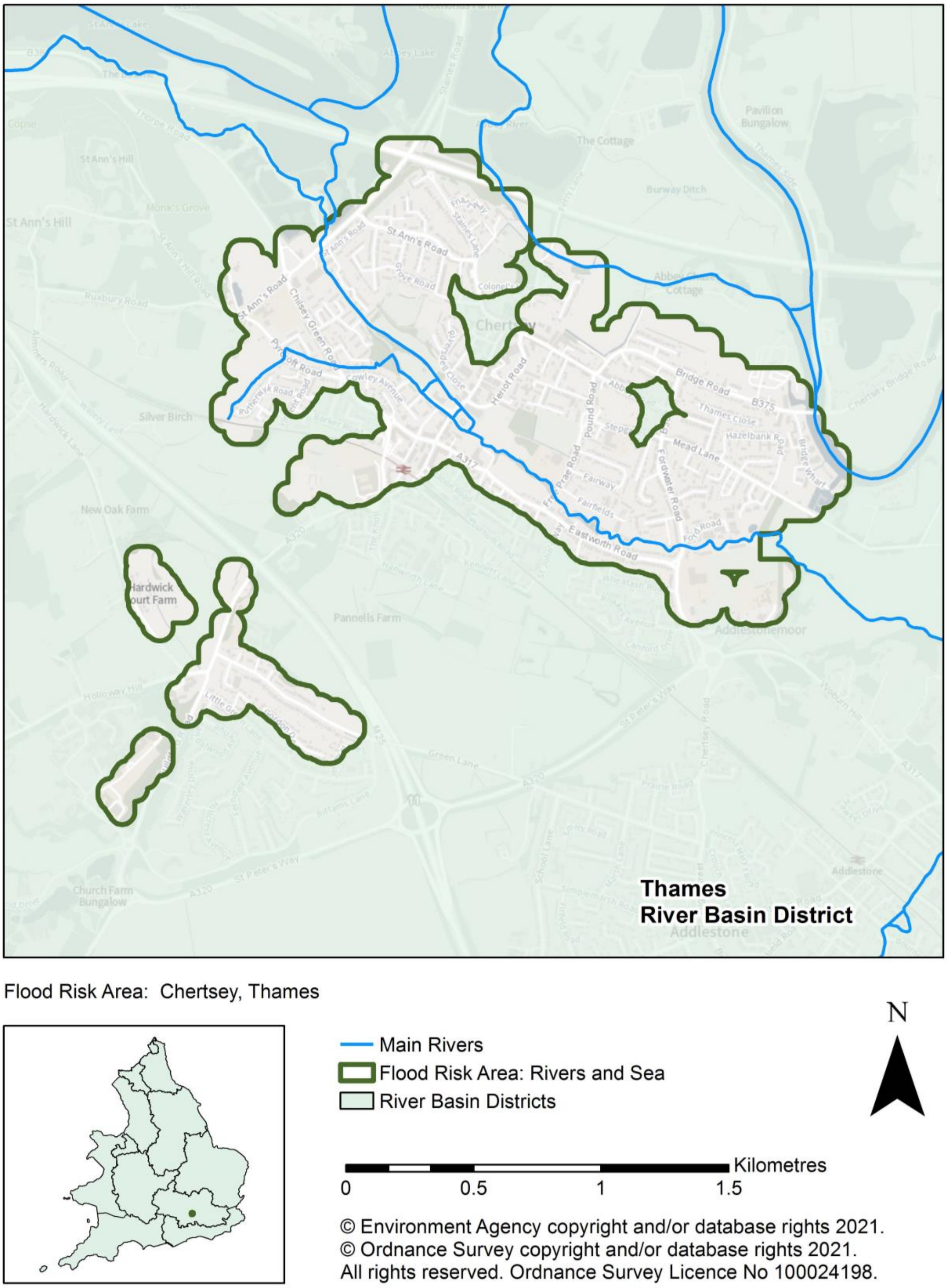


Figure 10: Map showing the Chertsey Flood Risk Area boundary and its location in England

The Chertsey Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the centre of the Thames RBD. It is reported solely by the Thames RBD. The Chertsey RS FRA has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Chertsey RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Chertsey RS FRA is located within Runnymede Borough and Surrey County. The area covers the main town of Chertsey and an area below the M25 near Runnymede Hospital.

The Risk Management Authorities (RMA) operating in Chertsey FRA include:

- Environment Agency
- Lead Local Flood Authority: Surrey County Council
- District Council: Runnymede Borough council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: National Highways and Surrey County council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The FRA is mainly flat and ranges from 13.5 metres above ordnance datum (mAOD) in the west to 12 mAOD in the east towards the River Thames with a sloping section of 19 mAOD below the M25 to the River Thames.

The topography of the FRA is strongly influenced by its underlying geomorphology. In the South East of England, there are three main types of underground rock (geology) which can impact permeability and infiltration rates. The underlying geology in Chertsey is Sand. The porosity of sand is quite high, which can result in high infiltration rates. The Chertsey Bourne is a heavily modified river due to it being in an urban setting.

The Chertsey FRA is a heavily populated urban area. It has good transport links being situated between the M25 and M3. Due to its location and transport links Chertsey is popular and prone to development.

Partnership working

The Environment Agency is working collaboratively with other RMAs and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a catchment-based approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment, and the ideas and commitment of our partners, means we can be confident that together we can resolve the identified issues.

Across the FRA, the character of the rivers and flow routes vary. The Chertsey Bourne and Rutherwyk Road Ditch are the main rivers flowing through the area. The River Thames to the north of the area has a wide floodplain which has an impact on Chertsey.

For information on how risk from other sources will be managed, this chapter should be read with the other sections of this plan for information as well as the Surrey Local Flood Risk Management (LFRM) Strategy 2017.

Current flood risk

The main source of flood risk within the Chertsey RS FRA is from main rivers including the Chertsey Bourne and its tributaries and the River Thames and its tributaries, for example, the Abbey River. The Chertsey Bourne is the dominant river within the area but the FRA will be impacted by the River Thames floodplain.

There are no formal flood defences in the area.

There have been several historic events that have affected the area but no significant flooding since 2015. A significant event is when 20 or more properties were affected by flooding.

Fluvial flood risk: description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency.

The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time when routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Chertsey FRA 7,904 people (76%) live at risk of flooding from main rivers. Of these, 12.3% are in areas of high risk. As well as people living within the floodplain, there are also services that have been built within

FRAs. There are 76 services in the FRA from Rivers and Sea including 21 services in areas at risk (27%). Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in Chertsey FRA are:

- 60.7% of non-residential properties
- 52.7% of the railway and 80.3% of motorways, primary and trunk routes, as classified by National Highways
- over half of the agricultural land (57%)
- just under half (47%) of listed buildings
- 4% of the Parks/Gardens
- there are 9.59 hectares (75.8%) of Scheduled Ancient Monuments at risk of flooding within the FRA
- 100% of Sites of Special Scientific Interest (SSSI)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that more steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Chertsey FRA is currently managed through a series of approaches. These include development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

In Surrey, the Environment Agency are part of the Surrey Flood Risk Partnership Board. This is a working group that aims to implement a joined-up approach to flood risk reduction.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding, the availability of barriers at national level and the availability of people may influence our ability to deploy the barriers.

The Environment Agency carries out maintenance to a proportion of the main rivers within the FRA. Future funding will help guide investment where it is most needed. The Environment Agency also maintains monitoring equipment for both flood risk and other purposes in the area.

To reduce flood risk from the River Thames, the Environment Agency are committed to working closely with partners and stakeholders to design a scheme, the River Thames Scheme, that provides the most benefit to communities. The River Thames Scheme is expected to reduce flood risk to communities including 11,000 homes and 1,600 businesses in Surrey and south-west London. Road, rail, power and water networks are also expected to be more resilient throughout the scheme footprint.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase which in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Chertsey RS FRA

Measures have been developed which apply specifically to the Chertsey RS FRA.

The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Chertsey Rivers and Sea FRAs.

You can find information about all the measures which apply to the Chertsey Rivers and Sea FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Chesham Surface Water Flood Risk Area

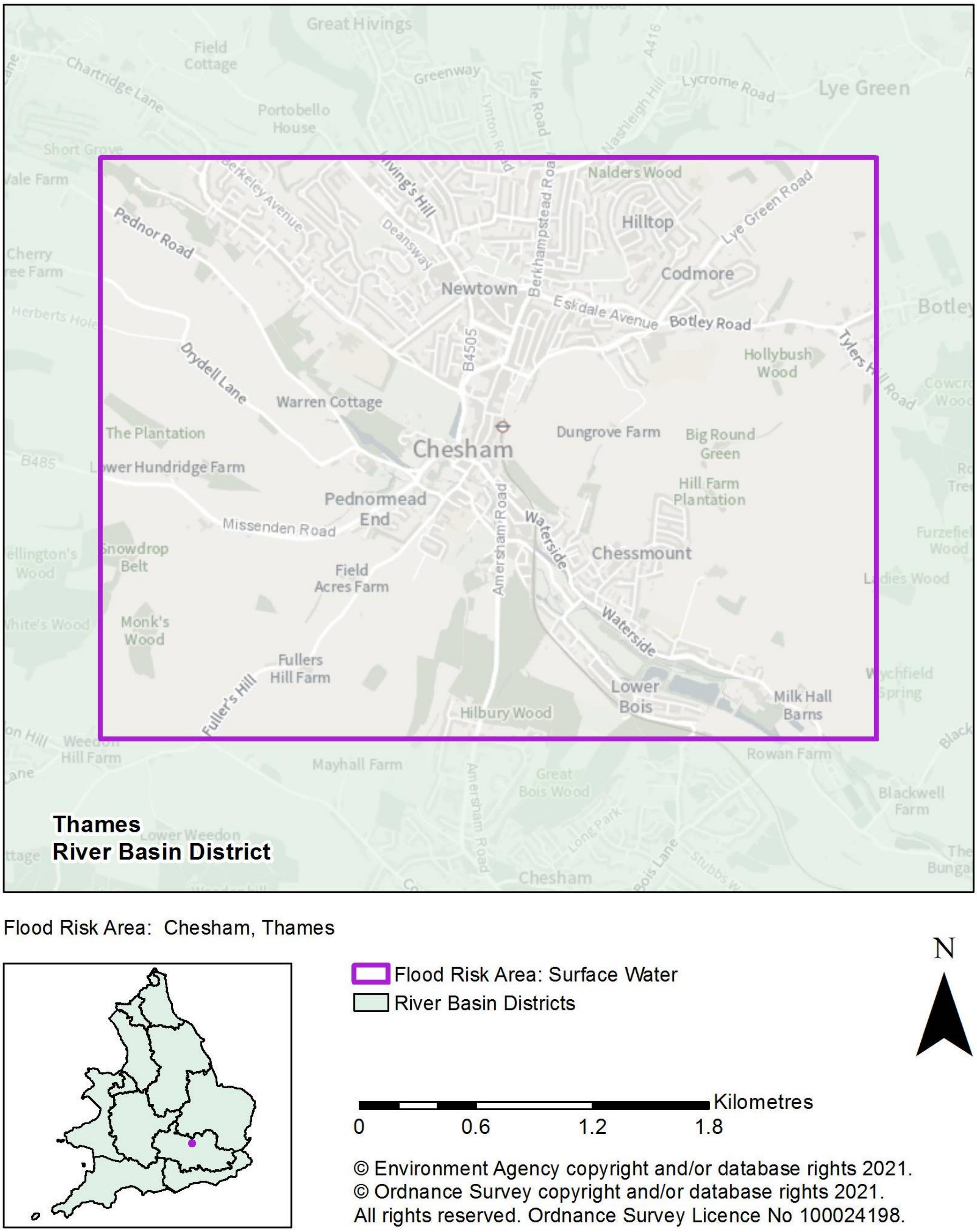


Figure 11: Map showing the Chesham Flood Risk Area boundary and its location in England

Chesham Surface Water (SW) Flood Risk Area (FRA) is in the South East of Engand, and to the north west of the Thames RBD. It will be reported solely by the Thames RBD. The Chesham SW FRA has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Chesham SW FRA was not identified in 2011 for the first cycle of the Flood Risk Management Plans (FRMPs). Buckinghamshire Counci leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water.

The Chesham SW FRA covers part of Buckinghamshire Council's area. The Chesham SW FRA is urban with a low proportion of arable land. Key urban areas include Pednormead End and the High Street. The flood risk present in this FRA is from a combination of river flooding and surface water flood risk, due to the underlying chalk geology. The River Chess is of particular significance as due to its chalk stream status.

The Risk Management Authorities operating in Chesham SW FRA include:

- Environment Agency
- Lead Local Flood Authority: Buckinghamshire Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Agencies: Buckinghamshire Council and National Highways
- Water and sewerage companies: Thames Water
- Department for Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the SW FRA is strongly influenced by the valley of the Vale Brook which slopes steeply either side of Chesham.

The underlying geology is chalk. The superficial geology is alluvium (clay, silt, sand and gravel) with areas of superficial head (clay, silt, sand and gravel). Within chalk and limestone areas (termed aquifers), water can infiltrate quickly, and move within and through these rocks. These areas become part of the major groundwater resources of the Chess River Basin and influences surface water. The groundwater from the chalk and limestone areas provides a significant baseflow component to the rivers in the Chess River Basin. Water flows slowly through the aquifers and is released at a slow rate into the rivers and will become surface water in places. The impact of rainfall will be spread out over a relatively long period of time.

The Chesham Flood Risk Area is mainly urban. The River Chess is a chalk stream and a priority Biodiversity Action Plan habitat.

Partnership working

Buckinghamshire Council works collaboratively with other Risk Management Authority (RMA) partners and communities to improve the water environment including through the Impress the Chess catchment partnership to better understand the catchment. Better understanding of the catchment and the ideas and commitment of our partners means that as a Lead Local Flood Authority (LLFA), we can be confident that together we can resolve the identified issues.

The FRA's urban areas are highly impermeable and have known risks of surface water flooding. The aim of FRMP cycle 2 is to create and implement targeted measures to reduce and mitigate this risk.

Other relevant plans include:

- Chesham Surface Water Management Plan
- Local Flood Risk Management Strategy

Current flood risk

Flooding in the Chesham SW FRA is caused by a mix of surface water and high river levels, both of which can be made worse by high groundwater levels. This section will discuss the surface water risk within this SW FRA.

In urban areas like Chesham, rivers typically run in man-made channels and culverts and only make an appearance as they flow through parks and green spaces. Surface water is linked to the rivers through the highways drainage system. This is also impacted by groundwater levels.

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Chesham SW FRA has been identified as being at significant risk of flooding due to low elevations and flat topography of the area, which are conducive to surface water ponding.

There have been several historic events that have affected the area. In 1903, 1912, 1915 and 1916, flooding was experienced in Vale Road and Berkhampstead Road. In 1918, major flooding was experienced around Pednormead End and Church Street and is written about as the 'Great Flood'. In 1950, flooding was experienced in Broad Street. In 2020/21, a series of flood events took place including:

- flooding of the road alongside Bury Pond
- five artesian wells flowing on Chesham Moor
- extensive and prolonged road flooding along Vale Road

In 2006, flooding was experienced in Broad Street and Berkhampstead Road. In 2008 flooding was also experienced in Pednormead End, The Spinney, High Street, Germain Street and Hivings Hill. In 2014, an intense rainfall event caused surface water runoff as well as increased flow in the River Chess and its tributary the Vale Brook. The increased flow exceeded the capacity of some structures, including the Vale Brook culvert. Although the most intense rainfall was short-lived, at least 34 properties were flooded internally in Chesham. Five residential properties and 29 businesses with 2-5cm of water.

Surface water flow through the Vale Brook culvert is known to be limited in capacity.

Surface water flood risk: description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SW FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered because this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRA. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Chesham SW FRA 5,792 live in areas at risk of flooding from surface water. Of these, 7.3% are in areas of high risk. As well as people living within the floodplain, there are also services that have been built within the SW FRA. There are 80 services within the Chesham SW FRA including 13 services in areas at risk. Schools and sewage treatment works are example of services. According to local date, 1 service is at high risk of groundwater flooding.

Also shown to be at risk of flooding from surface water in the Chesham SW FRA:

- 642 out of 979 non-residential properties. According to local data, 23 non-residential properties are also at high risk from groundwater flooding.
- 0.5 km (23%) of railway is at high risk of flooding from surface water, 0.16km (7%) is at medium risk of flooding from surface water, 0.15km (7%) is at low risk of flooding from surface water.
- Of these 796 hectares of agricultural land, 34.5 hectares (4%) is at high risk of flooding from surface water, 12.1 hectares (1.5%) is at medium risk of flooding from surface water, 35 hectares (4%) is at low risk of flooding from surface water.
- Natural environment at risk: 2 (25%) licensed water abstractions sites are at high risk of flooding from surface water, 4 (50%) are at medium risk of flooding from surface water, 2 (25%) are at low risk of flooding from surface water.
- Historic environment at risk: 19 (15%) listed buildings are at high risk of flooding from surface water, 29 (23%) are at medium risk of flooding from surface water, 12 (10%) are at low risk of flooding from surface water.

Conclusions based on risk statistics

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Groundwater flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

High groundwater levels in the Chesham SW FRA can exacerbate flooding from other sources. This can be seen through increased baseflows in the River Chess and Vale Brook.

How the risk is currently managed

Surface water flood risk within the Chesham SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness. Surface Water, fluvial and groundwater flood risk within the Chesham SW FRA is currently managed through a partnership approach with integrated working between Buckinghamshire Council, the Environment Agency, Thames Water, Affinity Water and Chesham Town Council. Coordination of this partnership working is overseen by the Buckinghamshire Strategic Flood Management Group.

Property flood resilience measures have been installed in the Pendormead End area of Chesham as part of the Pendnormead End Flood Project in partnership between Buckinghamshire Council and the Environment Agency in 2021.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

It is possible that areas within the Chesham SW FRA could experience more flooding in the future. As a result of larger flood extents and deeper depths of flood water due to the impacts of climate change, the level of protection provided by flood defences will likely decrease. There will also likely be additional maintenance needs and stresses on assets that function with a higher frequency than which they were designed.

Comparison of the maximum flood depths in areas with a chance of flooding of 1% each year (indicates that a predicted 29% increase in rainfall intensity in Chesham due to climate change could result in an increase in flood depths of greater than 20%, depending on location.

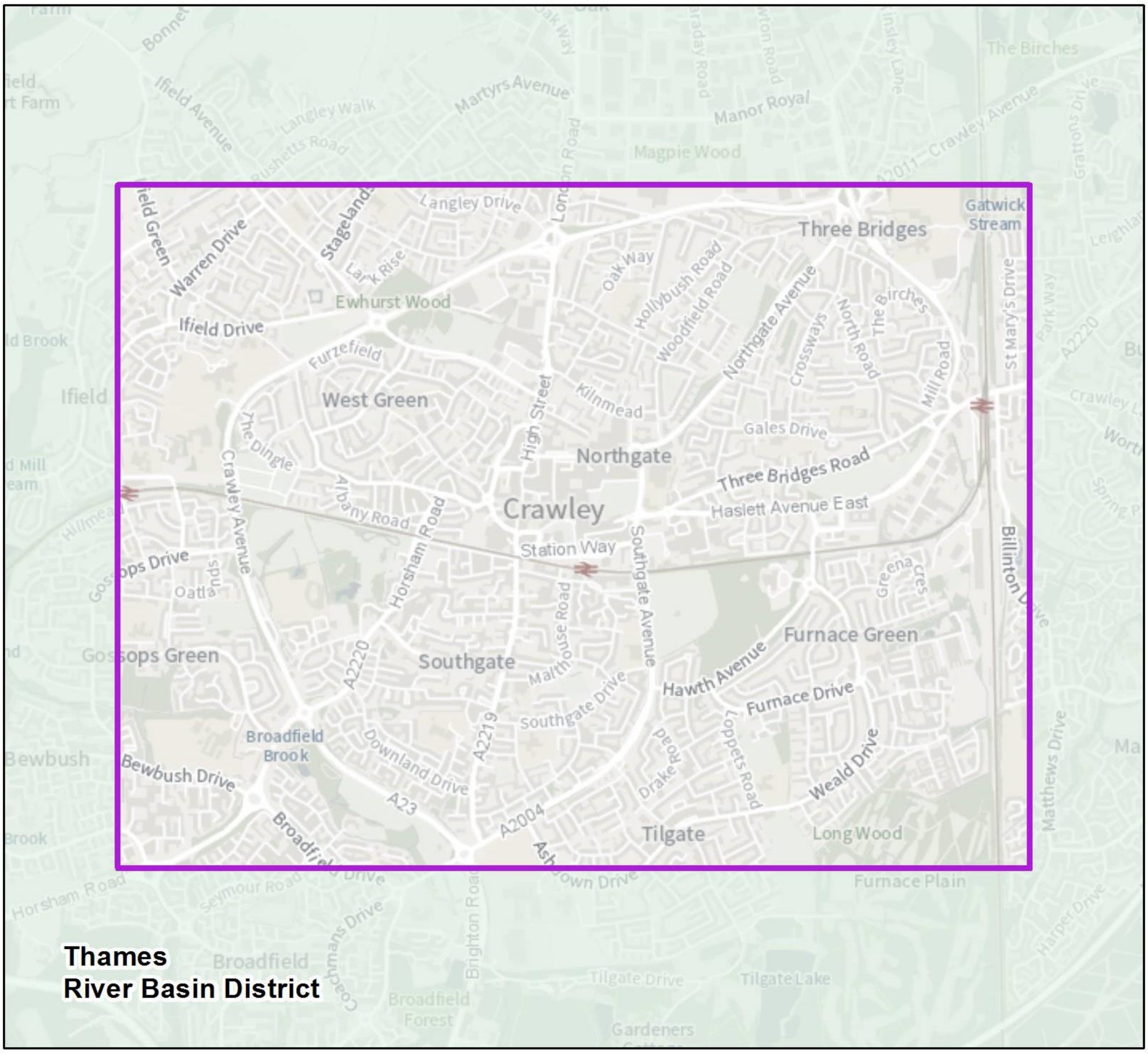
Two-dimensional computer models have been developed to support the Chesham Surface Water Management Plan.

Objectives and measures for the Chesham SW FRA

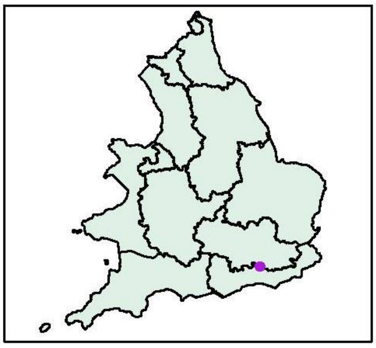
Measures have been developed which apply specifically to the Chesham SW FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin), but which also apply to the Chesham FRA.

You can find information about all the measures that apply to the Chesham FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Crawley Surface Water Flood Risk Area



Flood Risk Area: Crawley, Thames



Flood Risk Area: Surface Water
River Basin Districts

N

Kilometres
0 0.5 1 1.5

Figure 12: Map showing the Crawley Flood Risk Area boundary and its location in England

The Crawley Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the south of the Thames RBD. It will be reported solely by the Thames RBD.

The Crawley SW FRA has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Crawley SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The main sources of flood risk within the Crawley FRA are surface water and fluvial.

The relevant Lead Local Flood Authority (LLFA) leads on the development and delivery of the FRMP, as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMAs) operating in Crawley SW FRA, including:

- Environment Agency Area
- Lead Local Flood Authority: West Sussex County Council
- Unitary District/Borough Council: Crawley Borough Council
- Regional Flood and Coastal Committees (RFCCs): Thames RFCC
- Two Highways Authorities: National Highways (manage major motorways), West Sussex County Council
- Water and Sewerage Company: Thames Water
- Department for Communities and Local Government through local planning authorities

Environment Designations

The Crawley SW FRA is a predominantly urban area, covering the towns of Crawley, Ifield and Three Bridges.

Notable areas of open green space are:

- Tilgate Park
- Worth Park
- Ewhurst Wood
- Southgate Park and the Hawth Woods
- Goff's Park

There is also Ifield Mill, which used to be a working corn mill until the late 1920s. The millpond located there is now considered to be an important wetland site in Crawley.

The combined Crawley urban area has a population of 114,000 people, as of 2019. The population has doubled in the last 50 years due to the town's proximity to Gatwick Airport, and fast road and rail links to London and the southern coastal destinations. The expanding urban sprawl has reduced the amount of green space and increased impermeable land uses such as pavements and roads. This has increased the surface water flood risk in Crawley. Surface water flooding within the borough is associated with overland flow over impermeable surfaces during heavy rainfall. The flood extents show flow routes follow many of the road networks within Crawley which are impermeable surfaces.

In the Crawley SW FRA, there are no sites with a special environment designation, but there are designated sites and local wildlife areas just outside the Crawley SW FRA. The full details for the other designated sites can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The topography of the area is comprised of lower lying ground in the north-east, sloping to areas of higher elevation in the south-west. The High Weald Area of Outstanding Natural Beauty (AONB) runs along the southern edge of the study area, with a topographic high of approximately 149 metres above ordnance datum (mAOD). Most of the lower lying land across the central and northern areas is located between 60 and 80 mAOD.

The Crawley SW FRA is a heavily urbanised environment with limited green space and development mainly taking place on previous brownfield sites.

The geology of the Crawley SW FRA is mixed. A Weald Clay formation dominates the northern parts of the FRA, interspersed with a narrow band of Clay-Ironstone, also part of the Weald Clay formation. In the south-east portion of the FRA, the bedrock geology is predominantly Sandstone and Siltstone, part of the Tunbridge Wells Sand.

There are three types of predominant soil types across the FRA, each with their own dominant properties. In the north-west of the study area, the soil is seasonally wet loam and clays overlying shale; this is slowly permeable and can become waterlogged in winter months. In the eastern parts of the study area, silt overlying sandstone is the dominant soil type; this is also slowly permeable but is less prone to waterlogging in winter months due to improved permeability. The southern parts of the study area are dominated by deep loam which can become wet in winter months; these sandy and loamy soils can be seasonally affected by groundwater.

As a result of the dominant geology and soil types described above, the risk of groundwater flooding throughout the FRA is largely negligible with some isolated areas of low-moderate risk; these are described below in the section on groundwater flooding.

Watercourses

The principal watercourses in the Crawley SW FRA are:

- the Tilgate Brook
- Crawters Brook
- Broadfield Brook
- Creasys Brook
- the Gatwick Stream

They are all tributaries of the River Mole. A large part of the Tilgate Brook is culverted in Crawley and there are smaller culverted sections on the Crawters Brook and Gatwick Stream.

There have not been any significant flooding events in the Crawley area since 2015. A ‘significant event’ is when 20 or more properties were affected by flooding. There have been several recorded flood incidents across Crawley with fluvial and surface water being the most frequent cause of flooding. More recent events have been associated with capacity exceedances or blockages of the sewer network. These sources of flooding can also happen in combination, causing a cumulative effect.

Notable incidents reported by West Sussex County Council occurred in:

- September 1968
- Autumn 2000
- June 2012

There were further flood events according to the SFRA which occurred in:

- December 2008
- June 2012
- Winter 2013/14
- December 2019

Current flood risk

The main source of flood risk within this FRA is from surface water.

Surface Water Flood Risk

Surface water flooding happens when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Crawley SW FRA has been identified as being at significant risk of flooding due to a combination of factors.

These factors include:

- widespread impermeable urban land cover
- underlying low permeability clay soil
- culverted watercourses
- kerb and boundary wall heights
- constrictions within drainage infrastructure

Due to the complex nature of these factors, it can be difficult to predict surface water flooding and precise locations at risk.

Crawley is identified as an area most susceptible to surface water flooding across West Sussex, resulting in its classification as a ‘wet spot’, according to the Crawley Strategic Flood Risk Assessment Level 1 2020 (SFRA). A high level of urbanisation, underlying low permeability clay soil and constrictions within the drainage system, are all responsible for its increased susceptibility.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Crawley SW FRA some 10,039 (17%) people live in areas at risk of flooding from surface water.

Additional receptors at risk of surface water flooding within the Crawley SW FRA include:

- 24 services (7.1%)
- 302 non-residential properties (19.8%)
- critical Infrastructure: 2.20 km of railway (28%) 3.05 hectares of agricultural land (16.4%)
- historic environment: 0.23 hectares of Scheduled Ancient Monument (17.5%) and 1 listed building (3.3%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that more steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Fluvial flood risk

Fluvial flooding occurs from the river becoming inundated and overtopping its banks spilling onto its floodplain, usually as a result of a storm event. There is a small area at risk of fluvial flooding from the River Mole, Gatwick Stream, and Ifield Brook, in particular Langley Green, Three Bridges, Furnace Green, and Forge Wood. Elsewhere in the area, settlements are at fluvial flood risk from other watercourses (Crawter's Brook, Tilgate

Brook and Stanford Brook). Further areas impacted by fluvial flooding from ordinary watercourses are: Buckswood Drive, Horsham Road, between Gossops Green and Bewbush, and the land occupied by Gatwick Airport's Northern Terminal.

Ground water flood risk

Groundwater flooding happens as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

According to Crawley's Strategic Flood Risk Assessment, level 1, a majority of the area is at a 'negligible' risk of groundwater flooding. Some 'low' and 'moderate' risk areas are identified around Gatwick Airport, Three Bridges, Forge Wood, North Gate and Langley Green. In 2001, there were two instances of groundwater flooding at Bewbush and Furnace Green.

Sewer water flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages. Crawley's SFRA Level 1 states that most of the area is susceptible to sewer flooding with the most affected areas located within Pound Hill, Maidenbower, Ilfield, and Rusper.

How the risk is currently managed

Surface water flood risk within the Crawley SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. Crawley Borough Council Drainage Engineers undertake any consenting and technical flood risk appraisal work within the borough on behalf of the Lead Local Flood Authority in Crawley. They sit on the West Sussex Flood Risk Management Group that meets quarterly to review progress and coordinate work programmes. West Sussex County Council's policy for the management of surface water and the local flood risk management strategy help inform how surface water is managed in Crawley.

The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

While there are six hydrometric monitoring sites across the fluvial watercourses within the Crawley SW FRA which informs the Environment Agency incident response team on when to issue flood alerts and warnings. There is not a specific monitoring system in place for the surface water network that can be used for incident management purposes.

There are two flood warning alerts covering the Gatwick Stream and Ifield Brook and although these target fluvial flooding rather than surface water, due to the concurrent risk in certain locations, the flood warning service could still provide benefit for some properties at risk from surface water flooding. Please visit the flood warning information service to view the monitoring sites close to your area.

Flood defences

There are fluvial flood defences located along most of the watercourses in the study area. Types of fluvial defences include embankments, high ground, bank and channel maintenance. The standard of protection provided by these assets varies from a 20% AEP (Annual Exceedance Probability) up to a 0.5% AEP, and their condition is varied throughout the FRA. The Upper Mole Flood Alleviation Scheme is located on the upstream reaches of three of the main rivers flowing through the study area. The Scheme consists of three separate flood storage areas which store water during high flows and limit outflow downstream. The standard of protection provided by the storage areas ranges from 1% to 0.5% AEP.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report. Further information on local climate change considerations is included in the West Sussex LFRMS. This can be found in the flood risk management area of West Sussex County Council's website.

Objectives and measures for the Crawley SW FRA

Measures have been developed which apply specifically to the Crawley SW FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Crawley SW FRA.

You can find information about all the measures that apply to the Crawley FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Datchet Rivers and Sea Flood Risk Area

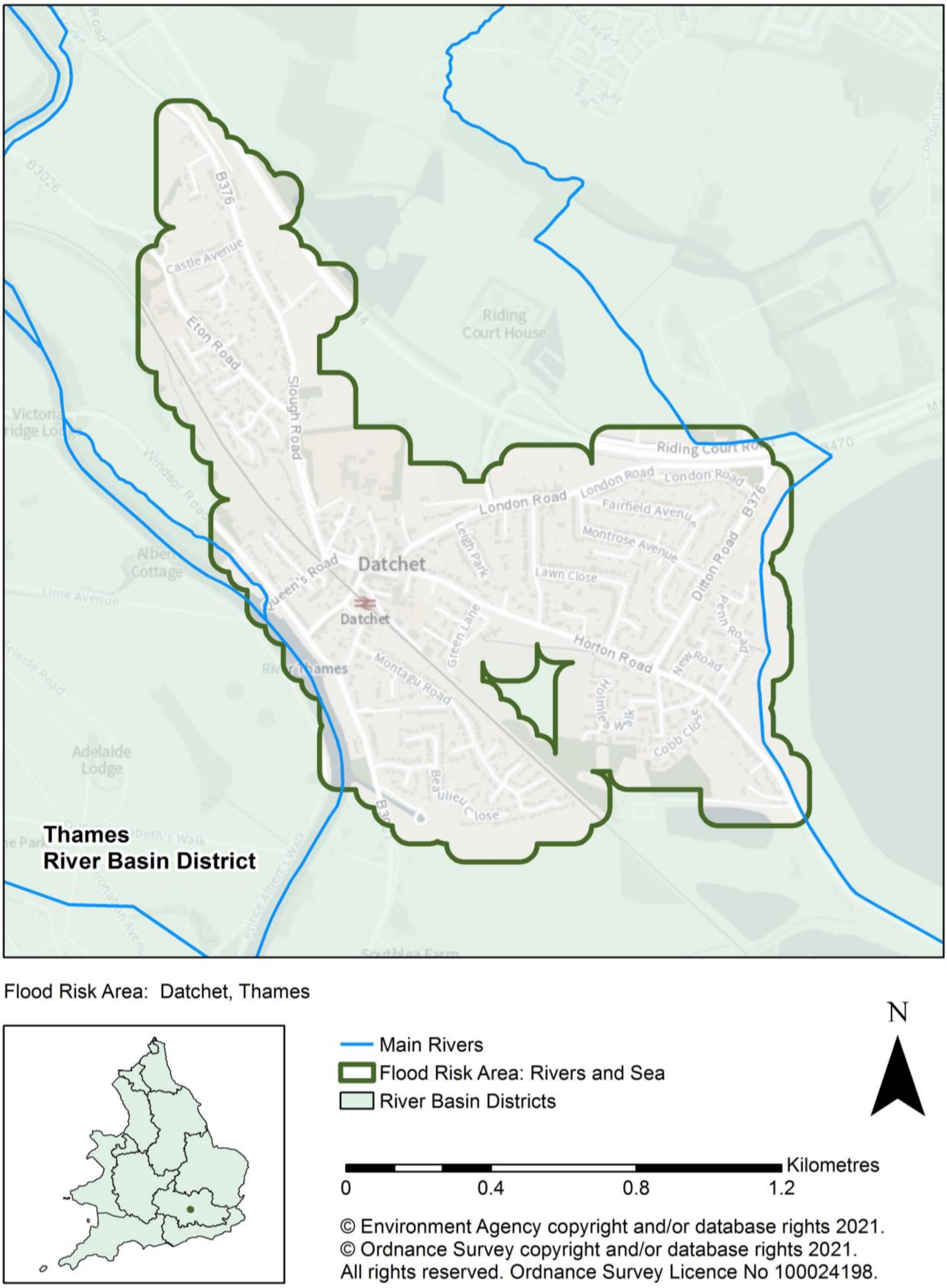


Figure 13: Map showing the Datchet Flood Risk Area boundary and its location in England

The Datchet Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and to the centre of the Thames RBD. It will be solely reported by the Thames RBD.

The Datchet RS FRA has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Datchet RS FRA was not identified in 2011 for the first cycle of FRMP. The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Datchet RS FRA is located entirely within the Royal Borough of Windsor and Maidenhead, to the South of Slough and below the M4 motorway and north of the River Thames.

The Risk Management Authorities (RMA) operating in the Datchet RS FRA include:

- Environment Agency
- Lead Local Flood Authority (LLFA): Royal Borough of Windsor and Maidenhead
- Thames Regional Flood and Coastal Committee
- Two Highways Authorities: National Highways and Royal Borough of Windsor and Maidenhead (predominantly)
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, Land Use

The topography of the FRA is strongly influenced by the River Thames which flows in an easterly direction south of the FRA.

The underlying geology is London and Lambeth Clay formations (clay, silt and sand) with the lowland floodplain of the River Thames characterised by a layer of Shepperton gravel. Because the porosity of clay is low in clay dominated areas, slow infiltration rates and increased surface water run-off are common. Alluvium is present alongside the River Thames.

The Datchet RS FRA is largely urban and surrounded by low lying open space.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a Catchment Based Approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve identified issues.

Current flood risk

The primary flood risk in the Datchet RS FRA is from main rivers however some areas are at risk from other sources, including groundwater.

The River Thames is a major river that rises in the Cotswold hills near Cirencester and flows for 215 miles from its source to the sea. Datchet Common Brook originates as an open channel Ordinary Watercourse in Slough Borough flowing South. Whilst some parts have been culverted, it remains an open channel throughout the FRA.

Many of the communities in the Datchet RS FRA have been affected by several major floods through the first half of the twentieth century, with a notable extreme event in 1947. A further large flood occurred in 1968 and more recently in 2003. In January and February 2014, we have seen further prolonged and widespread flooding in this area affecting many people, homes, and businesses.

Fluvial flood risk: description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps]. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that 4,927 people (98%) live in areas at risk of flooding from main rivers. Of these 40% are in areas of high risk. As well as people living within the floodplain, there are also services that have been built within FRAs. Fifteen (47%) services are in areas at risk of flooding from main river. A large proportion of services is at high risk. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in the Datchet RS FRA are:

- 137 (99%) non-residential properties are at risk of flooding with the majority (51%) shown to be at high risk of flooding
- less than a kilometre of motorways, primary and trunk routes, as classified by National Highways. Critical transport links within the area include parts of the M4 motorway
- a large proportion (57%) of the railway
- of the total area of agricultural land, 96% (58.10 ha) agricultural land
- one (100%) licensed abstraction which is shown to be at high risk of flooding

- a large proportion (86%) of listed buildings with the majority (68%) being shown at low risk of flooding
- all the parks/gardens in the area are shown to be at high risk of flooding

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Groundwater flood risk

The Environment Agency released the Lower Thames (Hurley to Teddington) 2019 flood model in January 2020. This has helped refine our understanding of flood risk in this area. The latest evidence (Lower Thames 2019 model) shows that large parts of Datchet are no longer shown to be impacted by 'overland' fluvial flooding during smaller/more frequent floods. This includes areas with 5% chance of flooding each year.

The change in the way flooding is represented does not suggest a reduction in flood risk in Datchet. Experience has shown that Datchet is highly susceptible to flooding due to elevated groundwater levels, where the river flows through the alluvial gravels. As such, flood water levels are partly associated with high levels in the River Thames.

The Environment Agency is keen to work with the Royal Borough of Windsor and Maidenhead to refine a flood outline which better represents the flooding mechanism in Datchet for smaller, more frequent floods to inform the definition of the functional floodplain, otherwise known as Flood Zone 3b.

How the risk is currently managed

Fluvial flood risk within the Datchet RS FRA is currently managed through a series of approaches. These include:

- development planning and adaptation
- flood risk assets
- flood warning systems
- flood risk modelling

The Datchet RS FRA has a long history of flooding and remnants of historic flood defence assets are present within the FRA such as part of the Sumptermead bank and Southlea riverside bank. While located outside of the FRA, third party assets located on Eton End School grounds help reduce flood risk to parts of the Flood Risk Area.

Fluvial flood risk within the Datchet RS FRA is currently managed through a series of approaches, including regular maintenance, planning and adaptation, response and warning and informing.

Our priority is to maintain the existing conveyance of the rivers. This will be done through an annual programme of bank and in-channel weed clearance and the removal of obstructions. Future funding will help guide investment where it is most needed. We will also continue to promote good riparian ownership.

When the levels on the River Thames are high, the River Myrke is unable to discharge into it and is prone to coming out of bank posing a flood risk to parts of Datchet RS FRA. Whilst located outside of the RS FRA, the Environment Agency maintains the Myrke Embankments and has a pumping programme in place to help with conveyance during a flood event.

The Environment Agency has been working with the Royal Borough of Windsor and Maidenhead as part of the Local Plan process to guide development across the borough. The emerging Borough Local Plan 2013-2033 was submitted to the Secretary of State for Housing, Communities and Local Government for independent examination in January 2018.

The Environment Agency is part of the Thames Valley Local Resilience Forum. There is a Multi-Agency Flood Plan (MAFP) which comprises the seven unitary local authorities of Berkshire and Milton Keynes, as well as the county and district local authorities of Buckinghamshire and Oxfordshire. This area includes the River Thames catchment and associated tributaries plus part of the Great Ouse catchment which falls in the Milton Keynes area.

In addition, the Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding, the availability of barriers at national level, and the availability of people, may influence our ability to deploy the barriers.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency's flood warning and alert service is available in all parts of the RS FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Due to the relatively long catchment response times associated with flooding from the River Thames, timely forewarning should be possible.

This enables the Council, emergency services, residents and businesses to prepare to reduce the impact of a flood.

Whilst that is the case, large parts of the RS FRA do not benefit from the presence of formal defences.

The River Thames Scheme Channel, which was proposed for reducing flood risk within Royal Borough of Windsor and Maidenhead, is not going ahead. This follows a decision by the Sponsorship Group to not include it, as the Royal Borough of Windsor and Maidenhead was not able to commit to its contribution at the time.

Working together, the Royal Borough and the Environment Agency are looking into different options to try and reduce the flood risk to Datchet.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Datchet RS FRA

Measures have been developed that apply specifically to the Datchet RS FRA. The measures created as part of the FRMPs are part of a strategic 6year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Datchet RS FRA.

You can find information about all the measures that apply to the Datchet RS FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Ditton Rivers and Sea Flood Risk Area

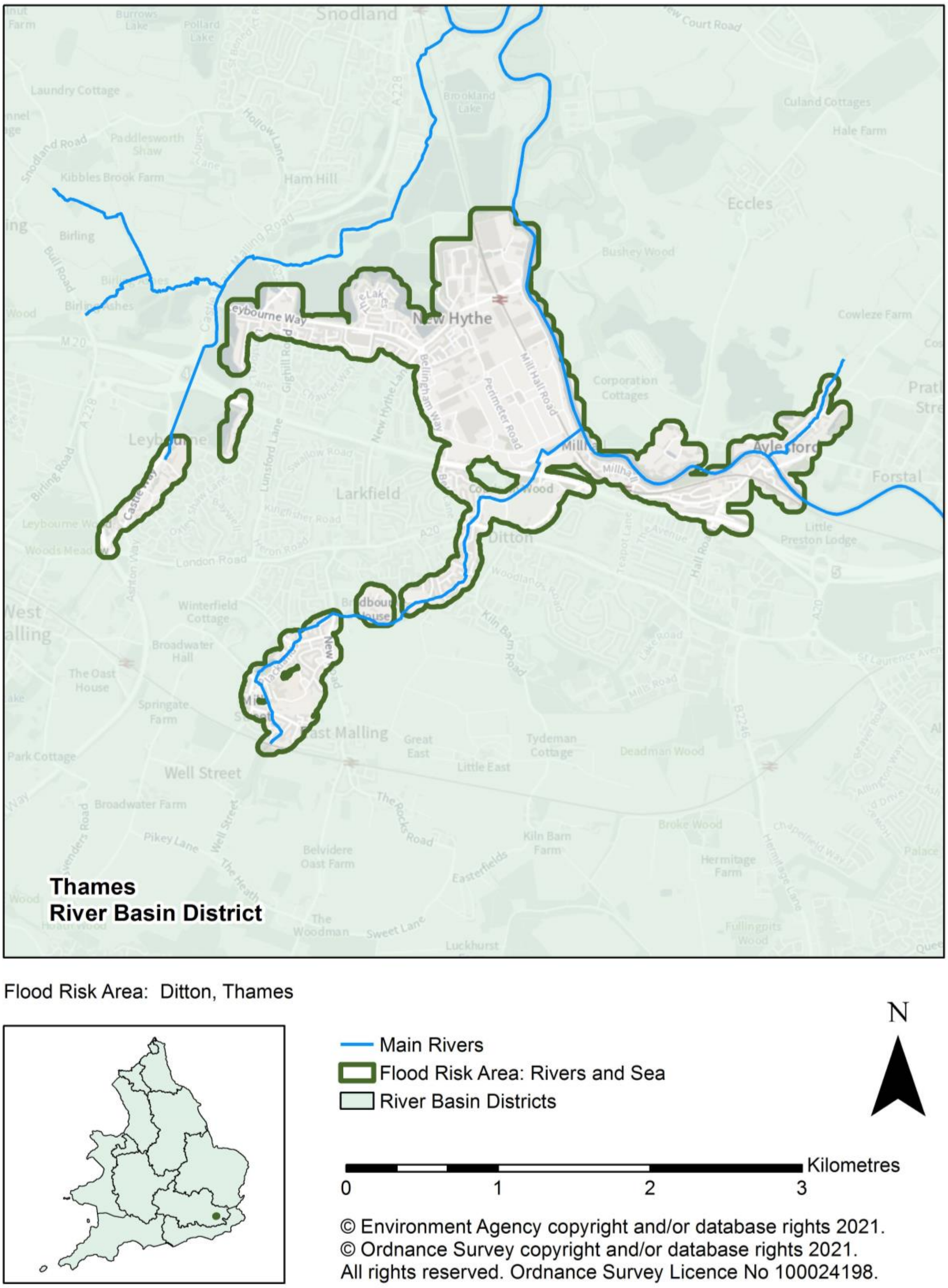


Figure 14: Map showing the Ditton Flood Risk Area boundary and its location in England

The Ditton Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the south-east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD.

It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Ditton RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

There are Risk Management Authorities (RMAs) operating in Ditton RS FRA, including:

- Environment Agency
- Lead Local Flood Authority: Kent County Council
- Unitary District/Borough Council: Tonbridge and Malling Borough Council
- Regional Flood and Coastal Committees (RFCCs): Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and Sewerage Company: Southern Water
- Department for Communities and Local Government through local planning authorities

Environment designations

The Ditton RS FRA is mainly rural with a mixture of fruit production, woodland, arable land as well as some improved pasture. Key urban areas include the village of East Malling and the community of Ditton, both at the lower end of the catchment.

The area is an old Saxon village with a history of paper making and recycling. Many of the old mills have been discontinued in their use now. However, there are also some quarries in the area. Many of these quarries are not used now but the ones still in use are for ragstone.

There are some historic features in Ditton such as that it is the only village to have a ford in the Tonbridge & Malling Borough. There are many historic manor houses and a church as well in the main village. The area historically benefitted from its access to raw materials and access to the Medway which helped develop the industrial sector in Ditton.

In the Ditton RS FRA, there is one site with a special environment designation. The Holborough to Burham Marshes is a site of special scientific significances (SSSI) and sits just at the northern edge of the FRA. There is another SSSI which sits just outside the boundary for the Ditton RS FRA called the Aylesford pits.

The full details for these designations can be found on the Defra MAGIC map database.

Much of the woodland in the FRA is designated as a Local Wildlife Site too around Leybourne Lakes and Eccles Old Pits.

Topography, geology, hydrogeology, land use

The topography of the Flood Risk Area is strongly influenced by dip slope of the Greensand Ridge, which falls to the north.

The Ditton Stream discharges into the tidal Medway within an area less than 5 metres above ordnance datum (mAOD). Elsewhere, the watershed at the southern end of the catchment rises up to 100 mAOD.

The underlying geology is an iron rich limestone of the Hythe Beds formation, known locally as ragstone.

The Hythe Beds has low transmissivity which means the rate of recharge is relatively slow compared to other aquifers. The groundwater from the ragstone provides a significant baseflow component to the Ditton Stream following prolonged periods of rainfall. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The impact of rainfall will be spread out over a relatively long period of time and high flow rates can be observed for several months after wet winters.

The Ditton RS FRA is 80% rural with a mix of fruit production, pasture, arable and woodland. Across the RS FRA, the character of the watercourses is predominantly fast flowing, spring fed channels. There are culverted sections through the urban areas.

Watercourses

The principal watercourses are the Medway Tidal Estuary and the Ditton Stream and its tributaries. The Ditton Stream is spring fed and due to the rural environment and high permeability of the catchment does not present a significant fluvial flood risk but there is a surface and groundwater flood risk. Towards the lower part of the catchment, the Ditton Stream passes through the Blacklands culvert. This conveys the Ditton Stream beneath a housing estate for approximately 400 metres. The significant issue is that the culvert is vulnerable to the precipitation of tufa, a carbonate rich mineral which precipitates from the water of carbon rich watercourses. The accumulation of tufa on the culvert lining is an important issue in managing fluvial flood risk within Ditton as it significantly reduces the capacity of the culvert leading to groundwater and surface water flooding.

The Ditton Stream discharges into the tidal reach of the River Medway. The Medway is defended by tidal walls at this point and presents a very low tidal flood risk to the area. There was a flood event from the Ditton Stream impacting basements to a few properties in later winter/spring 2021.This was driven by prolonged rainfall over the winter causing elevated spring flow.

Current flood risk

The main source of flood risk within this RS FRA is from main rivers.

Description of Risk Statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the RS FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Ditton RS FRA 4,057 (59%) people live in areas at risk of flooding from main rivers.

Additional receptors at risk of fluvial flooding within the Ditton RS FRA include:

- 4 services (7%)
- 258 non-residential properties (79%)
- Critical Infrastructure: .25 km of of motorways, primary and trunk routes, as classified by National Highways (14%) and 2.91 km of railway (83.6%)
- 36.58 hectares of agricultural land (59.5%)
- Natural environment: 2 Environmental Permitting Regulation installations (100%), 2.36 hectares of Sites of Special Scientific Interest (100%)
- Historic environment: 0.045 hectares of Scheduled Ancient Monument (100%) and 38 listed buildings (46%)
- 9 licensed water abstraction sites (69%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Groundwater flood risk

Groundwater flooding happens as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

The Ditton Stream is fed primarily from groundwater. The watercourse is slow to respond as dependent on groundwater levels but once it is inundated, leads to prolonged flooding for nearby properties. It is the main source for groundwater flooding for a few nearby properties in the Ditton RS FRA during periods of increased winter rainfall leading to greater spring flows through the subsequent dry periods.

How the risk is currently managed

Fluvial and tidal flood risk within the Ditton RS FRA is currently managed through a series of approaches. These include:

- development planning and adaptation
- flood risk assets
- flood warning systems
- flood risk modelling

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency works in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the tidal and fluvial watercourses which informs the Environment Agency incident response team on when to issue flood alerts and warnings.

There is no flow or level monitoring, so it is not possible to provide a Flood Warning Service from the Ditton Stream, nor is it considered necessary given the very low number of properties at risk. Those at risk are vulnerable to groundwater flooding. Please visit the flood warning information service to view the monitoring sites close to your area.

Flood defences

Maintenance of the Blacklands Culvert is the most significant asset in the area.

Cellar pumps are the most appropriate form of flood mitigation for those properties at greatest flood risk in this area. The Environment Agency actively undertakes routine maintenance of culverted sections in East Malling. KCC do likewise to highways drainage networks and in some cases, have provided sandbags to properties at risk to surface water flooding.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Ditton RS FRA

Measures have been developed which apply specifically to the Ditton Flood Risk Area. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Ditton RS FRA.

You can find information about all the measures that apply to the Ditton FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The East Peckham Rivers and Sea Flood Risk Area

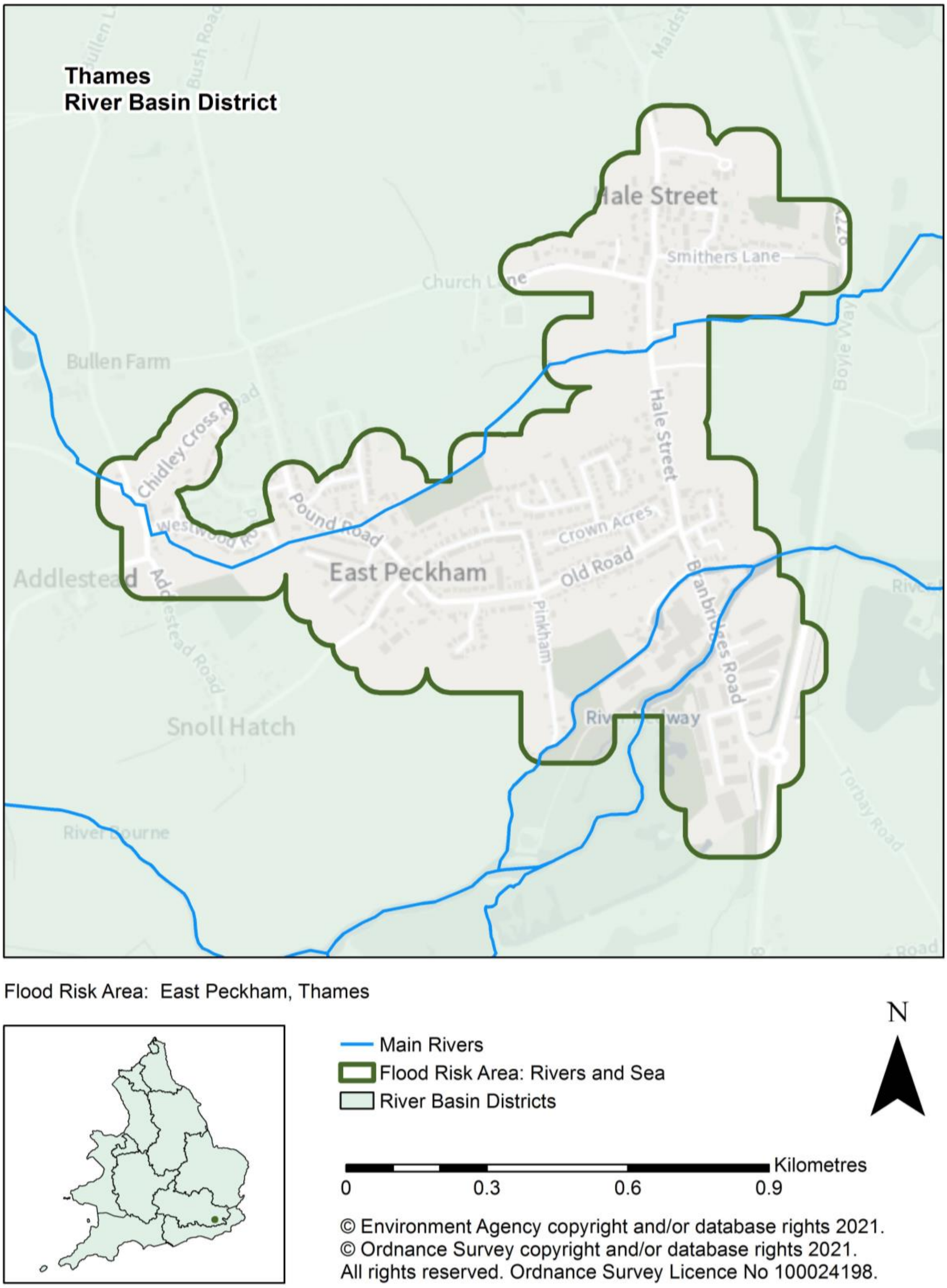


Figure 15: Map showing the East Peckham Flood Risk Area boundary and its location in England

The East Peckham Rivers and Sea (RS) Flood Risk Area (FRA) is in South East England and to the south-east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The East Peckham RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

There are Risk Management Authorities (RMAs) operating in East Peckham RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Kent County Council
- Unitary District/Borough Council: Tonbridge and Malling Borough Council
- Regional Flood and Coastal Committees (RFCCs): Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and Sewerage Company: Southern Water
- Department for Communities and Local Government through local planning authorities

Environment designation

East Peckham is a large village in Kent with a population of about 3,300 people. It has a long history of flooding due to its proximity to the Coult Stream, the River Bourne and the River Medway which run through or adjacent to East Peckham. East Peckham is situated on very fertile land which supported a long rural agriculture industry for wood, hop growing, and animal grazing. The proximity to the navigable river Medway was beneficial for East Peckham to remain connected to nearby towns for trade of resources and goods, allowing the village to grow and thrive.

In the East Peckham RS FRA, there are no sites with a special environment designation. There are local wildlife designated areas at the edge and near the border of the East Peckham FRA. The full details for these designations can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The geology of the River Medway catchment is Weald Clay bedrock with alluvium, clay, silt, sand and gravel superficial deposits. The low permeability of the Weald Clay means that the rivers in the catchment respond rapidly to rainfall contributing to flood risk in the area.

East Peckham is predominantly made up of residential and commercial properties. Arnolds Business Park and Branbridges Industrial Estate can be seen in the south-east part of the FRA. It is a mixed urban and rural environment with many old buildings and countryside characteristics mixed with the growing industrial sector.

Watercourses

The principal watercourse is the River Medway which runs through the lower end of the FRA. Another watercourse is the Coult Stream that runs across the FRA. The Coult Stream is the smallest of the three and runs East-West through the centre of East Peckham, close to residential properties. The River Bourne does not directly flow through the East Peckham FRA, however it flows through Little Mill to the south-west and connects to the River Medway. The River Medway flows through the south-east of the RS FRA close to the commercial properties. Due to the low-lying nature of the area, it is prone to fluvial flooding as well as pluvial flooding. For this reason, there has been a history of well documented flood events such as in 1947, 1958, 1960, 1963, 1968, 1974, and 1979.

The most recent flood events that affected the area occurred in 2000, 2002/3 and Christmas 2013/14. In 2013/14, 19 residential and 59 commercial properties were reported to have been flooded in East Peckham along with 13 residential properties and 2 commercial properties in Little Mill. Although only 32 residential properties were confirmed to have flooded in this event, it is likely more residential properties were affected than were reported.

The main flood management structure on the River Medway is the Leigh Flood Storage Area (FSA) located upstream from Tonbridge. This was primarily designed to reduce flood risk from the river Medway to Tonbridge Town Centre. Due to the number of tributaries that flow into the river Medway downstream of Tonbridge the benefit of the Leigh FSA reduces with distance downstream.

Current flood risk

The main source of flood risk within this FRA is from main rivers.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the East Peckham RS FRA 1,761 (83%) people live in areas at risk of flooding from main rivers.

Additional receptors at risk of fluvial flooding within the East Peckham FRA include:

- 6 services (40%)
- 110 non-residential properties (98.2%)
- 94.08 hectares of agricultural land (88%)
- historic environment: 29 listed buildings (88%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the RS FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk.

Groundwater flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages.

How the risk is currently managed

Fluvial flood risk within the East Peckham RS FRA is currently managed through a series of approaches. These include:

- development planning and adaptation
- flood risk assets
- flood warning systems
- flood risk modelling

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses which informs the Environment Agency incident response team on when to issue flood alerts and warnings. Please visit the flood warning information service to view the monitoring sites close to your area.

Flood defences

There are a series of assets in East Peckham to help manage river levels and provide protection from flooding such as the Coult Stream Dam and the Leigh Flood Storage Area.

A property level flood resilience scheme is underway to target all properties at very significant risk and properties that can provide evidence of internal flooding. The project is funding up to 7.5k in property flood resilience measures to residents that are eligible. The scheme is expected to complete in early 2022.

Hydraulic modelling

The Medway Model is a 2-D hydrodynamic model completed in 2015. It includes scenarios whereby peak flows during the 100Yr return period event are increased by 35% and 70%, which are two more likely scenarios estimated for the Thames RBD.

The Bourne and Coult Stream model was completed in 2019. This included new climate change scenarios for the 100Yr return period to model the increase by 35% and 70%.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the East Peckham RS FRA

Measures have been developed which apply specifically to the East Peckham RS FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the East Peckham RS FRA.

You can find information about all the measures that apply to the East Peckham FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Egham Rivers and Sea Flood Risk Area

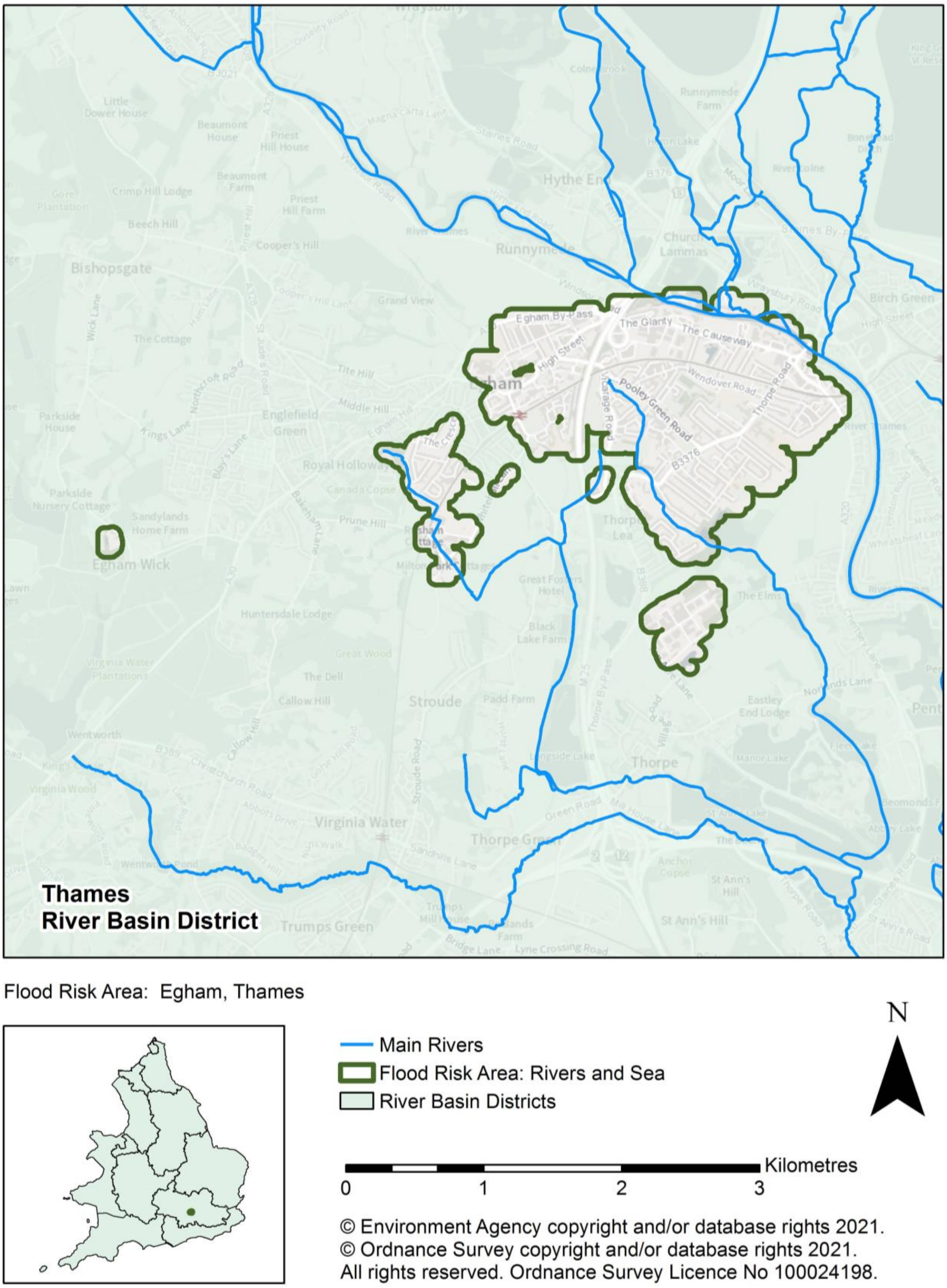


Figure 16: Map showing the Egham Flood Risk Area boundary and its location in England

The Egham Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Egham RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs). The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

Egham is one of the main towns in the borough of Runnymede within Surrey County Council boundary. The Egham RS FRA includes Ripley Springs and Egham Hythe and the M25 running through it. The River Thames is to the north and east. Egham Hythe is sandwiched between the M25 in the west and River Thames to the east.

There are several Risk Management Authorities (RMA) operating in the Egham Rivers and Sea Flood Risk Area including:

- Environment Agency
- Lead Local Flood Authority: Surrey County Council
- District council: Runnymede Borough Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: Surrey County Council and National Highways
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The land in the RS FRA slopes from Egham at around 18 metres above ordnance datum (mAOD) towards Egham Hythe at around 14 mAOD. The underlying geology is silt, sand and clay. The porosity of clay is low and this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding. The sand provides a well-drained coarse loamy sandy soil type that is common over gravel.

Groundwater flow in the gravels beneath large parts of the RS FRA is derived primarily from the natural discharge of water from a chalk groundwater catchment, flowing from the north towards the valley floor of the River Thames. Under normal conditions, this groundwater drains southward, underground through the gravels to discharge into the Thames and associated surface water channels and ditches.

The RS FRA is mainly urban with small pockets of farmland which are towards the south of Ripley Springs.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities (RMA) and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made of a group of organisations who are working together through a catchment-based approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve identified issues.

For information on how risk from other sources is managed, this chapter should be read in conjunction with other sections of this plan as well as Surrey Local Flood Risk Management (LFRM) Strategy 2017.

Current flood risk

The main source of flood risk within this FRA is from main rivers. The River Thames is the primary river in this area and other main rivers include the Ripley springs, Hurst Ditch and Meadlake Ditch. All are mainly open channel. The River Thames floodplain is the largest in the area.

There are no formal flood defences within the area. There have been several historic events that have affected the FRA, however there have not been any significant flooding events since 2015. A significant event is when 20 or more properties were affected by flooding.

Fluvial flood risk: description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Egham RS FRA 12,568 (86.9%) live in areas at risk of flooding from main rivers. Of these, 25.2% are in areas of high risk. As well as people living within the floodplain, there are also services that have been built within the FRA. 33 services (28.4%) are in areas at risk of flooding from main rivers.

Also shown to be at risk of fluvial flooding in the Egham RS FRA are:

- 642 Non-residential properties (80.2%)
- critical Infrastructure: 1.90 kilometres of motorways, primary and trunk routes, as classified by National Highways located (88.7%), and 2.37 kilometres of railway (73.1%).
- 37.77 hectares of agricultural land (67.5%)
- 0.64 hectares of parks and gardens (38.5%)
- historical landmarks: 0.15 (100%) hectares of Scheduled Ancient Monument area and 24 (68.5%) listed buildings
- 3 (100%) licensed water abstraction sites

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Egham RS FRA is currently managed through a series of approaches. These include:

- development planning and adaptation
- flood risk assets
- flood warning systems
- flood risk modelling

In Surrey, the Environment Agency are part of the Surrey Flood Risk Partnership Board. This is a working group that aims to implement a joined-up approach to flood risk reduction.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers would offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding, the availability of barriers at national level and the availability of people may influence our ability to deploy the barriers.

The Environment Agency carries out maintenance to a proportion of the main rivers within the RS FRA. Some sections on the Meadlake Ditch and Ripley Springs are maintained to ensure conveyance. Future funding will help guide investment where it is most needed.

To reduce flood risk from the River Thames, the Environment Agency are committed to working closely with partners and stakeholders to design a scheme, the River Thames Scheme, that provides the most benefit to communities. The River Thames Scheme is expected to reduce flood risk to communities including 11,000 homes and 1,600 businesses in Surrey and south-west London. Road, rail, power and water networks are also expected to be more resilient throughout the scheme footprint.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Egham RS FRA

Measures have been developed which apply specifically to the Egham RS FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Egham RS FRA.

You can find information about all the measures that apply to the Egham RS FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Esher Rivers and Sea Flood Risk Area

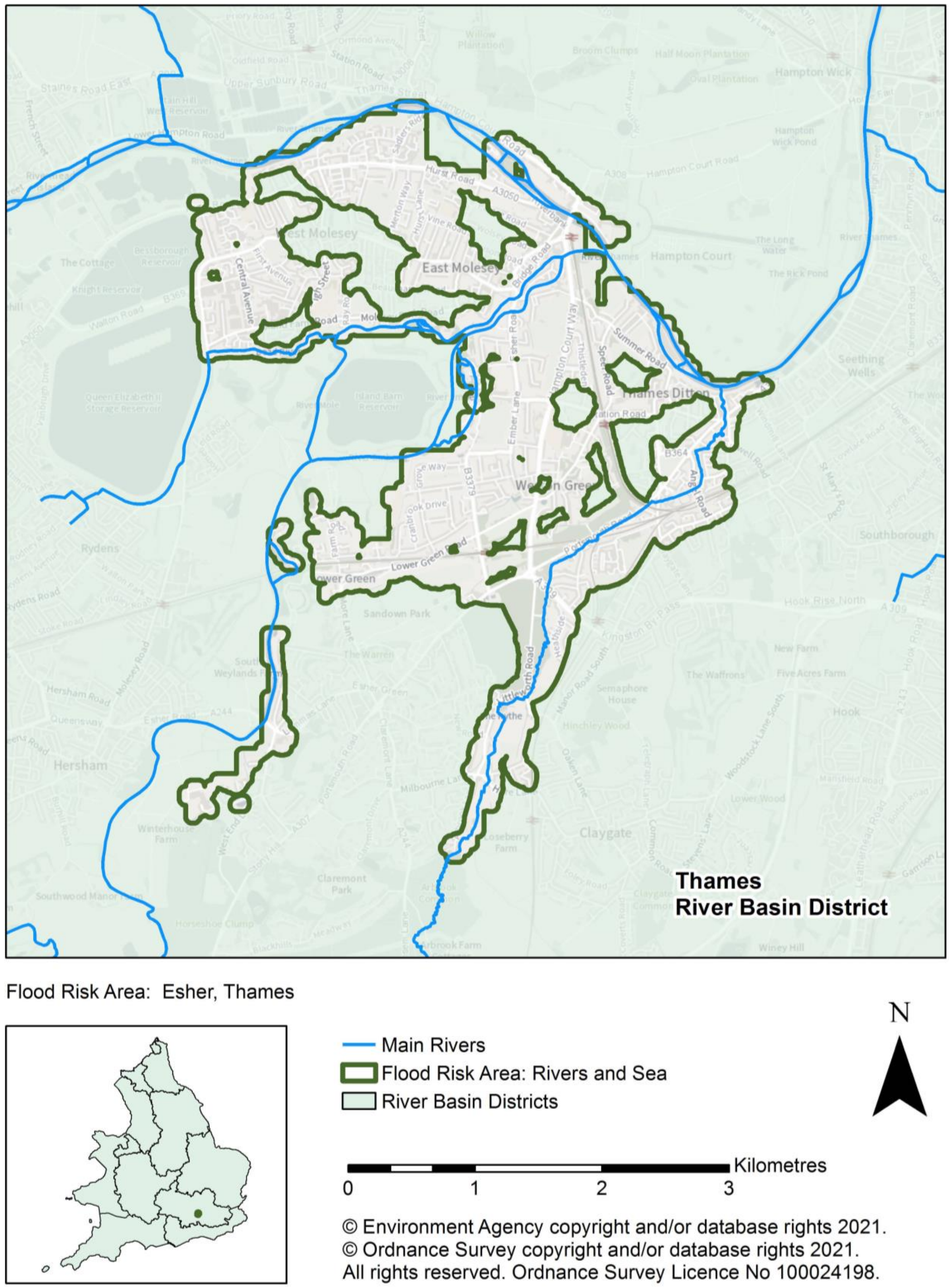


Figure 17: Map showing the Esher Flood Risk Area boundary and its location in England

The Esher Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and to the centre of the Thames River Basin District (RBD). It will be solely reported by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Esher RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs). The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Esher RS FRA spans across large parts of West and East Molesey, Esher and Thames Ditton. East and West Molesey border the London Borough of Richmond and Kingston, which lie on the opposite side of the River Thames. Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows across the ground. Parts of the Esher RS FRA overlaps with the Greater London FRA from Surface Water.

There are Risk Management Authorities (RMA) operating in Esher RS FRA, including:

- Environment Agency
- Lead Local Flood Authority: Surrey County Council, Greater London Authority
- District councils: Elmbridge Borough Council, London Borough of Richmond Upon Thames
- Regional Flood and Coastal Committee: Thames Regional Flood and Coastal Committee
- Highways Authorities: Surrey County Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The areas located adjacent to the River Thames are largely flat at about 5 to 10 metres above ordnance datum (mAOD). It is primarily residential in character ranging from predominantly Victorian housing in the east to 1960s housing in the west. The urban centre of Esher is not in itself at risk of fluvial flooding as it is located on high land (35-50 mAOD). The land falls away to the west towards the River Mole floodplain where levels are approximately 10 to 15 mAOD with relatively low density of the existing development. Whilst most of the built environment in Thames Ditton has been developed at a higher density in the past than other areas of Elmbridge, reflecting its location on the edge of London, most dwellings are either detached or semi-detached houses.

The Claygate Member (sand, silt and clay) and London Clay Formation (clay and silt) make up a large part of the FRA. Alluvium is present alongside the Rivers Thames. Because the porosity of clay is fairly low in clay dominated areas, this can result in slow infiltration rates and increased surface water run-off.

Partnership working

The Environment Agency works collaboratively with partners and communities to improve the water environment through the River Mole Catchment Partnership hosted by Surrey Wildlife Trust and South East Rivers Trust. Together they strive to better understand the catchment and to develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

Current flood risk

The main source of flood risk within Esher RS FRA is from main rivers including the River Mole and Ember (west and north), the River Thames (north) and the River Rythe (east). Some parts of the Flood Risk Area are also susceptible to groundwater flooding including East and West Molesey where the underlying geological conditions are more permeable.

The River Mole rises in the North Sussex hills near Rusper and flows into the River Thames at Molesey with parts of the Middle Mole and Lower Mole flowing through the FRA. The Lower Mole has been extensively modified by the construction of the Lower Mole Flood Alleviation Scheme between 1977 and 1991. The River Ember is a channel of the River Mole which flows around the east of Island Barn Reservoir before flowing north-east, parallel to the River Mole channel towards their confluence with the Thames, just south of Hampton Court Bridge.

The River Mole has experienced three major flood events in recent history: in 1968, 2000 and 2013. The most severe event remains the September 1968 event where several thousand properties and businesses along the Lower Mole in Molesey and Hersham were subject to flooding. The Lower Thames floodplain is relatively broad and flat and the river itself contains several islands. The River Thames is therefore slow to rise and fall and properties and businesses can be flooded for days or weeks. The normal tidal limit of the River Thames occurs near Teddington Weir, approximately 5km downstream from Thames Ditton.

There have also been serious floods to the north of the RS FRA. Large floods occurred there in 1947, 1968 and 2003. In January and February 2014 there was prolonged and widespread flooding affecting approximately 1,000 homes and many businesses. The estimated economic impact of a major flood in the River Thames Scheme area is currently around £1 billion. Due to the impact of climate change, damage could be twice as great by 2055.

The River Rythe rises near Oxshott, in the Prince’s Coverts woodland and flows northwards, through Claygate and along the edge of Hinchley Wood. The river then follows the Portsmouth Road towards Thames Ditton, and runs into the River Thames near Ferry Road, forming the boundary between Kingston and Thames Ditton. The River Rythe drains a total catchment area of approximately 19km2, half of which is urbanised.

Fluvial Flood Risk — Description of Risk Statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Esher RS FRA 18,332 (63.3%) people live in areas at risk of flooding from main rivers. Of these, 4.9% are in areas of high risk.

As well as people living within the floodplain, there are also services that have been built within the FRA. 49 services located within the Esher RS FRA are in areas at risk of flooding from main rivers. Schools and sewage treatment works are example of services.

Also shown to be at risk of flooding from main rivers in the Esher RS FRA are:

- 724 (67%) non-residential properties
- 4.53 km of stretches of motorways, primary and trunk routes, as classified by National Highways
- 0.52 km (5.4%) of railway is at high risk, 0.14 km (1.5%) is at medium risk and 0.99 km (10.2%) is at low risk
- 1.06 ha (18.7%) of Sites of Special Scientific Interest
- a small proportion (0.08 ha) of Special Protection Areas (SPA) and Ramsar being at high and medium risk
- 4.67 ha (47.3%) of parks and gardens
- one licensed water abstraction
- historic environment: 3.02 ha of Scheduled Ancient Monument area, 52 listed buildings

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the parts of the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Esher RS FRA is currently managed through a series of approaches. These include:

- development planning and adaptation
- flood risk assets
- flood warning systems
- flood risk modelling

In Surrey, The Environment Agency are part of the Surrey Flood Risk Partnership Board. This is a working group that aims to implement a joined-up approach to flood risk reduction.

In parts of the FRA, the Environment Agency is managing existing flood risk effectively and will keep this approach under review, looking for improvements and responding to new challenges or information as they emerge. Parts of the Esher FRA benefit from a reduction in flood risk from the Lower Mole Flood Alleviation Scheme which became operational in 1989.

The Lower Mole Flood Alleviation Scheme is composed of a range of asset types, including:

- an engineered flood relief channel
- embankments
- flood walls
- sheet piling with capping
- several river level control structures

Several river level structures are not owned nor operated by the Environment Agency. Works on elements of the Flood Alleviation Scheme are required to ensure that the current standard of protection can be maintained into the future. This presents opportunities to provide environmental outcomes in line with the River Basin Management Plan's ambitions.

These opportunities include removal of in-channel structures, channel enhancement including softening of banks, restoration of natural processes and improvements to fish passages. The Environment Agency is committed to working closely with partners and stakeholders to update the Scheme to ensure it is the best scheme for the environment, people and wildlife.

The Middle Mole and River Rythe do not benefit from the presence of formal defences.

To reduce flood risk from the River Thames, the Environment Agency are committed to working closely with partners and stakeholders to design a scheme, also known as River Thames Scheme, that provides the most benefit to communities. The River Thames Scheme is expected to reduce flood risk to communities including 11,000 homes and 1,600 businesses in Surrey and south-west London. Road, rail, power and water networks are also expected to be more resilient throughout the scheme footprint. In this area the scheme will consist of measures at a community level.

In addition, the Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barrier would offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the defences.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency's flood warning and alert service is available in most parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Esher RS FRA

Measures have been developed which apply specifically to the Esher RS FRA. The measures created as part of the Flood Risk Management Plans (FRMPs) are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Esher RS FRA.

You can find information about all the measures that apply to the Esher RS FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Farnborough Surface Water Flood Risk Area

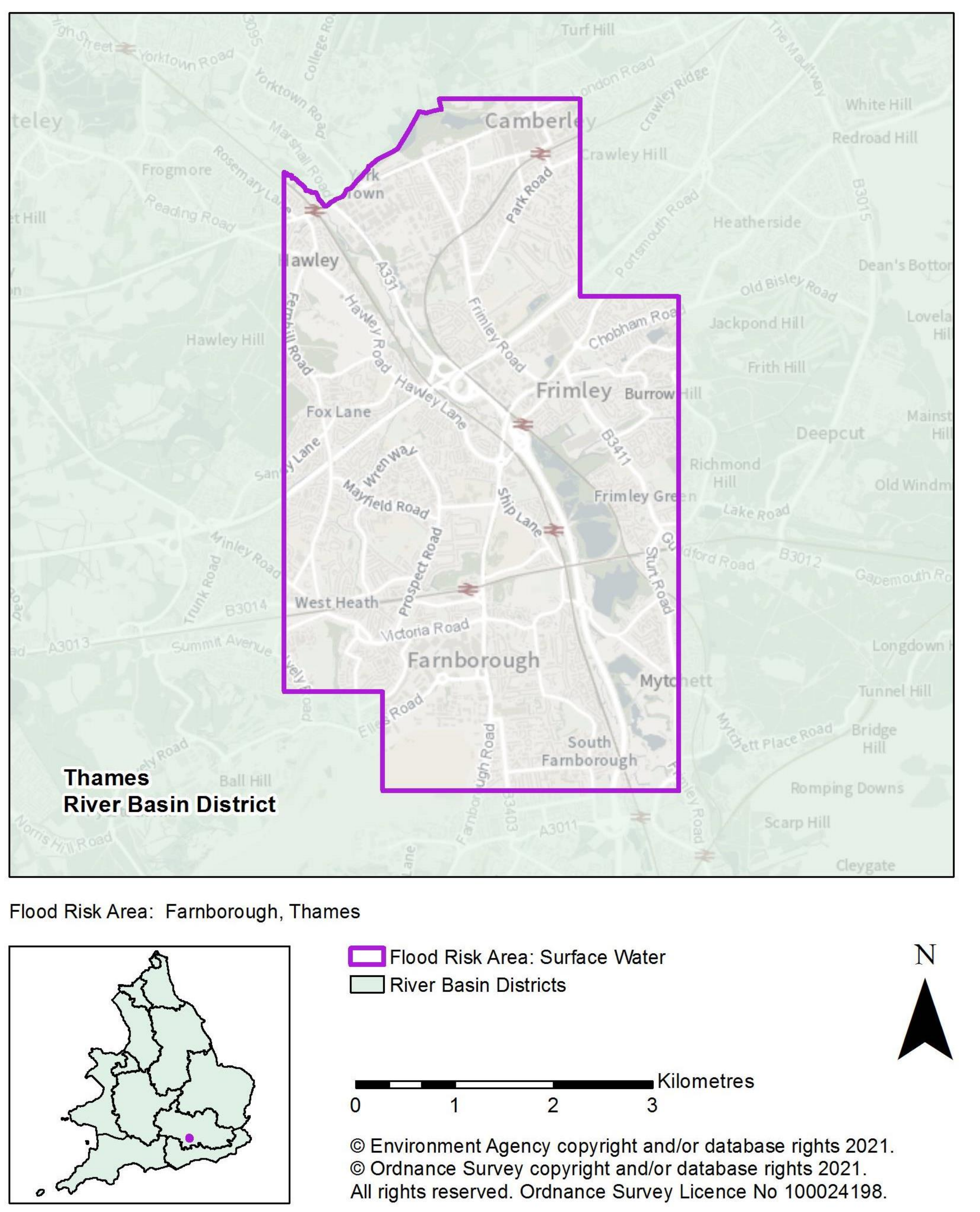


Figure 18: Map Showing the Farnborough Flood Risk Area Boundary and its location in England

The Farnborough Surface Water (SW) Flood Risk Area (FRA) is in the South East of England, and to the south-west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Farnborough SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs). Farnborough is in the north of the borough of Rushmoor, in the very north-east of the County of Hampshire. It forms, with Blackwater and Aldershot, a projection of north-east Hampshire into Surrey. The River Blackwater marks the county boundary. It is centred 34 miles (55 km) WSW of London and 16 miles (26 km) east of Basingstoke and is bordered by the administrative area of Surrey Lead Local Flood Authority (LLFA).

The relevant LLFAs within this SW FRA lead on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water.

Farnborough is one of two major urban areas in Rushmoor, the other being Aldershot in the South. Farnborough Airport is a business airport located to the south-west of Farnborough.

The town lies at the centre of the Blackwater Valley conurbation, which includes:

- Aldershot
- Camberley
- Yateley
- Sandhurst
- Frimley
- Blackwater
- Farnham

Within Farnborough the only naturally occurring significant flowing water is Cove Brook.

There are Risk Management Authorities (RMAs) operating in Farnborough SW FRA, including:

- Environment Agency
- Two Lead Local Flood Authorities (LLFAs): Hampshire County Council and Surrey County Council
- Three district councils: Rushmoor Borough Council, Hart District Council and Surrey Heath Borough Council
- Regional Flood and Coastal Committee: Thames
- Three Highways Authorities: Hampshire County Council, National Highways and Surrey County Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the SW FRA is strongly influenced by the River Blackwater valley.

Most of Farnborough is low lying and level, from approximately 50 metres above ordnance datum (mAOD) up to approximately 80 mAOD. Some artificial land levelling has taken place for industrial parks and the airport.

The underlying geology for the majority of Farnborough is Camberley Sand Formation in the north. River Terrace Deposits are also present in South Farnborough. Within these areas, the low porosity can result in slow infiltration rates and increased surface water run-off. As Farnborough is an urban area, this can exacerbate the potential issues for surface water flooding.

The Farnborough parts of the SW FRA are mainly urban with a minority / grassland and woodland. There are open areas including Farnborough Green, Queen Elizabeth Park and West Heath. Farnborough airport, business park and Air Sciences Trust Museum create large areas of impermeable surfacing. The Farnborough SW FRA covers parts of Hampshire County Council and Surrey County Council. The Farnborough SW FRA is urban with a low proportion of arable land. Key urban areas include the town centre and Farnborough airport.

The flood risk present in this FRA is from a combination of river flooding and surface water flood risk. This is due to the urban nature of the area. The River Blackwater and Cove Brook are of particular significance as they run adjacent to and through the town respectively. The river Blackwater has significant flood plains and wetlands on the Surrey side of the river. Some areas within the SW FRA are also at risk from other sources, including Cove Brook Flood Storage Area.

The A331 broadly follows the route of the River Blackwater and is at risk of surface water and fluvial flooding due to its impermeable nature.

In urban areas like West Heath, the Cove Brook occasionally runs in man-made channels and culverts but re-appears to flow through parks and green spaces.

Partnership working

Hampshire County Council and Surrey County Council work collaboratively with partners and communities to improve the water environment.

Relevant LLFAs work collaboratively with other Risk Management Authorities and partners within the Loddon Catchment Partnership area. This is hosted by South East Rivers Trust to better understand the catchment and to develop joint plans to improve the health of the local water environment. Better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

This chapter should be read in conjunction with other sections of this plan for information on how risk from other sources will be managed.

- Flood warning information service: River Blackwater and The Cove Brook
- Rushmoor Surface Water Management Plan

Current flood risk

The main sources of flood risk within Farnborough SW FRA are:

- Fluvial primarily from the River Blackwater and Cove Brook
- Surface Water in urbanised areas

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Farnborough SW FRA has been identified as being at significant risk of flooding due to low elevations and flat topography of the area. These are conducive to surface water ponding, road networks and impermeable surfaces.

Surface water flood risk: description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets that would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the SW FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Farnborough SW FRA (about 24,400 properties) some 14,516 people live in areas at risk of flooding from surface water. Of these, 1.5% are in areas of high risk. As well as people living within the floodplain, there are also services that have been built within SW FRAs. There are 594 services in the FRA including 42 in areas at risk of flooding from surface water. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from surface water in the Farnborough SW FRA:

- 1,105 non-residential properties (37.4%)
- transport infrastructure: 5.64 km of railways (32.3%) and 1.3 km (10.4%) of motorways, primary and trunk routes, as classified by National Highways

- natural environment: 4.13 hectares (17.4%) of parks and gardens, 0.45 hectares of Special Protection Areas (4.6%) and 0.92 hectares (8.5%) of Sites of Special Scientific Interest
- historic environment: 3 out 73 listed buildings
- 5 out of 6 licensed abstractions

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the parts of the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Fluvial flood risk

The Farnborough SW FRA consists of Blackwater River and its tributaries, of which Cove Brook is the largest.

The River Blackwater is a tributary of the Loddon in England and sub-tributary of the Thames. It rises at two springs in Rowhill Nature Reserve between Aldershot, Hampshire and Farnham, Surrey. It curves a course north then west to join the Loddon in Swallowfield civil parish, central Berkshire. Part of the river splits Hampshire from Surrey; a smaller part does so for Hampshire and Berkshire. The source is locally rare heath within the Thames Basin Heaths Special Protection Area, due to the Farnborough/Aldershot Built-up Area.

Cove Brook runs 4 miles (6.4 km) from near Farnborough Airport in Farnborough, Hampshire, England and flows through the former Southwood Golf Course where it is joined by Marrow Brook and other smaller streams. It runs north through Cove before joining the Blackwater at Hawley Meadows near the M3 motorway.

Gradient is an important factor in determining the hydrological response and in steeper catchments water levels can rise quickly after rainfall, with little advanced warning.

The River Blackwater tends to react more slowly to rainfall because the gradient is very low.

Cove Brook can react more quickly to rainfall because areas of it have been modified and located in urban areas.

How the risk is currently managed

Surface water flood risk within the Farnborough SW FRA is currently managed through a series of approaches. These include:

- development planning and adaptation
- sustainable drainage systems
- maintenance
- flood awareness

The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual probability events: 3.3% chance of flooding each year, 1% chance of flooding each year and 0.1% chance of flooding each year. The modelling helps the Environment Agency take a strategic overview of flooding and helps Hampshire County Council (as the LLFA) in their duties relating to management of surface water flood risk.

The following areas are shown to be at particular risk, although the following list is not exhaustive:

- surface water ponding is shown in an area of predominantly commercial properties north of Meudon Avenue (Empress ward)
- a large area of surface water ponding is shown to the north of Farnborough Rugby's grounds and northwards towards the M3 motorway (Westheath and Cherrywood wards)
- ponding also occurs on the northern side of the M3 (Farnhill ward). In west Farnborough surface water ponding is shown along Whetstone Road and other roads nearby (St John's ward)
- areas in southern Farnborough are identified as key flood 'hotspots'; areas around Cheyne Way, Netley Street/Osborne Road, Sunnybank Road, Sycamore Road, A325 Farnborough Road and Rectory Road

While surface water flood risk is the main risk being discussed in this section, parts of the FRA benefits from the Environment Agency asset known as Cove Brook FRA, which reduces the risk of flooding from main rivers. It has a volume of about 95,000m3. The scheme entails an associated earth embankment, about 900m long, which is located on the eastern bank of Cove Brook. At the north-eastern end of the embankment there are concrete reinforcing embankments about 2.5m high and 1m wide, with a concrete flume flow control.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

It is possible that areas within the Farnborough RS FRA could experience flooding in the future. As a result of larger flood extents and deeper depths of flood water due to the impacts of climate change, the level of protection provided by flood defences will likely decrease. There will also likely be additional maintenance needs and stresses on assets that function with a higher frequency than were designed.

Objectives and measures for the Farnborough RS FRA

Measures have been developed which apply specifically to the Farnborough Surface Water FRA. The measures created as part of the FRMP are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames RBD) but which also apply to the Farnborough Surface Water FRA.

You can find information about all of the measures which apply to the Farnborough SW FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Five Oak Green Rivers and Sea Flood Risk Area

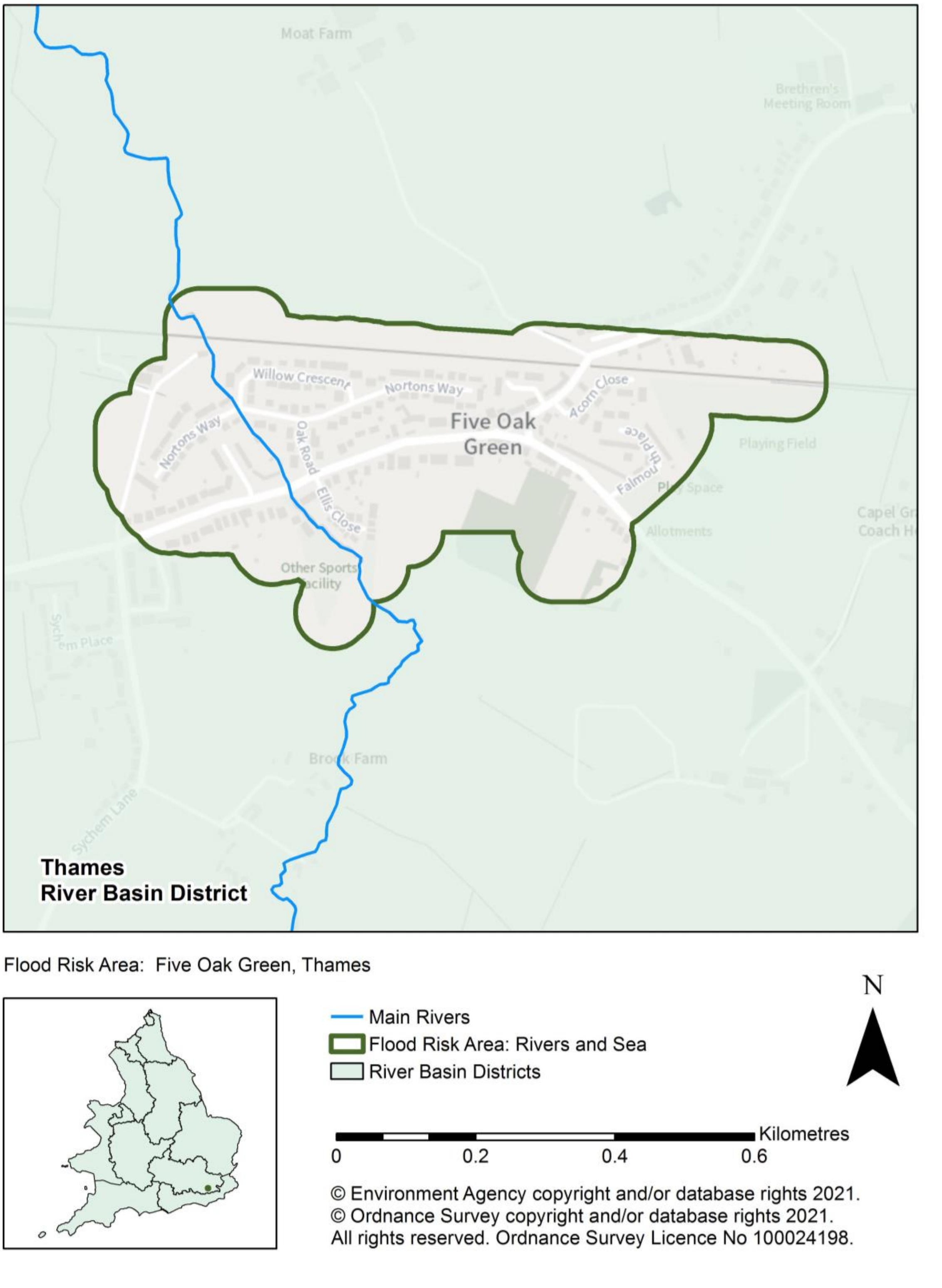


Figure 19: Map showing the Five Oak Green Flood Risk Area Boundary and its location in England

The Five Oak Green Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the south-east of the Thames RBD. It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Five Oak Green RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

There are Risk Management Authorities (RMAs) operating in Five Oak Green RS FRA, including:

- Environment Agency
- Lead Local Flood Authority: Kent County Council
- Unitary District/Borough Council: Tunbridge Wells Borough Council
- Regional Flood and Coastal Committees (RFCCs): Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and Sewerage Company: Southern Water
- Department for Communities and Local Government through local planning authorities

Environment designations

Five Oak Green is a small village in Kent with a population of about 1400 people. It has a long history of flooding due to its proximity to two major watercourses, the Alder Stream and the River Medway; the Alder Stream runs through the village before joining into the Medway outside the Five Oak Green RS FRA.

In the Five Oak Green RS FRA, there are no sites with a special environment designation but just outside its boundary there are some designated sites and local wildlife areas. The full details for the other designated sites can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The underlying geology is sandstone and siltstone (the Interbedded Tunbridge Wells Sand Formation) at the lower end of the catchment whilst further up the catchment the bedrock geology moves to Wadhurst Clay. Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off.

Five Oak Green village mainly consists of residential properties with some commercial properties. Further south of the village the land use primarily consists of rural farmland.

The area is generally a fast responding catchment due to the steep sided nature of the upper catchment. Surface water also plays a part in increasing flood risk whilst the fluvial side is exacerbated by the long culvert under the main residential part of the village. Gradient is an important factor in determining the hydrological response and in steeper catchments, water levels can rise quickly after rainfall, with little advanced warning.

Watercourses

The Alder Stream is the main watercourse that runs directly through Five Oak Green and enters a culverted area just as it meets the main residential part of the village. The culvert continues across the entire village before exiting into open channel by the railway to the north and eventually joining into the River Medway. There is also the southern water pumping station in the centre of the village which often requires to be pumped out during heavy rainfall events. Further up the catchment south of the village the channel enters a steeper sided valley susceptible to surface water runoff and rapid onset of flooding.

Five Oak Green has a long history of flooding due to its proximity to two rivers, the Alder Stream and the River Medway, the first of which runs directly through the village south to north. The River Medway runs adjacent to the FRA to the north of the village west to east and is also where the Alder Stream/River Medway confluence is located. In addition to the recent 2020 floods, the area has a well-documented flood history, suffering widespread flooding on multiple occasions, such as in 1960, 1968, 2000, 2001, 2009, and 2013.

Current flood risk

The main source of flood risk within this FRA is from main rivers.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment which could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted.

The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Five Oak Green RS FRA, 749 (83%) people live in areas at risk of flooding from main rivers.

Also shown to be at risk of fluvial flooding within the Five Oak Green RS FRA include:

- 1 service (12.5%)
- 17 non-residential properties (53%)
- 17.97 hectares of agricultural land (56.4%)
- historic environment: 11 listed buildings (100%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk. The surrounding catchment is dominated by farmland situated on steep sided hills that can generate surface runoff during heavy and localised rainfall events.

Ground water flood risk

Groundwater flooding happens as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly, it is also being associated with more localised floodplain sands and gravels.

Sewer water flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages. A sewage pumping station at centre of the village during heavy rainfall events is often overwhelmed and requires pumping out by the utility provider.

How the risk is currently managed

Fluvial flood risk within the Five Oak Green RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses which informs the Environment Agency incident response team on when to issue flood alerts and warnings. Visit the flood warning information service to see the monitoring sites close to your area.

A property flood resilience scheme is currently underway to protect residential properties at very significant flood risk and is expected to complete in 2022.

Flood defences

There are no designated hard engineered flood defences within the Alder Stream catchment. The upper catchment has however got areas with Natural Flood Management techniques implemented.

Hydraulic modelling

The catchment is covered by the Alder Stream fluvial model which was undertaken in 2015 by JBA Consulting.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Five Oak Green RS FRA

Measures have been developed which apply specifically to the Five Oak Green FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc.

These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Five Oak Green RS FRA.

You can find information about all the measures that apply to the Five Oak Green FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Greater London Surface Water Flood Risk Area

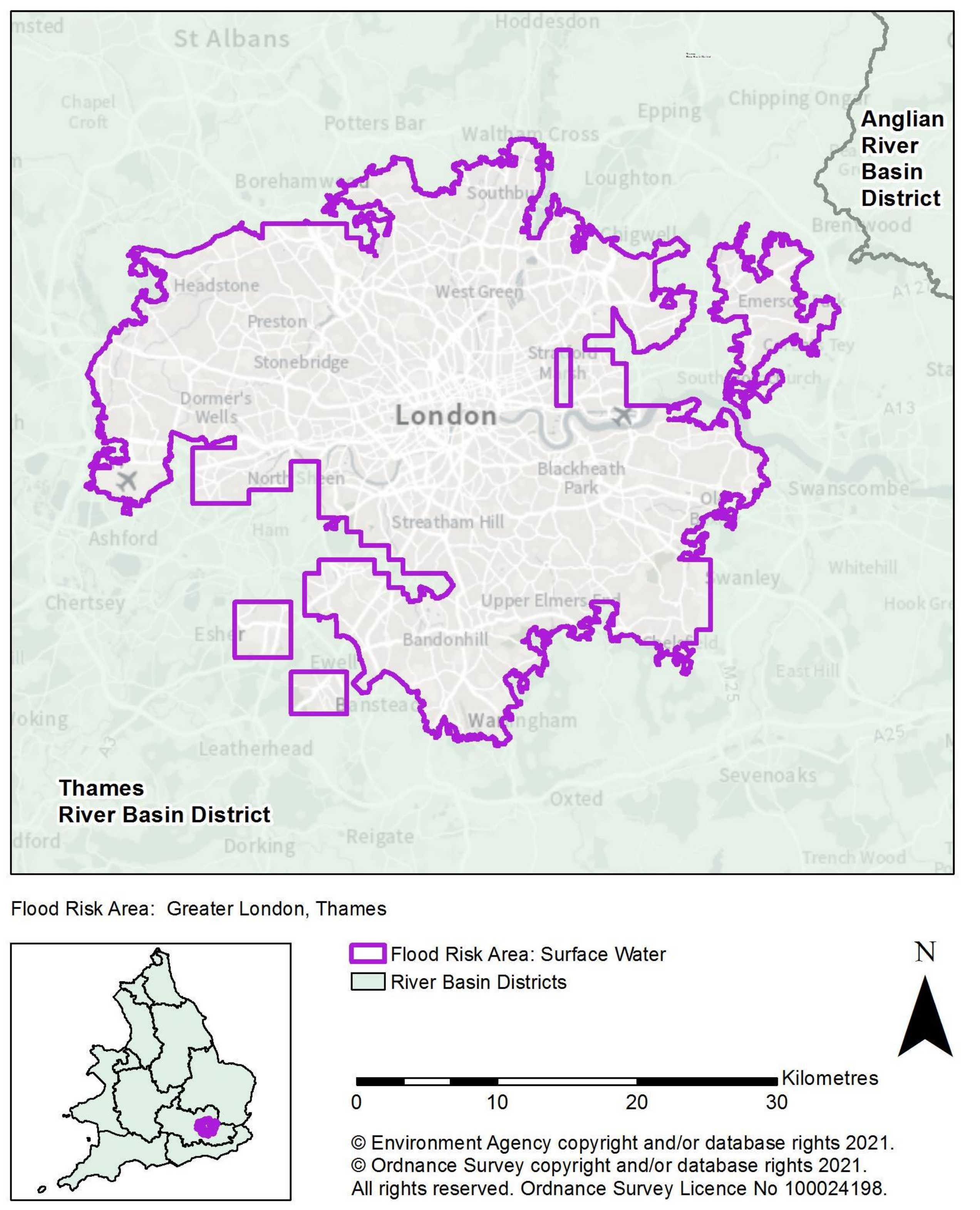


Figure 20: Map showing the Greater London Flood Risk Area Boundary and its location in England.

The Greater London Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Greater London SW FRA covers parts of all London boroughs and a small area north-east of Surrey. The Greater London SW FRA is mostly urban with a low proportion of parks, agricultural land, and the London green belt.

The main source of flood risk within the Greater London FRA is surface water. This section will discuss the surface water risk within this FRA. For more information on risk from rivers and sea in this area, please refer to the London and Thames Estuary Rivers and Sea FRA section of this document. The Greater London Surface water FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

Every London borough council has the role of Lead Local Flood Authority (LLFA) within their local authority area. In this role, they partner with other risk management authorities, including the Environment Agency, Thames Water, and other stakeholders, to manage surface water, groundwater, and ordinary watercourse flood risk.

Their duties include, but are not limited to:

- identifying flood risks within their borough
- determining potential interventions for managing the flood risk
- applying for funding to implement the identified interventions
- preparing and maintaining strategy for local flood risk
- maintaining a register of flood risk assets

Representatives from all London boroughs attend a joint forum called the London Drainage Engineers Group (LoDEG). The forum facilitates collaboration between the boroughs and other strategic risk management authorities to manage highway and land drainage systems and surface water flood risk. The 33 London borough councils are working to better understand their local flood risk within the Thames river basin catchment and to develop joint plans to improve the health of the local water environment.

For more information about the London Drainage Engineers Group, you can visit their website.

There are Risk Management Authorities operating in Greater London SW FRA, including:

- Environment Agency
- 34 Lead Local Flood Authorities
- District council: Elmbridge Borough Council
- Two Regional Flood and Coastal Committees: Thames RFCC and Southern RFCC
- 36 Highways Authorities: 34 LLFAs London Boroughs, Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980) and National Highways manage major motorways.

- Water and Sewerage Company: Thames Water
- MHCLG Ministry of Housing Communities and Local Government through local planning authorities

Environmental designations

In the Greater London SW FRA, there are several sites that have special environmental designations. These are clustered particularly in the Lee Valley and south-west London areas. The full detail of these designations can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The SW FRA is mainly urban, with dispersed green space. The existing urban areas within this SW FRA are densifying, with most new developments taking place on formerly developed sites (sometimes called brownfield sites).

The London Plan 2021 identifies Growth Corridors and Opportunity Areas in London. For more information, see the London Plan 2021. The London Plan 2021 also includes policies and details of credit systems that incentivise development of previously developed sites, as opposed to sites that have not been previously developed. Land use policies restrict inappropriate development on protected open land and green space. The London Plan also includes policies requiring the creation of replacement off-site habitat and on-site greening as compensation for any changes in land-use causing unavoidable impacts on the existing environment. This contributes to the retention of remaining permeable land, allowing for maximum rainwater infiltration and attenuation, which is important in mitigating current surface water flood risk.

Across the SW FRA, the character of the surface water flow routes varies considerably. There are multiple factors that contribute to their determinacy, including topography, sewerage capacity, land permeability, and groundwater storage.

The topography of the SW FRA is strongly influenced by the shape of the Thames river basin, with most of the SW FRA sitting in low-lying areas no more than 20 metres above ordnance datum (mAOD). The topography of the SW FRA is generally flat, but features discrete clusters of hilly areas in the boroughs of:

- Barnet
- Harrow
- Hillingdon
- Camden
- Islington
- Haringey
- Southwark
- Lewisham
- Bromley

- some lone hills in Sutton, Croydon, Greenwich, and Havering

The underlying geology is predominantly clay, which significantly impacts permeability in the area. However, the geology changes as the River Thames runs from west to east: from clay at Teddington Lock in the west, to sands, gravels, and chalk in Greenwich moving east out into the estuary.

Due to the low porosity of clay, infiltration rates are slow, which can result in increased surface water run-off. This is true for the majority of the catchment, however, within the London Clay formation there are sand lenses, which can exacerbate the potential issues of surface water flooding in urban areas.

Water can infiltrate chalks, sands, and gravels quickly, whilst also moving within and through these deposits. As a result, these form a major part of the Thames RBD's groundwater resources. The groundwater from within the chalk aquifers provide a significant baseflow component to the rivers in the Thames river basin. Water flows slowly through these aquifers and is released at a slow rate into the rivers, which can lead to a delayed impact from heavy rainfall.

Current flood risk

Current flood risk in this FRA is complex due to the dense population, aging infrastructure, fewer green spaces, and topography, however, the main source of flood risk within this FRA is from surface water.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Greater London SW FRA 1,399,544 (17.7%) people live at risk of flooding from surface water.

There are many other people, services and buildings also at risk of surface water flooding within the Greater London FRA. These include:

- 3,471 services, including schools, hospitals, nursing homes, etc. (8.7% of the total in the area)

- 53,625 non-residential properties at risk (17.6% of the total in the area)
- a significant number of historic and older buildings within this FRA - which can, in some cases, contribute to a lower level of resilience to surface water flooding if these buildings do not have measures in place to help drain away water
- recently developed buildings - which, due to local regulations and policies, often employ sustainable drainage systems and other measures to be resilient to flood risk
- 564.9 hectares of agricultural land (11.7%)
- 82 Environmental Permitting Regulation installations located within 50 metres of the Greater London SW FRA (96.5%)
- 414.9 hectares of parks and gardens (12.6%)
- Historical landmarks at risk include 18.7 hectares (15.4%) of Scheduled Ancient Monument area and 1,976 (11%) listed buildings
- 105 (21%) licensed water abstraction sites

The critical infrastructure at risk include:

- all 3 airports (100%)
- 194.2 kilometres of motorway, primary and trunk routes, as classified by National Highways (35.9%)
- 429 kilometres of railway (36.5%)
- ongoing specific critical infrastructure projects within this SW FRA, for example High Speed 2 and the Lower Thames Crossing

Protected areas at risk include:

- 37.7 hectares of Special Areas of Conservation (SAC) (11.7%)
- 10.4 hectares of Special Protection Areas (SPA) (5.8%),
- 10.4 hectares of Ramsar site area (5.8%)
- 46 hectares of World Heritage Site (5.9%)
- 162.2 hectares of Sites of Special Scientific Interest (SSSI) (15.2%)

Conclusions based on risk statistics

Flooding within the Greater London SW FRA is a complex system with many differing factors impacting its risk. There are 1,399,544 people living in the Greater London SW FRA at risk from surface water flooding. Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The sewerage system in London does not always separate surface water and foul water. In inner London, there is a combined system, which takes rain and foul water.

The Greater London SW FRA has been identified as being at significant risk of flooding due to a combination of factors including:

- widespread, impermeable urban land cover
- low-lying areas that are conducive to surface water ponding
- culverted watercourses
- kerb and boundary wall heights
- ageing drainage infrastructure that is often overwhelmed
- a Victorian combined sewerage system with limited capacity which gets overwhelmed when it rains heavily. This can lead to flooding in basement and lower-level properties and to rain being unable to reach the sewer system, exacerbating surface water flooding. The sewerage system in London does not always separate surface water and foul water. In inner London, there is a combined system, which takes rain and foul water

Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations at risk.

Many natural drainage systems, including tributary streams and ditches, have been largely removed or built over. The same can be said for the outer London boroughs, i.e., Harrow has 80 kms of rivers, of which 50 kms are in culvert. This has led to a dispersion of surface water risk over many small, localised areas with lower elevations than the surrounding land. The areas at risk can include structures such as residential basements, sub-surface car parks, and servicing yards, among others. This is especially true where natural drainage systems have been filled in or covered, but where the topography is still lower than surrounding areas. Sewer flooding often combines with surface water due to the limited capacity in combined sewer systems. For more information, refer to the London Regional Flood Risk Appraisal 2018 and Strategic Flood Risk Assessments of each of the London Boroughs.

It is worth noting the London 2021 flooding which occurred during the writing of this FRMP. In July 2021, several isolated days of intense rain across South East England resulted in major flooding in the capital.

London was hit by two extreme storms on 12th and 25th July. Parts of London received close to 100mm of rain, the equivalent of more than twice the average in just two hours. The rain caused damage and disruption to homes and infrastructure across the city and many Londoners required rehousing as their homes were flooded with stormwater and sewage. It rendered critical infrastructure unusable with the closure or partial closure of 30 London Underground stations and the evacuation of hospital wards and schools. Some of these schools (information dated May 2022) have still not seen students return to damaged classrooms as repairs continue. The Mayor convened a Roundtable following these events including the Environment Agency and London Councils, Thames Water and other key organisations instigated a Task and Finish Group More information can be found in the Mayor of London's Roundtable progress report and within the Thames Water Independent review London Flooding Investigations Non-Technical Summary.

We, collectively as the Environment Agency and our supporting LLFAs co-writing this FRMP, have reviewed the Mayor of London's 'round table' output and 'London Councils' TEC Executive Sub Committee report' within our wider pan-London steering groups and support the recommendations highlighted in this report. The report provides a summary of the work of the 'Surface Water Flooding Task and Finish Group' and a set of recommendations to develop a long-term strategic plan for surface water flood risk management in London. The Environment Agency co-chaired the group (with London Councils). All member organisations will continue to work in partnership with LLFAs and the future Strategic Water Governance Group in the development of the strategic plan manage surface water flood risk in London. We anticipate that the implementation plan will start during this cycle of the FRMP. Therefore, we want to ensure an iterative review of FRMP measures and ongoing liaisons to develop cycle 3 measures for the next FRMP cycle.

Sewer flood risk

The sewer network in London is Victorian and designed to serve a much less populous area. This sewer network is affected by groundwater ingress, blockages often referred to as 'fatbergs', as well as excess surface water entering the drainage network. Most of this flooding is a result of inadequate capacity within the sewerage system, insufficient capacity within the surface water network, and blockages. This is only exacerbated by the loss of natural flood plain as a result of historic and continued development pressures.

Central London's sewer system is combined: foul waste from homes joins rainwater runoff from gullies and roads. During heavy rainstorms, the sewerage systems can become overwhelmed by rainwater run-off. This is especially true in urban areas with impermeable land cover, which prevents rainwater filtering into the ground. Blockages or reductions in capacity within the sewer network can exacerbate the flooding in these situations.

It is difficult to predict this type of flooding due to its localised nature and the speed at which it can occur during intense storm events. In the outer London boroughs, added complexity arise from issues within the dual manhole network, allowing foul to cross into the surface water network and vice versa, which can cause trunk sewers to surcharge above ground in storm conditions. For more information about this, refer to the MD2339 Drain London & the London Sustainable Drainage Action Plan, and the Regional Flood Risk Appraisal 2018.

However, impacts from sewer flooding within the London and Thames Estuary FRA may be reduced locally when rainfall enters the sewer network served by the Thames Tideway Tunnel. The Thames Tideway Tunnel is a 25 km super sewer currently under construction underneath the River Thames. This new sewerage system will prevent the tens of millions of tonnes of pollution that currently pollutes the River Thames every year. This necessary expansion of London's sewer network is due for completion in 2025 and is taking place from 24 construction sites within London. These sites span from Acton in West London to Beckton in the East, and many are located on the river edge in the centre of the city. For more information, refer to the Tideway website.

Groundwater flood risk

There are two main types of groundwater flood risk within this SW FRA:

- flooding from the main aquifers
- flooding from the formation and stratification of the underlying geology

Groundwater flooding happens as a result of water overflowing from the underlying aquifer, or from water flowing from springs during times of surplus and inundating the surrounding area. This tends to occur after long periods of sustained and high levels of rainfall, with the area's most at risk being low-lying and where the water table is likely to be at shallow depth.

Groundwater flooding is known to occur in areas underlain by major aquifers, although it is increasingly associated with more localised floodplain sands and gravels. Due to the underlying geomorphology, there is some risk of groundwater flooding starting at Greenwich and heading east within the Greater London SW FRA.

The most significantly reported groundwater flooding occurred in Croydon. However, the London basin is complex, where flooding can occur due to a build-up of water within the permeable superficial deposits (sands and gravel / river terrace deposits from the River Thames) overlying the impermeable London Clays. There is also risk from a hydrological link to groundwater levels in the sand and gravels in areas like Spelthorne and Runnymede.

Canal flood risk

It is rare that a canal can be the cause of flooding, however, flooding may cause an impact to the canal infrastructure. Canals within the Thames River Basin are a combination of man-made cut canals and river navigations (where the river flow maintains navigable levels via a series of weir/sluice structures).

There are several canals located within this FRA, including:

- the Grand Union Canal
- Regent's Canal
- Lee Navigation
- London Docklands
- Limehouse Cut

Therefore, their management should be considered within this plan as it may impact storage capacity within the wider network.

How the risk is currently managed

Surface water flood risk within the Greater London SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

All boroughs have developed their own Local Flood Management Plans which manage flood risk including surface water.

Drainage maintenance, the installation of sustainable drainage systems (swales, rain gardens, permeable paving, etc.), property-level resilience, are becoming common practice in the boroughs. This includes the 'Making Space for Water' initiative in parks and open spaces across the London Boroughs, which encourages flood alleviation schemes, river restoration, de-culverting, storage and attenuation, and the imposing of disposal limits on all new developments through local plan policies and land drainage bylaws.

As this FRA covers the complex urban area of London and a small area of north-east Surrey, there is variation in how surface water is managed throughout the FRA and across the various LLFAs. Refer to the individual LLFA's Surface Water Management Plans for more information.

Modelling

Producing reliable and accurate surface water modelling is a challenge. This is due to the multiple flow routes and flood sources that exist. Surface water flooding can be difficult to predict and carrying out modelling can also be resource intensive.

Drain London was funded by Defra and created a partnership between the London Mayor, the Environment Agency, Thames Water, and the London boroughs. The partnership has supported the production of surface water flood risk mapping and funded detailed studies of over 20 areas that are at particularly high risk of surface water flooding.

Drain London has also supported work to prepare Surface Water Management Plans (SWMPs) in groups of London boroughs. This led to a project to investigate how sustainable drainage systems can be better implemented across London, which led to the publication of the London Sustainable Drainage Action Plan (LSDAP) in December 2016. This has been crucial to support the work of LLFAs, as hydraulic modelling and studies can be very costly. For more information about the London Sustainable Drainage Action Plan, refer to the Drain London report.

Future development

New construction and significant redevelopment projects are required to consider flood risk from multiple sources and identify mitigation and sustainable drainage options that are appropriate for the development. This is important in ensuring high standards of surface water flood resilience. The GLA, along with LODEG, have implemented a consistent approach for the information requested from developers in the form of a London Drainage Proforma.

The LLFAs have local processes in place to review Drainage Strategies, underpinned by Local Policies within the Flood Risk and Surface Water Management in Local Plans. In addition, regional policy (the London Plan Policies SI 12 Flood Risk Management and SI 13 Sustainable Drainage) and national policy (National Planning Policy Framework, Flood and Planning Practice Guidance and Non-Statutory Technical Guidance for SuDS) provides guidance across the FRA. It is worth noting that the Local Plans for each borough must be in accordance with at least the minimum standards of SI13 and SI12 of the London Plan.

Property flood resilience

Property Flood Resilience (PFR) is regulated through the planning process for developments. The Thames FLIP (flooding local improvement projects) scheme installed roughly 1100 Flips (pumps) within the Counters Creek project area, through partnership with Thames Water, the London Borough of Hammersmith and Fulham and the Royal Borough of Kensington and Chelsea.

There is also a drive across some of the boroughs' measures to promote and work with residents to understand basement flood protection methods through pump installation. This is addressed through planning policies and building regulations.

Sustainable drainage systems

All relevant bodies advocate the use of SuDS where possible, with the London Mayor's Transport Strategy, the London Environment Strategy and the new London Plan 2021 all advocating the use of sustainable drainage systems and green infrastructure. Transport for London has also produced resources and guides for incorporating sustainable drainage systems into roadways and public spaces. The Greater London Authority has mapped potential opportunity sites for installation of sustainable drainage systems across London, as well as key sites that SuDS have been installed in public spaces. More information on these schemes can be found on their websites. You can find more information on the London SuDS pilot project on the London Strategic SuDS Pilot Study | lotag website.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Greater London SW FRA

Measures have been developed which apply specifically to the Greater London SW FRA.

The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Greater London FRA. You can find information about all the measures that apply to the Greater London FRA in the interactive mapping tool - Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

As explained under section ‘Surface water flood risk’, all members of the Surface Water Strategic Governance group will work to develop and support the strategic surface water implementation plan.

The Harlow Surface Water Flood Risk Area

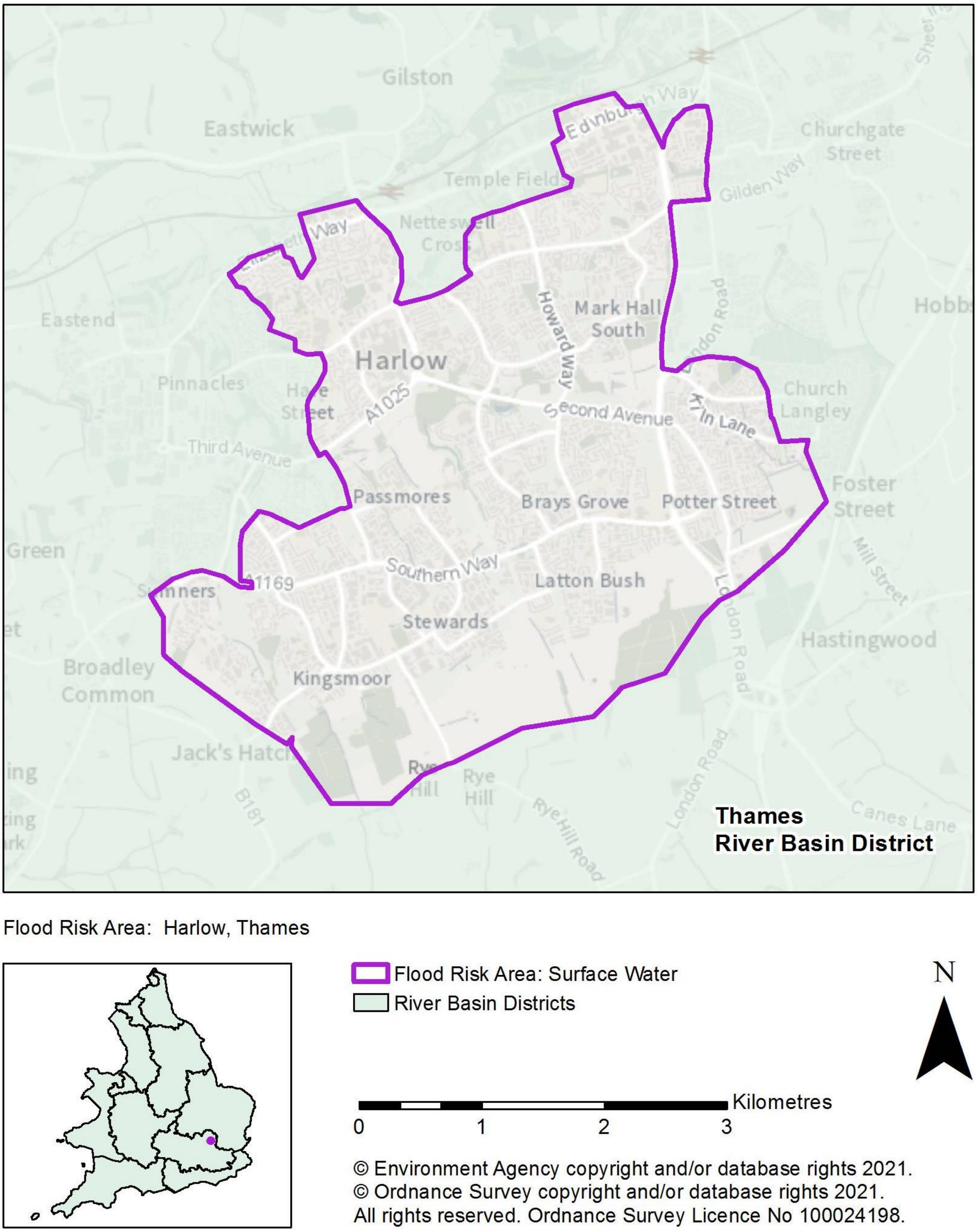


Figure 21: Map showing the Harlow Flood Risk Area Boundary and its location in England

The Harlow Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the north-east of the Thames River Basin District (RBD). It falls across the Thames and Anglian RBDs and can therefore be found in both plans. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The primary source of flood risk to properties in this FRA is surface water. The Harlow SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs), but it was considered within the Upper Lee Valley Catchment section. For more information, refer to Part A.

The Harlow SW FRA sits within Harlow District Council, which is a district of Essex County Council. Essex County Council will take the lead on the development and delivery of the FRMP for this SW FRA as the responsible authority for managing flood risk from surface water.

Essex County Council works collaboratively with partners and communities to improve the water environment as Risk Management Authorities (RMAs).

There are RMAs operating in this FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Essex County Council
- District Council: Harlow District Council
- Two Regional Flood and Coastal Committees (RFCCs): Thames RFCC and East Anglia RFCC
- Three Highways Authority: Essex Highways, Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980) and National Highways manage major motorways
- Water and Sewerage Company: Thames Water
- Department of Communities and Local Government through local planning authorities

Environmental designations

The following areas that hold environmental conservation designations are located within this FRA: Harlow Woods (Site of Special Scientific Interest) and Parndon Wood (Local Nature Reserve).

Topography, geology, hydrogeology, land use

The Harlow SW FRA is mainly urban. Harlow was developed as a New Town after World War II to ease overcrowding in London and the surrounding areas through the New Towns Act of 1946. The town was designed to respect the existing landscape, including landscaped Green Wedges designed to intersperse residential areas with green space. For more information, refer to the Harlow Local Plan.

The Harlow Local Plan sets out aims to develop the suburbs in the north, north-west and east of the town centre. More information can be found within the Harlow Strategic Site Assessment (EB1500-Harlow-Strategic-Site-Assessment-AECOM-2016). Future development, both within and outside Harlow, has the potential to impact flood risk to existing developments. As urban land use will increase or densify due to population growth and increased housing demand, land permeability has the potential to be reduced. It is a duty of the LLFA to seek mitigation measures if any new development will increase surface water run-off, which should be properly managed to avoid exacerbating flood risk issues. Most new developments, like the new Gilston Park development, consider their impact to both fluvial and surface water flooding. The cumulative impact of multiple development sites on flood risk has been historically overlooked and needs to be considered over the next six years.

The topography of the SW FRA is strongly influenced by the river valley. Flood flow routes predominantly follow topographical paths, particularly in the south of Harlow, flowing towards Todd Brook. Most of the SW FRA is 200 feet above sea level, with higher elevation in the south-east. However, closer to the watercourse this elevation drops to roughly 150 feet. Surface water tends to flow or pond along transport routes, in gardens, or on open land.

The underlying geology within the SW FRA is mostly clay. The porosity of clay is low, which can result in reduced infiltration rates and increased surface water run-off. In urban areas, this can exacerbate potential issues related to surface water flooding. However, in the north-west and north-east of the SW FRA, there are some chalk deposits. Underlying chalk responds differently when it is unconfined at the surface, which can impact water flow throughout the system, leading to some risk of potential groundwater flooding.

Partnership working

The Harlow SW FRA falls within the River Lea Catchment Partnership, which contributes to increasing understanding of the catchment and developing joint plans with the aim to improve the health of the local water environment. For more information, refer to the River Lea Catchment Partnership website.

Current flood risk

Surface water flood risk

The main source of flood risk within this SW FRA is from surface water. Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Harlow SW FRA has been identified as being at significant risk of flooding due to a relatively flat topography and its location within a river valley. This topography, in addition to impermeable urban land cover, can cause surface water ponding and run-off. Roads can convey water as a secondary channel within a flood event and flood tends to be centred in areas where sewer and fluvial flood risk are also likely.

Surface water - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The Flood Risk and Hazard Map shows an estimated 86,974 people living within the Harlow SW FRA. Of those, 11,045 (12.7%) live at risk of flooding from surface water.

Also at risk of surface water flooding within the Harlow SW FRA include:

- 37 services including schools, hospitals, nursing homes, etc. (8%)
- 502 non-residential properties (21.3%)
- 1.5 kilometres of of motorways, primary and trunk routes, as classified by National Highways (39%) and 0.4 kilometres of railway (90.8%)
- 15 kilometres of agricultural land (9.9%)
- 1 Environmental Permitting Regulation installation (100%) and 3.3 hectares of Sites of Special Scientific Interest (8.4%)
- 0.6 hectares of Scheduled Ancient Monument (54.8%) and 15 listed buildings (15.8%)

Conclusions based on risk statistics

It is clear from the above that flooding within the Harlow SW FRA is a complex system with many differing factors impacting the flood risk. 11,045 people living in the Harlow SW FRA are at risk from surface water flooding. Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Fluvial flooding

Overall, the fluvial flood risk within the FRA is relatively low. The River Stort flows laterally just above this SW FRA, and tributaries include:

- Harlowbury Brook

- Todd Brook
- Parndon Brook
- Canons Brook
- Pincey Brook

Fluvial flood risk in Harlow is predominantly associated with the River Stort and these tributaries and impacts railway lines, some roads, and properties.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network, especially as a result of the inadequate capacity of the sewage system and blockages. Sewer flooding is a problem that could occur in many locations across the Harlow SW FRA.

Historic flood events (2015 – 2020)

There have been 1,342 recorded flood events throughout Essex. Epping Forest and Harlow are two areas covering just 10% of the overall spatial area of Essex, but they are responsible for nearly two-thirds (63%) of the recorded flood event data. Harlow accounts for 20% of this flooding. For more information, please review the Essex County Council Preliminary Flood Risk Assessment. Since 2015 flooding in Harlow has not met the threshold for internal flooding (over 20 properties over one flood event) However, Harlow did experience surface water and sewerage flooding in 2018 and 2020.

How the risk is currently managed

Surface water flood risk within the Harlow SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

The management of surface water flood risk is led by Essex County Council in collaboration with other Risk Management Authorities (RMAs) and stakeholders including the Environment Agency, Anglian Water, Essex Highways and Harlow District Council. Surface Water flood risk within the Harlow SW FRA is currently managed through a series of approaches. These include:

- Critical Drainage Area
- surface water modelling and risk mapping
- asset management
- flood defences
- sustainable drainage systems
- careful monitoring of new development

Critical Drainage Areas

A Critical Drainage Area (CDA) is defined as a discrete geographic area (usually a hydrological catchment) where multiple or interlinked sources of flood risk cause flooding during a severe rainfall event, thereby affecting people, property or local infrastructure.

The Harlow Surface Water Management Plan (SWMP) (2013) and associated SWMP update (2018) identifies 9 CDA's within the Harlow FRA. These areas will be prioritised by the LLFA for targeting potential flood mitigation measures.

Table 13: Residential Properties at Risk within CDA's (2018)

CDA Ref.	CDA Name	Residential properties at risk (Greater than 0.1m internal flooding in areas with a chance of flooding of 1% each yea)	People at risk
NHLW_01	Sumners	89	208
NHLW_02	Kingsmoor	258	604
NHLW_03	Stewards	348	814
NHLW_04	Latton Bush	262	613
NHLW_05	Brays Grove	622	1455
NHLW_06	Netteswell	127	297
NHLW_07	Victoria Gate	94	220
NHLW_08	Rivermill	103	241
NHLW_09	Old Harlow	337	789

Flood risk asset management

As LLFA, Essex County Council have a duty to maintain a register of assets that consider the likely impact on flood risk in the County, and this is publicly available on request. Essex County Council have 10,176 records on register to date, and have in place a policy for designating assets, although there were no 'designated' assets at the time of compiling this report (May 2021).

Any capital flood management schemes delivered by Essex County Council are subject to third party maintenance agreements. The assets are added to the register and maintained through an annual inspection regime to ensure the condition of assets is reasonably maintained.

Measures implemented to reduce flood risk

Under the Flood and Water Management Act 2010 and Flood Risk Regulations 2009, Essex County Council as a LLFA are required to carry out some statutory and partnership roles which could be considered measures to reduce flood risk. These roles include:

- oversee local flood risk such as groundwater flooding, surface water run-off and ordinary watercourses
- prepare and maintain a strategy for local flood risk management
- maintain a register of assets – these are physical features that influence flooding
- look into flooding incidents and make the results from these investigations public
- play a lead role in emergency planning and recovery after a flood event
- commission works to manage flood risk from surface runoff or groundwater
- request information from any person in connection with the authority's flood and coastal erosion risk management functions
- give permission for any changes to ordinary watercourses
- record, investigate and publish reports on floods in the county
- manage any assets and features which have an impact on flood risk so they cannot be removed or replaced without permission
- work with organisations such as the Environment Agency and water companies to develop a local flood risk management strategy for managing surface runoff, groundwater and ordinary watercourses throughout Essex
- make sure that any developments/projects drain off run-off water in a way which does not increase the risk of flooding anywhere else
- manage surface water flooding – this includes flooding from rainfall run off from surfaces such as roads, roofs, and patios
- respond to major planning applications in relation to sustainable drainage systems

Essex County Council have also been able to provide a successful Property Flood Resilience Grant for individual homeowners and a Flood Capital Programme for wider flood alleviation schemes.

Flood Alleviation schemes have been delivered in the Harlow FRA through the Flood Capital Program, as highlighted in Table 14 below:

Table 14: Flood Risk Reduction Measures Delivered (2015 - Present)

Date	Location	Local Authority	Scheme	Status	Properties Benefitting
October 2018	Nicholls Field, Harlow	Harlow District Council	Capital Scheme (Attenuation bund)	Delivered	56
October 2018	Oaktree Gardens, Harlow	Harlow District Council	Capital Scheme (Attenuation bund)	Delivered	41

Date	Location	Local Authority	Scheme	Status	Properties Benefitting
December 2017	Kingsmoor, Harlow	Harlow District Council	NFM – Installation of leaky dams	Delivered	38
June 2018	Kingsmoor, Harlow	Harlow District Council	Capital Scheme (Attenuation bund)	Delivered	
March 2019	Sunmers, Harlow	Harlow District Council	CFIF / NFM – installation of several check dams within watercourse	Delivered	20
March 2018	Nettleswell, Harlow	Harlow District Council	Capital Scheme – construction of a reinforced wall	Delivered	31
May 2021	Rivermill, Harlow	Harlow District Council	Capital Scheme	IA	N/A
May 2021	Old Harlow	Harlow District Council	Capital Scheme	IA	N/A

Sustainable Drainage Systems (SuDS) are used to mitigate the impact of new development on flood risk and water pollution, while providing additional benefits such as amenity and biodiversity net gains. Examples of SuDS features include swales, rain gardens and detention basins but can also include engineered solutions, such as vortex separators, permeable paving and flow control devices as part of a scheme.

When assessing a new development site, the LLFA will look to mitigate any negative impacts that a development may have on the surrounding environment. However, where necessary, as indicated by the SWMP documents, Critical Drainage Areas (CDAs) and any other surface water flood mapping, the LLFA may also request that existing flooding risk issues are considered as part of the application process. Where possible Essex County Council would like to negotiate with the developer to deliver flood risk improvement schemes as part of the new development.

While the LLFA is not currently a statutory consultee on minor planning applications, Local Planning Authorities are encouraged to consult the LLFA to ensure that the principles of the Essex SuDS Design Guide are implemented on smaller sites. This is ensure that the cumulative effect of multiple, smaller developments does not lead to a significant increase in downstream flood risk.

Fluvial flood defences

A network of flood defences has been constructed to reduce the fluvial flood risk within Harlow that is concentrated along the River Stort and its tributaries' floodplains. While these defences are important in managing flood risk over large areas of Harlow, this flood defence infrastructure has the potential to increase the residual risk of flooding in these areas due to the possibility of its failure (if overtopped or breached).

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Essex Green Infrastructure Strategy

Essex County Council have published the Essex Green Infrastructure Strategy (2020) setting out our GI (Green Infrastructure) ambitions, defining the different types of GI across Greater Essex and importantly, aims to encourage stakeholder collaboration and a coordinated approach to delivering and managing a green infrastructure network across Essex. The strategy stated GI covers 782 km2 or 21% of Greater Essex. There is a wide and varied amount of green space in Greater Essex that represents a GI network of green, blue and sometimes brown components that lie within and between towns and villages and can cross local authority areas. Green Spaces are any vegetated areas of land or water within or adjoining an urban area. The types of green space (both publicly accessible and non-accessible) cover 46% of the Harlow authority area. Of their total green space there is no classified blue infrastructure of ponds, lakes and reservoirs and coastal features. However, the Stort River Valley is an important regional asset that runs along the boundary between Hertfordshire and Essex. There are 9% (2.8km2) of natural and semi natural open green space and 0.3% (0.1km2) of greenways (paths, cycleways, tow paths and bridleway).

The Harlow Open Space and Green Infrastructure Study (2013) is an integral part of the evidence base for the Local Plan and other local policies and includes locally derived standards for the provision of open space and recreational facilities in the area.

The study proposed the following GI interventions:

- Project P1. Multi-functional green space/ Todds Brook and Parndon Green Wedges
- Project P2. Urban semi natural green space: Improved urban greening and green access links between Town Centre and Town Park
- Project P3. Legible Harlow (primarily a non-spatial project

The study relates to a previous Harlow Green Infrastructure Plan (2005) that devised a series of ‘landscape scale’ GI proposals for enhanced habitat connectivity, landscape experience and access. These plans build upon the GreenArc Strategy (2004) and a strategic/’county scale’ GI plan published in 2011 covering the GreenArc area with a companion volume for the adjoining Hertfordshire area. The plan identified proposals directly relevant to Harlow, not least the recognition, conservation and ‘future proofing’ of 20th century planned and designed urban GI heritage such as the New Town and improvements to greenspace corridors and waterway connectivity and access. The river corridor projects present opportunities for water management enhancements with much wider benefits.

Through good design, both existing and the creation of new GI as part of the wider landscape, the GI network can contribute towards making areas less vulnerable to flood risk and improve water management, while ensuring development does not increase flood risk to third parties.

This is achieved through its role in delivering:

- sustainable drainage
- drought mitigation
- flood and water stress reduction
- opportunities for attenuation or infiltration that can help recharge Aquifers
- retained water levels in watercourses or other blue infrastructure features
- increased water quality through limiting diffuse pollution in watercourses

In response to the challenges of climate change and increased flood risk, the Essex Climate Action Commission was established in 2019. It recommends a multifunctional GI approach to build resilience into 75% of schemes developed by 2050, to include integrated water management, natural flood management and nature-based measures. Such schemes will need to provide biodiversity net gain and open space provision which will enhance aesthetic, amenity value and safe public access.

These designs should draw on national and local best practice guidance and must comply with requirements set out in the Essex SuDS Guide and national policy. GI should be integral to all stages of the planning process and can play a key part in place-making and place-keeping.

Essex Climate Action Commission

The Essex Climate Action Commission (ECAC) was established in 2019. One of the agreed actions of the ECAC is to address the resilience of the County to extreme weather and flooding and a focus throughout is on land use and green infrastructure.

The formal remit of the Commission is spread across two years of activities.

In year one, it will identify ways in which Essex County Council can mitigate the effects of climate change, improve air quality, reduce waste across Essex and increase the amount of green infrastructure and biodiversity in the county by drawing on in-house expertise, commissioning research and forming new external partnerships.

In year two, it will explore how to attract investment in natural capital and low carbon growth. The Commission will be provided with regular updates on the status of the year one recommendations so that it can monitor progress.

Emerging recommendations from the ECAC will help to manage the predicted sea level rise and increased rainfall intensity due to climate change in this area, and to become more resilient to future flood risk.

Essex County Council's work as the Lead Local Flood Authority will be directly influenced by the emerging recommendations of the ECAC.

Objectives and measures for the Harlow SW FRA

Measures have been developed which apply specifically to the Harlow SW FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Harlow SW FRA.

You can find information about all the measures that apply to the Harlow SW FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The High Wycombe and the Wye Valley Surface Water Flood Risk Area

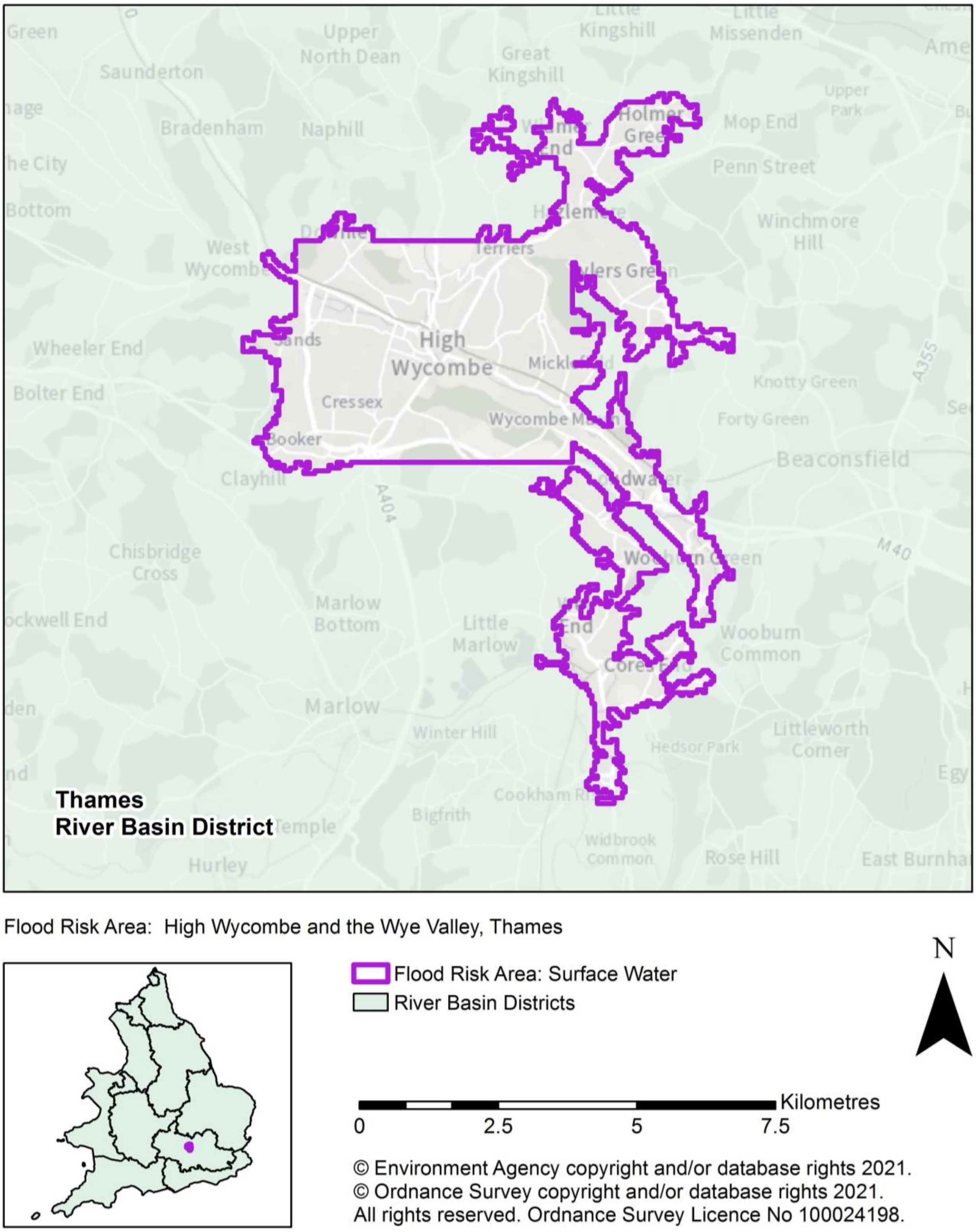


Figure 22: Map showing the High Wycombe Flood Risk Area Boundary and its location in England

The High Wycombe and the Wye Valley Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the north-west of the Thames River Basin District (RBD). This FRA will be reported solely by the Thames RBD.

It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage). The High Wycombe and the Wye Valley SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMP). The High Wycombe and the Wye Valley Surface Water SW FRA is largely within Buckinghamshire but extends over the River Thames to cover Cookham which is in the Royal Borough of Windsor and Maidenhead. The High Wycombe and the Wye Valley SW FRA is mostly urban with a proportion of arable land as well as some improved pasture. The primary source of flood risk in the Surface Water FRA is from surface water, however some areas within the FRA are also at risk of flooding from rivers.

The relevant Lead Local Flood Authorities (LLFA) within this FRA leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMA) operating in The High Wycombe and the Wye Valley SW FRA including:

- Environment Agency
- Two Lead Local Flood Authorities: Buckinghamshire Council and the Royal Borough of Windsor and Maidenhead
- Regional Flood and Coastal Committee: Thames
- Three Highways Authorities: Buckinghamshire Council, the Royal Borough of Windsor and Maidenhead and National Highways
- Water and sewerage company: Thames Water Utilities Ltd
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the SW FRA is strongly influenced by the Chilterns geology. High Wycombe lies in the Wye valley and up the side of the hills. The River Wye drains a permeable Chalk catchment of the Chilterns Hills with a total area of approximately 137km^2 to the Clampton Mill road crossing (5km upstream of the confluence with the River Thames). The study area covers the River Wye and its tributaries, including the Hughenden Stream which converges with the Wye in the urban area of High Wycombe. Due to the position of High Wycombe on the relatively gentler lower slopes of otherwise steep valleys, it is susceptible to flooding from the River Wye and Hughenden Stream, as well as flashy surface runoff from the now urbanised valleys. Gradient is an important factor in determining the hydrological response and in steeper catchments, water levels can rise quickly after rainfall, with little advance warning.

The geology of the catchment is predominantly Chalk. Bourne End is located on River Terrace Gravels overlaying the Chalk aquifer. To the north of Bourne End is the Chilterns, the Chalk aquifer. Within chalk, water can infiltrate quickly and move within and through these rocks. These areas become part of the major groundwater resources. The groundwater from chalk areas provides a significant baseflow component to the rivers. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The study area covers the River Wye and the Hughenden Stream (a tributary of the River Wye) both originating from the chalk aquifers and predominately rural slopes of the Chiltern Hills.

The upper catchments of the River Wye (north-west of Chapel Lane) and Hughenden Stream (north of Coates Lane) are predominantly rural, with arable and pasture farmlands as the main land use. Both upper catchments consist of relatively steep dry valleys converging towards the urbanised areas of High Wycombe.

There are many small settlements in the upper catchments including:

- Bradenham
- Saunderton Valley
- Bledlow Ridge
- Radnage
- Stokenchurch
- Hughenden Valley

The lower catchment of the River Wye and Hughenden Stream is heavily urbanised.

The River Wye which flows in a south-easterly direction through High Wycombe is culverted for approximately 800m beneath Abbey Way. Hughenden Stream which flows in a southerly direction is mostly in open channel up to Bellfield Road where it enters a culvert before joining the culverted section of the River Wye beneath Abbey Way. The River Wye emerges from culvert downstream of Abbey Way and continues flowing in a south-easterly direction.

Partnership working

Buckinghamshire Council works collaboratively with partners and communities to improve the water environment. Please refer to the Thames RBD section of this report for more information on this.

West Berkshire Council/Slough Council/Buckinghamshire Council are one of multiple partners who have recently been successful in securing funding though Defra’s Flood and Coastal Resilience Innovation Programme for a Groundwater Resilience and Community Engagement project (GRACE). The project, led by Buckinghamshire Council, will trial new approaches for managing groundwater flooding in the Chilterns and Berkshire Downs, including understanding community perceptions, increasing community resilience, property flood resilience measures in 10-12 communities, innovative groundwater monitoring, modelling and mapping techniques, and a Groundwater Flood Alert App for householders and businesses. The project includes 17 communities in West Berkshire, 150 communities in Buckinghamshire and the communities in Colnbrook (mainly residential) and Poyle (mainly business community) in Slough. The High Wycombe and the Wye Valley SW FRA falls within the Thames 21 Catchment Partnership area.

Current flood risk

The main sources of flood risk within the High Wycombe and the Wye Valley SW FRA are surface water and fluvial. This section will discuss the surface water risk within the High Wycombe and the Wye Valley SW FRA.

There are 287 residential properties throughout High Wycombe that have been identified as having a risk of flooding and are classified within either the very significant or significant risk banding.

Surface water flooding in the River Wye catchment is primarily driven by rainfall but interactions with river levels, high groundwater levels and piped drainage networks also occur to influence where flooding occurs. Numerous properties have low thresholds, sometimes below the surrounding road/ground level.

The River Wye is perched above the valley floor through some of the Desborough area, thus impeding discharge of surface water to the River.

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The High Wycombe and the Wye Valley SW FRA has been identified as being at significant risk of flooding due to low elevations and flat topography of the area, which are conducive to surface water ponding, road networks and impermeable surfaces.

The most acute flooding problem is in the Sands area of High Wycombe. It is thought that during heavy rainfall events, and particularly when the soil is saturated and groundwater levels in the underlying Chalk are high, local surface water can combine with runoff from two of the dry valleys (Hill Bottom Lane and Lane End Road) to cross the Primary A4010 route from the M40 (New Road/Chapel Lane) at the twin mini roundabouts. Evidence indicates that the road at this location floods relatively frequently. With the addition of flow from the New Road dry valley to the south, the flow path continues along Mill End Road crossing the junction with Gallows Lane/Dashwood Avenue before draining to a spring-fed natural watercourse to the west of the properties in Mill End Road and entering the southern channel of the River Wye via a culvert. Highway flooding in the area is relatively frequent.

Identified natural drainage routes often have significant upstream catchments which could be activated when the surrounding Chalk hills become saturated or frozen and have increased ability to generate runoff. In some locations, these surface flow routes can follow steep terrain through dense residential housing and could pose a risk to life through high velocities.

Buckinghamshire Council has records of parts of Bourne End flooding before the 2000s. These include in 1968 and 1998 when the River Wye burst its banks. In 1999, heavy storms, which affected large areas of southern Buckinghamshire, caused approximately 45 mm of rain to fall over High Wycombe where flooding occurred due to the drainage system being unable to cope with the deluge. This resulted in the River Wye flooding onto London Road near the Rye open area.

Since the 2000s there have been several flooding incidents. During the exceptionally wet winter 2000 – 2001, groundwater levels rose throughout the Chalk aquifer across Buckinghamshire and southern England. The high groundwater levels caused high river flows and widespread groundwater flooding in the valleys of the Chiltern Hills. The groundwater levels remained high for months and caused extensive flooding of properties, roads and public areas.

The two catchments make up the highest risk areas in High Wycombe and their combined area is roughly 20km2.

Bourne End was again impacted in 2006 and 2007 on several occasions. An intense rainfall event on 20th July 2007 followed many weeks of wet weather. Although High Wycombe did not experience the most intense rainfall, some surface water flooding occurred and some low-lying areas were flooded from the River Thames.

Surface water flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazards and risk maps show that in the High Wycombe and the Wye Valley FRA some 19,614 (16.5%) people live in areas at risk of flooding from surface water. Of these, 3% are in areas of high risk.

Also shown to be at risk of surface water flooding in the High Wycombe and the Wye Valley SW FRA:

- 74 services (7.0%). Schools and sewage treatment are examples of services
- 945 Non-residential properties at risk (21.7%)
- 119/1473 hectares of agricultural land
- protected areas: 10/116 hectares of parks and gardens

- historical landmarks: 32/307 listed buildings
- 2/3 licensed water abstraction sites
- roads: there are significant areas of both high risk and medium risk associated particularly with key roads including the A4010

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the parts of the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages.

Although High Wycombe is served by separate surface water and foul sewers, there is a known issue of ingress of surface water and/or groundwater into the foul sewer. Some surface water sewers serving High Wycombe are known to operate regularly at full capacity, but Thames Water has no evidence of flooding issues to justify improvements in the surface water network.

How the risk is currently managed

Surface water flood risk within the High Wycombe and the Wye Valley SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness. In parts of the FRA, relevant LLFAs are managing existing flood risk effectively and will keep this approach under review, looking for improvements and responding to new challenges or information as they emerge.

Based on national mapping made available in August 2009, Defra identified 5800 properties in High Wycombe that may be susceptible to surface water flooding, ranking High Wycombe as 50th highest risk in England. Based on this ranking, Buckinghamshire County Council as lead RMA has prepared a Surface Water Management Plan (SWMP) for High Wycombe. The SWMP identified numerous locations in the urban area of High Wycombe which could be at significant risk of surface water flooding, one of which is the Sands area to the west of the town.

The Sands community is a case study in The Ox-Cam project, one of three UK Property Flood Resilience (PFR) Pathfinder projects that have been funded by the UK

Government’s Department of Environment, Food & Rural Affairs. The Ox-Cam case study is the largest, consisting of approximately 1,873 houses.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

It is possible that areas within the High Wycombe and the Wye Valley Surface Water FRA could experience flooding in the future. As a result of larger flood extents and deeper depths of flood water due to the impacts of climate change, the level of protection provided by flood defences will likely decrease. There will also likely be additional maintenance needs and stresses on assets that function with a higher frequency than for which they were designed.

Objectives and measures for the High Wycombe and the Wye Valley SW FRA

Measures have been developed which apply specifically to the High Wycombe and the Wye Valley SW FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the High Wycombe and the Wye Valley SW FRA.

You can find information about all the measures that apply to the High Wycombe and the Wye Valley Surface Water FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Lee Valley Rivers and Sea Flood Risk Area

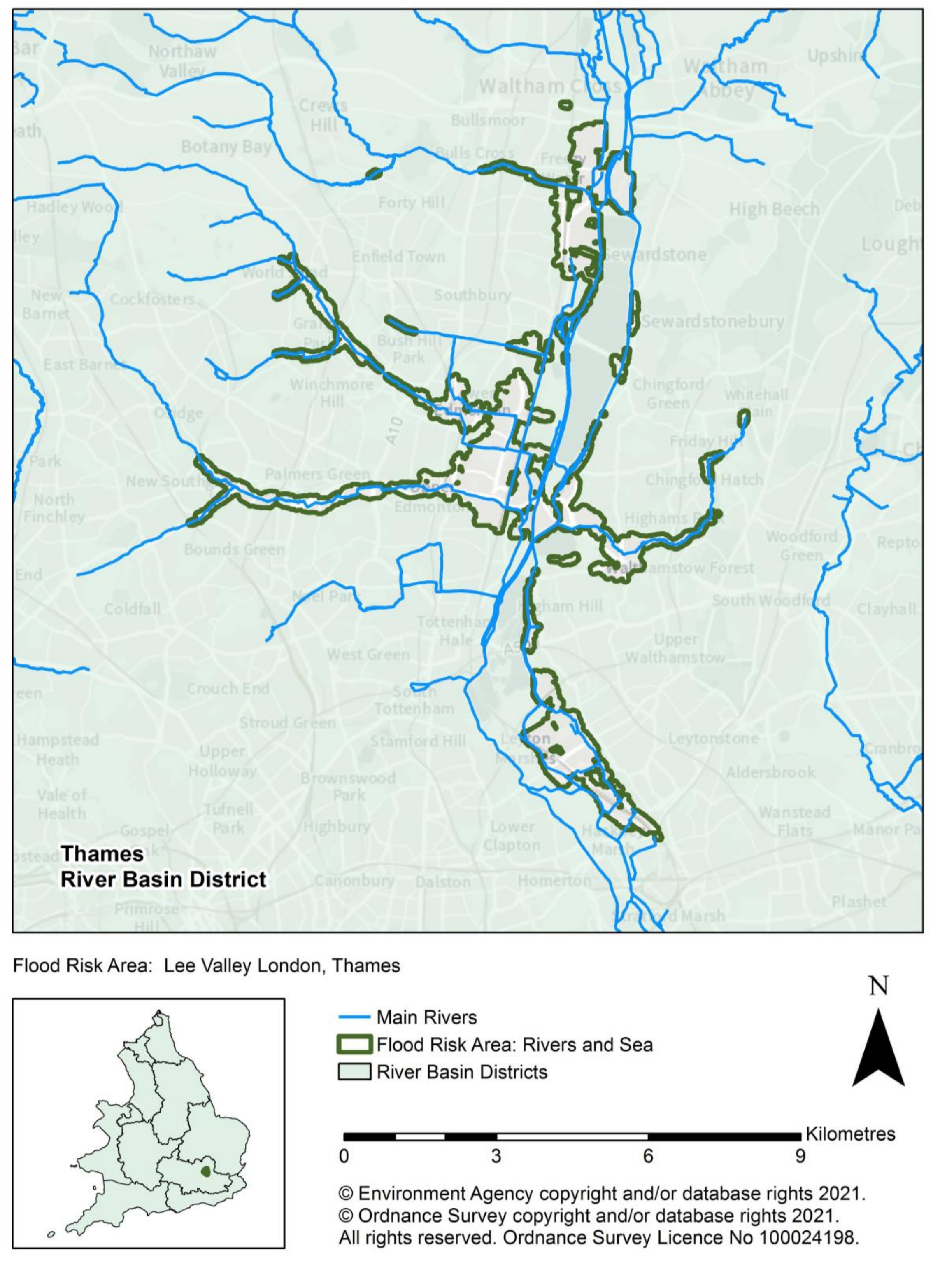


Figure 23: Map showing the Lee Valley Flood Risk Area Boundary and its location in England

The Lee Valley Rivers and Sea Flood Risk Area (FRA) is in the South East of England and to the east of the Thames River Basin District (RBD). It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Lee Valley Rivers and Sea (RS) FRA falls within the Hertfordshire and North London Environment Agency area. The Environment Agency leads on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA as the responsible authority for managing flood risk from main rivers and the sea. The Lee Valley RS FRA falls within the Lower Lee catchment, located south of the M25. It is mostly urban with a low proportion of dispersed industrial sites, parkland and areas of designated environmental importance. Important urban areas include parts of Enfield, Edmonton, Chingford, Walthamstow and Leyton. The Lee Valley Rivers and Sea FRA was not identified in 2011 for the first cycle of FRMPs.

The primary source of flood risk to properties in the Lee Valley RS FRA is from fluvial sources. Fluvial flooding within this FRA is related to the complex river system compromising the Lee Flood Relief Channel and the associated sluice gates, radial gates and weirs that control the system. Tributaries of the River Lee including Pymmes, Salmons, Ching, Dagenham Moselle and Turkey Brooks also pose a flood risk.

The Environment Agency works collaboratively with partners and communities to improve the water environment as Risk Management Authorities (RMAs). Refer to the Thames River Basin section of this FRMP for more information.

There are Risk Management Authorities operating in the Lee Valley RS FRA, including:

- Environment Agency
- Two Lead Local Flood Authorities: London Borough of Enfield and London Borough of Waltham Forest
- Regional Flood and Coastal Committee (RFCC): Thames RFCC
- Three Highways Authorities: Transport for London manages the TfL Road Network (or ‘red routes’). London Boroughs of Enfield and Waltham Forest manage the remaining public roads and National Highways manage major motor ways like the M25
- Water and Sewerage Company: Thames Water
- Department of Communities and Local Government through local planning authorities

Growth and development

Growth and development either within or adjacent to this FRA is expected to be significant, which, if not planned carefully, could place additional pressures on water management and flood risk. However, development could also create opportunities to reduce flood risk and minimise vulnerability to climate change.

The districts of Waltham Forest and Enfield are the principal districts which overlap geographically with this FRA. Population growth is one of the drivers for housing need, for example, the Waltham Forest population is expected to increase from 277,100 residents in 2020 to a total of 289,530 by 2025, an increase of 12,430 (4.5%). Enfield is also changing fast. Projection scenarios to 2036 show an increase of roughly 51,000 in population and an additional 31,000 households to Enfield's current 333,000 people and 130,000 households.

The London Plan (2021) sets ambitious housing targets for all the London Boroughs. The collective housing target for Enfield, Waltham Forest, Haringey, Hackney and Newham up to 2028/29 is 87,100 new homes. Boroughs are required to incorporate these housing targets when preparing Local Plans. There are many major development schemes within this RS FRA. An example of one is Meridian Water which is a major 20-year, 82-hectare, London regeneration programme led by Enfield Council. The aim of this scheme is to deliver 10,000 homes and 6,700 jobs to Enfield. The Environment Agency is working closely with the Council and their chosen developers to achieve a safe, sustainable, and well-sited development, maximising opportunities for environmental betterment including an overall reduction in flood risk.

Environmental designations

Portions of the following areas that hold environmental conservation designations are located within this FRA:

- Walthamstow Reservoirs (Site of Special Scientific Interest)
- Epping Forest (Site of Special Scientific Interest and Special Area of Conservation)
- Chingford Reservoirs (Site of Special Scientific Interest), Lee Valley (Special Protection Area and Ramsar site)

Topography, geology, hydrogeology, land use

Land use within this FRA is mainly urban (residential and commercial) with some dispersed industrial sites, parkland, reservoirs and areas of designated environmental importance.

Portions of the following areas that hold environmental conservation designations are located within this FRA:

- Walthamstow Reservoirs (Site of Special Scientific Interest)
- Epping Forest (Site of Special Scientific Interest and Special Area of Conservation)
- Chingford Reservoirs (Site of Special Scientific Interest)
- Lee Valley (Special Protection Area and Ramsar site)

The topography of this FRA is strongly influenced by the Lee river basin. Most of the FRA is low-lying, with some steeper areas to the east and west of the main channels, where the tributaries originate. The underlying geology of this FRA is clay. The porosity of clay is low, which can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues of surface water flooding.

Partnership working

The Lee Valley RS FRA falls within the River Lea Catchment Partnership, which contributes to increasing understanding of the catchment and developing joint plans with the aim to improve the health of the local water environment. For more information, refer to the River Lea Catchment Partnership website.

Lee2100 programme

The Lee 2100 programme aims to develop and produce a new Flood Risk Management Strategy for the River Lee catchment for the short, medium and long-term. This will include both the Upper Lee and Lower Lee and their tributaries. The strategy will be based on an integrated approach that considers the whole Lee catchment as well as climate change, resilience and adaptation.

The Lee programmes vision is to integrate different types of projects and collaborate with key stakeholders in the catchment to ensure that the flood and water environment are managed efficiently. It is anticipated that this integrated approach will help to attract funding from a wide range of partners by delivering additional benefits to flood risk reduction including economic growth and green space provisions.

The Lee Valley is also particularly valuable for its aquatic and wetland habitats and associated birds. Most of these are dependent on maintaining existing water management levels. It is expected that flood risk reduction schemes should look to incorporate and deliver environmental outcomes wherever possible. Therefore, there is a need to develop a strategy that puts environmental enhancements at its core, alongside reducing flood risk.

Current flood risk

The main source of flood risk within this FRA is from Rivers and Sea. This can be referred to as 'fluvial' flooding. This section will focus on the fluvial flood risk within the FRA, but it will also give a high-level overview of the other flood risk sources for context. For more information on surface water flood risk in this area, please refer to the Greater London SW FRA within this report.

Fluvial flood risk

The Lee Valley RS FRA is located in the River Lee basin, which covers an area of approximately 1,420 square kilometres in the north of London. The source of the River Lee is in Central Bedfordshire, north-west of this FRA and joins the tidal River Thames downstream of Stratford in East London, south of this FRA. The river catchment becomes smaller and more urban as it moves downstream. The Lee basin is a complex system with many controls on flow and a fair amount of interaction between channels. Flow routes change depending on the scale of the flood event and preceding catchment conditions can affect the response of the tributaries. Therefore, it is very difficult to predict the timing and volume of flows that will arrive downstream.

Dominant watercourse

The main stem of the lower River Lee consists of three principal channels: the Old River Lee, the Flood Relief Channel (FRC) and the Lee Navigation. The FRC is the most significant defence in the Lee catchment, comprising of over 45km of channel (excluding canals). Completed in the 1970s, it extends from Ware to Walthamstow and was designed to safeguard against a '1947-scale' flood event, estimated to be a 1.4% annual probability.

The FRC and its associated structures (sluice gates, radial gates and weirs) are critical to the management of flood risk along the lower River Lee catchment. South of the M25 the FRC is a concrete-lined channel that is designed to efficiently convey water and reduce the probability of flooding in the Lower Lee Valley. Eighteen important structures (weirs, sluices and gates) also operate within the Lower Lee system with the purpose of maintaining appropriate water levels for navigation, recreation, conservation and water abstraction.

There is also a significant flood risk on the lower Lee tributaries within this FRA. These tributaries are underlain by impermeable clay, have steep and small catchments with highly developed urban floodplains, and the channels are modified, all leading them to respond rapidly to rainfall. The tributaries on the east of the basin (including Ching Brook) discharge directly into the FRC. Those on the west of the basin (including Turkey Brook and Salmons Brook) discharge directly into the Old River Lee or the Navigation Channel, from which flows are distributed to the FRC.

Catchment response

The combination of concrete channel surfaces, steep catchments, and clay soils cause the watercourses within this FRA to respond rapidly to rainfall and can flood suddenly after storms. This is particularly evident at the confluences of the River Lee and its tributaries. If the downstream tributaries all reach peak flow levels simultaneously, it can result in large volumes of water quickly arriving further downstream where the Navigation Channel and FRC meet, causing flooding. The urban nature of the catchment leads to rapid run-off of rainwater, which can exacerbate these risks. Blockages in the watercourses, particularly in or near culverts and structures can also increase the risk. Severe flooding can happen particularly in the summer months due to intense thunderstorm rainfall and in the winter months due to prolonged rainfall.

Fluvial flooding – description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps](). These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazards and risk maps show an estimated 71,176 people living within the Lee Valley RS FRA. Of those in the area, 37,783 (53.1%) live at risk of flooding from fluvial sources.

Also at risk of fluvial flooding within the Lee Valley RS FRA include:

- 273 services including schools, hospitals, nursing homes, etc. (47%)
- 2,372 non-residential properties (70.6%)
- critical infrastructure: 4.1 kilometres of motorways, primary and trunk routes, as classified by National Highways (43.2%) and 5.8 of railway (45.6%). Disruption to transport routes as a result of flood risk can have an impact at both local and larger scales. The lengths of road or railway at risk only provide part of the picture of transport network flood risk as the duration of possible flooding has implications on wider impacts due to closure or restriction of routes or services
- 2.4 hectares of agricultural land (19%)
- natural environment: 13 Environmental Permitting Regulation installations (86.7%), 3 hectares of Special Area of Conservation (51.4%), 0.2 hectares of Special Protection Area (3.3%), 0.2 hectares of Ramsar site (3.3%), 15.2 hectares of Sites of Special Scientific Interest (60.6%)
- historic environment: 0.4 hectares of Scheduled Ancient Monument (100%) and 22 listed buildings (66.7%)
- 13 licensed water abstraction sites (68.4%)

Conclusions based on risk statistics

Flooding in the Lee Valley RS FRA is a complex system with many differing factors impacting the flood risk. There are 37,783 people living in the Lee Valley RS FRA at risk from flooding from rivers and sea.

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The surface water flood risk within this FRA is due to a combination of factors including widespread impermeable urban land cover, low-lying areas conducive to surface water ponding, culverted watercourses, kerb and boundary wall heights, and ageing drainage infrastructure that is often overwhelmed. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the risk. In London, many natural drainage systems, including tributary streams and ditches, have been largely removed or built over. This has led to a dispersion of surface water risk over many small, localised areas with lower elevations than surrounding land. This can include structures like residential basements, sub-surface car parks, and servicing yards, among others. This is especially true where natural drainage systems have been filled in or covered but the topography is still lower than surrounding areas.

Canal flood risk

It is rare that a canal can be the cause of flooding. However, flooding may cause an impact to the canal infrastructure.

The Lee Navigation Channel is managed by the Canal & River Trust. It runs vertically through this FRA. The Lee Navigation at Tottenham carries flood flows as part of the Lee Flood Relief Channel system. For more information about the Lee Navigation, refer to the section on fluvial flood risk above.

Groundwater flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This occurs especially after long periods of sustained and high levels of rainfall, and in low-lying areas where the water table is more likely to be at shallow depth. This FRA has very low impact of groundwater flooding.

Sewer Flood Risk

Sewer flooding is often caused by excess surface water entering the drainage network, especially as a result of the inadequate capacity of the sewage system and blockages. A significant number of sewage and industrial discharge locations within the River Lee basin also influence the hydrological regime, for example Deephams Sewage Treatment Works.

How the risk is currently managed

Fluvial flood risk within the Lee Valley RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

Flood defences

There are many important flood defences located within this FRA, as discussed in the section above. Together, the Lee Flood Relief Channel (FRC) and the associated sluice gates, radial gates and weirs, form an integrated flood alleviation scheme that reduce the risk of flooding in the area. Flood Storage Areas to hold flood waters in the upstream catchment are present on the Salmons Brook and Turkey Brook. There are only a few stretches of raised defences within this system, as the underlying gravels prevent this type of structure.

Instead, most defences provide additional storage or conveyance of water, along concrete channels such as on Pymmes Brook and the FRC, to efficiently move it through the lower River Lee basin and reduce the probability of flooding. Along the tributaries, long-term adaptation through redevelopment is a main strategy. This includes re-creation of river corridors to ensure space for natural river flow and water attenuation as well as defences that are sustainable as part of an overall catchment plan.

Flood storage and natural flood management

Within the lower area of the FRA, one of the best options to reduce the probability of flooding is to increase attenuation through the addition of flood storage capacity, especially along the tributaries. Large flood storage areas may not be feasible in this region due to land and economic constraints. However, focus has shifted from reliance on large flood storage areas to the cumulative benefits of many smaller storage areas within the catchment. As part of the process of increasing attenuation, re-establishing river corridors through restoration of parts of river channels and removal of artificial bank lining and culvert sections are options that could benefit the overall health and resilience of the watercourses.

Hydraulic modelling

Most rivers in the Lower Lee catchment have detailed fluvial flood modelling and associated flood mapping. Improvements to these models are being carried out in 2021 [At time of writing, these have not been finalised].

Development

Redevelopment rates across the area are very high but this can be positive as it provides opportunities to reduce current levels of risk and reliance on flood defences. Redevelopment can include measures that increase resilience and provide options for managing not just current risk but also the impacts of climate change. The existing river corridors provide room for water to enable climate change adaptation and those corridors and undeveloped floodplains should be safeguarded from inappropriate development.

Under the National Planning Policy Framework, Local Planning Authorities are required to take a proactive approach to flood risk and climate change when planning strategically for their development needs. Prioritising the allocation of land in areas of lowest flood risk before considering areas with higher levels of risk is one of the requirements of national policy. This can reduce the future risk of flooding and vulnerability to climate change and also minimise the potential future costs of flood alleviation and flood defence maintenance. Where, by exception, some development in areas of higher flood risk is necessary, Local Planning Authorities should outline in planning policies the standards expected to fully mitigate the risks. They should aim to achieve a reduction in flood risk ensuring that developments will be safe and there is no increase in flood risk elsewhere. In addition, policies should make provision for the possible future relocation of vulnerable development and infrastructure out of areas of increasing flood risk.

Flood warning and community preparedness

The Environment Agency's flood warning and alert service is available along the majority of the waterways within this FRA. The service aims to provide advance warning to people of the risk of flooding from rivers and the sea. There are 18 flood warning areas within this FRA. Emergency response and flood awareness are particularly important within this FRA because the catchments react very quickly to rainfall.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Lee Valley RS FRA

Measures have been developed which apply specifically to the Lee Valley FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Lee Valley FRA.

You can find information about all the measures that apply to the Lee Valley FRA in the interactive mapping tool - Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The London and Thames Estuary Rivers and Sea Flood Risk Area

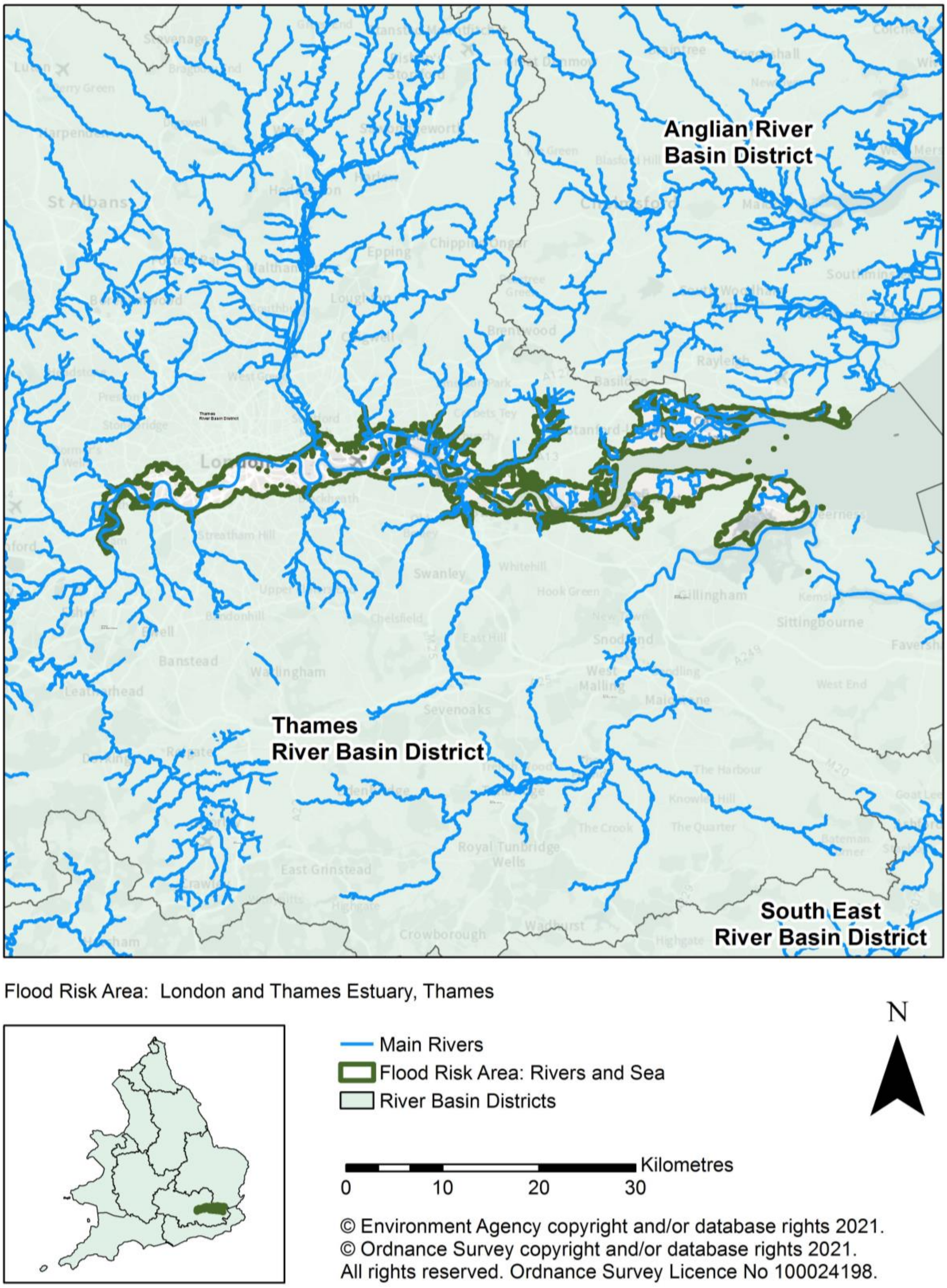


Figure 24: Map showing the London and Thames Estuary Flood Risk Area Boundary and its location in England

The London and Thames Estuary Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and to the east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency leads on the development and delivery of the Flood Risk Management Plans (FRMPs) for this FRA as the responsible authority for managing flood risk from main rivers and the sea. The London and Thames Estuary FRA was not identified in 2011 for the first cycle of FRMPs.

The main sources of flood risk within the London and Thames Estuary RS FRA are from rivers and sea. Please refer to the Greater London, Thurrock and Canvey Island SW FRAs for more information on surface water flood risk in this area.

There are Risk Management Authorities (RMAs) operating in London and Thames Estuary RS FRA, including:

- Environment Agency
- 22 LLFAs: Bexley, Greenwich, Lambeth, Lewisham, Richmond, Southwark, Wandsworth, Hammersmith and Fulham, Kensington and Chelsea, City of Westminster, City of London, Tower Hamlets, Newham, Barking and Dagenham, Havering, Hounslow, Ealing, Kent County, Medway, Southend on Sea, Thurrock, Essex County
- Five Unitary District/ Borough Council: Essex County Council, Southend-on-Sea Borough Council, Medway Borough Council, Kent County Council, Thurrock Council
- Three Regional Flood and Coastal Committees (RFCCs): Thames RFCC, Southern RFCC and Anglian Eastern RFCC
- 26 Highways Authorities: 22 London Boroughs, Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980), National Highways manage major motorways, Thurrock Highways Agency and Southend-on-Sea Highways Agency
- Two Water and Sewerage Company: Thames Water and Anglian Water
- Department for Communities and Local Government through local planning authorities

Environmental designations

The Thames Estuary has traditionally been, according to Historic England, an international shipping route and maritime entrance to London. The FRA is mainly urban with dispersed green space. The existing urban areas within this FRA are densifying and new developments are mainly taking place on formerly developed sites (sometimes called brownfield sites).

The Thames Estuary 2050 Vision highlights aspirations for future growth, the creation of nearly 900 hectares of new habitat by 2100 to replace the 1,200 hectares lost to tidal flooding and the completion of the Thames Path to improve access to the natural environment.

There are several sites in London, Essex and along the Thames Estuary that have special environmental designations. These are clustered particularly in the Lee Valley, Swanscombe, Thames Estuary and Marshes, along the Essex stretch of outer estuary and south-west London. The full detail of these designations can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The areas alongside the river Thames in London form a dense urban environment with dispersed green space. Development mainly takes place on formerly developed sites. Within the London and Thames Estuary RS FRA, the central government district of Whitehall, including the Houses of Parliament and City Hall are located. To the East is the London financial district. All locations sit within the Thames floodplain.

There are also sites with environmental designations further downstream into the estuary such as Shorne and Higham Marshes, Swanscombe. Over 1.4 million people living within the Thames floodplain and this FRA are vulnerable if current tidal defences were to fail. 700 healthcare centres and 68 emergency service stations are also at risk. This means response and recovery could be unavailable to those affected during a flood event. Within this FRA there are also multiple sites of critical energy, transport and water infrastructure. These support the needs of communities and businesses in London and the South East. This includes 2400 km of roads, almost 4000 electricity substations, 2 airports, Network Rail lines and London Underground lines.

The Thames Estuary sees the convergence of the freshwater River Thames, its many tributaries, and the North Sea. The Thames floodplain could flood from tidal and fluvial sources if the flood defences were not present. Every day, twice a day, the freshwater Thames which flows across Teddington Weir in west London is met by the incoming tide from the North Sea. The Thames estuary has an average daily rise and fall in water levels of 7 m.

In addition to the daily tides, the Thames estuary is predisposed to an increase in water levels caused by a North Sea surge. Surge tides occur when a band of low pressure or ‘depression’ moves across the Atlantic towards the British Isles and the sea under it rises above the normal level creating a rise in water levels. This moves with the depression, passing the north of Scotland and moves south into the North Sea.

The mass of water moves down the east coast of England, growing higher as it gets squeezed as it travels southwards due to the reducing distance between our coastline and mainland Europe’s, and finally funnels up the Thames Estuary. Strong northerly winds can then further increase the height of the surge. A surge tide entering the Thames Estuary can increase water levels by 1 to 3m and can be a major flood threat, especially if this happens during a ‘spring’ tide cycle when normal peak tide levels are higher.

Watercourses

In addition to the River Thames, other principal watercourses within the London and Thames Estuary RS FRA include:

- the Colne
- Crane
- Brent
- Lee
- Roding
- Ingrebourne
- Beam
- Ravensbourne
- Marshdykes
- Wandle
- Beverley Brook
- Darent,
- Cray
- Mardyke
- Stanford Brook

This list does not include all culverts and ‘lost’ rivers within London. One of the aims of this FRMP cycle is to try and uncover and re-naturalise waterbodies which have been heavily modified. The Environment Agency will also continue to work collaboratively with partners and communities to improve the water environment.

Without the current river walls many areas of London alongside the Thames and along the tidal stretches of the tributaries would be inundated twice a day through the normal tidal cycle. River walls have been steadily built up since Roman times to give increasing levels of flood protection and to enable urban development.

Records of incidents of this type of flood risk date back to at least 1236. More recently, in 1928, 14 people were drowned in Westminster; this was the last time that central London suffered tidal flooding. In 1953, London was largely spared the impacts of a devastating tidal flood that cost the lives of over 300 people in the East of England. The most recent tidal surge in 2013/14 reached 4.10 metres above ordnance datum (mAOD) at Southend and no properties where flooded. This same event saw over 300 residential properties flooded in Norfolk & Suffolk, but not within the Thames Estuary.

Communities in London and elsewhere in the Thames Estuary benefit from an integrated system of world class flood defences, warning systems and local flood plans. The last serious loss of life was in 1953. Partly because of this disaster, the entire Thames flood plain, 1.25 million people, and £320 billion worth of property are now protected by an integrated system of warnings, defences and locally formulated flood plans.

The Thames Barrier has been closed 195 times since it became operational in 1982 (correct as of January 2021). Of these closures, 107 were to protect against tidal flooding and 88 were to protect against combined tidal/fluvial flooding.

Thames Estuary 2100 Plan

The Thames Estuary 2100 Plan sets out how the Environment Agency and key partners can work together to manage tidal flood risk in the Thames Estuary. Climate change, ageing flood defences and population growth mean tidal flood risk will increase over time, unless this risk is carefully managed. The Thames Estuary 2100 Plan will ensure the Environment Agency continue to protect 1.4 million people and £320 billion worth of property and critical infrastructure from increasing tidal flood risk.

The Thames Estuary 2100 Plan aims to do more than manage flood risk. The flood walls and embankments are an intrinsic part of the Thames landscape. As flood defence works are carried out there will be opportunities for creating better access for communities to the river; to create additional habitat; and enhance the social, economic and commercial benefits the river provides.

The plan aims to:

- manage the risk of flooding to people, property and the environment
- adapt to the challenges of climate change
- ensure sustainable and resilient development in the floodplain
- protect the social, cultural and commercial value of the tidal Thames, tributaries and floodplain
- enhance and restore ecosystems and maximise benefits of natural floods

The Thames Estuary 2100 Plan was the first adaptive flood risk management strategy developed in England. It is a trailblazer of the adaptive pathways approach advocated by the new National FCERM Strategy published in 2020. By taking an adaptive approach, the Environment Agency can better anticipate and respond to a range of future climate scenarios. This ensures investment into the right flood risk management actions at the right time, creating a resilient estuary.

Current flood risk

The main source of flood risk within this FRA is from main rivers.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the RS FRA.

Residential streets which would also be at risk of flooding are not included in the assessment which could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted.

The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the London and Thames Estuary FRA 1,038,191 (88.1%) people live in areas at risk of flooding from main rivers.

Also at risk of fluvial and tidal flooding within the London and Thames Estuary RS FRA include:

- 2,739 services including schools, hospitals, nursing homes, etc. (42.7%)
- 47,631 non-residential properties (87.1%)
- critical infrastructure: 2 airports (100% in the area), 82.4 kilometres of motorways, primary and trunk routes, as classified by National Highways
- (79.7%) and 227.1 km of railway (81.6%). Disruption to transport routes as a result of flood risk can have an impact at both local and larger scales. The lengths of road or railway at risk only provide part of the picture of transport network flood risk, as the duration of possible flooding has wider implications due to closure or restriction of routes or services
- 4,512.1 hectares of agricultural land (86.5%)
- natural environment: 6 EU designated bathing waters within 50m (100%), 77 Environmental Permitting Regulation installations (97.5%), 0.09 hectares of Special Area of Conservation (2.3%), 3296.3 hectares of Special Protection Area (92%), 4,053.5 hectares of Ramsar site (93.4%), 337.5 hectares of World Heritage Site within area (86.8%) 5,102.7 hectares of Sites of Special Scientific Interest (92.2%) and 444.7 hectares of parks and gardens within area (85.7% of the total area).
- historic environment: 211.4 hectares of Scheduled Ancient Monument (92.3%) and 2,804 listed buildings (84%)
- 271 licensed water abstraction sites (94.1%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Communities in London and elsewhere in the Thames Estuary benefit from an integrated system of world class flood defences, warnings systems and local flood plans. The last serious loss of life as a result of flooding was in 1953. Partly because of this disaster, the entire Thames floodplain 1.25 million people and £320 billion worth of property, are now protected by an integrated system of warnings, defences, and locally formulated flood plans.

The climate is changing however, so the Environment Agency has funded major new research on how the River Thames functions and how it may change in the future. This research included changes to fluvial flows, sea storm surges, sea level rise, functionality of flood defence structures and the consequences of more people living and working in the floodplain.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk. In central and inner London, many natural drainage systems, including tributary streams and ditches, have been largely removed or built over. This has led to a dispersion of surface water risk over many small, localised areas with lower elevations than surrounding land.

Sewer flood risk

The sewer network in London is Victorian and was engineered and designed by Sir Joseph Bazalgette to serve a much less populous area. This sewer network today, in many cases, is affected by groundwater ingress, blockages often referred to as 'fatbergs', as well as excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewerage system, the insufficient capacity within the surface water network, and blockages. This is further exacerbated by loss of natural flood plain.

It is hard to predict this type of flooding because it often happens in localised areas, over a short period of time as a result of intense storm events. In the outer London boroughs, added complexity arise from issues within the dual manhole network, which can allow foul to cross into the surface water network and vice versa, causing trunk sewers to surcharge above ground in storm conditions.

However, impacts from sewer flooding within the London Boroughs should be reduced due to the construction of the Thames Tideway Tunnel. The Thames Tideway Tunnel is a 25 km super sewer currently under construction underneath the River Thames. This new sewerage system will prevent the tens of millions of tonnes of pollution that currently pollute the River Thames every year. This necessary expansion of London's sewer network is due for completion in 2025 and is happening across 24 construction sites in

London. These span from Acton in West London to Beckton in the East, and many are located on the river edge in the centre of the city.

Canal flood risk

It is rare that a canal can be the cause of flooding, but flooding may cause an impact to the canal infrastructure.

There are several canals located within this FRA, including the Grand Union Canal, Regent's Canal, the Lee Navigation, London Docklands, and Limehouse Cut. Therefore, the management of canals should be considered in terms of the impact on storage capacity within the wider network.

Groundwater flood risk

There are two main types of groundwater flood risk within this RS FRA:

- flooding from the main aquifers
- flooding from the formation and stratification of the underlying geology

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer, or from water flowing from springs at times of surplus that inundate the surrounding area. This tends to occur after long periods of sustained and high levels of rainfall, and the areas most at risk are often low-lying, where the water table is more likely to be at shallow depth.

Groundwater flooding is known to occur in areas underlain by major aquifers, although it is increasingly associated with more localised floodplain sands and gravels. The London Basin is complex, where flooding can occur due to a build-up of water within the permeable superficial deposits (sands and gravel or river terrace deposits from the River Thames) overlying the impermeable London Clays.

How the risk is currently managed

Fluvial flood risk within the London and Thames Estuary RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have an incident response team open 24 hours a day, ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses and the tidal Thames which informs the Environment Agency incident response team on when to issue flood alerts and warnings. There are multiple tidal Flood Alerts and Flood Warnings to cover the entire stretch of the London and Thames Estuary too. There are alerts in place to help inform our partners responsible for ensuring flood gates are operational during a high tide and/or storm surge event.

Flood defences

Flood defences within the Thames Estuary have been built up over hundreds of years and the Environment Agency have tended to respond to flood events by successively raising the heights of these flood defences walls and embankments. The current system of defences was last upgraded based on the knowledge of sea-level rise in the 1970s and 1980s and in response to the tidal surge of 1953, which includes the construction of the Thames Barrier.

A world-class system of flood defences (or structures) currently reduces the risk of tidal flooding in the Thames Estuary. This system includes:

- the Thames Barrier and 8 other flood barriers
- over 330km of walls and embankments
- over 400 other structures such as flood gates, outfalls and pumps

These structures work together to protect London, Essex and Kent from regular flooding from the sea.

To understand what is being done as part of TE2100 plan and to review and improve flood risk assets across the Thames Estuary, please visit TEAM2100 website.

Modelling

There are various flood models covering the London and Thames Estuary RS FRA designated area, which have been recently updated or have planned future updates.

Table 15: Model updated in the London and Thames Estuary FRA

Model name	Update
Canvey Island Integrated Urban Drainage Model 2015 by Black & Veatch	Joint partnership project between Anglian Water, the Environment Agency, Essex County Council, Essex Highways, Castle Point Borough Council and the RSPB) - pluvial / fluvial
Tilbury Integrated Urban Drainage Model 2015 by JBA	Partnership with Thurrock Council, EA and Anglian Water to develop a pluvial / reservoir / fluvial model
Benfleet Brook 2015 by JBA	Fluvial Model

Model name	Update
Stanford Brook, Stanford-Le-Hope 2016 by CH2M Hill	Fluvial Model
Thames Tidal Upriver Breach Inundation Modelling May 2017 and the Thames Tidal Downriver Breach Inundation Modelling May 2018 completed by Atkins Ltd.	A modelling approach where all upriver and downriver breach locations along the Thames are equitably modelled, to ensure a consistent approach across London. This modelling simulates 5,679 continuous tidal breaches along the entire extent of the Thames from Teddington to the Thames Barrier (Upriver) and 3,149 continuous tidal breaches from the Thames Barrier to east of Gravesend on the south bank and east of Tilbury on the north bank (Downriver). For hard and composite defences breaches are set at 20 m wide - for soft defences, breaches are 50 m wide.
East Anglia Coastal Modelling 2018 by JBA	Tidal update
River Darent and Cray completed in March 2019 by JBA	Fluvial model - Hydrology was converted to continuous simulation and includes hydraulic updates
Dartford and Crayford Creeks in 2020, by JBA.	Tidal model of the joint probability levels in the creeks
Beam and Ingrebourne Modelling Study 2019 by JBA	Updated for new CC (Climate Change) scenarios (5 total, formerly just 100yr +20%), as well as increasing the model extent further upstream on the River Rom.
Mardyke 2019 by Mott McDonald	Fluvial Model
Marsh Dykes 2020 by JBA	Combined model - the integrated model outputs show the flood extents from multiple sources, flood risk from fluvial, pluvial runoff (surface water), and sewers

Future modelling plans to include new climate change events

- River Crane model update
- Thames Tidal Upriver and Downriver Breach Inundation Model update
- River Wandle model update
- River Ravensbourne model update

For the second cycle of the FRMPs, the Environment Agency have created measures in line with the implementation of the TE2100 plan.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the London and Thames Estuary RS FRA

Measures have been developed which apply specifically to the London and Thames Estuary FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the London and Thames Estuary FRA.

You can find information about all the measures that apply to the London and Thames Estuary FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Luton and Dunstable Surface Water Flood Risk Area

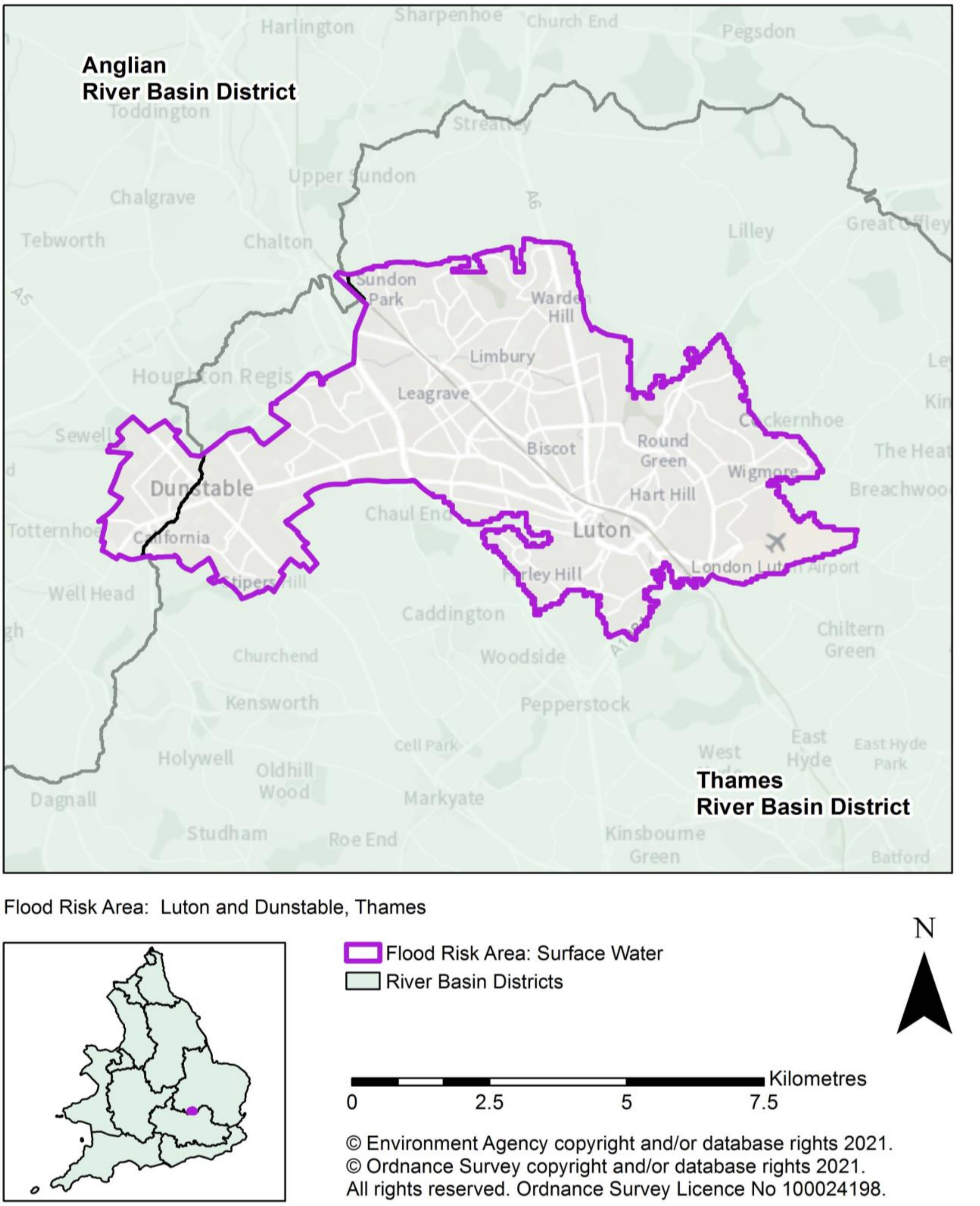


Figure 25: Map showing the Luton and Dunstable Flood Risk Area Boundary and its location in England

The Luton and Dunstable Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the north west of the Thames Rover basin District (RBD). This FRA is located on the boundary between the Thames RBD and Anglian RBD FRMP areas. It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The main source of flooding in this FRA is from surface water sources. The Luton and Dunstable SW FRA covers parts of both Luton Borough Council and Central Bedfordshire Council. Luton Borough Council and Central Bedfordshire Council lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA as the responsible authorities for managing flood risk from surface water. The Luton and Dunstable FRA was not identified in 2011 for the first cycle of FRMPs.

The councils work collaboratively with partners, other flood Risk Management Authorities (RMAs), as well as communities at risk in order to improve the water environment.

There are Risk Management Authorities operating in the Luton and Dunstable SW FRA, including:

- Environment Agency Area
- Two Lead Local Flood Authority (LLFA): Luton Borough Council and Central Bedfordshire Council
- Regional Flood and Coastal Committees (RFCC): Thames RFCC
- Two Highways Authorities: Luton Borough Council and Central Bedfordshire Council Highways
- Two Water and Sewerage Companies: Thames Water and Anglian Water
- The Department of Communities and Local Government through local planning authorities

Environmental designations

There are two Sites of Special Scientific Interest (SSSI) partially located within the south-west of this FRA: Dunstable and Whipsnade Downs and Blow's Down. Cowslip Meadow is another SSSI located in the North of Luton. Details of these designations can be found on the Defra MAGIC Database.

The Luton and Dunstable SW FRA falls within the Luton Lea Catchment Partnership area, which contributes to improving the understanding of the catchment and the development of joint plans to improve the health of the local water environment.

Topography, geology, hydrogeology, land use

This FRA is mainly urban, with a low proportion of public parks, playing fields and arable land, located within a valley of the Chiltern Hills. Key urban areas include Luton and Dunstable. Luton is a large town located 30 miles north of London. Dunstable is situated in the south of Central Bedfordshire and is one of the two largest urbanised areas within

Central Bedfordshire, located immediately to the west of Luton, on the eastern edge of the Chiltern Hills.

The main land use is residential, interspersed with industrial and commercial estates, including the Luton town centre commercial area, Dunstable High Street and the London Luton Airport, which has grown into a major transport hub since it opened in 1938. Most of the FRA is heavily urbanised or suburban, with open spaces typically limited to parks and school playing fields. The key areas of forecast strategic growth are located within the north and south-east of this FRA.

Across the FRA, the watercourses are predominantly modified concrete channels that are straightened and canalised and/or culverted. Surface drains and sewer networks are vulnerable to overflow and inundation, with the network designed to national highway and sewerage standards. However, the surface water flood risk within these networks has increased due to the lack of catchment conveyance and storage and a reliance on the urban drainage to drain the whole catchment.

The topography of the FRA is strongly influenced by the River Lea, which runs in a south-easterly direction through the centre of Luton. The topography of the surrounding area generally slopes towards the River Lea. The areas with the lowest elevations are in the south-east, and the areas with the highest elevations are located in the north-west.

The underlying geology in the FRA is chalk. Within chalk aquifers, water can infiltrate quickly and move within and through the rock. The groundwater in chalk areas flows slowly through the aquifers and is released at a slower rate, compared to overland flows into the rivers. This can create a delayed flood response after a storm event and exacerbate flooding.

Current flood risk

The main source of flood risk within this Luton and Dunstable SW FRA is surface water, but the area can also be impacted by fluvial, groundwater and sewer flooding. This section will focus on the surface water flood risk within the FRA but will also give a high-level overview of the other flood risk sources for context.

Surface water flood risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The flood risk in Luton and Dunstable is partly due to the rapid expansion of Luton to the north from the 1950s through to the 1980s, without a simultaneous upgrade of the downstream sewer system. The issues of surface water flooding are further compounded by the local topography, which is now shaped to funnel surface water towards the centre of Luton. The area has become somewhat reliant on pumped or piped drainage which can become overwhelmed during heavy rain.

Details of significant flow routes

The areas within this SW FRA that are particularly susceptible to overland flow and surface water ponding include river valleys, low-lying areas, railway cuttings and embankments. Roads can convey water, acting as a secondary channel within a flood event, with flooding tending to occur in areas where sewer and fluvial flood risk are also likely.

The Luton Borough Council Surface Water Management Plan (ROFSW 2019) identifies 14 Critical Drainage Areas (CDAs) where the risk of surface water flooding is particularly high. These are scattered throughout the SW FRA.

The Local Flood Risk Management Strategy (LFRMS) includes an assessment of properties expected to be at risk of surface water flooding identified by parish. Dunstable, located within this FRA, is split between two parishes: Dunstable and Houghton Regis, both of which are classified as 'Higher Risk' areas, which is defined as areas of greater than 501 properties at risk. The assessment was based on the updated Flood Map for Surface Water (uFMfSW) and the preceding Flood Map for Surface Water (FMfSW) for higher risk areas. The assessment of risk was enhanced by Central Bedfordshire Council considering flooding history and local knowledge which subsequently classified both parishes as 'Medium Risk'. The Dunstable Flood Study identifies 8 Critical Drainage Areas (A-H) across Dunstable and provides an in-depth review of flood mechanisms in the area.

Surface water flood risk — description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA.

Residential streets which would also be at risk of flooding are not included in the assessment which could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted.

The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazards and risk maps show an estimated 236,815 people living within the Luton and Dunstable SW FRA. Of those in the area, 30,849 (13%) live at risk of flooding from surface water.

Also, at risk of surface water flooding within the Luton and Dunstable SW FRA are:

- 67 services (5.7% of the total in the area), including: Luton Fire Station and some schools (Beechwood Primary School, Challney High School for Boys/Girls and Luton Sixth form College, all affected by SW flow paths)
- 1,533 non-residential properties (19.5% of the total in the area)
- 1 airport (100% of the total in the area)

Airports tend to create a large impermeable area used for runways and terminal buildings. Ponding of surface water can create disruptions and run-off from chemical de-icers used on the planes can cause environmental harm to surrounding watercourses. Surface Water flooding impacts on access routes to Luton Airport and Luton Airport Parkway Rail Station. London Luton Airport has developed a surface water drainage strategy and is currently embarking on a systematic programme of facilities and service development. This is to ensure the airport is able to comply with all current and anticipated future environmental regulations and prevents surface water and groundwater pollution in accordance with the objectives of the Luton Local Plan and the National Planning Policy Framework.

- 8 kilometres of motorways, primary and trunk routes, as classified by National Highways (45.5%), including major infrastructure links, such as the A5, A6 and the new linking road between the M1 and A6, and 3.4 kilometres of railway (28.3%) Disruption to transport routes as a result of flood risk can have an impact at both the local and larger scale. The lengths of road or railway at risk only provide part of the picture of the impact flooding can have on the transport network as the duration of possible flooding can have wider implications due to the closure or restriction of routes or services.
- 77.7 kilometres of agricultural land (13.7%)
- 6 hectares of parks and gardens (27.6%)
- 1.5 hectares of Scheduled Ancient Monument (9.5%) and 11 listed buildings (8.2%)
- 2 licensed water abstraction sites (16.7%)

Conclusions based on risk statistics

Flooding within the Luton and Dunstable SW FRA is a complex system with multiple factors impacting the flood risk. The Flood Risk and Hazards map shows 30,849 people living in the Luton and Dunstable SW FRA are at risk from surface water flooding.

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Fluvial flood risk

Fluvial flood risk within this SW FRA is mainly managed by transferring the water in concrete channels and conveying it through Luton. Most of the river channels within this SW FRA have been modified, with significant lengths of the River Lea through Luton having been canalised and/or culverted. Watercourses are typically straight concrete-lined channels with many culverts and structures. The culverted and canalised sections fulfil an important flood risk management role to Luton Town Centre and surrounding properties. It is also worth noting that there are no open watercourses located within Dunstable.

Groundwater flood risk

Groundwater flooding occurs as a result of either water overflowing from the underlying aquifer or from water flowing from abnormal springs. It often occurs after periods of long, sustained, or high levels of rainfall, and in low-lying areas where the water table is more likely to be at shallow depth.

Many of the watercourses in this FRA are spring fed, where the water table is very close to the surface in locations throughout the borough. Despite this, groundwater flooding is not a frequently occurring source of flooding within this FRA. Areas of potential groundwater flood risk mostly align with the path of the River Lea.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network, usually as a result of the inadequate capacity of the sewage system, as well as blockages within the system.

Historically, areas of Luton and Dunstable have experienced flooding as a result of surcharged sewers. This is thought to be associated with rapid urban expansion in the north, without a subsequent upgrade of the sewer system.

The Integrated Catchment Model (ICM) found the surface water drainage network is operating close to capacity across most of Dunstable and that a significant proportion of the network will surcharge during smaller, more frequent floods.

Historic flood events (2015 – 2020)

In June 2016, the Luton and Dunstable area were impacted by major surface water flooding to properties and critical infrastructure. A flood event is considered by this FRMP as an event which impacts more than 20 properties internally. There have also been other flood events which have impacted the area since 2016, but this has not impacted more than 20 properties. For more information, please review the local strategies.

How the risk is currently managed

Surface water flood risk within the Luton and Dunstable SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

Flood defences

The main flood defences within this FRA are the Icknield Way Flood Storage Area and the Pastures Way Flood Storage Area. There is also a deep pumping well near the underpass managed by Anglian Water.

Hydraulic modelling

Several hydraulic models have been produced in recent years, with some still in progress, assessing flood risk from a variety of sources in and around the FRA catchment.

Table 16: shows current modelling within the FRA

Model & Date	Owner	Flood Risk Assessed	Coverage
Houghton Brook Model 2020	EA	TBC	TBC – this work is still ongoing and full information will be released within this FRMP period
Dunstable FAS, 2019	CBC	Surface Water	Dunstable topographic catchment, partially extends into Luton
RoFSW Update, 2019	LBC	Surface Water	All of Luton area to the Lea via four individual models
Integrated Sewerage Model, TBC	Thames Water	Surface Water	TBC – this work is still ongoing and full information will be released within this FRMP period
Upper Lea 2015	EA	Fluvial	Upper Lea, Houghton Brook and Lewsey Brook

Future development – Luton

LBC aim to encourage development within the local authority area to reduce overall flood risk, where possible, through the design and layout of schemes that restore flood plain areas and enhance natural forms of drainage (including, but not limited to, floodplain creation, incorporation of green roofs, creation of surface water storage, and the removal of culverts and barriers to flow).

LBC also work with the Environment Agency in the management of flood risk to ensure any risk of flooding is appropriately mitigated and the natural environment is protected by all new development.

Local Plan Policies (LLP) 36 and 38 were created to consider the water environment, with LLP36 focusing on Flood Risk issues and LLP38 focusing on Pollution and Contamination. These policies were developed to stipulate LBC requirements of developers in planning applications. More information can also be found in the Luton Strategic Flood Risk Assessment (SFRA).

Future Development – Dunstable

CBCs Local Plan to 2035 includes specific policy objectives for repositioning and re-development within Dunstable (policy R3), as well as specific local policies for Climate Change and Sustainability, including flood risk management and sustainable drainage. The Local Plan is supported by the SFRA and Water Cycle Strategy (WCS) for Central Bedfordshire.

Weighting should be given to the FRA designation in the development control process, ensuring both new and redevelopments contribute to the FRMP objectives and measures, where applicable, and the sustainable management of existing and future flood risk.

Property flood resilience

There are plans to develop a business case for Property Flood Resilience (PFR) through the Resilient and Adaptive Communities project. (At the time of writing further information on this funding was not available.)

The thresholds for properties are typically low across parts of Dunstable, putting these properties at increased risk of surface water flooding. However, these properties were not identified as at risk by the RoSWM due to assumptions in the mapping. Therefore, the ICM has accounted for this in the Dunstable Flood Study and is expected to be progressed within this FRMP cycle.

Flood warning and community preparedness

There are fluvial flood warnings available for the River Lea, but there are currently no national provisions for surface water flood warnings or long-term forecasting for future flood warnings. Surface water flooding is hard to forecast, with different events seeing flood flows following different routes and seeing different areas. It is the aim of the RMAs within this FRA to develop a more integrated flood warning system for multiple sources.

Investment strategies

As part of their local strategy, Central Bedfordshire Council has developed an investment strategy, which will focus investment and prioritise works for surface water flood resilience. The council is also creating an Outline Investment Strategy to enable Strategic Investment Planning. This will be used to outline a collaborative approach, working more effectively as an authority and with partners, to reduce multisource flood risk and seeking opportunities for efficiently packaging work. The Outline Investment Strategy will aim to use all available resources and funds in an integrated way to support priority projects and achieve efficiency savings.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Luton and Dunstable Surface Water FRA

Measures have been developed which apply specifically to the Luton and Dunstable FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Luton and Dunstable FRA.

You can find information about all the measures that apply to the Luton and Dunstable FRA in the interactive mapping tool - Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Maidenhead Rivers and Sea Flood Risk Area

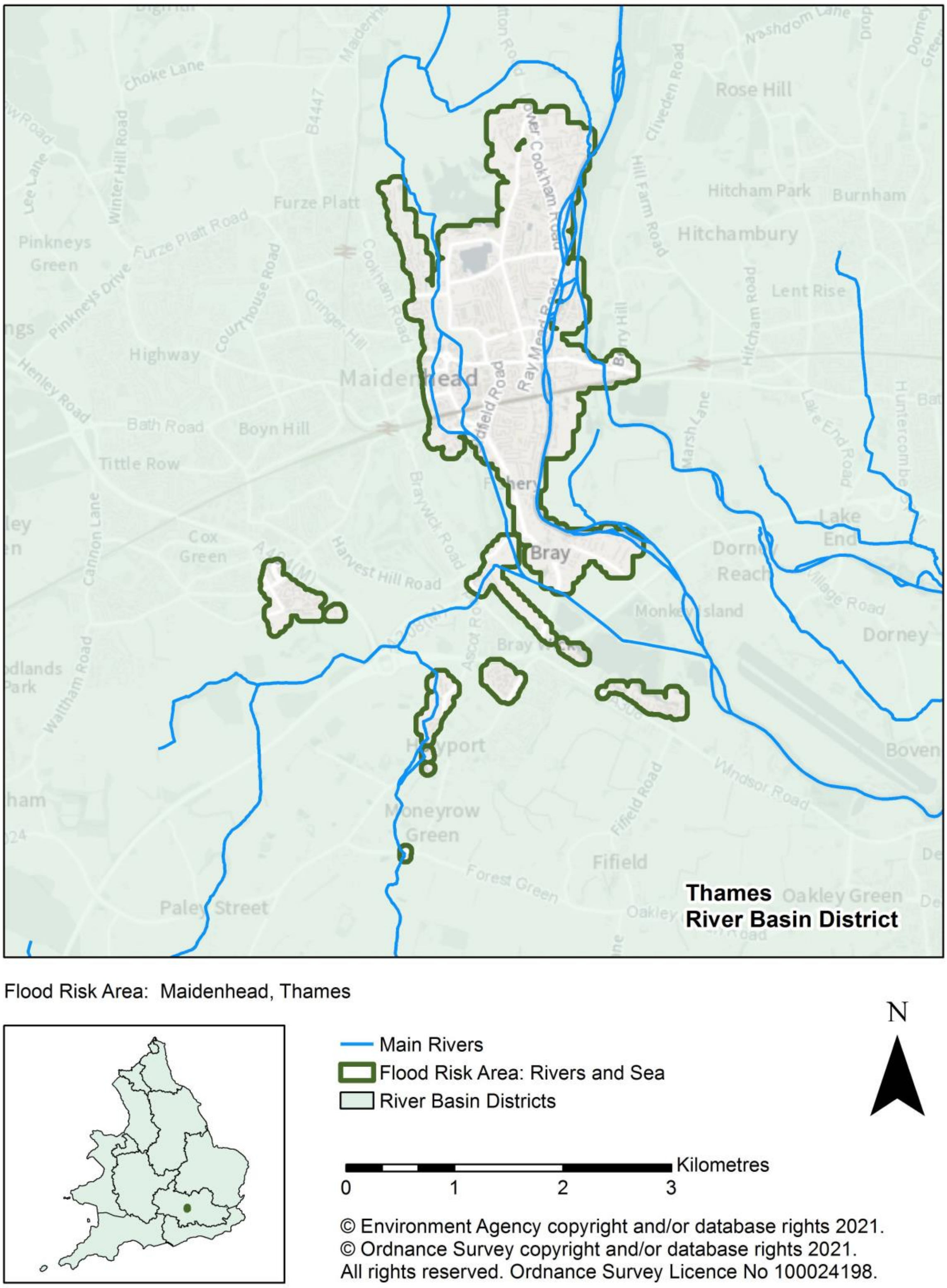


Figure 26: Map showing the Maidenhead Flood Risk Area Boundary and its location in England

The Maidenhead Rivers and Sea (RS) Flood Risk Area (FRA) is in the south east of England, to the north west of the Thames River Basin District (RBD). This FRA will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Maidenhead RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Maidenhead Rivers and Sea (RS) Flood Risk Area covers part of the Royal Borough of Windsor and Maidenhead and a small part of Buckinghamshire Council, west of the River Thames. Large parts of the FRA are located north of M4, east of the A404M and west of the Jubilee River (part of the Maidenhead, Windsor and Eton Flood Alleviation Scheme). The Maidenhead FRA spreads over key urban areas including Maidenhead, Ockwells Road and Cox Green Road area as well as parts of Holyport. It is estimated that 12,589 people are at risk of flooding from main rivers (84.9%) within the FRA, in addition to 419 non-residential properties.

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows across the ground. Parts of the Maidenhead Rivers and Sea FRA overlap with the Maidenhead FRA from surface water. This means that large parts of Maidenhead have been identified as being at significant risk of flooding from watercourses and surface water run-off. Refer to the Maidenhead Surface Water (SW) FRA for more information on the flood risk from surface water.

There are several Risk Management Authorities (RMA) operating in the Maidenhead FRA including:

- Environment Agency Areas
- Two Lead Local Flood Authorities (LLFAs): Royal Borough of Windsor and Maidenhead (predominantly) and Buckinghamshire Council
- Thames Regional Flood and Coastal Committee
- Two Highways Authorities: Royal Borough of Windsor and Maidenhead (predominantly) and Buckinghamshire Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the Maidenhead RS FRA is strongly influenced by the lower lying floodplains of the River Thames. The town centre of Maidenhead is relatively flat at approximately 30 metres above ordnance datum, with more elevated areas to the north-west, at approximately 60-70m above ordnance datum.

Most of the superficial geology of the FRA is alluvium and Shepperton Gravel Member which is often associated with susceptibility to groundwater flooding. The predominant underlying geology is chalk to the north of the FRA. Within chalk and limestone areas (termed aquifers), water can infiltrate quickly and move within and through these rocks. These areas become part of the major groundwater resources of the Thames River Basin. The groundwater from the chalk and limestone areas provides a significant baseflow component to the rivers in the Thames River Basin. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The impact of rainfall on main rivers such as the River Thames will be spread out over a relatively long period of time. The Maidenhead FRA is mainly urban with dispersed green space.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a Catchment Based Approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that the Environment Agency can be confident that together we can resolve the identified issues.

Current flood risk

The main source of flood risk within this FRA is from main rivers.

The River Thames is the predominant watercourse in the Maidenhead Rivers and Sea FRA which flows in a southerly direction to the east of Maidenhead. The River Thames is a major river that rises in the Cotswold hills near Cirencester and flows for 215 miles from its source to the sea. The River Thames is intensely used and controlled by a series of weirs, sluices and locks for navigational purposes. This section of the River Thames is not influenced by the tide which stops near Teddington weir. During times of normal flow, the Thames acts like a series of ponds that are fed via upstream locks, with water levels controlled by downstream structures. For bankfull flows, the sluice gates on the Thames are fully open and the water surface slope becomes closer to the natural channel bed slope. At times of high flow, the Thames floods its large floodplain, and the water surface is determined by the floodplain flow.

Tributaries of the River Thames which fall within the FRA include the Whitebrook at the confluence, Maidenhead ditch, also referred to as the York Stream and Moor Cut through Maidenhead town centre, the Cut and Chawridge Bourne. There are a number of gravel pit lakes within the FRA including Summerleaze lake to the north of the FRA and parts of Bray Lake to the south.

The Maidenhead area has experienced flooding several times in past years including in 1894, 1947, 1954, 1959, 1974, 1981, 1990, 2000, 2003, 2007, 2012 and 2013/14. The impact of recent floods has reduced due to the operation of the Maidenhead, Windsor and Eton Flood Alleviation Scheme which opened in 2002.

Fluvial flood risk — description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps](). These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment which could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Maidenhead FRA 12,589 (84.9%) people live in areas at risk of flooding from main rivers. Of these, 10.4% are in areas of high risk. The majority of people are at low risk. As well as people living within the floodplain, there are also services that have been built within FRAs. 41 (30.9%) services are in areas at risk of flooding. The majority are at low risk. Schools and sewage treatment works are examples of services.

Also shown to be at risk of fluvial flooding in the Maidenhead RS FRA include:

- 419 non-residential properties out of 477. Most non-residential properties are at low risk
- 2.83km of the railway
- less than half a kilometre of motorways, primary and trunk routes, as classified by National Highways is shown to be at risk of flooding
- a large proportion (83.87ha) of agricultural land
- all (7) licensed water abstractions
- a large proportion (86.5%) of listed buildings with the majority (75.5%) being shown at low risk of flooding
- approximately three quarters (3.01ha) of the Parks/Garden
- there are over four hectares of Sites of Special Scientific Interest (SSSI) which are all at medium risk of flooding

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Maidenhead RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

The Environment Agency is managing existing flood risk effectively in large parts of the FRA mainly along the river Thames.

Parts of the Maidenhead RS FRA benefit from the Maidenhead, Windsor and Eton Flood Alleviation Scheme. The Scheme was built by the Environment Agency and completed in 2001. The scheme reduces the risk of flooding from the River Thames to approximately 3,200 homes in Maidenhead, Windsor and Eton. The main component of the flood alleviation scheme is the Jubilee River. It conveys water from Taplow near Maidenhead and runs parallel to the north of the main course of the Thames, re-joining the main Thames downstream of Windsor. It is 11.6km long and acts as a flood relief channel for the River Thames, allowing water levels to be controlled by diverting flows from the Thames during times of high flow. It is designed to appear natural with the channel varying in appearance. It provides an outdoor resource for the local community with accessible paths, bridleways and canoe portage points along its length. The scheme also incorporates flood embankments and flood gates to the north of Maidenhead and the west and north of Cookham.

The Environment Agency has been working with the Royal Borough of Windsor and Maidenhead as part of the Local Plan process to guide development across the borough. The Borough Local Plan 2013-2033 was adopted on 8 February 2022.

The Environment Agency is part of the Thames Valley Local Resilience Forum. There is a Multi-Agency Flood Plan (MAFP) which comprises the seven unitary local authorities of Berkshire and Milton Keynes, as well as the county and district local authorities of Buckinghamshire and Oxfordshire. This area includes the River Thames catchment and associated tributaries plus part of the Great Ouse catchment which falls in the Milton Keynes area.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

The Environment Agency's flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Due to the relatively long catchment response times associated with flooding from the River Thames, timely forewarning should be possible. This enables the Council, emergency services, residents and businesses to prepare to reduce the impact of a flood.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Maidenhead RS FRA

Measures have been developed which apply specifically to the Maidenhead FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Maidenhead Flood Risk Area.

You can find information about all the measures that apply to the Maidenhead FFRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Maidenhead Surface Water Flood Risk Area

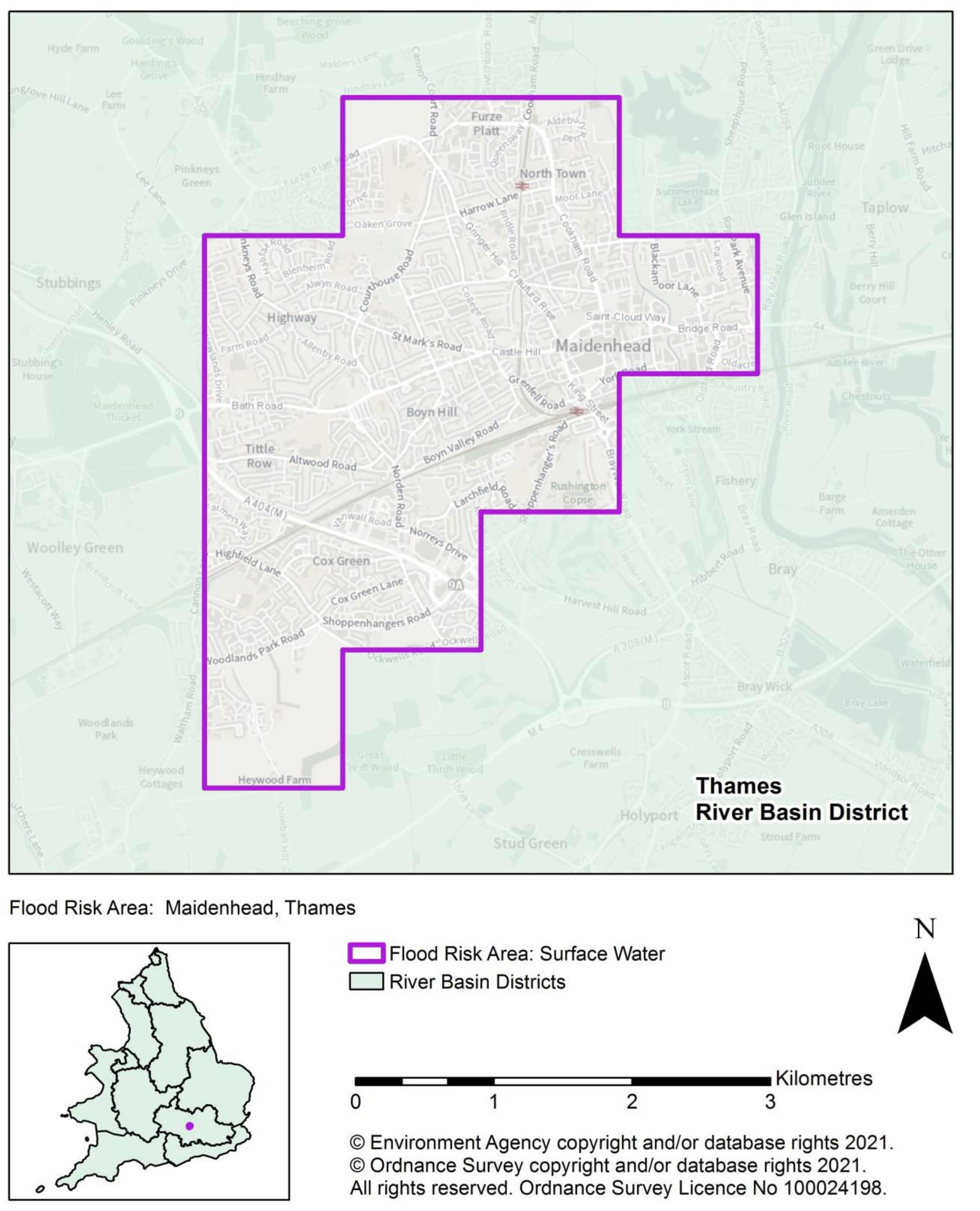


Figure 27: Map showing the Maidenhead Flood Risk Area Boundary and its location in England

The Maidenhead Surface Water (SW) Flood Risk Area (FRA) is in the South East of England, to the north-west of the Thames River Basin District (RBD). It wil be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Maidenhead SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs). The Maidenhead SW FRA is located wholly within the administrative boundary of the Royal Borough of Windsor and Maidenhead. The FRA is in a mostly urban environment, with a relatively low proportion of park. The FRA is bounded to the north, east, west and south by green belt land.

The main sources of flood risk within the Maidenhead SW FRA are surface water, groundwater and fluvial. Parts of the Maidenhead SW FRA overlap with the Maidenhead Rivers and Sea (RS) Flood Risk Area. This means that large parts of Maidenhead have also been identified at being at significant risk of flooding from main rivers. Refer to the Maidenhead Rivers and Sea FRA for more information on the flood risk from main rivers.

The Royal Borough of Windsor and Maidenhead leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water. In this role they partner with other Risk Management Authorities (RMA), including the Environment Agency, Thames Water, and other stakeholders, to manage surface water, groundwater, and ordinary watercourse flood risk.

Duties include:

- identifying flood risks within their borough
- determining potential interventions for managing the flood risk
- applying for funding to implement the identified interventions
- preparing and maintaining strategy for local flood risk
- maintaining a register of flood risk assets, among others

There are Risk Management Authorities operating in Maidenhead SWFRA, including:

- Environment Agency Area: Thames
- Lead Local Flood Authority (LLFA): Royal Borough of Windsor and Maidenhead
- Regional Flood and Coastal Committee (TRFCC): Thames
- Two Highway Authorities: National Highways and the Royal Borough of Windsor and Maidenhead as
- Thames Water is the only water and sewerage company

Topography, geology, hydrogeology, land use

The topography of the Maidenhead SWFRA is strongly influenced by the lower lying floodplains of the River Thames. The town centre of Maidenhead is relatively flat at approximately 30m above ordnance datum, with more elevated areas to the north-west, at approximately 60-70m above ordnance datum.

The geology of Maidenhead is generally conducive to infiltration, and much of the impermeable area also drains via soakaway.

The underlying geology is Seaford Chalk Formation, Newhaven Chalk Formation and Lambeth Group (Clay, Silt and Sand).

Within chalk areas, water can infiltrate quickly and move within and through these rocks. These areas become part of the major groundwater resources of the Thames River. The groundwater from the chalk areas provides a significant baseflow component to the rivers in Maidenhead. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The impact of rainfall on groundwater flood risk will be spread out over a relatively long period of time, relative to the surface water flood risk in the FRA which has a much quicker response time.

Due to the underlying geomorphology, there is some risk of groundwater flooding within the Maidenhead SW FRA.

The FRA is mainly urban with dispersed green space. The centre of Maidenhead within the FRA is currently going through significant urban renewal, but the areas surrounding the FRA are designated green belt so are unlikely to be developed in the immediate future. The Borough’s Local Plan guides development across the borough. There is a supplementary planning document for Maidenhead Town Centre, the Maidenhead Town Centre Area Action Plan.

Environmental designations

The entirety of the Maidenhead SW FRA is located within Source Protection Zones (SPZ) 1, 2 or 3. SPZs are defined around large and public potable groundwater abstraction sites. The purpose of SPZs is to provide additional protection to safeguard drinking water quality through constraining the proximity of an activity that may impact upon a drinking water abstraction.

The full detail of all designations within the FRA can be found on the [Defra MAGIC map database].

Current flood risk

Surface water flood risk - overview of risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Maidenhead SW FRA has been identified as being at significant risk of flooding due to a combination of factors including widespread impermeable urban land cover, low-lying areas that are conducive to surface water ponding, interaction with the downstream watercourses, and ageing drainage infrastructure that is often overwhelmed. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the risk.

The principal drainage system serving the Maidenhead SW FRA is the surface water public sewer, owned and maintained by Thames Water. This system serves the residential and commercial properties within the FRA and the public highway largely drains to it. Discharge from the surface water sewer system is to York stream and The Strand which flow through central Maidenhead.

These rivers discharge to The Cut, and then the River Thames and therefore the Surface Water FRA is impacted by the interaction of the water levels in these downstream rivers.

Since 2015 to time of writing, three incidents of flooding due to surface water have been recorded within the Maidenhead SW FRA.

In August 2015 one property on Haddon Road suffered flooding of a garage. Two independent incidents occurred in September 2016 as a result of a high intensity rainfall event. This impacted both Maidenhead High Street, where commercial properties were affected, and residential and commercial properties in the Cox Green Road, Brill Close and Norreys Drive area of the FRA.

Surface water flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRA. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazards and risk maps show that in the Maidenhead FRA 7,842 (16.2%) live in areas at risk of flooding from surface water. Of those, 2.4% are in areas of high risk.

Also shown to be at risk of surface water flooding:

- 21 services (8.7%)
- 367 Non-residential properties at risk (23.3%). There are a significant number of historic and older buildings within this FRA, which can, in some cases, contribute to a lower level of resilience to surface water flooding if these buildings do not have measures in place that help to drain away water. There are also many recently developed buildings, which, due to local regulations and policies, often employ sustainable drainage systems and other measures to be resilient to flood risk
- critical Infrastructure: 1.08 kilometres of motorways, primary and trunk routes, as classified by National Highways (33.8%), and 2.8 kilometres of railway (35.4%). 40.35 hectares of agricultural land (23.8%)

- protected areas: 0.99 hectares of Sites of Special Scientific Interest (SSSI) (35.0%)
- historical landmarks: 2 listed buildings (3.2%)
- 2 licensed water abstraction sites

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Despite the entirety of the Maidenhead SW FRA being located within an area of separated sewers (dedicated surface water and foul systems), surface water may still enter the foul sewers via misconnections.

Most foul sewer flooding is a result of the inadequate capacity of the sewage system and blockages.

How the risk is currently managed

Surface water flood risk within the Maidenhead SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

For more detail, refer to the borough's Local Flood Risk Management Strategy which details the objectives and actions proposed to manage flood risk, as well as the FRMP measures (link available at the bottom of this section).

Modelling

Reliable and accurate surface water modelling is difficult. This is due to the multiple flow routes and flood sources. Surface water flooding can be difficult to predict and carrying out modelling can be resource intensive. The most accurate surface water modelling exercise undertaken covering the entirety of Maidenhead SW FRA has been undertaken by the Environment Agency.

In addition to this, the Royal Borough of Windsor and Maidenhead has commissioned an enhanced hydraulic modelling assessment of the Cox Green Road, Brill Close and Norreys Drive area of the FRA. This modelling has been developed to better understand the flood mechanism which saw this area of the borough impacted by surface water flooding in 2016. The modelling exercise also assessed several flood mitigations options to tangibly quantify the benefits they would provide.

Delivery of the preferred modelled option is included within the Maidenhead SW FRA measures for the second cycle FRMP.

Development

New construction and significant redevelopment projects are required to consider flood risk from multiple sources and identify mitigation and sustainable drainage options that are appropriate for the development. This regulation is important to ensure high standards of resilience.

Flood risk asset management

The Royal Borough of Windsor and Maidenhead in its capacity as highway authority undertakes routine maintenance of the highway drainage infrastructure within the Maidenhead SW FRA to ensure that water drains efficiently from the highway.

Thames Water and the Environment Agency also undertake maintenance of their assets to ensure all drainage infrastructure works effectively.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Maidenhead SW FRA

Measures have been developed that apply specifically to the Maidenhead SW FRAThe measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Maidenhead SW FRA.

You can find information about all the measures that apply to the Maidenhead FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Marlow Rivers and Sea Flood Risk Area

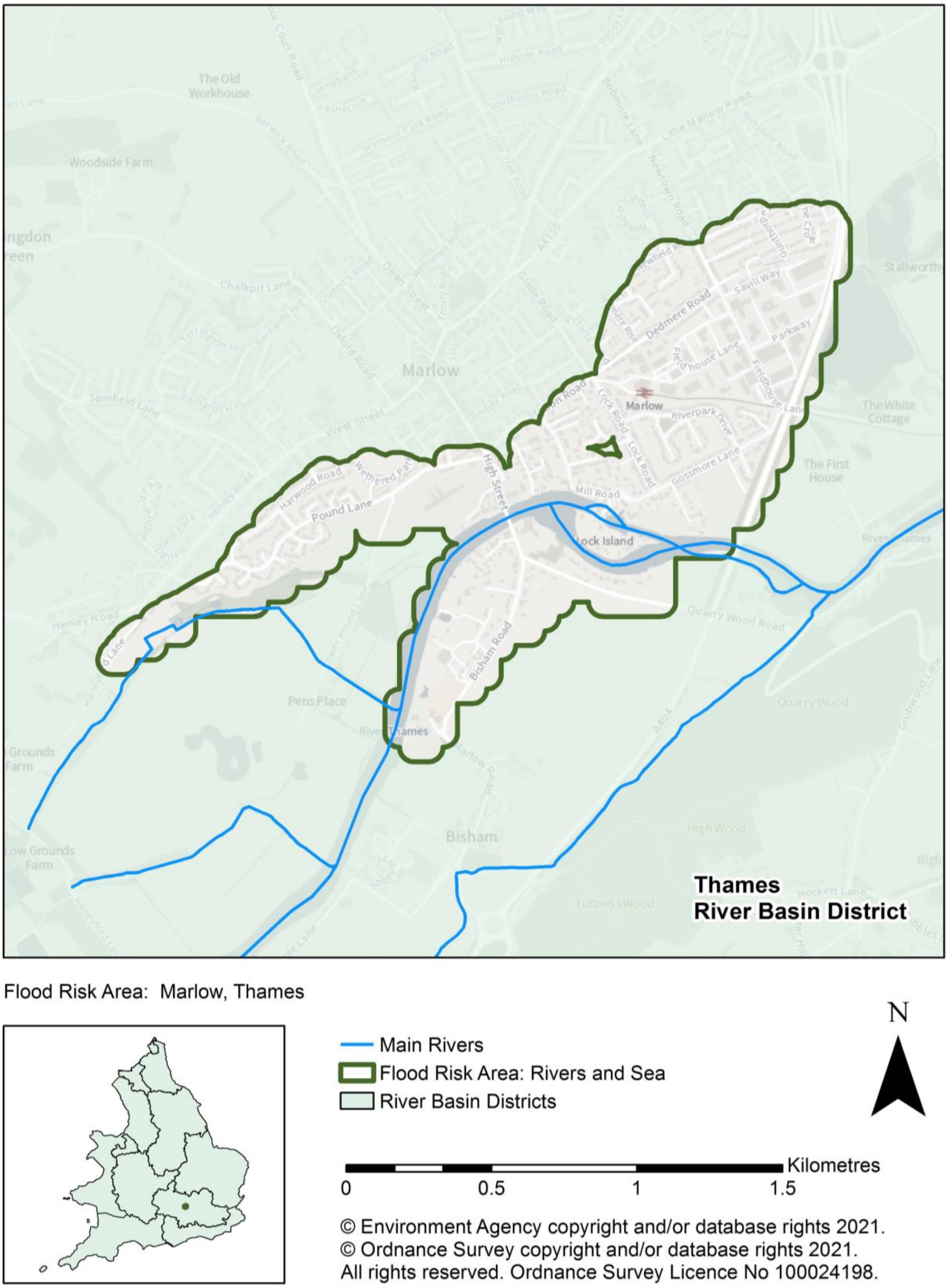


Figure 28: Map showing the Marlow Flood Risk Area Boundary and its location in England

The Marlow Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and to the north-west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Marlow Rivers and Sea FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Marlow FRA covers parts of Buckinghamshire Council on the left bank of the River Thames including Lower Pound, Firview close and Gossmore playing fields. It also covers parts of Royal Borough of Windsor and Maidenhead on the right bank of the River Thames from Bisham Abbey National Sports Center to the A404 bridge over the River Thames.

There are Risk Management Authorities (RMA) operating in the Marlow RS FRA including:

- Environment Agency
- Two Lead Local Flood Authorities (LLFAs): Buckinghamshire Council and Royal Borough of Windsor and Maidenhead
- Thames Regional Flood and Coastal Committee
- Three Highways Authorities: National Highways, Buckinghamshire Council and Royal Borough of Windsor and Maidenhead
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the RS FRA is strongly influenced by the Chiltern Hills which run in a south-west to north-easterly direction across the district, to the north of Marlow.

The underlying geology is Cretaceous Chalk with the lowland floodplain of the River Thames (including Marlow to the south of the A4155) characterised by River Terrace Deposits such as sands and gravels.

Within chalk areas (termed aquifers), water can infiltrate quickly, and move within and through these rocks. These areas become part of the major groundwater resources of the Thames River Basin. The groundwater from the chalk and limestone areas provides a significant baseflow component to the rivers in the Thames River Basin. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The impact of rainfall on main rivers such as the River Thames will be spread out over a relatively long period of time.

The development of Pound Lane estate dates to the 1960s and at its closest point, the River Thames lies approximately 300m south of the estate. The development of Gossmore Lane dates back to the 1930s. During the early 1950s, a new housing estate was developed along the north side of Gossmore Lane. Firview Close was built in 1979 and is situated about 200m north of the River Thames.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities and partners through the South Chilterns Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a Catchment Based Approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

Current flood risk

The primary source flood risk in the Marlow RS FRA is from main rivers, however some areas within the RS FRA are also at risk from other sources, including surface water and groundwater.

The predominant watercourse in the Marlow RS FRA is the River Thames which flows in a west to east direction through the middle of the RS FRA. The River Thames is a major river that rises in the Cotswold hills near Cirencester and flows for 215 miles from its source to the sea. The Thames is intensely used and controlled by a series of weirs, sluices and locks. This section of the River Thames is not influenced by the tide which stops near Teddington weir. During times of normal flow, the Thames acts like a series of ponds that are fed via upstream locks, with water levels controlled by downstream structures. For bankfull flows, the sluice gates on the Thames are fully open and the water surface slope becomes closer to the natural channel bed slope. At times of high flow, the Thames floods its large floodplain and the water surface is determined by the floodplain flow.

The Harveyford Ditch flows to the west of the RS FRA and is a tributary of the River Thames.

Bisham is located on the floodplain between the River Thames and the Bisham Brook and has a history of fluvial and groundwater flooding.

The River Thames tends to react slowly to rainfall because the baseflow is largely dependent upon groundwater levels.

During January 2003 the area suffered flooding from a combination of floodwater inundation from the River Thames and rising groundwater. The floods lasted for approximately one week, from 3 to 9 January 2003. There have also been other flood events in 1947, 2006, 2007, 2009, 2012 and 2013/2014. In Bisham, areas around Quarry Wood Road and Bisham Green were particularly affected. Several properties were also affected from internal flooding during 2013/2014 events.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the RS FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Marlow RS FRAs 2,574 people live in areas at risk of flooding from main rivers. As well as people living within the floodplain, there are also services that have been built within RS FRAs. There are 12 services in areas at risk of flooding from main river.

Also shown to be at risk of flooding from main rivers in the Marlow RS FRA:

- 3 (1.64%) non-residential properties out of 182 are at high risk, 64 (35.2%) are at medium risk and 83 (45.6%) are at low risk
- 0.24 km (21%) of motorways, primary and trunk routes, as classified by National Highways located is at high risk, 0.53 (46.5%) is at medium risk and 0.33 (28.9%) is at low risk
- 0.53 km of railway
- 10.22 ha of agricultural land
- 2 listed buildings (4.5%) are at high risk, 13 (29.5%) are at medium risk and 4 (9.1%) are at low risk

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water and groundwater flood risk

The River Thames catchment can take a long time to rise and fall which can lead to long duration flooding. However, the Newt Ditch and drainage system in Marlow can respond quickly after rainfall with little advance warning. Groundwater flow in the gravels beneath Pound Lane and Firview Close is derived primarily from the natural discharge of water from a chalk groundwater catchment, flowing from the north towards the valley floor of the River Thames. Under normal conditions, this groundwater drains southward, underground through the gravels to discharge into the Thames and associated surface water channels and ditches.

The Pound Lane area suffered from a series of surface water drainage problems in the 1970s, 1980s and 1990s. In September 2002, Buckinghamshire County Council installed a pumped road drainage system to alleviate the surface water flooding issues in the Pound Lane area.

However, there is a history of groundwater flooding in the area, when the water rises above ground level leading to an elevated groundwater level in the Chalk. The gravel also provides hydraulic continuity. This rise of groundwater levels was compounded by the high levels of the Thames, which reduced the ability of the gravels to drain and caused groundwater to back up, raising levels yet further within the gravels. During these extremes of river level, there may be recharge from the Thames (and associated surface water) back into the gravel aquifer and it is believed that the groundwater hydraulic gradient is locally reversed causing the groundwater to rise above ground level.

Sewer flood risk

Reports indicate that both the Pound Lane and Firview Close areas have suffered foul sewage flooding problems in the past. It is understood that Thames Water has upgraded the sewage systems in these areas with sealed systems of larger capacity to help address this issue.

The Marlow Flood Alleviation scheme also helps to alleviate problems of sewer flooding by reducing the risk of foul and combined sewers filling with surface or groundwater.

The sewerage systems will still need to operate correctly during flood events, for instance with foul water pump stations continuing to operate, to ensure system capacity is maintained and backing up/surcharging does not occur.

How the risk is currently managed

Fluvial flood risk within Marlow RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling. The Environment Agency is managing the flood risk effectively as showed by the operational Marlow Flood Alleviation Scheme.

The Marlow Flood Alleviation Scheme reduces flood risk from both fluvial, surface and groundwater flooding to 287 properties. The scheme consists of a series of walls and embankments at Pound Lane area, Gossmore Playing Fields and Pergola Playing Fields, drainage systems, storage areas at Marlow Sports Club and Lower Pound Lane and a groundwater pumping system. The pumping system is used during times of higher groundwater levels, normally occurring at approximately the same time as river flood events. The combined sources scheme reduces the risk of flooding to homes and businesses for areas which have a chance of flooding of less than 1% each year on the River Thames.

Buckinghamshire County Council are appraising options on further reducing the risk of flooding from surface water flooding.

The Marlow Flood Alleviation scheme also helps to alleviate problems of sewer flooding by reducing the risk of foul and combined sewers filling with surface or groundwater.

The sewerage systems will still need to operate correctly during flood events, for instance with foul water pump stations continuing to operate, to ensure system capacity is maintained and backing up/surcharging does not occur.

To the South of the RS FRA, in Bisham, relevant risk management authorities have explored ways to manage flood risk including the installation of a flood relief pipe south of Marlow bridge. To date, studies have not identified a lead option which would significantly reduce peak flood levels in the area upstream of Bisham road. We are not carrying out any active investigations at present. This is part of a process that ensures that taxpayers' money is invested in those projects that will deliver the greatest benefits for society.

The Environment Agency is part of the Thames Valley Local Resilience Forum. There is a Multi-Agency Flood Plan (MAFP) which comprises the seven unitary local authorities of Berkshire and Milton Keynes, as well as the county and district local authorities of Buckinghamshire and Oxfordshire. This area includes the River Thames catchment and associated tributaries plus part of the Great Ouse catchment which falls in the Milton Keynes area.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

The Environment Agency's flood warning and alert service is available in all parts of the RS FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Due to the relatively long catchment response times associated with flooding from the River Thames, timely forewarning should be possible. This enables the Council, emergency services, residents and businesses to prepare to reduce the impact of a flood.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Marlow RS FRA

Measures have been developed which apply specifically to the Marlow RS FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Marlow FRA.

You can find information about all the measures that apply to the Marlow FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Newbury Surface Water Flood Risk Area

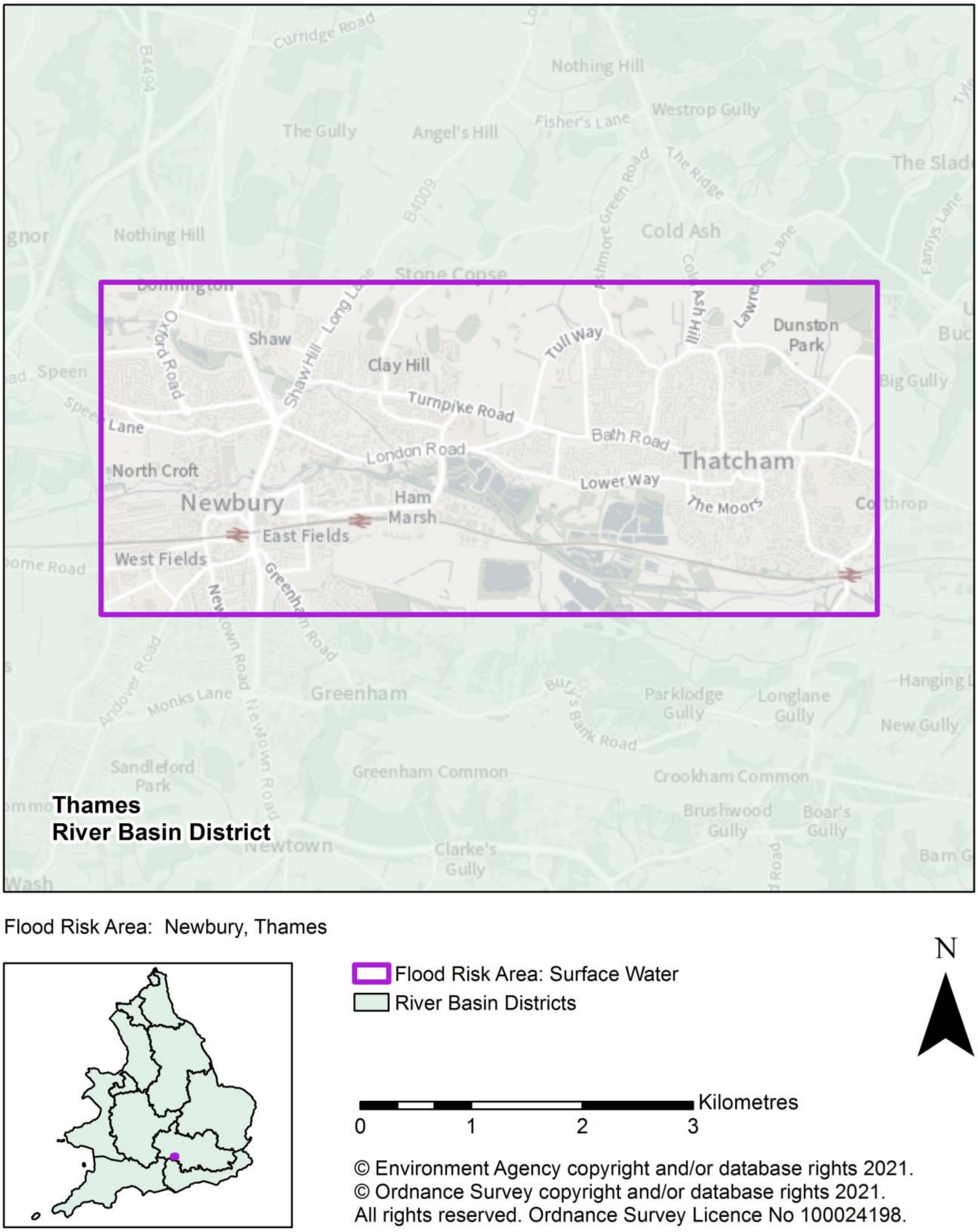


Figure 29: Map showing the Newbury Flood Risk Area Boundary and its location in England

The Newbury Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as an FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage). The Newbury FRA was not identified in 2011 for the first cycle of Flood Risk Management Plan (FRMP).

The Newbury FRA covers parts of West Berkshire Council. The Newbury FRA is mainly urban and covers most of the towns of Newbury and Thatcham, with some of the surrounding rural area.

The primary sources of flood risk in the Newbury FRA are from surface water and groundwater, however some areas in the River Lambourn and River Kennet valleys are also at risk from rivers, particularly through Newbury town centre.

West Berkshire Council leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water.

There are several risk management authorities (RMA) operating in Newbury FRA including:

- Environment Agency
- Lead Local Flood Authority (LLFA): West Berkshire Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: West Berkshire Council and National Highways
- Water and sewerage company: Thames Water Utilities Ltd
- Department of Communities and Local Government through local planning authorities

Principal land use and significant environmental designations

Newbury and Thatcham are located at the foot of the North Wessex Downs in the River Kennet and Lambourn valley, which runs from west to east through the area. The land slopes towards the valley bottom from the north and south. Elevations vary from around 65 to 130 metres above ordnance datum (mAOD).

Much of Newbury is underlain by Chalk, a Principal Aquifer and part of the major groundwater resources of the Thames River Basin. The groundwater from the chalk and limestone areas provides a significant baseflow component to the rivers in the Thames River Basin. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The impact of rainfall will be spread out over a relatively long period of time.

Thatcham and south Newbury are underlain by the Thames and Lambeth Groups, sedimentary bedrock made up of clay, silt, sand and gravel. Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In these areas, this can exacerbate the potential issues for surface water flooding. The river valleys contain clay, silt, sand and gravel associated with floodplain and river terrace deposits.

The North Wessex Downs Area of Outstanding Natural Beauty (AONB) forms the catchment of the FRA to the north, west and south. Designated for the quality of its scenic beauty and chalk landscape, it is a nationally important and legally protected landscape.

The Rivers Kennet and Lambourn are groundwater-fed chalk streams of national importance. There are three Special Area of Conservation (SAC) within the FRA including River Lambourn, the Kennet and Lambourn Floodplains and the Kennet Valley Alderwoods. The Rivers Kennet and Lambourn are also designated Sites of Special Scientific Interest (SSSI), along with Thatcham Reed Beds, providing vital habitat to wetland birds, aquatic wildlife, and vegetation. The rivers are also UK Biodiversity Action Plan (BAP) designated chalk river priority habitats. The River Kennet and Lambourn both have ‘moderate’ overall status throughout the FRA under the Water Framework Directive.

Historic or future development of the area relevant to flood risk

The SW FRA mainly consists of urban areas of adjacent towns Newbury and Thatcham, which are surrounded by mixed rural land use of pasture, arable and woodland. The two towns have a current population of around 70,000 people and existing residential areas were mostly built since the 1960s at relatively low density. Both towns are under significant pressure to accommodate large areas of new development through the emerging West Berkshire Local Plan, particularly large greenfield sites around the northern edges of both Newbury and Thatcham.

Partnership working

West Berkshire Council works with partners and communities to improve the water environment. Please refer to the Thames River Basin section of this report for more information on this.

West Berkshire Council works closely to manage flood risk with other Risk Management Authorities including the Environment Agency, Thames Water Utilities Ltd and the Highways Agency. It works with the Canal & Rivers Trust, which manages the Kennet & Avon Canal, a significant part of the water management system within Newbury FRA. It also works with riparian owners and Parish Councils to help to prepare communities for flood events.

The Newbury FRA falls within the Kennet Catchment Partnership area, which is hosted by Action for the River Kennet (ARK). The priorities in this FRA include an aim to bring the whole of the River Kennet catchment to good condition by 2027. West Berkshire Council is working with other risk management authorities and partners through its involvement in the Kennet Catchment Partnership to better understand the catchment and to develop joint plans to improve the health of the local water environment. Better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

West Berkshire Council are one of several partners who have recently been successful in securing funding though Defra's Flood and Coastal Resilience Innovation Programme for a Groundwater Resilience and Community Engagement project (GRACE). The project, led by Buckinghamshire Council, will trial new approaches for managing groundwater flooding in the Chilterns and Berkshire Downs, including understanding community perceptions, increasing community resilience, property flood resilience measures in 10-12 communities, innovative groundwater monitoring, modelling and mapping techniques, and a Groundwater Flood Alert App for householders and businesses. The project includes 17 communities in West Berkshire.

There are several local flood risk management plans which set out how flood risk will be managed in West Berkshire:

- West Berkshire Local Flood Risk Management Strategy (2020-2025)
- Thatcham Surface Water Management Plan (2010)
- Newbury Flood Management Plan (2013)

Current flood risk

Newbury is a SW FRA due to the significantly high risk of pluvial flooding and flooding in ordinary watercourses from intense rainfall events. There are several significant surface water flow routes from the rural land to the north of Newbury and Thatcham towards the River Kennet. The flow paths follow roads and the paths of culverted ordinary watercourses. These watercourses have been integrated into the Thames Water surface water drainage network, which conveys flows through the town. The surface water sewer system can be overwhelmed in heavy rainfall events causing flooding from manholes. Surface water also commonly enters the foul system causing localised foul sewer flooding, for example at Newbury railway station.

There is a risk of groundwater flood risk (water at or near the ground surface in a medium risk event) in both Newbury and Thatcham. High groundwater happens in the chalk and in the superficial sand and gravel deposits alongside the River Kennet.

The River Kennet and its tributary, the River Lambourn, flow from the west and north-west into Newbury, converging just downstream of Newbury town centre before flowing along the southern edge of Thatcham. Areas in the River Lambourn and River Kennet floodplains are at risk of flooding from rivers, particularly through Newbury town centre.

The River Kennet also interacts with the Kennet & Avon Canal through Newbury, which is perched above ground level at this location. If the canal overflows, water cannot drain back into it easily and may flood nearby areas for a long time.

A full flood history for Newbury and Thatcham can be found in West Berkshire Preliminary Flood Risk Assessment PFRA (2011, updated 2017) and West Berkshire Strategic Flood

Risk Assessment SFRA (2019). The most significant event was the July 2007 surface water flood event, which severely affected the SW FRA, with over 1250 properties and significant non-residential and critical infrastructure (schools, railway station) flooded in Newbury and Thatcham.

Since 2015, there has been one flood event in Newbury SW FRA. On 15 and 16 September 2016, a very intense storm caused surface water flooding in the Newbury area. The flooding affected 16 residential properties in Bartlemy Road, Bartholomew Street, Pound Street, Church Road, Mill Lane, Essex Street, Groombridge Close. Newbury railway station and parts of the railway track were flooded. Many parts of the highway network around the Newbury area were affected.

Surface water flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazards and risk maps estimate that 54,619 people are living within the Newbury FRA. Of those, 8,577 (15%) live at risk of flooding from surface water.

Also shown to be at risk of surface water flooding in the Newbury FRA include:

- 19 services (4%). This includes one primary school and one secondary school
- 366 non-residential properties at risk (16%)
- Critical infrastructure: 0.42 kilometres of road (9%) and 1.61 kilometres of railway (19%). Newbury Railway Station is also at risk
- 145 hectares of agricultural land (13%)
- Protected areas: 17 hectares of Special Areas of Conservation (SAC) (45%), 33.7 hectares of Sites of Special Scientific Interest (SSSI) (39%) and 3.2 hectares of parks and gardens (10%)
- Historical landmarks: 0.01 hectares (9%) of Scheduled Ancient Monument area and 13 (5%) listed buildings
- 2 (15%) licensed water abstraction sites

Conclusions based on risk statistics

Based on this information it is concluded that further steps should be taken to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment both now and in the future. Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Surface water flood risk within the Newbury SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

West Berkshire Council works closely with Thatcham Flood Forum and Parish Flood Wardens to promote community preparedness and communicate surface water flood risk data and information. Groundwater monitoring data and groundwater flood alerts provided by the Environment Agency are shared with community partners. West Berkshire Council attends Flood Forum meetings to provide updates on flood risk and ongoing projects; runs twice yearly 'Meet the Experts' training sessions for the public, parish planning groups and parish councils; and holds a twice-yearly Parish Council conference.

Development control

West Berkshire Lead Local Flood Authority works closely with the Local Planning Authority to ensure that new development does not increase flood risk and meets the requirements of national and local policy and guidance. To assist with this role, and informing developers of expectations, West Berkshire Council has developed a Supplementary Planning Guidance (SPG) which provides guidance on designing sustainable drainage for new developments which deliver multiple benefits.

Flood risk modelling and maps

An integrated 1D/2D model of surface water and the sewer system was developed originally for the Thatcham Surface Water Management Plan in 2010 and most recently updated in 2020 in InfoWorks-ICM through the Environment Agency's Boosting Action for Surface Water funding. The model covers a large area of Thatcham. There is currently no local surface water model for Newbury.

Flood risk assets and recent flood risk improvements

There are several important surface water flood risk management assets located within Newbury FRA. Following the July 2007 floods, the Thatcham Surface Water Management Plan (2010) was completed, setting out an Action Plan for managing surface water flood risk in Thatcham. As a result of this strategy, several surface water flood storage schemes have now been constructed. These schemes have provided some mitigation of the major flow routes from the north and east and reduced flood risk to many of the homes at risk in Thatcham.

They include:

- the Cold Ash Hill Flood Alleviation Scheme (2014) – four cascading detention basins, at Little Copse, north of Heath Land and west of Cold Ash Hill. The scheme manages surface water flood risk to 131 properties in north-central Thatcham, particularly around Northfield Road and Heath Lane
- the Tull Way Flood Alleviation Scheme (2018) – a surface water retaining bund, which reduces flood risk to over 250 properties south of Tull Way
- the Dunstan Park Flood Alleviation Scheme (2020) – an attenuation basin and retaining embankment will be constructed to the north of Floral Way, North Thatcham, reducing flood risk to over 500 properties
- the South East Thatcham Flood Alleviation Scheme (2020) – a series of earth bunds and swales in Dunstan Green Park and the Kennet School playing fields, and basins located in the Siege Cross public park area. This scheme reduces flood risk to 62 properties

Current investment plans and work programmes

There are several flow routes identified in the Thatcham Surface Water Management Plan Action Plan which have not yet been mitigated, leaving smaller pockets of unprotected properties which remain at risk.

There are several smaller flood storage schemes planned, including:

- North Thatcham – two flood storage areas at Bowling Green and Health Lane (construction 2022)
- East Thatcham – flood storage area and swale at Floral Way/Siege Cross (construction 2021)
- Memorial Fields – flood storage area in Memorial Fields park (construction 2023)
- West Thatcham – flood storage area at Henwick Field (pipeline project/2023 onwards)
- Pipers Lane – flood storage area at Pipers Lane (pipeline project/2023 onwards)
- Lower Way – improvements to highway drainage (pipeline project/2023 onwards)

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Climate change modelling of Thatcham using the 1D/2D integrated model shows that in a medium risk event, surface water flooding will be more extensive. This is shown throughout Thatcham but particularly the residential areas to the north of Bath Road, including Memorial Fields and Harts Hill Road area, The Moors and Beancroft Road and Colthrop industrial estate.

Flooding is predicted to be deeper (generally 0.05-0.2m deeper) and more hazardous. The level of protection provided by flood defences will likely decrease, although most of the Thatcham Surface Water Management Plan Schemes have been designed for a medium risk event plus 20% climate change event. There will also likely be additional maintenance needs and stresses on assets that function with a higher frequency than were designed.

Objectives and measures for the Newbury SW FRA

Measures have been developed which apply specifically to the Newbury SW FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. This includes information on which national objectives each measure helps to achieve.

These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Newbury SW FRA.

You can find information about all the measures that apply to the Newbury FRAin the interactive mapping tool - Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Oxford Rivers and Sea Flood Risk Area

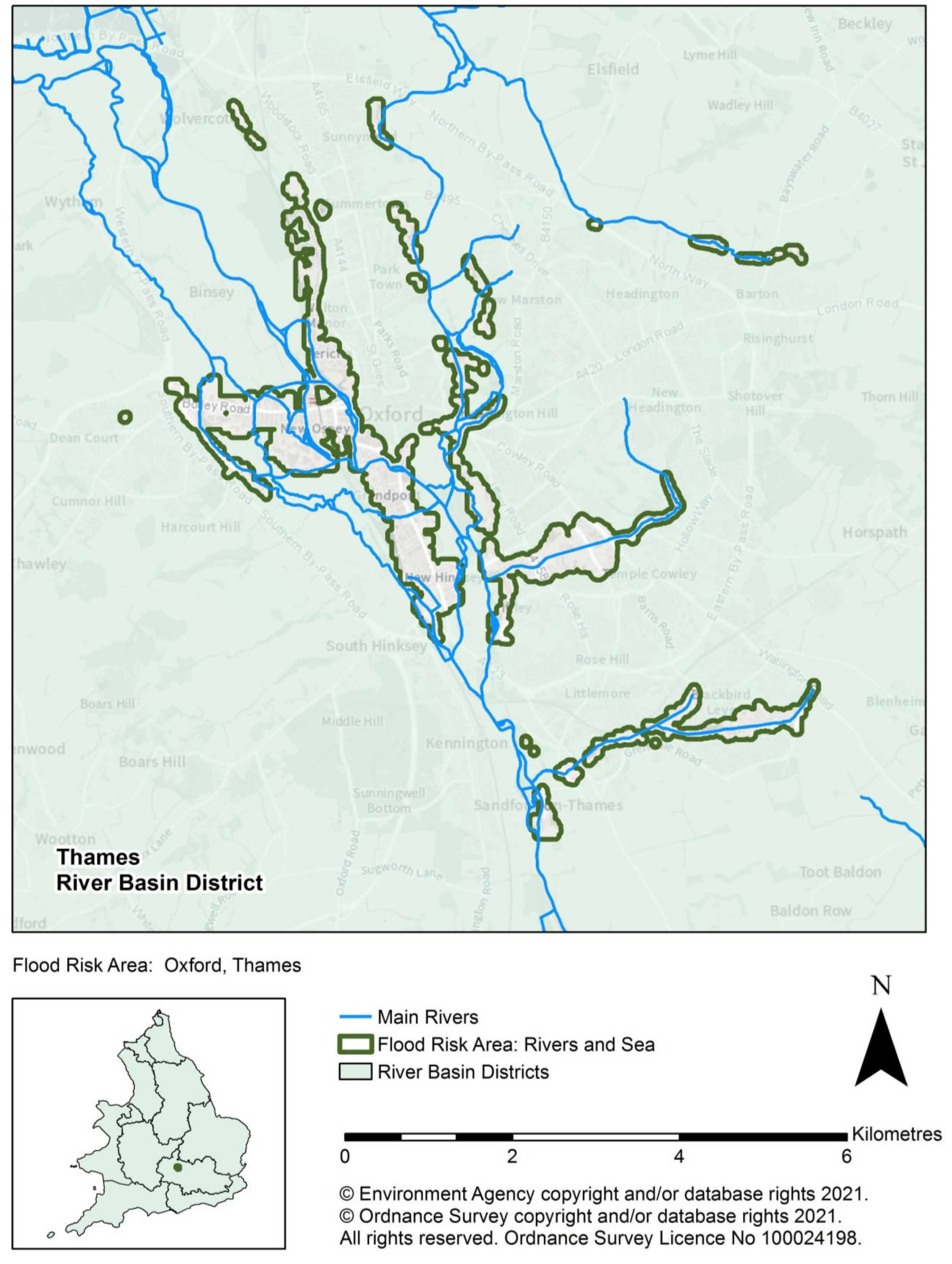


Figure 30: Map showing the Oxford Flood Risk Area Boundary and its location in England

The Oxford Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and to the north-west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Oxford RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Oxford Rivers and Sea (RS) FRA spans across large parts of Oxford along the River Thames to the west and along the River Cherwell to the east. Settlement areas exist along Thames tributaries including Boundary Brook, Littlemore Brook and Northfield Brook also form part of the Oxford FRA.

There are several Risk Management Authorities (RMA) operating in the Oxford RS FRA including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Oxfordshire County Council
- District councils: Oxford City Council, Vale of White Horse District, South Oxfordshire District
- Regional Flood and Coastal Committee: Thames Regional Flood and Coastal Committee
- Highways Authorities: Oxfordshire County Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

Oxford sits at the confluence of seven rivers draining a catchment area of approximately 3,000 km2. The floodplain narrows significantly immediately downstream of Oxford to only 300m wide which constrains flow and effectively acts as a throttle, holding back water within Oxford during times of high flows.

The Oxford Clay Formation and West Walton Formation, also known as mudstone, make up a large part of the FRA. Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. Alluvium is present alongside the Rivers Thames and its tributaries. Beckley sand is present in the south of the FRA.

The flooding within the Oxford FRA has been exacerbated by historic development within the floodplain, which includes road and railway embankments that further restrict flow.

Partnership working

The Environment Agency also works collaboratively with partners and communities to improve the water environment through several Catchment Partnerships to better understand the catchment and to develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

Current flood risk

The primary flood risk in the Oxford RS FRA is from main rivers including the River Cherwell and River Thames and associated tributaries. This can be referred to as 'fluvial' flooding. Oxford also has an extensive network of braided watercourses that leave and re-join the River Thames. All these constraints result in flood water flowing out of the river channels and causing damage to property and infrastructure during periods of high flow.

Some parts of the FRA are also susceptible to groundwater flooding including along the River Thames where the underlying geological conditions are more permeable.

The River Thames flows into the city from the North-West, passing through Wolvercote before entering the western side of the city centre. The River Cherwell flows into the city from the North-East, passing through Marston before entering the eastern side of the city centre. The flood plains of both watercourses consist of farmland and recreational areas with few properties at risk. However, the city of Oxford, located at the confluence of the River Cherwell and Thames is vulnerable from both watercourses independently and, in wider flood events, concurrently. Flooding in Oxford is long lasting, typically seven to nine days. This duration of flooding to key roads brings Oxford to a standstill, disrupts Oxford’s residents, businesses and visitors, reducing investor confidence and limiting Oxford’s future growth opportunities.

Oxford has experienced flooding numerous times in past years, including:

- September 1947
- summer 1977
- winter 1979
- autumn 1992/93
- easter 1998
- winter 2000
- New Year 2003
- summer 2007
- winter 2012
- winter 2013
- winter 2014
- winter 2019
- winter 2020

The floods experienced in recent years have been relatively small with only the properties at highest risk of flooding affected. However, the potential impact on properties with a lesser flooding risk also needs to be considered, as they will be affected in a larger flood.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Oxford FRA some 10,141 people live in areas at risk of flooding from main rivers. Of these, 49% are in areas of high risk. Much of this is concentrated along the River Thames. As well as people living within the floodplain, there are also services that have been built within FRAs. An estimated 15% (29) of services are in areas at risk of flooding from main rivers. Schools and sewage treatment works are examples of services. The majority is shown to be at high risk of flooding.

Also shown to be at risk of flooding from main rivers in the Oxford RS FRA:

- 25% (273) of non-residential properties with a large proportion (12.4%) shown to be at high risk of flooding
- 23% (0.94 km) of railways
- 0.27km (53%) of motorways, primary and trunk routes, as classified by National Highways
- 37% (17.47 ha) of agricultural land
- all three of the licensed water abstractions
- 68% (0.77 ha) of the Special Areas of Conservation
- a large proportion (83%) of Sites of Special Scientific Interest
- 46% (11.96 ha) of the parks/gardens with the majority shown to be at high risk
- historic environment: 28% of Scheduled Ancient Monuments - 38 out of 123 listed buildings with the majority being at high risk of flooding

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Oxford RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

Through regular channel maintenance and the deployment of temporary defences, the Environment Agency can reduce the risk of flooding to a large proportion of the properties at highest risk of flooding. The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the defences. However, in those areas they are not a cost effective or reliable long-term solution.

The Environment Agency also operates and maintains a sluice gate and overflow pipes at Hythe Bridge Street.

To provide a more robust solution to reduce flood risk to a greater number of properties within the FRA, the Environment Agency is working with local partners on a major new scheme for the City. The Oxford Flood Alleviation Scheme will cost around £150 million and is one of the biggest flood schemes in the country. It will reduce flood risk to homes, businesses, services and major transport routes into the city.

Oxford has the second fastest growing economy of all UK cities. The scheme will keep Oxford open for business and keep the economy thriving. It will also bring environmental benefits to the area in addition to reduced flood risk.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency's flood warning and alert service is available in most parts of the RS FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Oxford FRA

Measures have been developed which apply specifically to the Oxford FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Oxford FRA.

You can find information about all the measures that apply to the Oxford FRA in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Rainham Surface Water Flood Risk Area

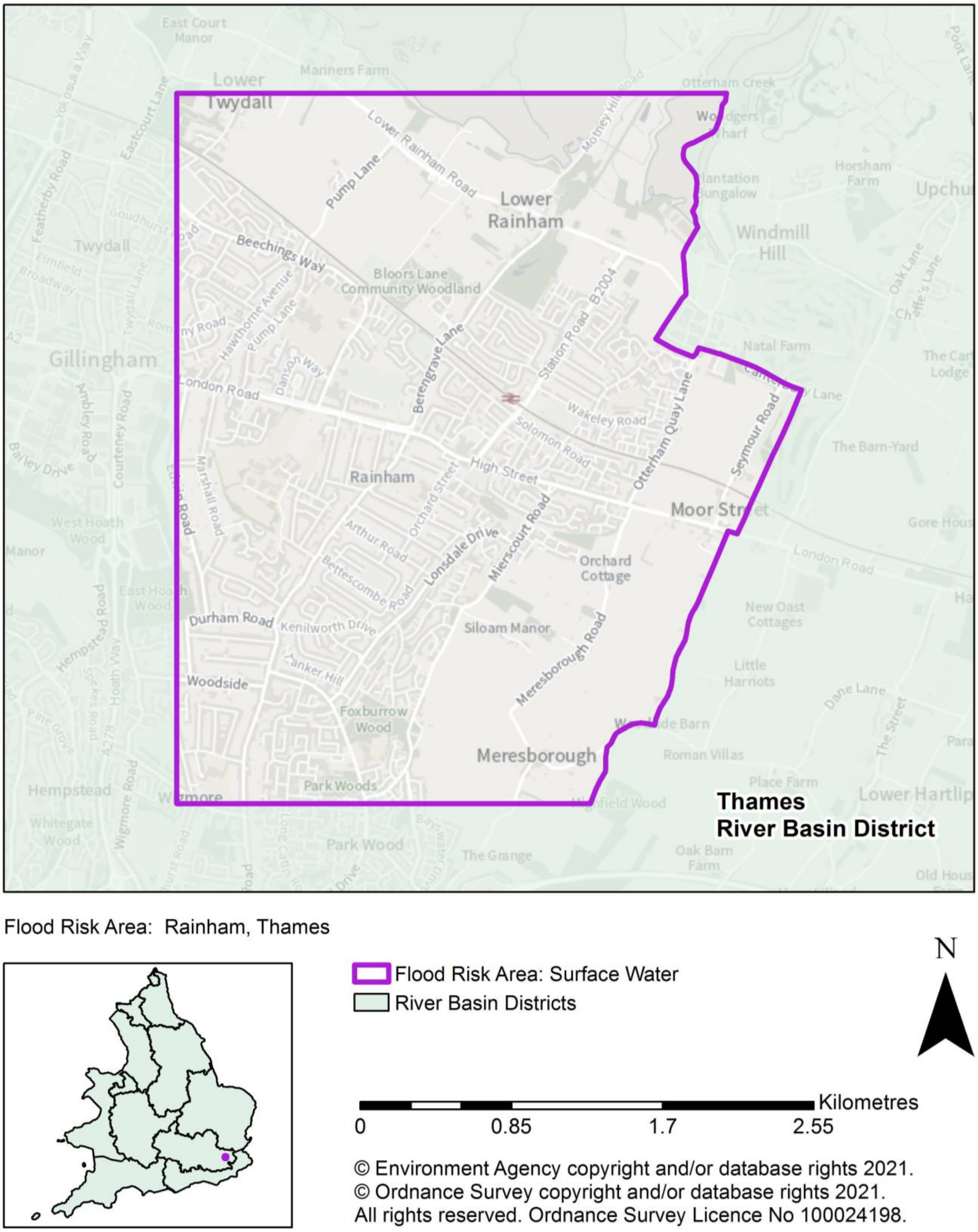


Figure 31: Map showing the Rainham Flood Risk Area Boundary and its location in England

The Rainham Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the south-east of the Thames River Basin District (RBD). This FRA will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The Rainham SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

This chapter focuses on describing how the Environment Agency, in partnership with relevant Risk Management Authorities, is working with communities to manage flood risk in the Rainham FRA.

There are Risk Management Authorities (RMAs) operating in Rainham SW FRA, including:

- Environment Agency
- Lead Local Flood Authority: Medway Unitary Authority
- Unitary District/Borough Council: Medway Unitary Authority
- Regional Flood and Coastal Committee: Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and sewerage company: Southern Water
- Department of Communities and Local Government through local planning authorities

Environmental designations

In the Rainham SW FRA, there is one site with a special environment designation. Part of the Medway Estuary and Marshes which sits on the north-east side of the FRA and is a Site of Special Scientific Interest (SSSI). There are also many designated local wildlife sites and ancient woodlands within the Rainham FRA and within its vicinity.

The full detail of the designated sites can be found in the Defra Magic map database.

Topography, geology, hydrogeology, land use

Rainham is an urbanised area with dispersed green space. The existing Medway Unitary Authority Local Plan (2003) and the emerging Medway Unitary Authority Local Plan characterises the area as important to the prosperity of the Medway District.

Policies within the Medway Unitary Authority Local Plan restrict inappropriate development and ensure that properties or areas of brownfield land that are vacant or deteriorating are redeveloped over using the limited greenfield sites within Rainham.

Medway Unitary Authority is required to significantly boost its supply of housing but it is important for the area to preserve its greenspace and therefore areas are included within developments to promote landscaping, ecology and sustainable drainage to ensure that there are suitable measures to minimise and mitigate surface water flooding within the region.

The underlying geology of the catchment is Lewes Nodular Chalk and Seaford Chalk.

Watercourses

The principal watercourse in the Chatham FRA is the river Medway.

There have been flood events attributed to surface water flooding and highway flooding within the Rainham FRA. The Lead Local Flood Authority (LLFA), Medway Unitary Authority, keep records of all flood events which occur within the Medway Region. Large events have occurred at Cherry Tree Lane and Maidstone Road.

Current flood risk

The main source of flood risk within this SW FRA is from surface water.

Description of Risk Statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Rainham FRA some 6,247 people live in areas at risk of flooding from surface water. Of these, 18.7% are in areas of high risk.

Also at risk of surface water flooding within this SW FRA include:

- 10 services (7%)
- 161 non-residential properties (26%)
- critical Infrastructure: 1.21 km of railway (31.7%). 81.57 hectares of agricultural land (15.7%)
- natural environment: 18.96 hectares of Sites of Special Scientific Interest (SSSI) (29%), 18.96 hectares of Ramsar site area (29%), 18.96 hectares of Special Protection Area (SPA) (29%)
- historic environment: 2 listed buildings (5.7%)

- 1 licensed water abstraction site (100%)

Conclusions

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the SW FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface Water Flood Risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of the local drainage network and water flows over the ground. The Rainham FRA has been identified as being at risk of flooding due to a combination of factors including impermeable urban land cover, low lying areas that are conducive to surface water ponding, culverted watercourses, kerb and boundary wall heights, and ageing drainage infrastructure that is often overwhelmed. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the risk.

Medway Unitary Authority have recently carried out a Surface Water Management Plan for this area which assesses the overall risk for the area. At this stage no options have been undertaken. However, this is being monitored. Over recent months, many of the systems within the area have been cleaned to ensure that the system is able to deal with heavy rain and high-water levels.

Groundwater Flood Risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from springs at times of surplus that inundate the surrounding area. This tends to occur after long periods of sustained and high levels of rainfall, and the areas most at risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although it is increasingly associated with more localised floodplain sands and gravels. The DEFRA Magic map highlights that this area ranges from medium to high groundwater flooding within this area.

How the risk is currently managed

Surface water flood risk within the Rainham SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Rainham FRA

You can find information about all the measures which apply to the Rainham FRA in the Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Reading Rivers and Sea Flood Risk Area

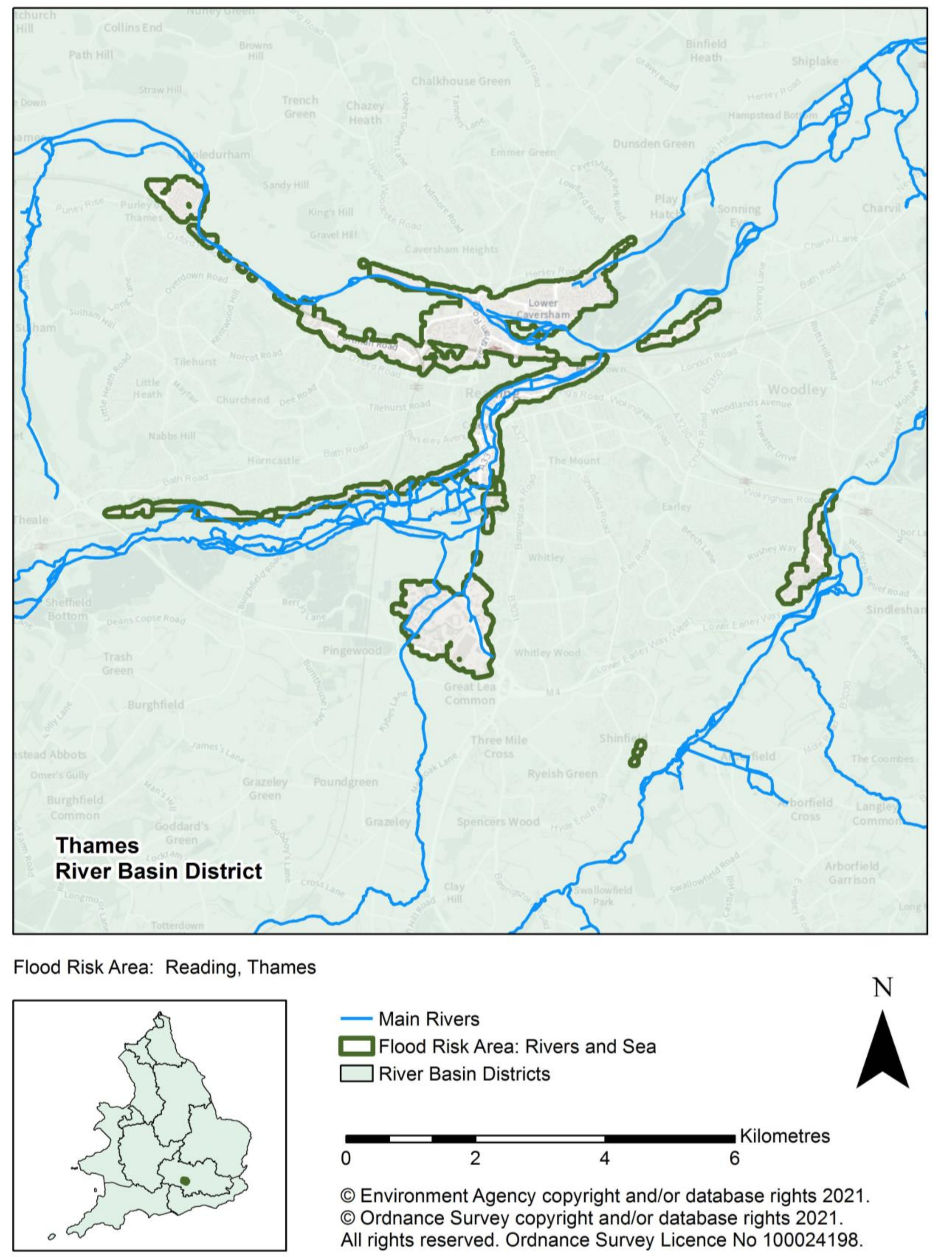


Figure 32: Map showing the Reading Flood Risk Area Boundary and its location in England

The Reading Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and to the west of the Thames River Basin District (RBD). This FRA will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Reading Rivers and Sea FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Reading RS FRA is primarily located in Reading Borough Council with parts falling in West Berkshire Council and Wokingham Borough Council. It is centred on Caversham and located entirely north of the M4. Areas at risk include Purley on Thames and Calcot (to the west), Thames Valley Business Park and Lower Earley (to the east) and Shinfield and Green Park (to the south).

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows across the ground. Parts of the Reading RS FRA overlap with the Reading Flood Risk Area from Surface Water. This means that a large part of Reading has been identified at being at significant risk of flooding associated with existing watercourses and road networks.

There are Risk Management Authorities (RMA) operating in the Reading FRA, including:

- Environment Agency
- Three Lead Local Flood Authorities (LLFA): Reading Borough Council (predominantly), West Berkshire Council and Wokingham Borough Council
- Regional Flood and Coastal Committee: Thames
- Four Highways Authorities: National Highways, Reading Borough Council, West Berkshire Council and Wokingham Borough Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the RS FRA is strongly influenced by the River Thames. The course of the River Thames delineates part of West Berkshire’s north-eastern boundary, and the settlement of Purley-on-Thames is bounded by the river. The River Thames flows in a west to east direction through the area with Caversham Weir, located immediately downstream of Reading Bridge, controlling upstream water levels for navigation. Christchurch Ditch (a much smaller, surface water fed watercourse) runs parallel less than 100m to the north and joins the River Thames downstream of the Caversham Weir complex near Heron Island. Berry Brook also flows through the FRA. Parts of three other main rivers fall within the FRA. The River Kennet is a tributary of the River Thames and includes the secondary channels of the Holy Brook and the Kennet & Avon Canal, which is a navigable channel. The River Kennet has its confluence with the River Thames at

Kennetmouth to the north-east of the town centre. The Foudry Brook runs in a northerly direction through the south of Reading close to the A33 until it joins the Kennet & Avon Canal near Rose Kiln Lane. The River Loddon also flows through a small part of the FRA to the east. The River Loddon mostly flows in an easterly direction in areas of open undeveloped floodplain with villages and market towns to its confluence within the River Thames at Wargrave.

The Seaford Chalk and Newhaven Chalk Formations (undifferentiated) make up a large part of the FRA along the River Thames and River Kennet Valley. The London and Lambeth Clay formations are present in other parts of the FRA. Alluvium is present alongside the Rivers Thames and Kennet and their tributaries. Within chalk and limestone areas (termed aquifers), water can infiltrate quickly, and move within and through these rocks. These areas become part of the major groundwater resources of the Thames River Basin. The groundwater from the chalk and limestone areas provides a significant baseflow component to the rivers in the Thames River Basin. Water flows slowly through the aquifers and is released at a slow rate into the rivers. The impact of rainfall on main rivers such as the River Thames will be spread out over a relatively long period of time. Within clay areas, because the porosity of clay is fairly low, this can result in slow infiltration rates and increased surface water run-off.

The Reading FRA is highly urbanised, with the notable exception being the water meadows centred around the network of link channels and tributaries of the River Kennet in the south-western part. The historic centre of Reading lies on a nominal ridge of high ground between the River Thames and the River Kennet, reflecting the town’s history as a river port.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities, partners, and communities through, for example, the Berkshire Strategic Flood Risk Management Partnership and the South Chilterns, Kennet and Loddon Catchment Partnership to better understand the wider Berkshire area and to develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

For information on how risk from other sources will be managed, this chapter should be read in conjunction with the other sections of this plan as well as other documentation listed below:

- The Reading Climate Emergency Strategy 2020-2025
- Reading and Caversham Flood Alleviation Scheme policy paper

Current flood risk

The main sources of flood risk within the Reading FRA are from main rivers and surface water flooding. This section will discuss the fluvial risk within this FRA. For more information on surface water risk in this area, please refer to the section about the Reading Surface Water (SW) FRA.

The primary source of flood risk in the FRA is associated with the River Thames, caused primarily by overtopping of the banks. The River Thames is the longest river in England, draining a considerable catchment area, and flooding is typically associated with long duration, regional rainfall events.

The River Kennet drains a considerable catchment area and flooding is typically a result of long duration, regional rainfall events and due to the relatively long catchment response times, substantial forewarning of a pending flood event can generally be provided.

There is a long history of flooding in the Reading FRA. While detailed records are not available to confirm properties affected, the most extensive flooding to occur in Reading was in 1947. Reading Borough Council records show flood events occurred in 2000, 2003, 2007 and 2014. In January 2003, following prolonged and heavy rainfall, over 200 properties in Purley-on-Thames, to the north of the railway lane, were affected by flood waters. In July 2007 people and properties across most of the country were affected by flooding. While much of the flooding was due to surface runoff, Lower Earley Way was also impacted. Data from the Royal Berkshire Fire and Rescue Service shows significant confirmed property flooding in 2007 and 2015. In 2014, flooding affected over 100 properties (32 of which experienced internal flooding) and multiple roads were closed due to flooding. Most of these properties were on Queens Road, Mill Green and Send Road. Amersham Road has also been significantly affected in past flood events.

Fluvial flood risk - description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps](). These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Reading RS FRA some 13,023 people live in areas at risk of flooding from main rivers. Much of this is concentrated in Caversham. As well as people living within the floodplain, there are also services that have been built within the RS FRA; 22 (11%) services are at risk of flooding from main river. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in the Reading RS FRA:

- 579 (44%) non-residential properties
- a small proportion (7% or 1.1 km) of the railway. The town’s recently upgraded railway station provides a frequent train service to London, the West Country and Wales as well as trains to Birmingham, the North and the South Coast
- 1.22 km (31%) of motorways, primary and trunk routes, as classified by National Highways. Reading is well served by wider transport links, with the M4 Motorway providing a direct link east and west, to London (and Heathrow Airport) and Bristol/Wales respectively
- 54% (109.93 ha) of agricultural land with a large proportion indicated at low risk
- 2 out of 7 licensed water abstractions
- 48% (0.70 ha) of the parks/gardens with almost all being at medium risk
- historic environment: 35 out of 116 listed buildings are at risk of flooding with the majority being at medium risk of flooding - a small proportion (5%) of Scheduled Ancient Monuments

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the RS FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Reading RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

To the west of the RS FRA, the Environment Agency is maintaining a raised defence (bund) and is deploying pumps at the crossroads between Wintringham Way and Chestnut Grove in Purley on Thames. These actions help reduce the impact of small and frequent floods.

The Green Park Floodplain Management Scheme made up of a flood storage area and conveyance channel (Longwater Flood Relief Channel) was built to enable development of the Green Park area. This ensures that the development is safe for its lifetime and does not increase flood risk elsewhere. It also helps to alleviate flooding in South Reading.

The Environment Agency currently operate and maintain Caversham Weir, undertake routine maintenance of the associated navigable watercourse through shoal removal, and monitor the condition of assets, however these are primarily for a navigation requirement.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency's flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Due to the relatively long catchment response times associated with flooding from the River Thames, timely forewarning should be possible. This enables the Council, emergency services, residents and businesses to prepare to reduce the impact of a flood.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

Despite a history of flooding there are currently no formal flood defences in a large part of the FRA, leaving significant numbers of properties at risk of flooding. Reading is the most densely populated area in the River Thames catchment with no formal flood alleviation scheme implemented. The Environment Agency is working in partnership looking at options to reduce flood risk in the wards of Kentwood, Caversham and Abbey in the town of Reading.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

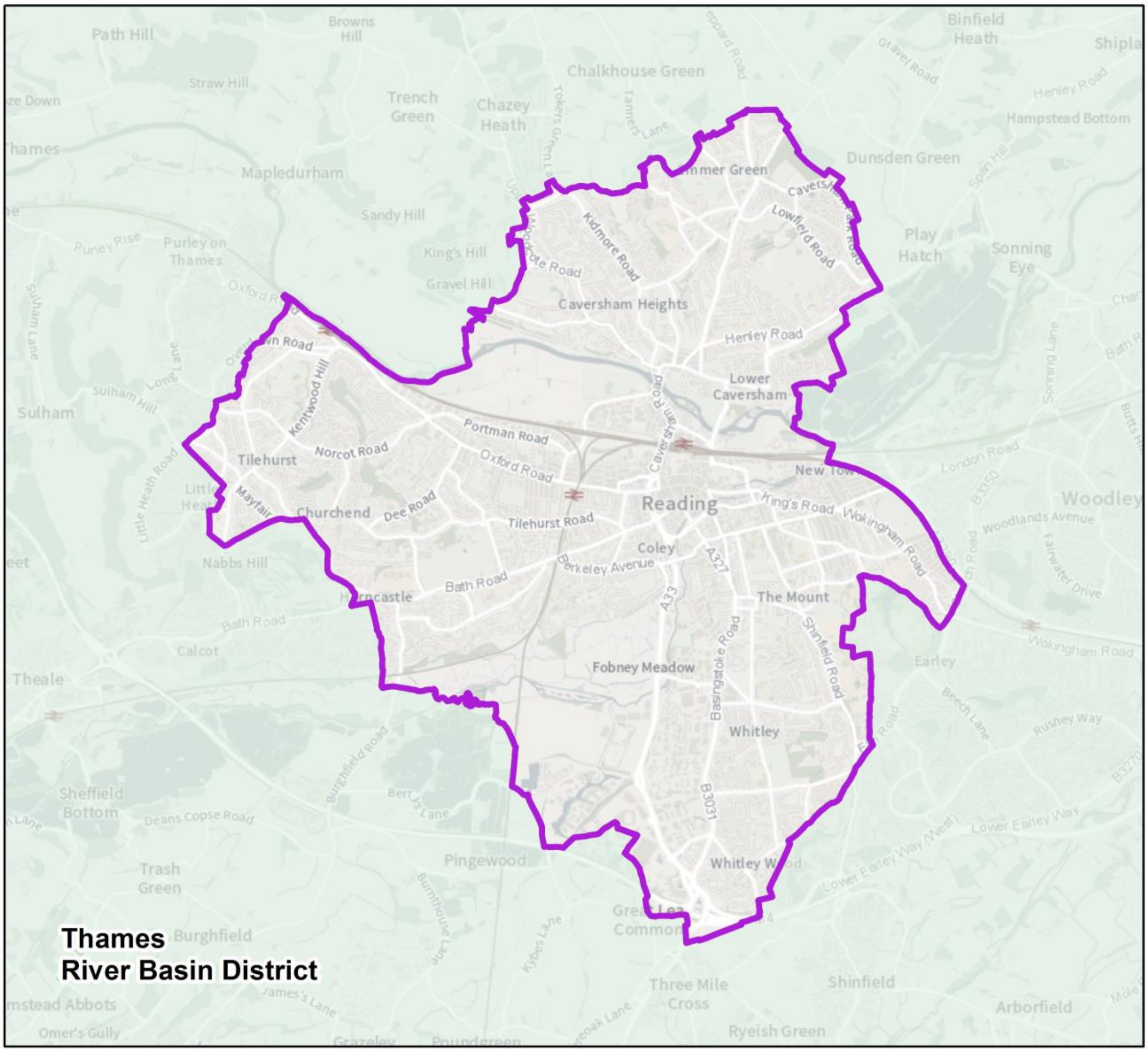
For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Reading RS FRA

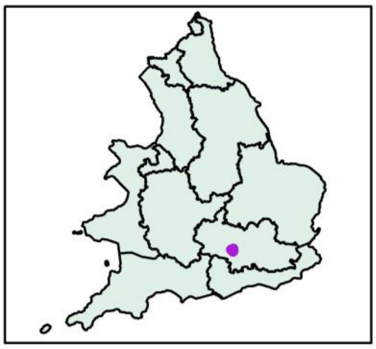
Measures have been developed which apply specifically to the Reading RS FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Reading FRA.

You can find information about all the measures that apply to the Reading FRA in the interactive mapping tool - Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Reading Surface Water Flood Risk Area



Flood Risk Area: Reading, Thames



Flood Risk Area: Surface Water
River Basin Districts

N

0 2 4 6 Kilometres

Figure 33: Map showing the Reading Flood Risk Area Boundary and its location in England

The Reading Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD.

It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage). The Reading Surface Water (SW) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Reading SW FRA covers the entire of Reading Borough. The SW FRA is primarily urban with a very low proportion of arable land.

The Reading SW FRA overlaps with a Reading Rivers and Sea (RS) FRA associated with the River Thames and Kennet which flow through the centre of Reading. For information on how risk from other sources (mainly fluvial) is managed refer to Reading RS FRA.

Reading Borough Council leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMA) operating in the Reading SW FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Reading Borough Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: Reading Borough Council and National Highways
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the Reading Surface Water (SW) FRA is strongly influenced by the River Thames which divides the FRA. The River Thames flows west to east through the middle of the FRA. The area to the north of the River Thames slopes to the south and the area to the south of the Thames slopes to the north. The River Kennet joins the River Thames from the south-west forming a topographical valley through the southern part of the Reading SW FRA. Surface water flows towards the River Kennet and River Thames.

Land rises more steeply to the south of the River Thames towards the centre of Reading and West Reading. Land rises from a level of approximately 37 metres above ordnance datum (mAOD) to a level of approximately 80 mAOD. Land rises more gradually to the north towards Caversham and Emmer Green to a level of approximately 92 mAOD.

The underlying geology is variable. There is chalk in the north of the Reading SW FRA and clay and sandy, gravelly clay (Lambeth Group) in the south. Within northern areas, the porosity of the chalk is low, which can result in fast infiltration rates and reduced surface water run-off. However, infiltration is heavily reduced by the urban extent across the SW FRA.

The vast majority of the Reading SW FRA is urban with a minority of green spaces made up of arable land and grassland. Immediately next to the River Thames there are some areas of arable floodplain. There are also some areas of arable and grassland floodplain associated with the River Kennet in the south of the SW FRA.

Partnership working

Reading Borough Council is working collaboratively with other risk management authorities and partners through the Berkshire Strategic Flood Risk Management Partnership. The aim is to better understand the wider Berkshire area and to develop joint plans to improve the health of the local water environment. Better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

Reading Borough Council, as the Lead Local Flood Authority, has a responsibility to manage surface water flood risk across the Reading SW FRAs. Reading Borough Council work collaboratively with Thames Water and the Environment Agency to determine how surface water flood risk can best be managed.

Reading Borough Council also works collaboratively with partners and communities to improve the water environment. Please refer to the Thames River Basin section of this report for more information on this.

The Reading SW FRAs falls within the South Chilterns Catchment Partnership area, which is hosted by Thames 21.

This section should be read in conjunction with the following local documents:

- Reading Local Flood Risk Management Strategy (2015)
- The Reading Climate Emergency Strategy 2020-2025
- Reading Surface Water Management Plan (2013)
- Reading Preliminary Flood Risk Assessment (2011)

Current flood risk

Surface water flood risk - overview of risk

The main source of flood risk within this FRA is surface water. This section will discuss the surface water risk within this FRA. For more information on fluvial risk in this area, please refer to the Reading Rivers and Sea (RS) Flood Risk Area section.

The surface water flood risk across the Reading SW FRA follows flow paths. These flow paths are created by topography and is influenced by urban features such as the road network within Reading.

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Reading SW FRA has been identified as being at significant risk of flooding due to the dense urban areas and associated impermeable surfacing.

Within the Reading SW FRA, the River Kennet and Thames run in man-made channels but are open throughout. However, there are short sections for culverted highway crossings. The River Kennet is more naturalised in its upstream sections in the south-west of the FRA and is constrained through the city centre. The River Thames follows a more natural path but with man-made banks on either side as it passes through the Reading Surface Water FRA. The River Thames is used for navigation and forms a focal point for recreation within the city.

The urban areas are served by a drainage system which is primarily the responsibility of Thames Water.

Surface water flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazards and risk maps estimate that 27,009 people are living within the Reading Surface Water FRA. Of those, 13,023 (48.2%) live at risk of flooding from surface water.

Also shown to be at risk of surface water flooding:

- 24 services (12.1%)
- 579 Non-residential properties at risk (43.7%)
- critical Infrastructure: 1.22 kilometres of road (31.4%), and 1.12 kilometres of railway (7.0%)
- 109.92 hectares of agricultural land (53.9%)
- protected areas: 0.69 hectares of parks and gardens (47.6%)
- historical landmarks: 0.07 (5.1%) hectares of Scheduled Ancient Monument area and 35 (30.2%) listed buildings
- 2 (28.6%) licensed water abstraction sites

Conclusions based on risk statistics

Based on this information it is concluded that further steps should be taken to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment both for now and in the future. Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Surface water flood risk within the Reading SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness. Reading Borough Council are managing existing flood risk effectively in parts of the FRA. However, Reading Borough Council keeps its approach under review, looking for improvements and responding to new challenges or information as they emerge. Surface Water flood risk within the Reading SW FRA is currently managed through the drainage network which is the responsibility of Thames Water. Reading Borough Council monitor critical assets to ensure these are maintained.

Flood defences

Reading Borough Council have installed several important flood defences within this SW FRA for specific localities. This includes an underground storage tank in the vicinity of Vernon Crescent and Kingsley Close. Furthermore, a surface water overflow system at Harness Close has been constructed to improve the capacity of the sewer network. Small scale flood alleviation schemes have also been implemented at Merrival Gardens, Lousehill Copse, in the form of an enhanced network of existing ponds, and a large open storage area in Stockton Road/the Cowsey. Property Flood Resilience measures have been installed at residential properties at Circuit Lane and Kingsley Close.

Hydraulic modelling

The best available hydraulic modelling for surface water flood risk within the Reading SW FRA is the Environment Agency Risk of Flooding from Surface Water mapping.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

It is possible that areas within the Surface Water FRA could experience flooding in the future. As a result of larger flood extents and deeper depths of flood water due to the impacts of climate change, the level of protection provided by flood defences will likely decrease. There will also likely be additional maintenance needs and stresses on assets that function with a higher frequency than were designed.

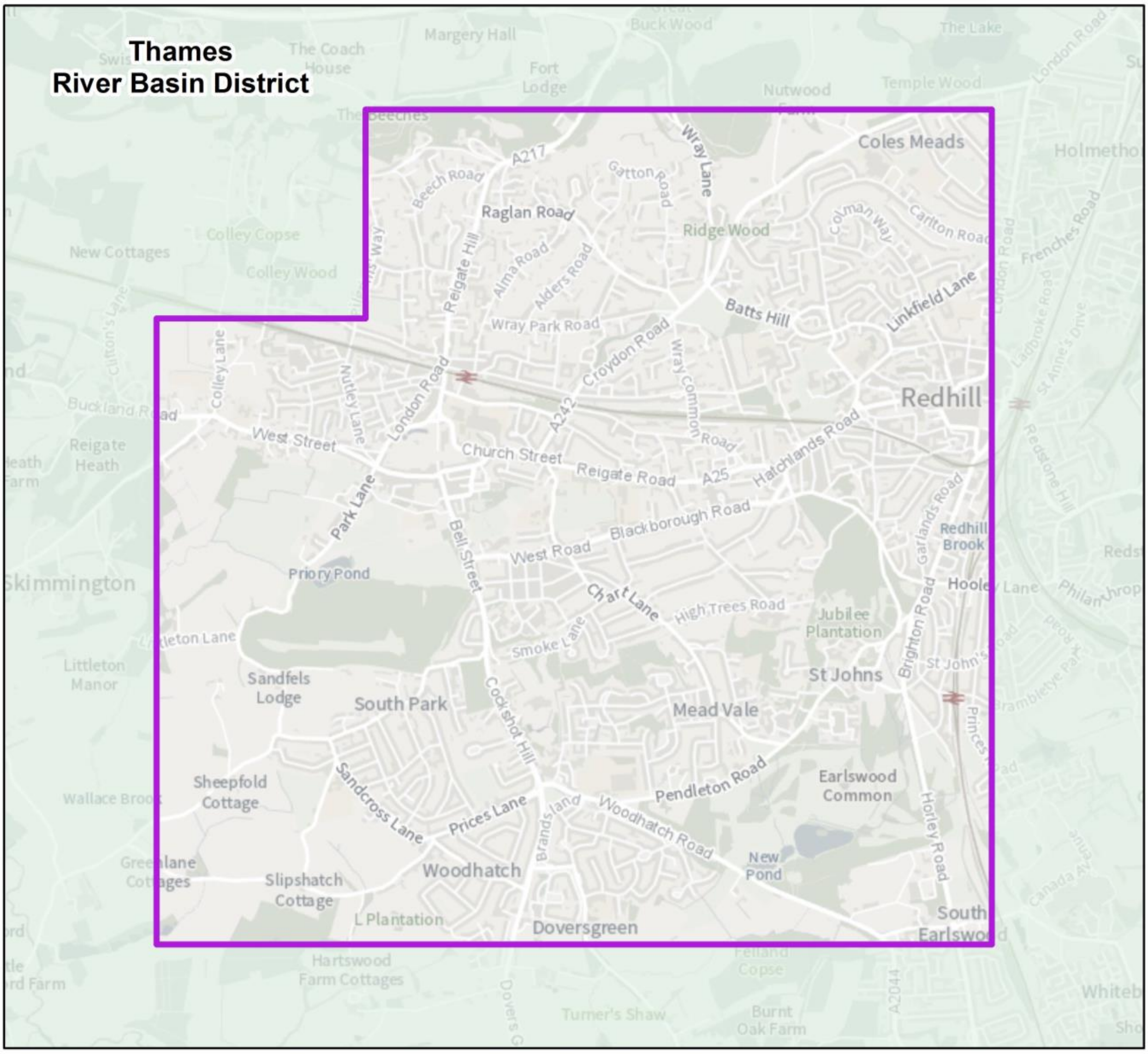
There is currently no up-to-date hydraulic modelling for the SW FRA to show how the impact of climate change will affect future flood risk. However, it is expected that the increase in rainfall intensity would increase flood extents and depths across the SW FRA putting a greater number of people, properties and infrastructure at risk.

Objectives and measures for the Reading SW FRA

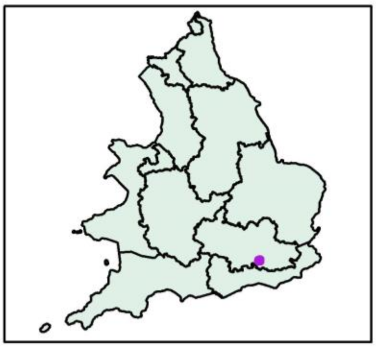
Measures have been developed which apply specifically to the Reading FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Reading FRA.

You can find information about all the measures that apply to the Reading FRA in the interactive mapping tool, Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Reigate Surface Water Flood Risk Area



Flood Risk Area: Reigate, Thames



Flood Risk Area: Surface Water
River Basin Districts

N

0 0.8 1.6 2.4 Kilometres

Figure 34: Map showing the Reigate Flood Risk Area Boundary and its location in England

The Reigate Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and to the south of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage). The Reigate Surface Water SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

This chapter focuses on describing how the Environment Agency, in partnership with relevant Risk Management Authorities (RMAs), is working with communities to manage flood risk in the Reigate FRA.

The Reigate SW FRA covers part of Reigate and Banstead Council and Surrey County Council. The Reigate SW FRA is urban with a low proportion of arable land and open greenspaces. Key urban areas include Reigate, Redhill, Woodhatch, South Park, Mead Vale and Coles Meads.

There are several risk management authorities operating in the Reigate SW FRA including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Surrey County Council
- District council: Reigate and Banstead Borough Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: Surrey County Council and National Highways
- Water and sewerage company: Thames Water Utilities Limited
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the SW FRA is strongly influenced by the Chalk – Greensand ridge that extends west to east in the foothills of the Surrey North Downs.

The topography generally decreases from the north of the FRA to low points of the Reigate and Redhill urban centres. The topography then increases to the south of Reigate along a west-east sandstone ridge. The topography then generally decreases in elevation to the south of the SW FRA and further south to the floodplain of the river Mole.

The FRA is located on the foothills of the north downs on the north flank of the Weald fold structure. The underlying Cretaceous geology of this SW FRA changes from chalk / Greensand ridge in the north to a mixture of sands and clays to the south. Within clay areas, the porosity of clay is low, which can result in slow infiltration rates and increased surface water run-off.

The central parts of the SW FRA are mainly urban with a minority of grassland and some dispersed arable land and woodland. The Reigate and Redhill centres have expansive areas of urban land and impermeable surfaces.

Environmental designations

There are several protected area designations within the SW FRA. The full detail of these designations can be found on the Defra MAGIC map database.

Partnership working

Surrey County Council is working collaboratively with other risk management authorities and partners through the Surrey Flood Risk Partnership.

The Reigate FRA falls within the River Mole Catchment Partnership which is jointly hosted by Surrey Wildlife Trust and South East Rivers Trust (as of December 2021). Partners are working together to better understand the catchment and to develop joint plans to improve the health of the local water environment. Better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

This section should be read in conjunction with the following local documents:

- Surrey Local Flood Risk Management Strategy
- Reigate and Banstead Strategic Flood Risk Assessment

Current flood risk

The main source of flood risk within the Reigate Surface Water SW FRA is from surface water.

Surface water flooding happens when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground.

The SW FRA has been identified as being at significant risk of flooding due to steep terrain to the north of the relatively low elevation urban centres. This is conducive to surface water ponding, impact to road networks and surface water run-off from impermeable surfaces.

Across the SW FRA, the character of the drainage system and flow routes varies considerably. In urban areas like Reigate and Redhill, rivers typically run in man-made channels and culverts and only make an appearance as they flow through parks and green spaces.

We do not hold a record of significant flooding in the FRA. A significant event is when 20 or more properties were affected by flooding.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Reigate SW FRA 645 (1.6%) people live in areas at risk of flooding from surface water.

Also shown to be at risk of surface water flooding:

- 31 services (10.2%)
- 379 non-residential properties at risk (27.1%)
- critical Infrastructure: 9.6 kilometres of motorways, primary and trunk routes, as classified by National Highways (53.3%), 2.43 kilometres of railway (38.4%)
- 11.27 Ha of agricultural land are at risk (10.2%)
- protected areas: 0.14 hectares of Special Areas of Conservation (SAC) (1.1%), 4.3 hectares of Sites of Special Scientific Interest (SSSI) (13.1%), and 8.41 hectares of parks and gardens (9.46%)
- historic landmarks: 0.34 hectares of Scheduled Ancient Monument area are at risk (9.5%), and 6 listed buildings are at risk (4.2%)

Conclusions

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Groundwater flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

It is often difficult to identify groundwater emergence at surface because the result is overland surface water flow. The British Geological Survey 'Susceptibility' information gives an indication on the potential for groundwater emergence at surface. There is potential for groundwater emergence at surface in the north of the FRA from the Greensands and in the middle (West-East) of the FRA related to the Folkstone and Sandgate formations. This West-East trend is primarily located in the low elevation and linked to the classified main river sections in Reigate and Redhill.

Sewer flood risk

Thames Water Utilities Limited is carrying out a Drainage and Wastewater Management Plan (DWMP) across its operational area which includes the Reigate SW FRA. This project is assessing current and future flooding issues and capacity of the sewer network. Surrey County Council and other RMAs are included in this assessment of the sewer network capacity review in order to look at opportunities for carrying out flood reduction activities.

How the risk is currently managed

Surface water flood risk within the Reigate SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

Local flood risk management strategy

Surrey County Council as Lead Local Flood Authority (LLFA) has a duty to prepare and publish a Local Flood Risk Management Strategy (LFRMS) under the Flood and Water Management Act 2010. The local strategy is being developed to manage flood risk through a catchment based collaborative multi-agency approach. The local flood risk Management strategy 2022 update will include catchment action plans that will be used to monitor, prioritise and coordinate RMA flood risk work.

Flood warning and alerts

While there is no Flood Warning Service associated with surface water flooding, there are classified main river sections in Reigate and Redhill town centres.

The Flood Warning Area ‘Redhill Brook at Redhill’ covers the low topography area in Redhill town centre. There is also a Flood Alert Area for this area.

The Flood Alert Area ‘River Mole and its tributaries from Kinnersley Manor to South Hersham’ covers the low elevation in Reigate town centre. The same alert area also covers the southern boundary of the FRA in South Earlswood.

Sustainable drainage

Surrey County Council has a statutory duty to consult on major developments regarding local flood risk. Objective 6 of the local flood risk management strategy aims to reduce flooding to and from development through planning policy and processes. More information about sustainable drainage is available on the Surrey County Council website.

Current work programmes

There are two Flood Defence Grant in Aid (FDGIA) flood alleviation schemes (FAS).

The Reigate FAS is led by Surrey County Council and is focussed on managing surface water flood risk through a series of interventions through-out the local Reigate drainage catchment.

The Redhill FAS was led by the Environment Agency and focussed on assessing options for flood risk management in the local Redhill catchment. The assessment included the construction of an integrated catchment model. The recommendation from the assessment was not to progress through the FDGiA process. There is an opportunity to use the updated modelling for assessing new development applications and their local impact on flood risk.

These flood alleviation schemes and parallel catchment focussed flood reduction work are being monitored as part of the wider LFRMS and the measures associated with this SW FRA.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Reigate SW FRA

Measures have been developed which apply specifically to the Reigate SW FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Reigate FRA.

You can find information about all the measures that apply to the Reigate FRA in the interactive mapping tool, Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Rochester Rivers and Sea Flood Risk Area

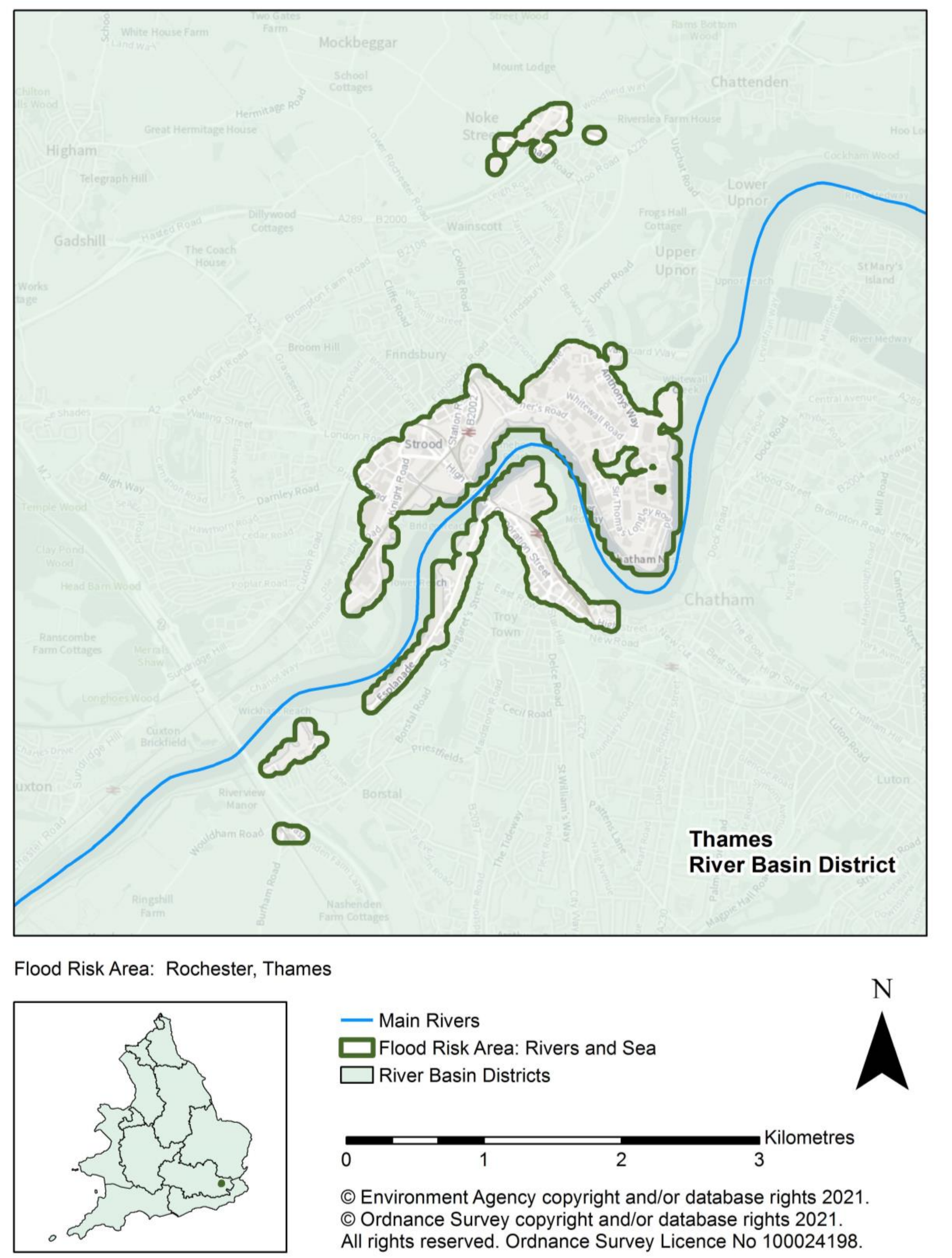


Figure 35: Map showing the Rochester Flood Risk Area Boundary and its location in England

The Rochester Rivers and Rea (RS) Flood Risk Area (FRA) is in the South East of England, and to the south-east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Rochester Rivers and Sea RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea. See the Chatham Surface Water (SW) FRA for the pluvial/surface water flood risk.

There are Risk Management Authorities (RMAs) operating in Rochester RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Medway Council
- Unitary District/Borough Council: Medway Council
- Regional Flood and Coastal Committees (RFCCs): Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Medway Council
- Water and Sewerage Company: Southern Water
- Department for Communities and Local Government through local planning authorities

Environmental designations

The Rochester RS FRA covers the towns of Strood and Rochester. It is a large, urbanised area nowadays with a long history due to its position near the confluence of the Medway and the Thames. The River Medway is the primary watercourse which flows through the middle of the FRA, with Strood on the north bank and Rochester on the south bank. Rochester a large town with a population of approximately 62,980 people and Strood is a smaller town with a population of approximately 33,180 people. Rochester and Strood are two of the five Medway towns, the remaining three being Chatham, Gillingham and Rainham. There is a history of pluvial and sewer flooding in the Rochester RS FRA and little history of fluvial and tidal flooding due to the extensive line of flood defences along the River Medway that create flood storage within the River Medway channel.

In the Rochester RS FRA, there are no sites with a special environment designation but on its boundary, there are some designated sites and local wildlife areas. The full details for the other designated sites can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

Rochester and Strood are both low-lying towns on the southern and northern banks of the River Medway. In the area there is little topographic variation.

The underlying geology of this RS FRA changes from the Thanet Formation (sand, silt and clay) and Seaford Chalk Formation to the Lewes Nodular Chalk Formation in the south. Strood is underlain by the Seaford Chalk Formation and Rochester is underlain by the Lewes Nodular Chalk Formation.

Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues around surface water flooding.

Watercourses

The Rochester RS FRA sits near the confluence of the river Thames and river Medway. The principal water course runs through the middle of the FRA with the towns of Strood and Rochester on either side of the river.

The primary flood risk to Rochester FRA is fluvial and tidal due to its proximity to the River Medway and the River Medway Estuary and the River Thames Estuary. The River Medway has tributaries, but these merge into the river Medway upstream of Rochester, in Yalding.

There are no historic records of fluvial or tidal flooding in this FRA. However, there are records of surface water and sewer flooding, recorded by Medway Council and Southern Water.

Current flood risk

The main source of flood risk within this RS FRA is from main rivers.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Rochester RS FRA some 2,830 (48%) people live in areas at risk of flooding from main rivers.

Also at risk of fluvial flooding within this RS FRA are:

- 11 services (14.4%)
- 933 non-residential properties (58%)
- critical Infrastructure: 1.09 km of railway (17.5%).10.72 hectares of agricultural land (43.5%)
- natural environment: 1 Environmental Permitting Regulation installation (100%), 0.47 hectares of parks and gardens within area (0.64% of the total area)
- historic environment: 0.04 hectares of Scheduled Ancient Monument (4.3%) and 29 listed buildings (27%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk.

For more information on surface water flood risk, see the Chatham Surface Water (SW) FRA section. The boundary for that FRA overlaps with the Rochester RS FRA.

Groundwater flood risk

Groundwater flooding happens as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

The southern half of the Medway's administrative area, which includes Rochester and Strood, has a degree of susceptibility to groundwater flooding due to the presence of the Chalk and Thanet Sands formations.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. The majority of this flooding is a result of the inadequate capacity of the sewage system and blockages.

How the risk is currently managed

Fluvial flood risk within the Rochester RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses which inform the Environment Agency incident response team on when to issue flood alerts and warnings. There are multiple Flood Alerts and Flood Warnings to cover the entire Rochester FRA too. Please visit the flood warning information service to view the monitoring sites close to your area.

Fluvial and tidal flood risk within the Rochester RS FRA is currently managed through flood defences creating a flood storage area around the River Medway.

Flood defences

There are several important flood defences located within this RS FRA, including walls, high ground and raised embankments located all along the northern and southern banks of the River Medway. Significant flood defences which reduce flood risk in areas with a 0.1% chance of flooding each year are located:

- on the south bank of the River Medway, stretching from Rochester Bridge south-westerly towards Chatham
- on the south bank of the River Medway, adjacent to Esplanade
- on the north bank of the River Medway by Sir Thomas Longley Road

Hydraulic modelling

The Rochester RS FRA is included in the North Kent Coast model, which was most recently updated in 2018. The North Kent Coast Model can be used to model the flood map, defended and undefended flood extents (including in climate change and wave overtopping scenarios), defended and undefended flood levels (again, including climate change and wave overtopping scenarios) and historic flood extents in Rochester RS FRA and neighbouring FRAs.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Rochester RS FRA

Measures have been developed which apply specifically to the Rochester FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Rochester RS FRA.

You can find information about all the measures that apply to the Rochester RS FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Slough Rivers and Sea Flood Risk Area

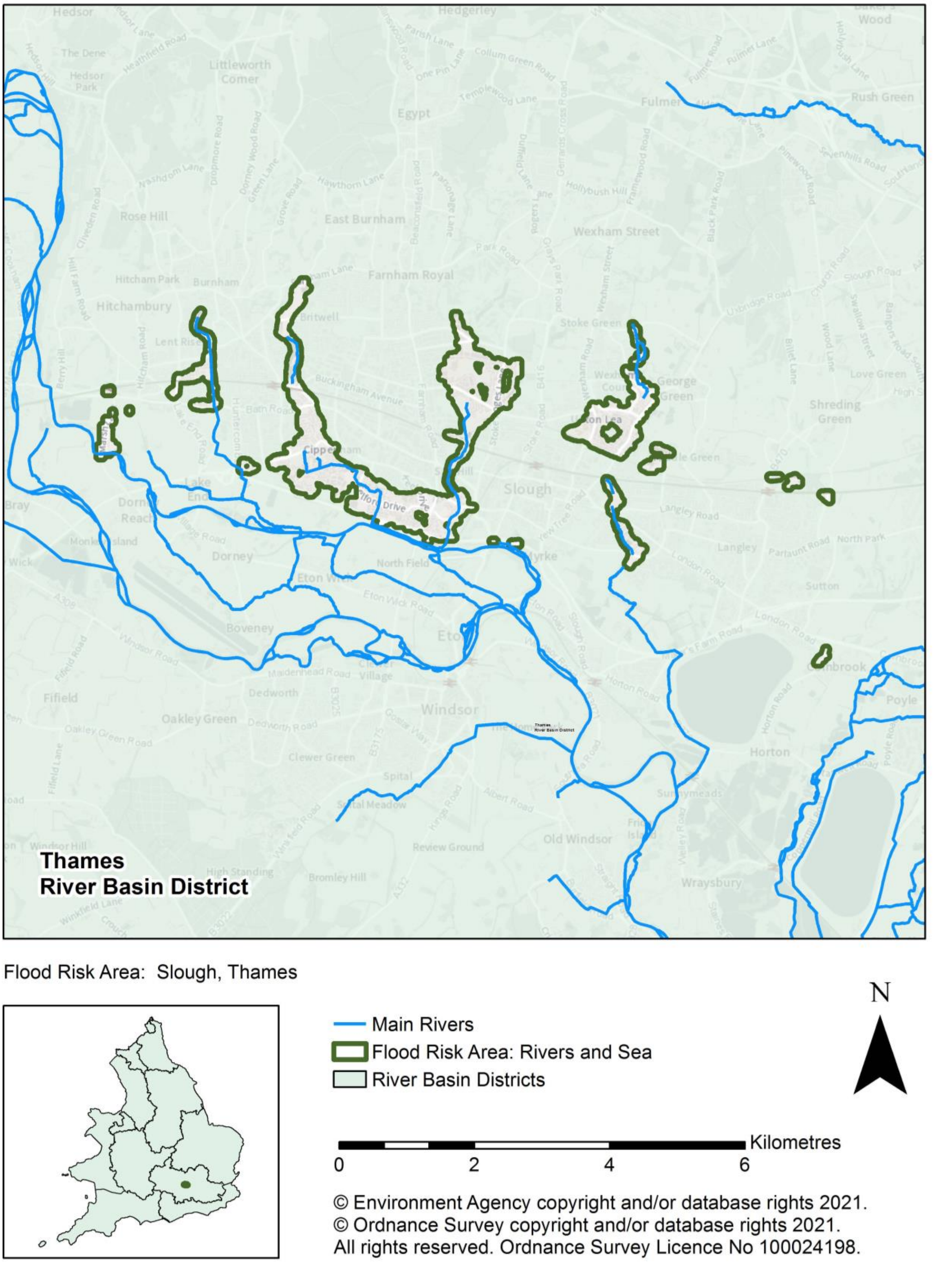


Figure 36: Map showing the Slough Flood Risk Area Boundary and its location in England

The Slough Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and in the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Slough Rivers and Sea (RS) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Slough Rivers and Sea (RS) FRA is located north of the River Thames and is confined along watercourse valleys. Surface water flooding happens when heavy rainfall exceeds the capacity of local drainage networks and water flows across the ground. Parts of the Slough RS FRA overlap with the Slough Surface Water (SW) Flood Risk Area. This means that large parts of Slough have been identified at being at significant risk of flooding associated with existing watercourses and road networks.

There are Risk Management Authorities (RMAs) operating in the Slough FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Slough Borough Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: National Highways, Slough Borough Council
- One Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The Slough RS FRA is mainly confined to a few watercourse valleys and is defined by the Chiltern Hills to the North and the River Thames to the South. The land slopes from north to south, and west to east.

The predominant underlying geology is silt, sand and clay from the Lambeth Group.

Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

The Slough RS FRA is highly urbanised with several culverted watercourses.

Partnership working

The Environment Agency is working collaboratively with other RMAs and partners through, for example, the Berkshire Strategic Flood Risk Management Partnership and the Maidenhead to Teddington Catchment Partnership hosted by Thames21 to better understand the wider Berkshire area and to develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

The Water Framework Directive (WFD) improvements works on the Salt Hill Stream are an example of this. Partners are working together to help the stream meet the 2027 WFD requirements.

Current flood risk

The Slough RS FRA is at risk of multiple sources of flooding. The primary flood risk is from main rivers.

These rivers include, but are not limited to:

- the River Thames
- Huntercoombe Lane Stream
- the Chalvey Ditches
- Salt Hill Stream
- Datchet Common Brook

The River Thames is the longest river in England, draining a considerable catchment area, and flooding is typically associated with long duration, regional rainfall events. The Huntercombe Lane Stream is culverted for most of its length within the Slough Borough and joins the Roundmoor Ditch. The Chalvey Ditches are also culverted for most of their lengths. In high flows, the water ponds behind a structure and dam (Haymill Dam) at the junction of Buckingham Avenue and Burnham Lane discharging into the River Thames. The Salt Hill Stream originates in two tributaries in wooded or rural parts of Farnham Common and Stoke Poges. It is also culverted in parts and discharges into the River Thames. Datchet Common Brook originates as an open channel Ordinary Watercourse in Slough Borough flowing south. It has been culverted in several areas.

In recent years, Slough has experienced flooding from rivers (fluvial), surface water, groundwater and sewers. There is a recorded history of fluvial flooding in 1947, 1969, 1989, 2000, 2001, 2003 and 2007.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the RS FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the RS FRA. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Slough RS FRA 14,260 people (54%) live at risk of flooding from main rivers. A large proportion of people are at medium risk. As well as people living within the floodplain, there are also services that have been built within FRAs. 27 (22%) services are in areas at risk of flooding from main river. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in the Slough RS FRA:

- 190 out of 405 non-residential properties
- a small proportion (7%) of the railway
- less than 0.1 kilometre of motorways, primary and trunk routes, as classified by National Highways is shown to be at very low risk of flooding. Critical transport links within the area include parts of the M4 motorway
- 58% (47.24 ha) of agricultural land with the majority indicated at low risk
- 1 (100%) licensed water abstraction which is shown to be at high risk of flooding
- 9 listed buildings
- 31% (0.71 ha) of parks/garden
- 43% (0.6 ha) of Scheduled Ancient Monuments

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and businesses that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Slough RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

Haymills Flood Storage Area is maintained by Slough Borough Council and operated by the Environment Agency. It reduces flood risk from the Chalvey Ditches to part of the Slough FRA.

The Environment Agency has explored options to further reduce the risk of fluvial flooding from the Chalvey Ditches, Salt Hill Stream and the Datchet Common Brook in Slough as well as to reduce the risk of surface water flooding through working in partnership with Slough Borough Council and Thames Water.

Available evidence suggests a reduction of fluvial flood risk in the area compared to previously available evidence. As a result, Slough Borough Council has taken the lead role in the partnership for the appraisal stage to investigate options to reduce flood risk from various sources in addition to seeking environmental enhancements in line with the Water Framework Directive objectives. Slough Borough Council in partnership with the Environment Agency is updating the flood risk model for Slough to provide up-to-date baseline flood risk for the area upon which any future investigations may be based on.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

The Environment Agency's flood warning and alert service is available in all parts of the RS FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Slough RS FRA

Measures have been developed which apply specifically to the Slough FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Slough RS FRA.

You can find information about all the measures that apply to the Slough RS FRA in the interactive mapping tool, Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Slough Surface Water Flood Risk Area

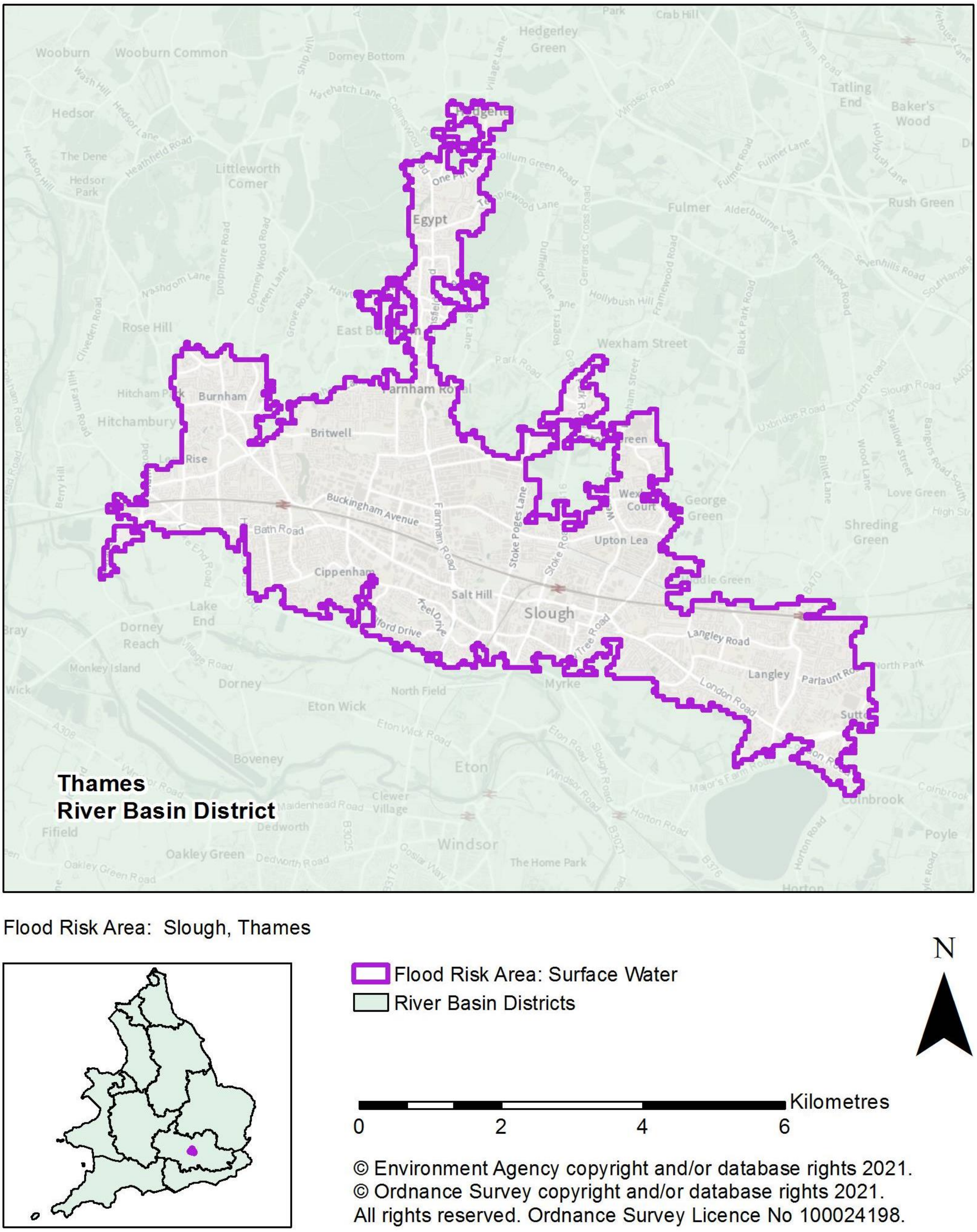


Figure 37: Map showing the Slough Flood Risk Area Boundary and its location in England

The Slough Surface Water (SW) Flood Risk Area (FRA) is in the South East of England and in the centre of the Thames River Basin District (RBD). It will be reported by the Thames RBD. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage). The Slough FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs). The Slough Surface Water FRA is located North of the River Thames and is defined by topography. The Slough Surface Water (SW) FRA covers parts of Slough Borough Council, Buckinghamshire Council and the Royal Borough of Windsor and Maidenhead.

The Slough SW FRA is primarily urban with a low proportion of arable land. There are some communities at risk of flooding from Surface Water, due to the urban nature of the area and the underlying geology. Key urban areas include Slough, Burnham, Cippenham, Salt Hill, Farnham Royal, Chalvey, Upton and Langley.

The primary source of flood risk varies across this SW FRA. Parts of the Slough SW FRA overlap with the Slough Rivers and Sea FRA. See the Slough Rivers and Sea (RS) FRA for more information on the flood risk from main rivers.

The relevant Lead Local Flood Authorities (LLFAs) within this FRA lead on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMA) operating in the Slough SW FRA, including:

- Environment Agency
- Two Lead Local Flood Authorities (LLFAs): Slough Borough Council and Royal Borough of Windsor and Maidenhead
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: National Highways, Slough Borough Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The FRA is mainly confined to watercourse valleys and is strongly influenced by two terraces, the upper terrace and the river terrace. The FRA is defined by the Chiltern Hills to the North and the River Thames to the South. The land slopes from north to south, and west to east.

The lower areas include Cippenham, Chalvey and Upton (less than 25 m above ordnance datum). Elsewhere, the land rises to 51 m above ordnance datum, for example in Britwell.

The predominant underlying geology is silt, sand and clay from the London Clay formation in the East and the Lambeth Group in the West.

Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

The Slough SW FRA is highly urbanised with several culverted watercourses and their floodplains.

Due to the urban nature of the SW FRA, the building density reduces the permeability in the area.

Environmental designations

The following environmental designations are located within the Slough SW FRA:

- Three local nature reserves: Cocksherd Wood, Haymill Valley and Herschel Park
- One Nitrate Vulnerable Zone (NVZ): To the south-west of the Slough SW FRA
- Two scheduled monuments: Montem Mound and the Moated site at Cippenham Court
- One drinking water protection zone: Thames (Cookham to Egham)
- One drinking water safeguard zone (Surface Water): Thames_SWSGZ4015, 4016_Cookham Teddington & Wey
- Source protection zones:
- Zone I: Britwell, Salt Hill
- Zone II: Britwell, Cippenham, Salt Hill, Chalvey and Upton
- Zone III: majority of the Slough SW FRA

The following Water Framework Directive (WFD) management catchments are located within the Slough FRA:

- Chalvey Ditches
- Salthill Stream
- Datchet Common Brook
- Grand Union Canal, Uxbridge to Hanwell Locks, Slough Arm, Paddington Arm
- Horton Brook
- Colne Brook

All WFD management catchments, apart from the section of the Grand Union Canal and the Horton Brook, have hydromorphological designations of heavily modified water bodies. The section of the Grand Union Canal is artificial, while the Horton Brook is not designated artificial or heavily modified.

Across the SW FRA, the character of the rivers, drainage system and flow routes vary. In urban areas like Slough, rivers typically run in man-made channels and culverts and only make an appearance as they flow through parks and green spaces.

Partnership working

Slough Borough Council is working collaboratively with other Risk Management Authorities (RMAs) risk management authorities and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a Catchment Based Approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. Better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues. The WFD improvements works on the Salt Hill Stream are an example of this. Partners are working together to help the stream meet the 2027 WFD requirements.

Slough Borough Council, Buckinghamshire Council and West Berkshire Council are Risk Management Authorities which have recently been successful in securing funding though Defra's Flood and Coastal Resilience Innovation Programme for two projects, 'Smarter flood resilience – sponge catchments for people and nature' and 'Groundwater Resilience and Community Engagement project (GRACE)'.

The 'Smarter flood resilience – sponge catchments for people and nature' project is led by Slough Borough Council. It will address the challenges of surface water and river flooding in a heavily urbanised environment. The Chinese 'sponge city' concept, as well as new collaborative approaches to catchment management and local community involvement, will champion innovative flood resilience in south Buckinghamshire and northern Slough.

GRACE led by Buckinghamshire Council, will trial new approaches for managing groundwater flooding in the Chilterns and Berkshire Downs.

These include:

- understanding community perceptions
- increasing community resilience
- property flood resilience measures in 10-12 communities
- innovative groundwater monitoring
- modelling and mapping techniques
- Groundwater Flood Alert App for householders and businesses

The project includes 17 communities in West Berkshire / 150 communities in Buckinghamshire / Colnbrook in Slough.

This chapter should be read in conjunction with the other sections of this plan for information on how risk from other sources will be managed as well as other documentation listed below:

- Local Flood Risk Management Strategy (LFRMS) for Slough
- Slough Borough Council Strategic Flood Risk Assessment
- Slough Borough Council Surface Water Management Plan

Current flood risk

Slough FRA is at risk of multiple sources of flooding. The primary flood risk in the Slough FRA is from surface water. This section will discuss the surface water flood risk within this FRA. For more information on other sources of flood risk in this area, see the Slough Rivers and Sea (RS) section as well as the River Basin section of this document.

Surface water flood risk - overview of risk

The surface water flood risk follows the topography of the Slough SW FRA. The area is predominantly urban, therefore is particularly susceptible to flash flooding as a result of localised intense rainfall. There are areas of low, medium and high surface water flood risk across the Slough SW FRA.

The areas of higher risk are mostly located in areas to the East of Burnham, including:

- Farnham Common
- Britwell and Manor Park
- the Slough Trading Estate
- Wexham
- Areas of Upton
- Langley

For more information, see the Environment Agency flood risk maps.

In recent years, Slough has experienced flooding from surface water, rivers (fluvial), groundwater and sewers. There is a recorded history of surface water flooding in 2007, 2008, 2012, 2014, 2015 and 2016.

These events were located across the Slough FRA; Burnham, Manor Park, Slough Trading Estate, Slough Centre, Cippenham and Upton. Most of these events occurred within the Chalvey Ditches and Salt Hill Stream river catchments.

Surface water flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the SW FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Slough SW FRA some 27,994 people (20%) live in areas at risk of flooding from surface water source. A small proportion are at high and medium risk (5%) and a large proportion of people are at low risk (15%). As well as people living at risk, there are also services that have been built within FRAs. 51 (6%) services are in areas at risk of flooding from surface water. Schools and sewage treatment works are examples of these services.

Also shown to be at risk of flooding from surface water in the Slough SW FRA:

- 635 out of 3,685 non-residential properties
- a third (31%) of the railway
- 0.3 kilometres of motorways, primary and trunk routes, as classified by National Highways is shown to be at very low risk of flooding. Critical transport links within the area include parts of the M4 motorway
- 20% (94.36 ha) of agricultural land with the majority indicated at low risk
- two (11%) licensed abstractions which are shown to be at high risk of flooding
- 13 out of 160 listed buildings with a third (4) at high risk of flooding
- 26% (4.06 ha) of parks/garden
- 20% (0.04 ha) of Scheduled Ancient Monuments

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Groundwater flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

There are large areas of the Slough SW FRAs susceptible to groundwater flooding, with almost half of the Slough Borough identified with potential for groundwater flooding to occur.

In the south of the Slough SW FRA, the lower terrace, the groundwater level is influenced by the permeability of the bedrock in conjunction with the River Thames, and is therefore relatively high, between one to two metres below the surface.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages.

The Slough SW FRA is at risk of sewer flooding, but this is limited in geographical area and is generally associated with storm events when the sewer system is surcharged with surface water run-off.

How the risk is currently managed

Surface water flood risk within the Slough SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness and close collaboration within council departments and with the Environment Agency and Thames Water.

Slough Borough Council's project in the Defra's Flood and Coastal Resilience Innovation Programme, The Smarter flood resilience – sponge catchments for people and nature, will help to manage surface water flood risk in the Salt Hill Stream and Chalvey Ditches catchments.

Hydraulic modelling

Slough Borough Council are working to develop the existing Integrated Catchment Modelling of the Slough Borough, this will be used to further understand the flood risk mechanisms and inform the management of the flood risk within the Slough SW FRA.

Development

Slough Borough Council are currently developing a sustainable drainage systems (SuDS) Policy to inform planning and development control.

To date, no property-level protection/property resilience projects have been instituted.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces. For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Slough are working to further understand the impacts of climate change in the catchment through the development of the existing Integrated Catchment Modelling of the Slough Borough.

Objectives and measures for the Slough SW FRA

Measures have been developed which apply specifically to the Slough FRA.The measures created as part of the Flood Risk Management Plans are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed as well as measures covering a wider geographic area (Thames River Basin) but which also apply to the Slough SW FRA.

You can find information about all the measures that apply to the Slough SW FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Smallfield Rivers and Sea Flood Risk Area

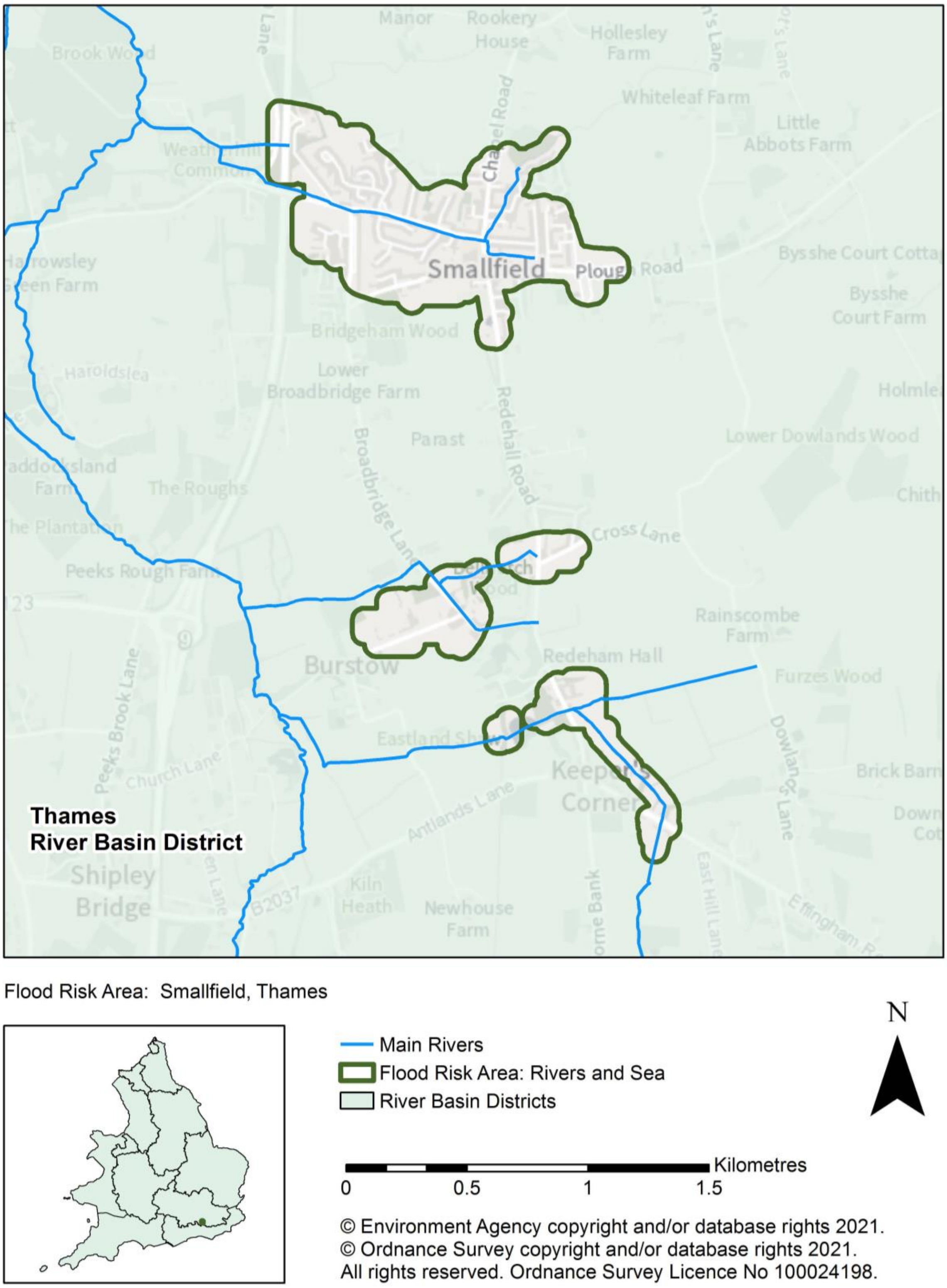


Figure 38: Map showing the Smallfield Flood Risk Area Boundary and its location in England

The Smallfield Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the south of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Smallfield Rivers and Sea (RS) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

There are Risk Management Authorities (RMAs) operating in Smallfield RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Surrey County Council
- Unitary District/Borough Council: Tandridge Borough Council
- Regional Flood and Coastal Committees (RFCCs): Thames RFCC
- Two Highways Authorities: National Highways (manage major motorways), Surrey Highways
- Water and Sewerage Company: Thames Water
- Department for Communities and Local Government through local planning authorities

Environment designations

The Smallfield RS FRA is predominantly a small rural area, covering the village of Smallfield. The population of Smallfield is approximately 4,000 people as of 2019. The area is subject to development pressure for more housing due to its proximity to Gatwick Airport and the M23 Motorway.

In the Smallfield RS FRA, there are no sites with a special environment designation, but just outside its boundary there are some designated sites and local wildlife areas. The full details for the other designated sites can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The central part of the RS FRA is the village characterised by many residential properties surrounded by grassland, some dispersed arable land and woodlands.

The topography is strongly influenced by the geology and the geological area this FRA sits in is known as the Weald basin.

The topography decreases from the north and south of the FRA to the low central points of Smallfield village. This means drainage is channelled through the floodplain of the Weatherhill Stream towards the confluence with the Burstow Stream and subsequently the River Mole at Horley.

The underlying bedrock geology is the Weald Clay Formation. The porosity and permeability of clays are generally low. This commonly results in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

There are mapped, Quaternary, river terrace superficial deposits covering the low point of the terrain including the village urban area. Localised groundwater can occur in these gravel deposits located on top of the impermeable clay.

Watercourses

The main sources of flood risk are from fluvial (river) and surface water. The fluvial risk and principal watercourse is from the Weatherhill Stream, a tributary of the Burstow Stream. The watercourse is culverted throughout most of Smallfield. There are other watercourses on the main river line that are tributaries of the Burstow Stream such as the Broadbridge Brook, Redehamhall Brook and the Copthorne Common Ditch.

Across Smallfield, the character of the drainage system and flow routes vary considerably. In the more urban village centre, the watercourses run in man-made channels and culverts. The majority of the Weatherhill Stream throughout Smallfield is culverted. Some of the inflows are surface water sewers and man-made drains. The only open channel sections are all upstream of the village centre.

There is a history of flooding within this FRA. A few recent ones that impacted Smallfield were in 2013/14, 2019, and 2020. In the December 2019 event, there were 19 reported affected properties. In the February 2020 event, there were 14 reported affected properties.

Current flood risk

The main source of flood risk within this RS FRA is from main rivers.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the RS FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show an estimated 2.356 people living within the Smallfield RS FR. Of these, some 1,564 (66%) people live in areas at risk of flooding from main rivers.

Also at risk of fluvial flooding within the Smallfield RS FRA include:

- 5 services (42%)
- 45 non-residential properties (68.2%)
- critical Infrastructure: 0.29 km of motorways, primary and trunk routes, as classified by National Highways (85%)
- historic environment: 2 listed buildings (100%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the RS FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk.

Ground water flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

It is often difficult to identify groundwater emergence at surface as the end result is overland surface water flow. The British Geological Survey 'Susceptibility to Groundwater Flooding' information gives an indication on the potential for groundwater emergence at surface. There is potential for groundwater emergence at surface in the low points of the terrain related to the superficial river terrace deposits.

Sewer water flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages.

Thames Water Utilities Limited is carrying out a Drainage and Waste Water Management Plan (DWMP) across its operational area which includes the Smallfield RS FRA. This project is assessing current and future flooding issues and capacity of the sewer network. The Environment Agency and other RMAs are included in this regional assessment of their sewer network capacity review in order to look at opportunities for carrying out flood reduction activities.

How the risk is currently managed

Fluvial flood risk within the Smallfield RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

In Surrey, the Environment Agency is part of the Surrey Flood Risk Partnership Board; a working group which aims to implement a joined-up approach to flood risk reduction.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency leads on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses which inform the Environment Agency incident response team on when to issue flood alerts and warnings. The data from these monitoring sites feeds into the decision on when to issue the Flood Alert for the ‘Upper River Mole and Burstow Stream’ which covers the area upstream of M23 for all Smallfield.

Please visit the flood warning information service to view the monitoring sites close to your area.

Flood defences

There is one Flood Defence Grant in Aid (FDGiA) Flood Alleviation Scheme (FAS) within this FRA. The Smallfield FAS is led by Surrey County Council and is focussed on managing surface water flood risk through a series of interventions throughout the local Smallfield drainage area and the wider Weatherhill Stream catchment. It is anticipated that the Outline Business Case which will highlight the preferred option will be produced in 2021.

Hydraulic modelling

The existing Burstow Stream hydraulic model (2012) covers the Weatherhill stream which flows through Smallfield. Some inconsistencies and known issues have led to the EA commissioning an updated hydraulic 1D-2D model which is due for completion in Winter 2021. Sections of the Weatherhill stream have been resurveyed so that the most up-to-date topographic data can be included in this model. Following delivery, the new modelling will inform flood map updates and be used to appraise new schemes to reduce fluvial flood risk in the Smallfield RS FRA.

In conjunction with the Environment Agency work underway to remodel the Burstow catchment, Surrey County Council, the LLFA, have developed an Integrated Catchment Model to better understand the combined surface and sewer flood risk in the area. Surrey is currently writing an Outline Business Case which will appraise options to reduce surface water and sewer flood risk in the Smallfield FRA.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Smallfield Surface Water FRA

Measures have been developed which apply specifically to the Smallfield FRA. The measures created as part of the FRMPs are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Smallfield FRA.

You can find information about all the measures that apply to the Smallfield RS FRA in the interactive mapping tool, [Flood Plan Explorer](). This includes information about which national objectives each measure helps to achieve.

The Staines Rivers and Sea Flood Risk Area

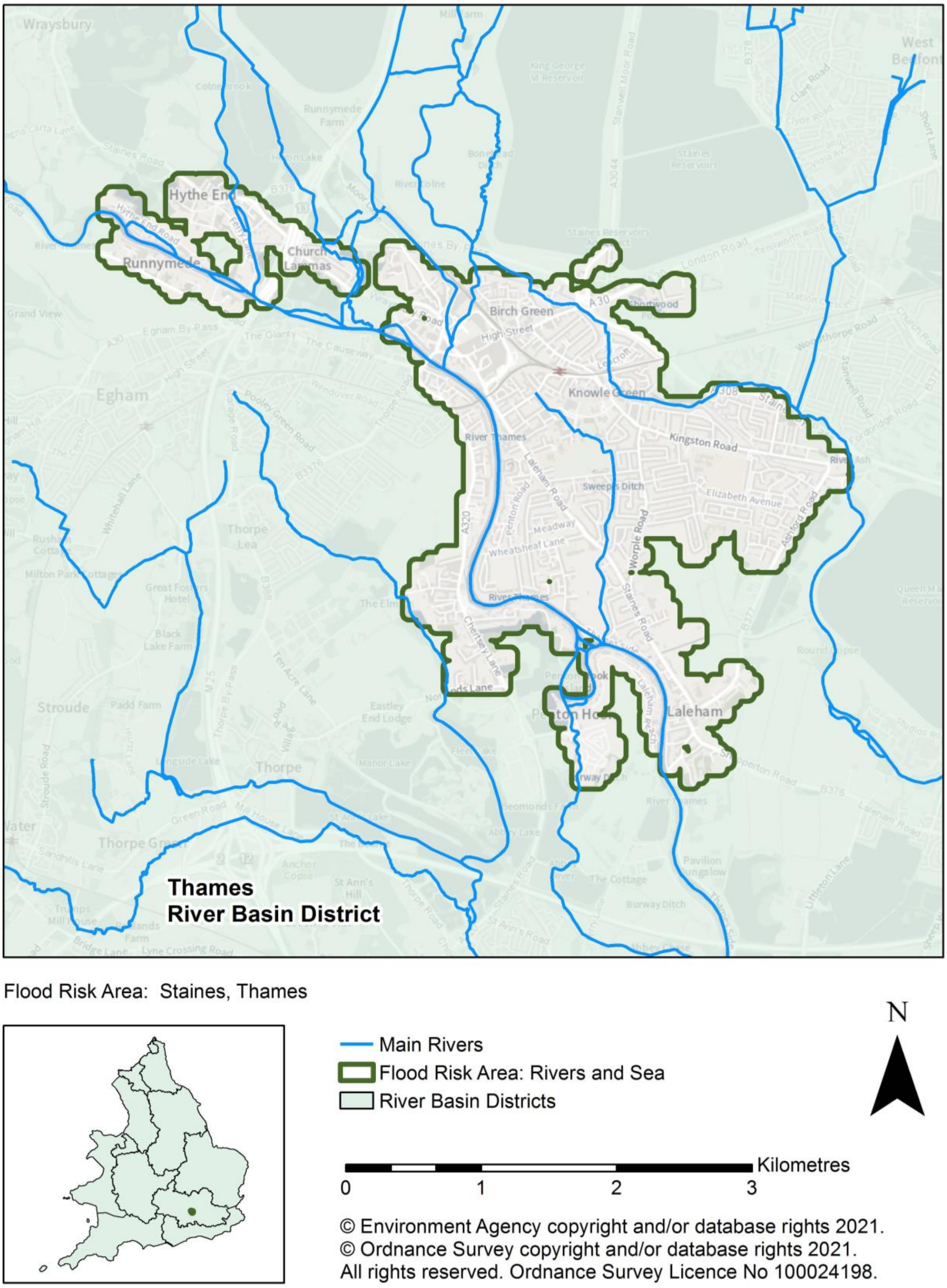


Figure 39: Map showing the Staines Flood Risk Area Boundary and its location in England

The Staines Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Staines Rivers and Sea FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Staines RS FRA includes Staines Upon Thames, Laleham and Penton Hook. Staines FRA is located near the M25 and the A308. It is close to major transport links such as Heathrow airport. The River Thames flows from north to south in the east of the FRA.

There are Risk Management Authorities (RMA) operating in the Slough RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Surrey County Council
- Two District councils: Runnymede Borough Council and Spelthorne Borough Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: Surrey County Council and National Highways
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The land in the Staines FRA is mainly flat at around 20 to 25 metres above ordnance datum (mAOD). The underlying geology is silt, sand and clay. Because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding. The sand provides a well-drained, coarse, loamy, sandy soils type which is commonly found over gravel.

Groundwater flow in the gravels beneath most of the RS FRA is derived primarily from the natural discharge of water from a chalk groundwater catchment, flowing from the north towards the valley floor of the River Thames. Under normal conditions, this groundwater drains southward, underground through the gravels to discharge into the Thames and associated surface water channels and ditches. The FRA is urban and densely populated.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities (RMAs) and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a Catchment Based Approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together, we can resolve the identified issues.

This chapter should be read in conjunction with other sections of this plan for information on risks from other sources as well as the Surrey Local Flood Risk Management (LFRM) Strategy 2017.

Current flood risk

The main source of flood risk within this RS FRA is from main rivers. The River Thames is the primary river in the area and tends to react slowly to rainfall with prolonged periods of flooding when it occurs. The Sweeps Ditch, the Ash and the Colne rivers are also situated within the RS FRA. The River Colne flows south into the Thames at Staines upon Thames. There are no formal flood defences in the area.

There have been several historic flood events however no significant events have occurred since 2015 within the area. A significant event is when 20 or more properties were affected by flooding.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impact of flooding in the FRA. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Staines RS FRA, 25,762 (95.5%) people live at risk of flooding from main rivers. As well as people living within the floodplain, there are also services that have been built within FRAs. 71 services (36.9%) are in areas at risk of flooding from main rivers. Schools and sewage treatment works are examples of services.

Also shown to be at risk of fluvial flooding in the Staines RS FRA include:

- 956 non-residential properties at risk (97.5%)
- Critical Infrastructure: 4.92 kilometres of motorways, primary and trunk routes, as classified by National Highways (95.5%), and 2.72 kilometres of railway (93.4%)
- 25.87 hectares of agricultural land (99.3%)

- Protected areas: 0.02 hectares of Special Protection Areas (SPA) and Ramsar site area (1.8%) and 5.95 hectares of Sites of Special Scientific Interest (SSSI) (84.8%)
- Historical landmarks: 2.42 ha (100%) of Scheduled Ancient Monument area and 61 (81.3%) listed buildings
- 4 (100%) licensed water abstraction sites

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Staines RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

In Surrey, the Environment Agency is part of the Surrey Flood Risk Partnership Board, a working group which aims to implement a joined-up approach to flood risk reduction.

The Environment Agency is working with Thames Water to ensure appropriate management and operation of the Thames Water Staines Reservoir Aqueduct to manage flood risk to people and properties in part of the RS FRA.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding, the availability of barriers at national level, and the availability of people may influence our ability to deploy the barriers.

The Environment Agency carries out maintenance to a proportion of the main rivers within the FRA. Future funding will help guide investment where it is most needed. The Environment Agency also maintains monitoring equipment for both flood risk and other purposes in the area. In 2021, we are progressing work to the Moor Lane embankment to ensure that our assets continue to operate as intended. Whilst the embankment is located outside of the FRA, it helps manage the flood risk to people and properties within the FRA mainly in the Church Lammas area.

To reduce flood risk from the River Thames, the Environment Agency is committed to working closely with partners and stakeholders to design a scheme, the River Thames Scheme, that provides the most benefit to communities. The River Thames Scheme is expected to reduce flood risk to communities including 11,000 homes and 1,600 businesses in Surrey and south-west London. Road, rail, power and water networks are also expected to be more resilient throughout the scheme footprint.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Staines RS FRA

Measures have been developed which apply specifically to the Staines FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Staines FRA.

You can find information about all the measures that apply to the Staines FRA in the interactive mapping tool, Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

The Thurrock Surface Water Flood Risk Area

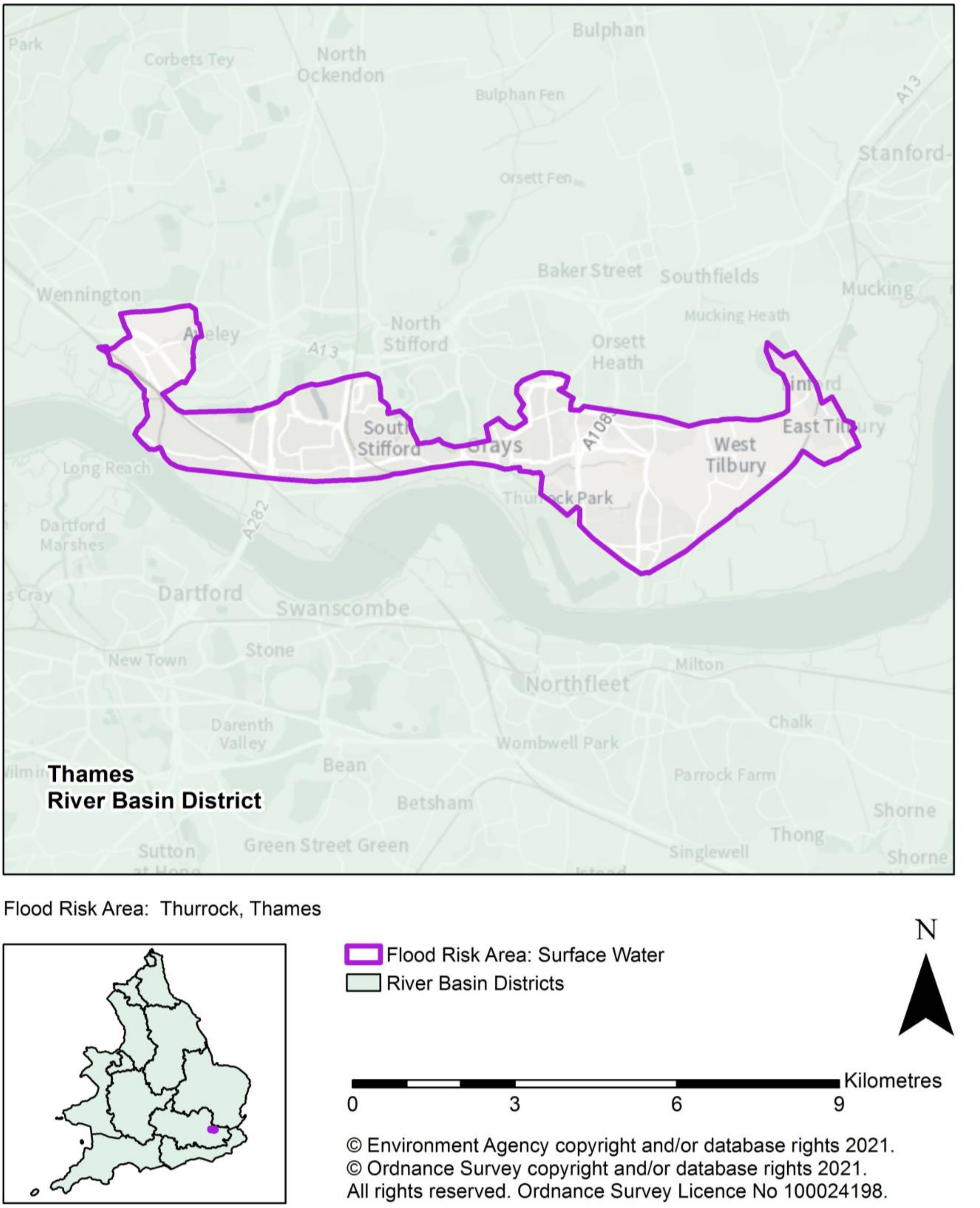


Figure 40: Map showing the Thurrock Flood Risk Area Boundary and its location in England

The Thurrock Surface Water (SW) Flood Risk Area (FRA) is in the South East of England, and to the eastern edge of the Thames River Basin District (RBD). It sits just north of the river Thames. This SW FRA falls across the Thames and Anglian RBDs and can therefore be found in both plans. It has been identified as a FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

The main source of flooding within this FRA is from surface water. Surface water flooding here can result from overflow of surface drains, inundated sewers, or rapid runoff from urban expansion and the surrounding steep topography. There are overland surface water flow paths across Thurrock, mostly associated with run-off following local topography, influenced by catchment antecedent conditions and hardstanding areas (typical of large towns), and capacity of the urban drainage network. Blockages and constrictions in and around channels and culverts can influence the scale and location of flooding. Often these types of flooding occur simultaneously, which can make it difficult to determine the cause. The Thurrock SW FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans.

Thurrock Borough Council leads on the development and delivery of the Flood Risk Management Plan (FRMP) for this SW FRA as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMA) running in this FRA, including:

- Environment Agency
- Two Lead Local Flood Authorities (LLFAs): Essex County Council and Thurrock Borough Council
- District Council: Thurrock Borough Council
- Two Regional Flood and Coastal Committees (RFCCs): Thames RFCC and East Anglia RFCC
- Three Highways Authority: Essex Highways, Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980) and National Highways manage major motorways
- Water and Sewerage Company: Anglian Water
- Department of Communities and Local Government through local planning authorities

Environmental designations

There are four Sites of Special Scientific Interest (SSSI) that hold environmental conservation designations located within Thurrock SW FRA:

- Purfleet Chalk Pits
- Lion Pit
- Globe Pit
- Hangman’s Wood and Deneholes

Topography, geology, hydrogeology, land use

The FRA covers an area of approximately 22km2. The FRA Stretches from Aveley in the west to East Tilbury in the east. The main settlements include Aveley, Chadwell St Mary, Grays, Purfleet, Tilbury and West Thurrock, Linford and East Tilbury.

The area largely consists of both residential and commercial uses. Marshland forms on the east of Thurrock along the Thames Estuary. The built environment of Thurrock is very varied, with redevelopment and renewal of the area creating mainly residential developments along the banks of the Thames. Old industrial sites have also been developed into new housing areas and the Lakeside retail development. Historically, the main urban centres have grown up around the riverbank industries including oil, aggregate, cement works, scrapyards, power stations and docks. The main infrastructure consists of World's End pumping station and flood storage reservoir in Tilbury. In addition, there are 2 major outfalls and the Mardyke Sluice.

The Purfleet-Grays ridge rises from the Thames, forming a central belt of sands and gravels across the borough, where short acidic grassland can develop.

Thurrock Local Plan (TLP) will determine the amount and distribution of new development providing a comprehensive and long-term planning framework for the period up to 2035. Essex Thames Gateway including the London to Southend-on-Sea corridor has been identified as a transport investment priority.

Thurrock is the dynamic heart of the Thames Gateway, a place of ambition, enterprise and opportunity, where communities and businesses flourish and the quality of life for local people is continually improving.

Master planning initiatives are underway under the Thames Gateway and Local Plan development.

Chalk underlies the whole of Thurrock and is near to ground surface in the south-west of the borough. This chalk dips southward beneath the Thames and northward beneath deep deposits of London Clay. The bedrock consists of essentially Thanet Sand Formation and White chalk subgroup.

The soils along the coastal zone are predominantly alluvial with a significant clay content and are periodically or permanently waterlogged, whereas the soils inland are predominantly clay but also exhibit a loamy characteristic making them more suitable for cultivation.

Thurrock is in the process of creating a new Flood Risk Asset Register which would encapsulate all the details pertaining to those flood risk assets including location, condition and ownership.

Current flood risk

The main source of flood risk within this FRA is from surface water. Flooding events have occurred in Thurrock, with the most significant being in 1953. A Flood Investigation was produced for Quebec Road in Tilbury in 2013 following flooding in January 2012, April 2012, June 2012 and September 2012 and this area was subsequently identified as an Area of Critical Drainage (AoCD) in Thurrock's Surface Water Management Plan. The most recent flooding occurred in January and February 2021 due to wet antecedent conditions and persistent rain, although less than 4 properties were reported to have suffered from internal flooding.

Surface water flood risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Thurrock SW FRA has been identified as being at significant risk of flooding due to the relatively flat topography of the area and location within a river valley. This topography, in addition to impermeable urban land cover, can cause surface water ponding and run-off. Roads can convey water as a secondary channel within a flood event and flood tends to be centred in areas where sewer and fluvial flood risk are also likely.

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SW FRA.

Residential streets which would also be at risk of flooding are not included in the assessment which could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted.

The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that, of the 51,320 people in the Thurrock FRA, some 15,654 people live in areas at risk of flooding from surface water. Of these, 41% are in areas of high risk.

Also shown to be at risk of flooding from surface water are:

- 1093 non-residential properties
- 58 out of 474 services
- 5.50ha of railways
- 2.17ha of motorways, primary and trunk routes, as classified by National Highways

- 256ha of agricultural land, of which around 119ha is at high risk
- 3 sites regulated under the EPR
- 5 licensed water abstraction sites
- 3 listed buildings
- 0.17ha of Scheduled Ancient Monument
- 4.96ha of SSSI

Conclusions based on risk statistics

It is clear from the above that flooding within the Thurrock SW FRA is a complex system with many differing factors impacting the flood risk. 51,320 people living in the Thurrock SW FRA are at risk from surface water flooding.

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network, especially as a result of the inadequate capacity of the sewage system and blockages. Sewer flooding is a problem that could occur in many locations across the Thurrock FRA.

How the risk is currently managed

Surface water flood risk within the Thurrock SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

The management of surface water flood risk is led by Thurrock Council in the role of LLFA in collaboration with other Risk Management Authorities (RMAs) and other stakeholders, including:

- Anglian Water
- Highways Authority

In the absence of a Flood Risk Management team until recently, the Thurrock Highway Authority, as the RMA, has been carrying out the flood risk management activities, including the clearance of ditches. Moreover, active maintenance and cyclic maintenance are being carried out routinely by the Highways Authority in areas within their remit to ensure the structures are kept free of obstruction.

There are very limited active schemes being implemented. The Quebec Road drainage improvement project is being developed and other schemes have been identified. Future projects to be developed and implemented to cover surface water management schemes will help to manage surface water within the FRA. There is also an aspiration to introduce catchment and localised surface water monitoring in the SW FRA.

During the recent flooding event in January and February 2021, issues have come to light which are being investigated. Most of the ditches within the authority are being managed either by the Highways Authority or by riparian landowners.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Thurrock SW FRA

Measures have been developed which apply specifically to the Thurrock SW FRA.The measures created as part of the Flood Risk Management Plans are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Thurrock FRA.

You can find information about all the measures that apply to the Thurrock FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Tonbridge Rivers and Sea Flood Risk Area

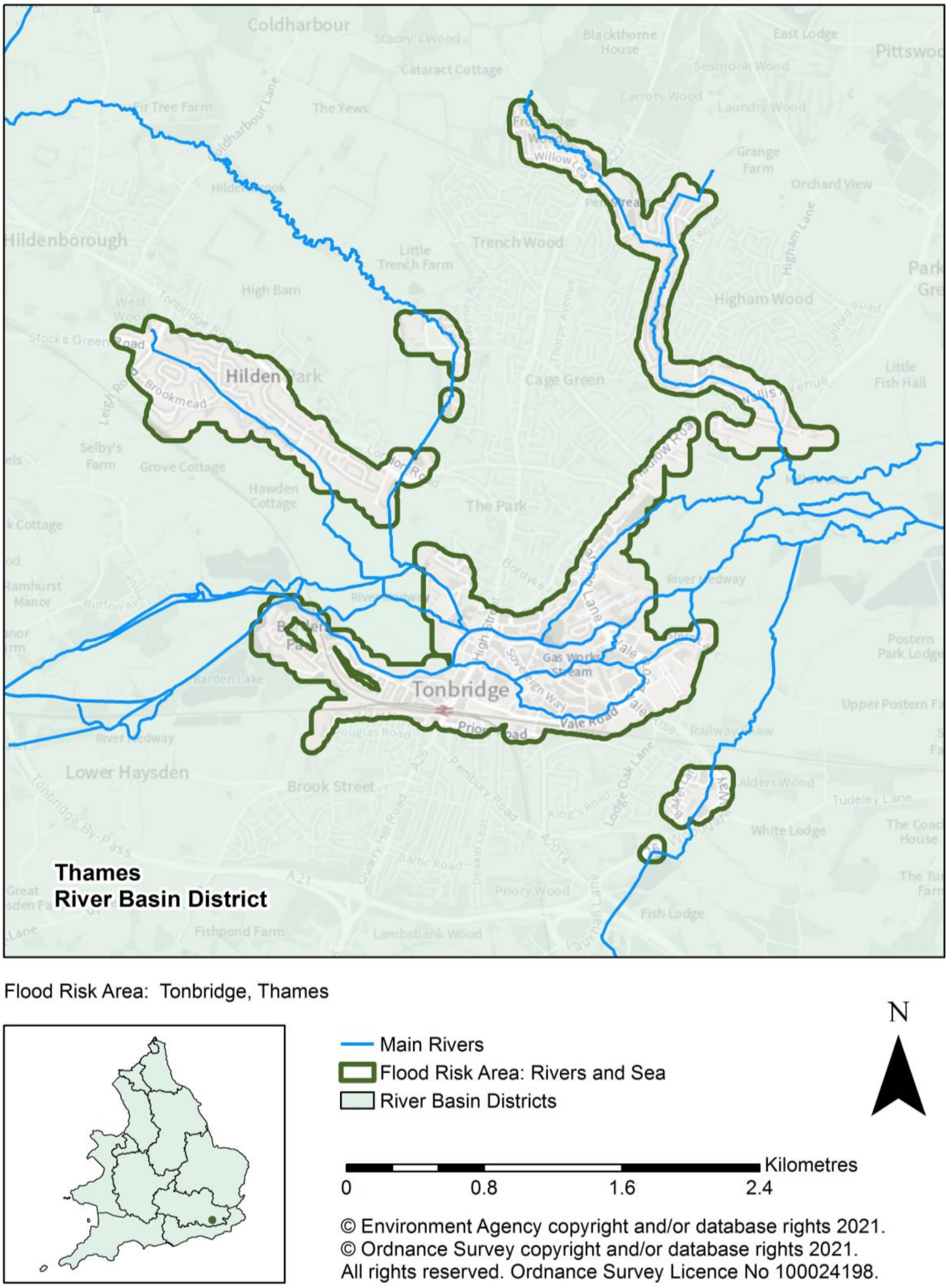


Figure 41: Map showing the Tonbridge Flood Risk Area Boundary and its location in England

The Tonbridge Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the south of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Tonbridge RS FRA was not identified in 2011 for the first cycle of FRMPs.

This chapter focuses on describing how the Environment Agency, in partnership with relevant Risk Management Authorities (RMAs), is working with communities to manage flood risk in the Tonbridge FRA. If you want to understand the surface water flood risk, this FRA overlaps with the Chatham Surface Water (SW) FRA, so please refer to that section for further details on the flood risk from surface water.

The Risk Management Authorities (RMA) in the Tonbridge RS FRA include:

- Environment Agency
- Lead Local Flood Authority (LLFA): Kent County Council
- Unitary District/Borough Council: Tonbridge and Malling Borough Council
- Regional Flood and Coastal Committees (RFCCs): Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and Sewerage Company: Southern Water
- Department for Communities and Local Government through local planning authorities

Environment designations

The Tonbridge RS FRA covers parts of Tonbridge and Malling Borough Council. Tonbridge is a large town in Kent with a population of approximately 41,290 people. The population of Tonbridge has grown more than thirty-fold in two hundred and fifty-years, with twice as many people living in the town compared to 1945. It has a long history of flooding due to the River Medway running through the centre of Tonbridge.

There are also many tributaries that flow into the River Medway, including the Hawden Stream, Hilden Brook, the Tonbridge Mill Stream and the Pen Stream. The town’s proximity to the river lent to its long navigation history with the Medway Navigation Company to transport various goods across Kent and towards the Thames. The navigation ended with the industry becoming dependent on the railways. The main Tonbridge railway station helps keep the town connected to nearby towns and cities.

In the Tonbridge RS FRA, there are no sites with a special environment designation but on its boundary, it is located near some designated sites and local wildlife areas. The full details for the other designated sites can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The underlying geology of this RS FRA changes from Weald Clay Formation (Mudstone) at Tonbridge and locations north of Tonbridge, such as Hildenborough and Higham Wood, to Wadhurst Clay Formation and Ashdown Formation south of Tonbridge. The Ashdown Formation is composed of sandstone and siltstone, while the Wadhurst Clay Formation is made of mudstone.

Within clay areas, because the porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

The central part of Tonbridge is mainly urban with a small section of land to the north of Tonbridge designated as grassland and used as parks and greenspaces. The main land use in Tonbridge is for both residential and commercial properties. Further east of the town, the land use changes to more rural farmland.

The primary fluvial flood risk to Tonbridge originates from the River Medway. The River Medway runs directly through the centre of Tonbridge in a west to east direction. The River Medway has tributaries that merge within the Tonbridge FRA. These include:

- the Hawden Stream (originating near Hildenborough and later converging with the Hilden Brook to the west of Tonbridge)
- the Hilden Brook (flowing in a south easterly direction towards Tonbridge, converging with the River Medway at Tonbridge Recreation Ground)
- the Tonbridge Mill Stream (flowing in a north easterly direction through Tonbridge Golf Course, later re-joining The River Medway at the confluence of Pen Stream near Hadlow Stair Farm)
- the Pen Stream (flowing in a south easterly direction through Higham Wood, until it re-joins the River Medway)
- the Tonbridge Mill Stream near Hadlow Stair Farm

The River Medway enters Tonbridge from the west via channels. The River Medway splits into two channels as it makes its way through the centre of Tonbridge. The northern channel of the River Medway passes south of Tonbridge School, runs next to the Tonbridge Swimming Pool, where it continues through the Town Lock and leaves Tonbridge to the north-east.

The southern channel of the River Medway from the west, runs south from Barden Park, around the Racecourse and then flows next to Avebury Avenue to just pass the Bowling Green where it continues north to join the northern section of the River Medway. At the Weir near River Lawn Road, the River Medway separates to form the Botany Stream. The Botany Stream running east, flows under the High Street, passes The Angel Centre where it becomes culverted to flow south under Avenue Le Puy and then remerges as an open channel south of the industrial estate. This later converges with the Gas Works Stream which originates from the footbridge just to the east of the Angel Centre. The Gas Works Stream continues north of the industrial estate. Just before meeting the Botany Stream and continuing north-east of Tonbridge, the stream is culverted under the Trading Estate and re-opens near to the Fire Station, where it joins the main channel of the River Medway.

Watercourses

The River Medway is the dominant watercourse within this RS FRA as it runs directly through the centre of Tonbridge, however, some of its tributaries also increase the fluvial risk to this area, such as the Pen Stream, Hilden Brook and Hawden Stream.

The Botany Stream and Gas Work Stream are watercourses south of the industrial estate that have in the past flooded the town centre (upstream of the weir) as well as Avenue du Puy before spreading to Sainsbury's Car Park.

Due to its proximity to the River Medway and its tributaries, the Tonbridge RS FRA has an extensive history of flooding. Well documented flood events that have affected Tonbridge occurred in 1960, 1963, 1967, 1968, 2000, 2013, 2014 and more recently the 2019/2020 winter period.

The flood event of December 2013 caused significant widespread flooding across the Medway Catchment, in particular Tonbridge. It was reported that 102 homes and 19 businesses were flooded in Tonbridge, 157 homes flooded in Hildenborough, and 80 homes flooded in Barden Road and Danvers Road in the Avebury Avenue area.

Current flood risk

The main source of flood risk within the Tonbridge RS FRA is from main rivers.

Description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impact of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Tonbridge FRA, some 6,025 (56%) people live in areas at risk of flooding from main rivers. The flood hazards and risk maps show an estimated 10,824 people living within the Tonbridge RS FRA. Of those in the area, 6,025 (56%) are at risk of flooding from fluvial sources.

Also at risk of fluvial flooding within the Tonbridge RS FRA are:

- 28 services (34.5%)
- 559 non-residential properties (86%)
- critical Infrastructure: 1.4 km of motorways, primary and trunk routes, as classified by National Highways (55%) and 2.63 km of railway (67%). 73.44 hectares of agricultural land (69%). Natural environment: 0.47 hectares of parks and gardens within area (0.64%)
- historic environment: 0.94 hectares of Scheduled Ancient Monument (44%) and 8 listed buildings (47%)
- 9 licensed water abstraction sites (100%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the Tonbridge RS FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk.

Tonbridge frequently experiences surface water flood events and historically these events have been dependent on the rate of runoff and the condition of the surface water drainage system.

Ground water flood risk

Groundwater flooding occurs as a result of water overflowing from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained and high levels of rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

Sewer water flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Most of this flooding is a result of the inadequate capacity of the sewage system and blockages.

Southern water is responsible for most sewers in this area and there have been some sewer flood incidents recorded in Tonbridge Town.

How the risk is currently managed

Fluvial flood risk within the Tonbridge RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses which inform the Environment Agency incident response team on when to issue flood alerts and warnings.

Please visit the flood warning information service to view the monitoring sites close to your area.

A key way that flood risk is managed is through local flood defences and the Leigh Flood Storage Area. The flood storage area reduces the risk of flooding to around 1,200 homes and businesses in Tonbridge and Hildenborough. The Leigh Flood Storage Area when full, covers approximately 278 hectares and is formed of a 1.3km long, 5m high earth embankment across the Medway valley. To reduce the flood risk further, there are planned improvements to expand the capacity of the Leigh Flood Storage Area from 28.05 metres above ordnance datum (mAOD) to 28.60 mAOD and also to construct a new embankment in Hildenborough.

Flood defences

As well as the Leigh Flood Storage Area, there are several important flood defences within this RS FRA, including walls in Tonbridge Town Centre. Flood walls are present along parts of the River Medway, particularly at the following locations: next to Avebury Avenue, Burleys Weir to Wharf Road and Tonbridge Town Walls and Town Lock defences between Wharf Road and Town Lock.

Hydraulic modelling

The Medway Model is a 2-D hydrodynamic model completed in 2015. It includes scenarios whereby peak flows during the 100Yr return period event are increased by 35% and 70%, which are two more likely scenarios estimated for the Thames River Basin area.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Tonbridge RS FRA

Measures have been developed which apply specifically to the Tonbridge RS FRA.The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Tonbridge FRA.

You can find information about all the measures that apply to the Tonbridge FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Walton on Thames Rivers and Sea Flood Risk Area

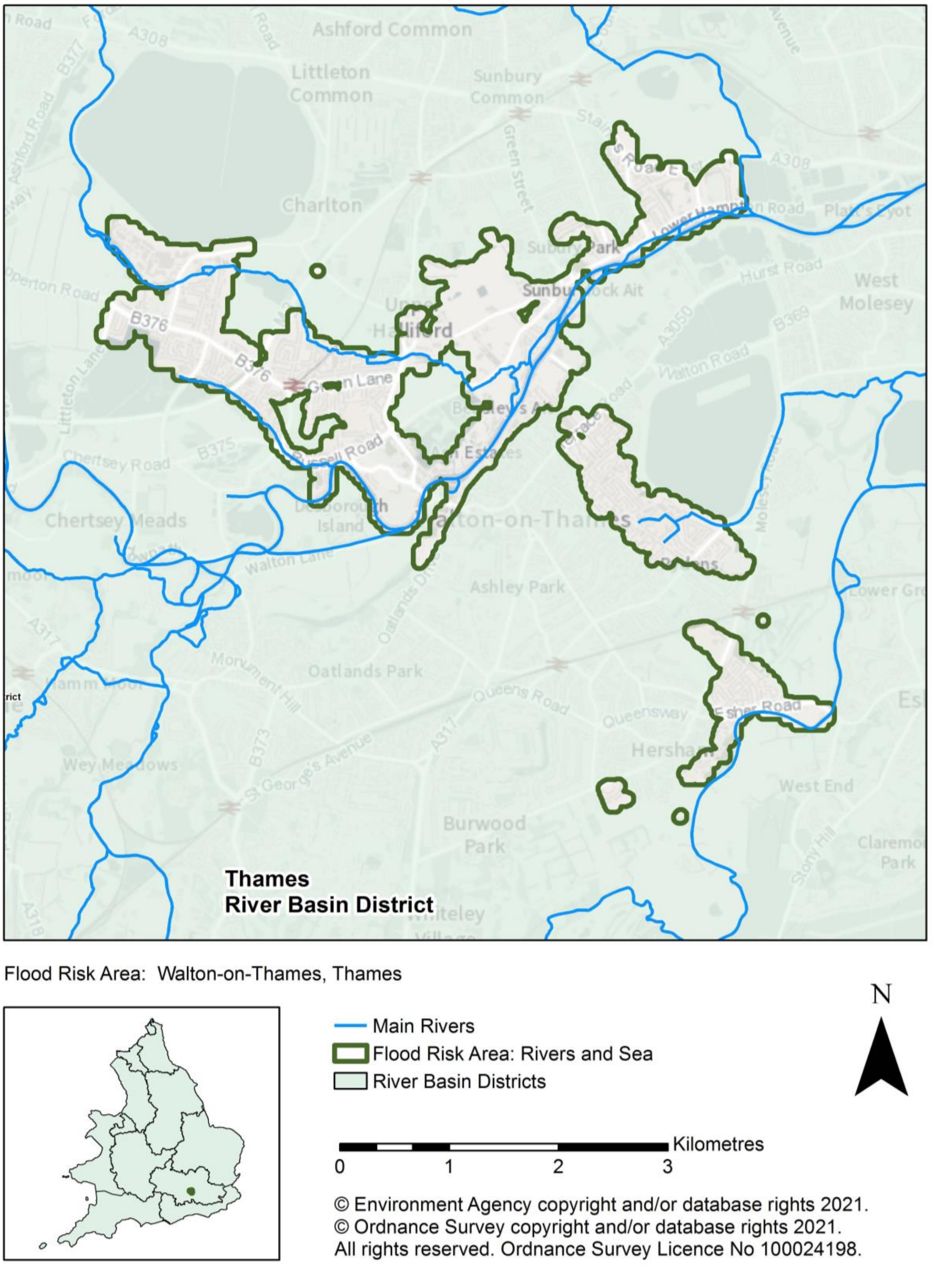


Figure 42: Map showing the Walton on Thames Flood Risk Area Boundary and its location in England

The Walton on Thames Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England and in the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Walton on Thames RS FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Walton on Thames RS FRA covers parts of Spelthorne and Elmbridge Council(s). The Walton on Thames RS FRA is a popular urban area with key urban areas include Shepperton, Sunbury, Hersham and Walton on Thames. The FRA extends north of the River Thames towards Shepperton and Littleton and south of the Thames towards Esher.

The Risk Management Authorities (RMA) in the Walton on Thames RS FRA include:

- Environment Agency
- Lead Local Flood Authority (LLFA): Surrey County council
- Two District councils: Spelthorne and Elmbridge Borough Councils
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: National Highways and Surrey County Council
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The majority of the FRA is low lying and flat, as fitting with its location close to both the Rivers Mole and Thames.

The area rises towards Hersham and Esher. The underlying geology is sand and clay. The west of Shepperton is made up of sand, whereas east Shepperton, Sunbury and Walton on Thames is mostly clay and silt. The porosity of clay is low, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding. The porosity of sand is high, which can result in fast infiltration rates and water flowing slowly through the aquifers and released at a slow rate into the river Pool End Ditch.

The River Thames waterbody flows in an easterly direction through Walton on Thames. The channel is open and is described as heavily modified to allow for navigational purposes. Its floodplain is vast and includes the key urban areas above.

Partnership working

The Environment Agency is working collaboratively with other Risk Management Authorities (RMAs) and partners through the Maidenhead to Teddington Catchment

Partnership hosted by Thames21 and the River Mole Catchment Partnership hosted by Surrey Nature Partnership to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

The Environment Agency also works collaboratively with partners and communities to improve the water environment.

This chapter should be read in conjunction with other sections of this plan for information on how risk from other sources will be managed as well as the Surrey Local Flood Risk Management (LFRM) Strategy 2017.

Current flood risk

The primary flood risk in the Walton on Thames RS FRA is from rivers, mainly the River Thames. However, some areas are at risk from other sources, including surface water.

Several rivers including the River Thames and its tributaries flow through the Walton on Thames FRA. The River Ash, Pool End Ditch and the Dead River flow into the Thames at various locations within the area.

The Dead River is also located in Walton-on-Thames and outfalls into the lower reaches of the River Mole, not far upstream from the River Mole's confluence with the River Thames. The Dead River flows through a predominately urban area, with some pockets of green space and recreational areas.

There have been several historic flooding events that have affected the FRA but no significant flooding events have occurred since 2015. A significant event is when 20 or more properties were affected by flooding.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Walton on Thames RS FRAs some 17,301 (67.7%) people live in areas at risk of flooding from main rivers. As well as people living within the floodplain, there are also services that have been built within FRAs. There are 117 services within the FRA. 34 (29%) services are in areas at a risk of flooding. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in the Walton on Thames RS FRA include:

- 428 out of 590 (72.5%) non-residential properties
- 1km (60%) of motorways, primary and trunk routes, as classified by National Highways
- 0.39km (46%) of railway
- 77.24ha (78.8%) of agricultural land
- 0.03ha of parks and gardens
- nine out of 11 licensed water abstraction sites
- 1.77ha (100%) of scheduled ancient monuments
- 57 (82%) listed buildings

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Walton on Thames RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

In Surrey, the Environment Agency is part of the Surrey Flood Risk Partnership Board, a working group which aims to implement a joined-up approach to flood risk reduction.

The Environment Agency is managing existing flood risk effectively in parts of the RS FRA. There are several important flood defences and structures located with this FRA, including outfalls and raised embankments. The structures and embankments are maintained by the Environment Agency.

Parts of the Walton on Thames RS FRA benefit from a reduction in flood risk from the Lower Mole Flood Alleviation Scheme which became operational in 1989. The Lower Mole Flood Alleviation Scheme is composed of a range of asset types, including an engineered flood relief channel, embankments, flood walls, sheet piling with capping and several river level control structures. Not all of the river level structures are owned and operated by the Environment Agency. Works on elements of the Flood Alleviation Scheme are required to ensure that the current standard of protection can be maintained into the future. This presents opportunities to provide environmental outcomes in line with the River Basin Management Plan's ambitions. These opportunities include removal of in-channel structures, channel enhancements including softening of banks, restoration of natural processes and improvements to fish passage. The Environment Agency is committed to working closely with partners and stakeholders to update the Scheme to ensure it is the best scheme for the environment, people and wildlife.

Furthermore, the Environment Agency is committed to working closely with partners and stakeholders to design a scheme, the River Thames Scheme, that provides the most benefit to communities. The River Thames Scheme is expected to reduce flood risk to communities including 11,000 homes and 1,600 businesses in Surrey and south-west London. Road, rail, power and water networks are also expected to be more resilient throughout the scheme footprint.

In addition, the Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriersoffer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the defences.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Walton on Thames FRA is covered by the Environment Agency flood warning service, for both alerts and warnings. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

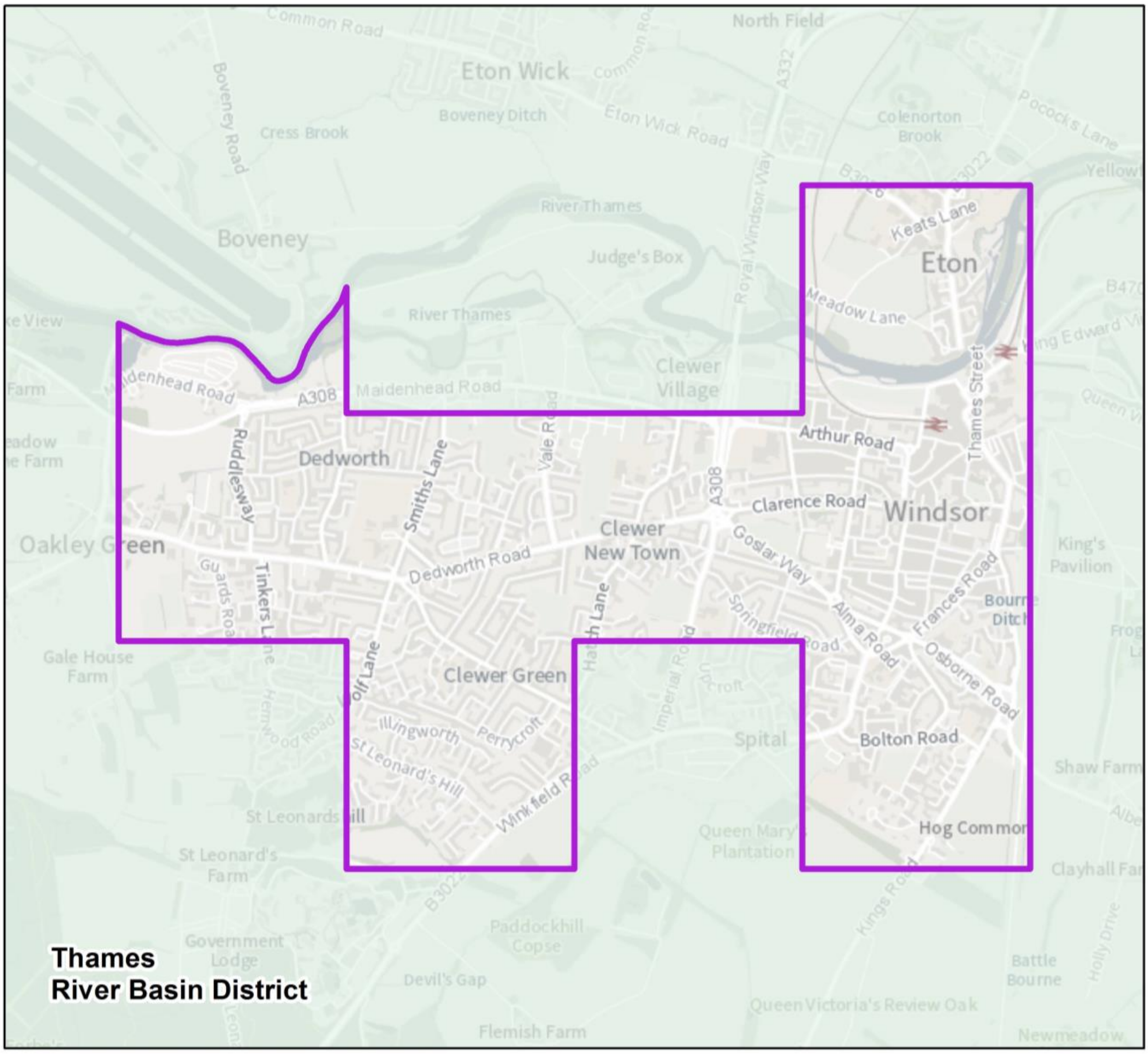
For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Walton on Thames RS FRA

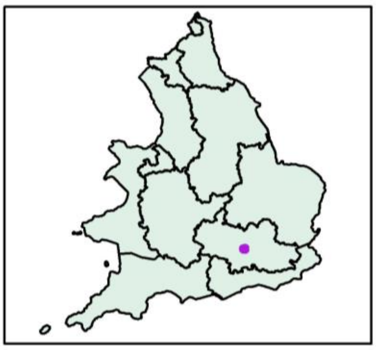
Measures have been developed which apply specifically to the Walton on Thames FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Walton on Thames FRA.

You can find information about all the measures that apply to the Walton on Thames FRA in the interactive mapping tool, Flood Plan Explorer This includes information about which national objectives each measure helps to achieve.

The Windsor Surface Water Flood Risk Area



Flood Risk Area: Windsor, Thames



Flood Risk Area: Surface Water

River Basin Districts

N

0 0.5 1 1.5 Kilometres

Figure 43: Map showing the Windsor Flood Risk Area Boundary and its location in England

The Windsor Surface Water (SW) Flood Risk Area (FRA) is in the South East of England, and in the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. has been identified as an FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage). The Windsor Surface Water (SW) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

All the Windsor SW FRA is in the administrative boundary of the Royal Borough of Windsor and Maidenhead. This is a mostly urban environment, with a low proportion of parks. The FRA is bounded to the north, east, west and south by green belt land.

The main sources of flood risk within the Windsor SW FRA are surface water, and groundwater. The Royal Borough of Windsor and Maidenhead leads on the development and delivery of the FRMP for this SW FRA as the responsible authority for managing flood risk from surface water.

There are Risk Management Authorities (RMA) operating in Windsor SW FRA including:

- Environment Agency
- Lead Local Flood Authority (LLFA): the Royal Borough of Windsor and Maidenhead
- Regional Flood and Coastal Committee (TRFCC): Thames
- Two Highway Authorities: The Royal Borough of Windsor and Maidenhead and National Highways
- Thames Water is the only water and sewerage company

Environmental designations

Most of Windsor is not located within a Source Protection Zone (SPZ), but the southern and eastern areas of the Windsor SW FRA are located within SPZ 3. SPZs are defined around large and public potable groundwater abstraction sites. The purpose of SPZs is to provide more protection to safeguard drinking water quality through constraining the proximity of an activity that may impact upon a drinking water abstraction.

The full detail of all designations within the SW FRA can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The topography of the Windsor SW FRA Area is strongly influenced by the lower lying floodplains of the River Thames. The town centre of Windsor is relatively flat at about 20-30 metres above ordnance datum (mAOD), with more elevated areas to the south, at about 60-70 mAOD.

The underlying geology in the Windsor SW FRA is London Clay, which significantly impacts permeability in the area.

Closer to the River Thames, the geology changes to Thames Gravels, which are highly permeable soils beneath the historical floodplain of the River Thames. During periods of high water levels in the river, the local water table within this gravel layer rises, often resulting in localised groundwater flooding to properties situated away from direct influence of the river.

The FRA is mainly urban with some dispersed green space. The centre of Windsor within the FRA is a significant tourist hotspot, as well as being a significant shopping area. The areas surrounding the FRA are designated green belt so are unlikely to be developed in the immediate future. The Borough's Local Plan guides development across the borough.

Current flood risk

Surface water flood risk - overview of risk

Surface water flooding occurs when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The Windsor SW FRA has been identified as being at significant risk of flooding due to a combination of factors including widespread impermeable urban land cover, low-lying areas that are conducive to surface water ponding, interaction with the downstream watercourses, and ageing drainage infrastructure that is often overwhelmed. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the risk.

The principal drainage system serving the Windsor SW FRA is the surface water public sewer, owned and maintained by Thames Water. This system serves the residential and commercial properties within the FRA, and the public highway largely drains to it. Discharge from the surface water sewer system is to the River Thames to the north of Windsor.

Within the older areas of Windsor, the sewer system is combined (i.e. one pipe serving both foul and surface water). The culverted main river, the Bourne Ditch, flows through the southern area of the Windsor FRA and impacts the performance of the surface water sewers in that area. Since 2015 to time of writing, two incidents of flooding as a consequence of surface water have been recorded within the Windsor SW FRA.

In June 2016 one property on Kings Road suffered internal flooding and a second surface water flooding incident resulted in a road closure on Park Street.

Surface water flood risk - description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps](). These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SW FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Windsor SWFRA some 7,484 (24.8%) live in areas at risk of flooding from surface water.

Also shown to be at risk of surface water flooding in the Windsor SW FRA include:

- 25 services (10.5%)
- 294 non-residential properties at risk (21.0%). There are a significant number of historic and older buildings within this FRA, which can, in some cases, contribute to a lower level of resilience to surface water flooding if these buildings do not have measures in place that help to drain away water. There are also many recently developed buildings, which, due to local regulations and policies, often employ sustainable drainage systems and other measures to be resilient to flood risk
- critical Infrastructure: 0.04 kilometres of railway (2.2%). Disruption to transport routes as a result of flood risk can have an impact at both local and larger scales. The lengths of road or railway at risk only provide part of the picture of transport network flood risk as the duration of possible flooding has implications on wider impacts due to closure or restriction of routes or services.
- 32.35 hectares of agricultural land (33.6%)
- protected areas: 1.17 hectares of Special Areas of Conservation (SAC) (12.0%), 1.17 hectares of Sites of Special Scientific Interest (SSSI) (12.0%), and 6.90 hectares of parks and gardens (15.0%)
- historical landmarks: 0.15 hectares of Scheduled Ancient Monument area and 5 (1.7%) listed buildings
- 1 licensed water abstraction sites (of the 3 total within the FRA)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the SW FRA. Taking further action to reduce risk will require another appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Groundwater flood risk

Within the Windsor SW FRA there is a known risk of groundwater emergence along the River Thames due to the presence of ‘Thames Gravels’. This is a term commonly used to describe the highly permeable soils beneath the historical floodplain of the River Thames.

During periods of high-water levels in the river, the local water table within this gravel layer rises, often resulting in localised groundwater flooding to properties situated away from the direct influence of the river.

Equally, where flood defences have been constructed to mitigate the risk of fluvial flooding, a residual risk of groundwater emergence may remain. Groundwater can move through the Thames Gravels, driven by high water levels in the river, leading to flooding of land behind the river defences.

Sewer flood risk

Sewer flooding is often caused by excess surface water entering the drainage network. Even in areas of the Windsor SW FRA which are located within an area of separated sewers (dedicated surface water and foul systems), surface water may still enter the foul sewers via misconnections.

Within the older areas of Windsor, the sewer system is combined: foul waste from homes joins rainwater that runs off from gullies and roads. During heavy rainstorms, these combined sewerage systems can be overwhelmed by rainwater run-off. This is especially true in urban areas with impermeable land cover which prevents rainwater from filtering into the ground. Blockages or reductions in capacity within the sewer network can exacerbate the flooding in these situations. It is hard to predict this type of flooding because it often happens in localised areas over a short period of time during intense storm events.

How the risk is currently managed

Surface water flood risk within the Windsor SW FRA is currently managed through a series of approaches, including development planning and adaptation, sustainable drainage systems, maintenance and flood awareness.

The Royal Borough of Windsor and Maidenhead acts as a Lead Local Flood Authority (LLFA). In this role they partner with other risk management authorities, including the Environment Agency, Thames Water, and other stakeholders, to manage surface water, groundwater and ordinary watercourse flood risk.

Duties include:

- identifying flood risks within their borough
- determining potential interventions for managing the flood risk
- applying for funding to implement the identified interventions
- preparing and maintaining strategy for local flood risk
- maintaining a register of flood risk assets

Surface water flood risk within the Windsor SW FRA is currently managed through a series of approaches, including drainage maintenance, installation of sustainable drainage systems (swales, rain gardens, permeable paving, etc.), community engagement, property-level resilience and protection, among many others.

For more detail, refer to the boroughs' Local Flood Risk Management (LFRM) strategy which details the aims and actions proposed to manage flood risk, as well as the FRMP measures (link available at the bottom of this section).

Modelling

Reliable and accurate surface water modelling is difficult. This is due to the multiple flow routes and flood sources. Surface water flooding can be difficult to predict and carrying out modelling can be resource intensive. The most accurate surface water modelling exercise undertaken covering the Windsor FRA has been undertaken by the Environment Agency.

Development

New construction and significant redevelopment projects are required to consider flood risk from multiple sources and identify mitigation and sustainable drainage options that are appropriate for the development. This regulation is important to ensure high standards of resilience.

Flood risk asset management

The Royal Borough of Windsor and Maidenhead in its capacity as highway authority undertakes routine maintenance of the highway drainage infrastructure within the Windsor FRA to ensure that water drains efficiently from the highway.

Thames Water and the Environment Agency also undertake maintenance of their assets to ensure all drainage infrastructure works effectively.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will increase the load on sewerage capacity and increase run off on impermeable surfaces.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Windsor SW FRA

Measures have been developed which apply specifically to the Windsor FRA. The measures created as part of the FRMPs are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Windsor FRA.

You can find information about all the measures that apply to the Windsor FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Wokingham Rivers and Sea Flood Risk Area

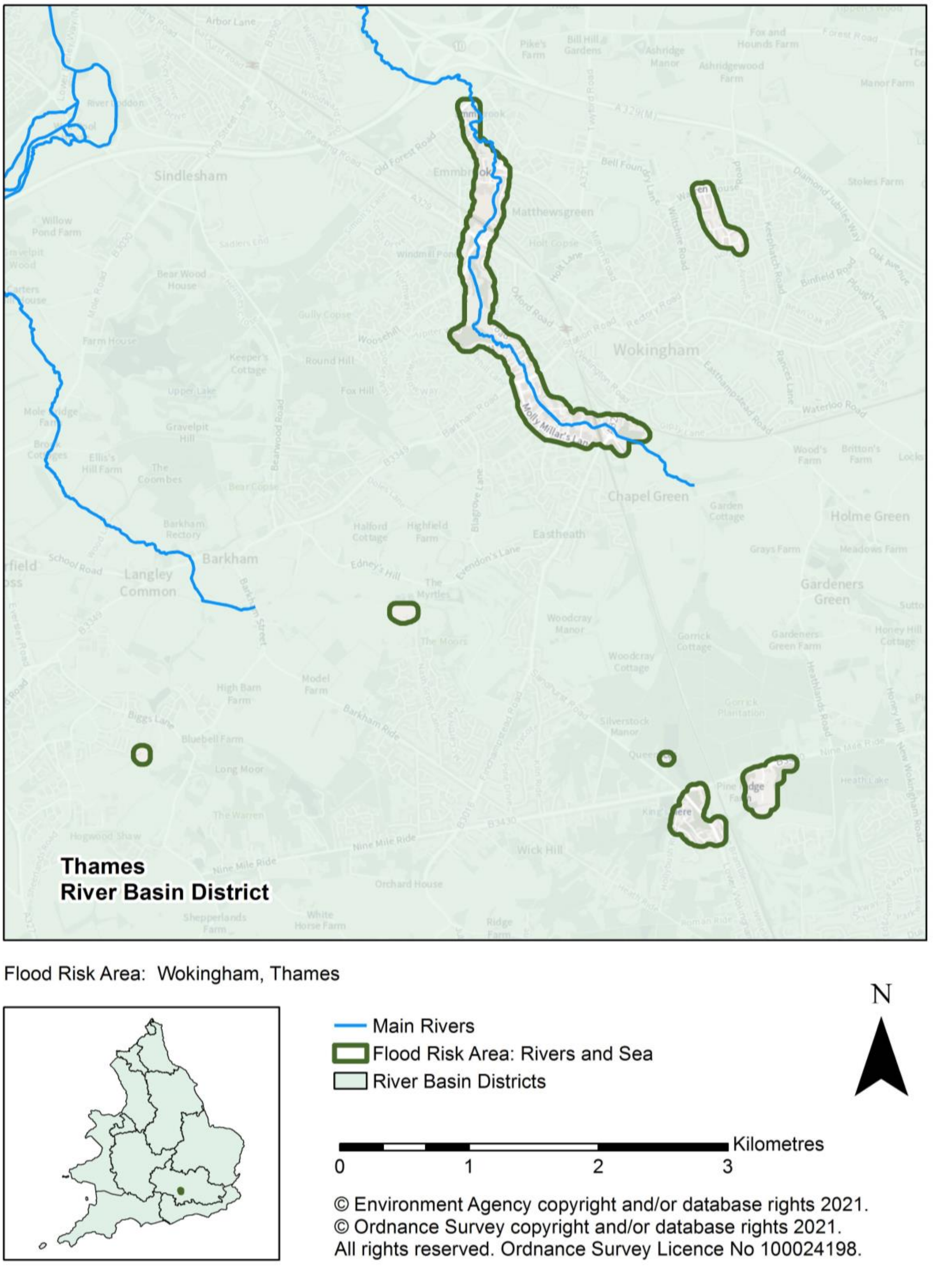


Figure 44: Map showing the Wokingham Flood Risk Area Boundary and its location in England

The Wokingham Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as an FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Wokingham Rivers and Sea FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Wokingham Rivers and Sea (RS) FRA covers parts of Wokingham Borough Council and is centred on the south of Wokingham. It also covers small areas in Shinfield, Arborfield Garrison, Lower Earley, Dowlesgreen, Finchampstead and locations along the B3430 (Nine Mile Ride).

There are Risk Management Authorities (RMAs) operating in Wokingham RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Wokingham Borough Council
- Regional Flood and Coastal Committee: Thames
- Two Highways Authorities: Wokingham Borough Council and National Highways
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The Wokingham RS FRA is urban with a low proportion of arable land. The key urban area is Wokingham town.

The underlying geology is alluvium (clay, silt, sand and gravel) underlain by bedrock geology of London Clay formation. Because the porosity of clay is fairly low, in clay areas, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

Partnership working

The Environment Agency is working collaboratively with other RMAs and partners through the Loddon Catchment partnership. This is hosted by the South East Rivers Trust to better understand the catchment and to develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

The priorities in this FRA include creating a healthy, functioning and wildlife rich aquatic environment within the River Loddon Catchment, valued and cared for by everyone now and in the future.

Current flood risk

The primary source of flood risk in the Wokingham RS FRA is from the Emm Brook which flows through Wokingham. Wokingham town is located within the floodplain of the Emm Brook. Some areas within the FRA are at risk of flooding from the ordinary watercourse tributaries of the Emm Brook and the Barkham Brook and from surface water. Barkham Brook is a tributary of the River Loddon.

The Emm Brook is mostly open channel through the FRA. The Emm Brook has its source south of the Nine Mile Road junction with Old Wokingham Road, then flowing in a north-westerly direction towards Wokingham through mostly agricultural land uses. The Emm Brook flows through the villages of Chapel Green before flowing in a northerly direction to the west of Wokingham town centre. It continues to flow in a northerly direction under the M4 and A329(M) and has its confluence with the River Loddon north of Winnesh and Dinton Pastures Country Park.

Historically, the Wokingham RS FRA has been impacted several times by fluvial flood events from Emm Brook. Just since 2015, there have been three notable flood events within the Wokingham RS FRA. Significant rainfall during the 2015/2016 winter caused flooding from the Emm Brook and the River Loddon in Wokingham. Some key roads within Wokingham including the A329 Reading Road were also impacted by the flooding causing severe travel disruption.

Significant rainfall and hail during September 2016 caused high volumes of surface water runoff. Roadside gullies and highway drains were blocked with vegetation dislodged by the intensity of the rainfall.

A high intensity, short duration rainfall event in July 2017 caused flooding to 50 properties within Wokingham Borough.

Fluvial flood risk - description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps](). These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Wokingham RS FRA some 1,524 people live in areas at risk of flooding from main rivers. Of those, 744 (25%) are in areas of high risk. As well as people living within the floodplain, there are also services that have been built within FRAs. 4 (10.5%) services are in areas at risk of flooding from main river. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in Wokingham RS FRA include:

- 66 of non-residential properties
- 21% (0.14km) of railway
- 11.91 ha (41%) of agricultural land

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Wokingham RSFRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

The Environment Agency maintain an annual programme of bank and in-channel weed clearance and the removal of obstructions. We also maintain four outfalls into the Emm Brook in the north-western part of the FRA. Future funding will help guide investment where it is most needed. We will also continue to promote good riparian ownership.

The Environment Agency is working with Wokingham Borough Council to achieve long-term adaptation of urban floodplain. The planned growth within Wokingham FRA has the potential to increase the number of social and economic receptors if it takes place in the floodplain. The Environment Agency ensures that Wokingham Borough Council has the relevant evidence to inform future decision making and land use planning. National planning policy also has an important role to play in helping to reduce these impacts and in controlling the source of surface water flooding.

The Environment Agency is part of the Thames Valley Local Resilience Forum. There is a Multi-Agency Flood Plan (MAFP) which comprises the seven unitary local authorities of Berkshire and Milton Keynes, as well as the county and district local authorities of Buckinghamshire and Oxfordshire. This area includes the River Thames catchment and associated tributaries plus part of the Great Ouse catchment which falls in the Milton Keynes area.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency's flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Due to the relatively long catchment response times associated with flooding from the River Thames, timely forewarning should be possible. This enables the Council, emergency services, residents and businesses to prepare to reduce the impact of a flood.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Wokingham RS FRA

Measures have been developed which apply specifically to the Wokingham RS FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Wokingham FRA.

You can find information about all the measures that apply to the Wokingham FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Wraysbury Rivers and Sea Flood Risk Area

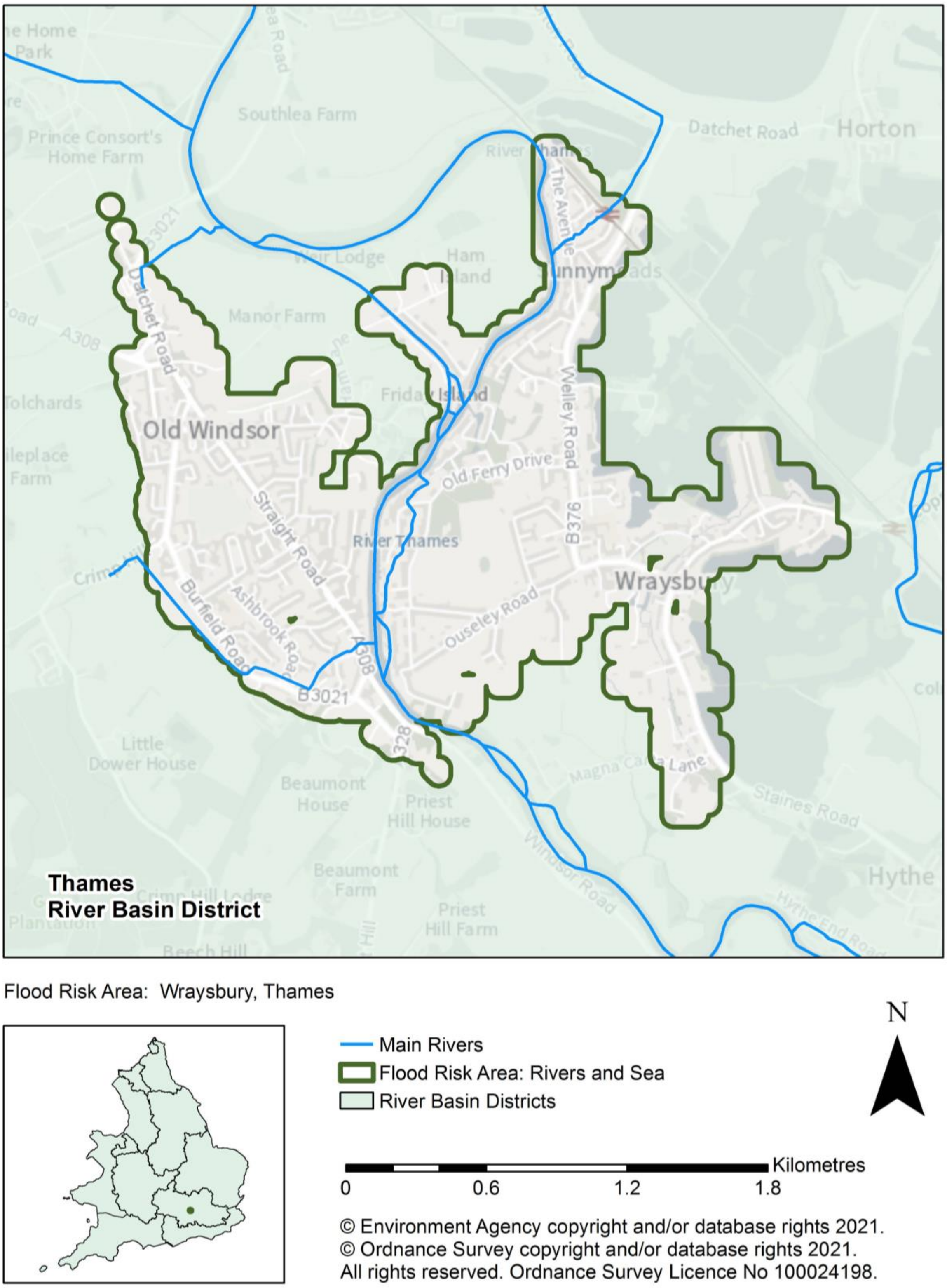


Figure 45: Map showing the Wraysbury Flood Risk Area Boundary and its location in England

The Wraysbury Rivers and Sea (RS) Flood Risk Area (FRA) Flood Risk Area (FRA) is in the South East of England, and in the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Wraysbury Rivers and Sea (RS) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

The Wraysbury RS FRA is located primarily within the Royal Borough of Windsor and Maidenhead. It spans across Old Windsor and large parts of Wraysbury. The River Thames divides the FRA and flows west to east. It is estimated that 6,840 people (90%) are at risk of flooding from a fluvial source, in addition to 187 non-residential properties.

There are Risk Management Authorities (RMA) operating in the Wraysbury RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Royal Borough of Windsor and Maidenhead
- Thames Regional Flood and Coastal Committee
- Two Highways Authorities: National Highways and Royal Borough of Windsor and Maidenhead (predominantly)
- Water and sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the FRA is strongly influenced by the River Thames. The River Thames flows in an easterly direction and divides the FRA through the middle.

The underlying geology is London Clay formation with the lowland floodplain of the River Thames characterised by a layer of Shepperton gravel. Because the porosity of clay is fairly low, within clay areas, this can result in slow infiltration rates and increased surface water run-off. Alluvium is present alongside the River Thames.

The FRA is mainly urban and surrounded by low lying open space.

Partnership working

The Environment Agency is working collaboratively with other RMAs and partners through the Maidenhead to Teddington Catchment Partnership hosted by Thames21. It is made up of a group of organisations who are working together through a Catchment Based Approach (CaBA) to better understand the catchment and develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

Current flood risk

The main flood risk in the Wraysbury FRA is from rivers including the River Thames, Datchet Common Brook and Burfield Road Ditch.

The River Thames is a major river that rises in the Cotswold hills near Cirencester and flows for 215 miles from its source to the sea. Datchet Common Brook originates as an open channel Ordinary Watercourse in Slough Borough flowing south. Whilst some parts of the brook have been culverted, it remains an open channel throughout the FRA where it discharges into the River Thames. Burfield Road Ditch is a tributary of the River Thames. It is partially culverted and discharges into the River Thames south of the FRA.

Many of the communities in the Wraysbury FRA have been affected by several major floods through the first half of the twentieth century, with a notably extreme event in 1947. A further large flood occurred in 1968 and more recently in 2003. In January and February 2014, the FRA experienced further prolonged and widespread flooding affecting many people, homes and businesses.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded is only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Wraysbury RS FRA 6,840 people (90%) live in areas at risk of flooding from main rivers. As well as people living within the floodplain, there are also services that have been built within FRAs. 25 (40%) services are in areas at risk of flooding from main river. Schools and sewage treatment works are examples of services.

Also shown to be at risk of flooding from main rivers in Wraysbury RS FRA:

- 187 out of 199 non-residential properties. A large proportion (40%) of non-residential properties are at medium risk
- all the railways with the majority (0.62 km) being at medium risk
- 96% of agricultural land

- one (100%) licensed abstraction which is shown to be at high risk of flooding
- the majority (91%) of listed buildings with them being shown at medium and low risk of flooding
- a large proportion (57%) of parks/garden is shown to be at low risk of flooding.
- all Ramsar (22.37 ha), Scheduled Ancient Monuments (19.7 ha), Special Protection Areas (22.37 ha) and Sites of Special Scientific interest (22.37 ha)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Wraysbury RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

Our priority is to maintain the existing conveyance of the rivers. This will be done through an annual programme of bank and in-channel weed clearance and the removal of obstructions. The Environment Agency maintains the Battlebourne raised embankment which helps reduce the impact of flooding to parts of the FRA (Old Windsor). Future funding will help guide investment where it is most needed. We will also continue to promote good riparian ownership.

The Environment Agency has been working with the Royal Borough of Windsor and Maidenhead as part of the Local Plan process to guide development across the borough. The Borough Local Plan 2013-2033 was adopted on the 8 February 2022.

The Environment Agency is part of the Thames Valley Local Resilience Forum. There is a Multi-Agency Flood Plan which comprises the seven unitary local authorities of Berkshire and Milton Keynes, as well as the county and district local authorities of Buckinghamshire and Oxfordshire. This area includes the River Thames catchment and associated tributaries plus part of the Great Ouse catchment which falls in the Milton Keynes area.

In addition, the Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3%

each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency's flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Due to the relatively long catchment response times associated with flooding from the River Thames, timely forewarning should be possible. This enables the Council, emergency services, residents and businesses to prepare to reduce the impact of a flood.

Whilst that is the case, large parts of the RS FRA currently do not have formal defences.

The River Thames Scheme Channel that was proposed for reducing flood risk within Royal Borough of Windsor and Maidenhead is not going forward. This follows a decision by the Sponsorship Group to not include it, as the Royal Borough of Windsor and Maidenhead was not able to commit to its contribution at this time.

Working together, the Royal Borough and the Environment Agency is looking into different options to try and reduce the flood risk to Wraysbury.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Wraysbury RS FRA

Measures have been developed which apply specifically to the Wraysbury RS FRA. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Wraysbury FRA.

You can find information about all the measures that apply to the Wraysbury FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Yalding Rivers and Sea Flood Risk Area

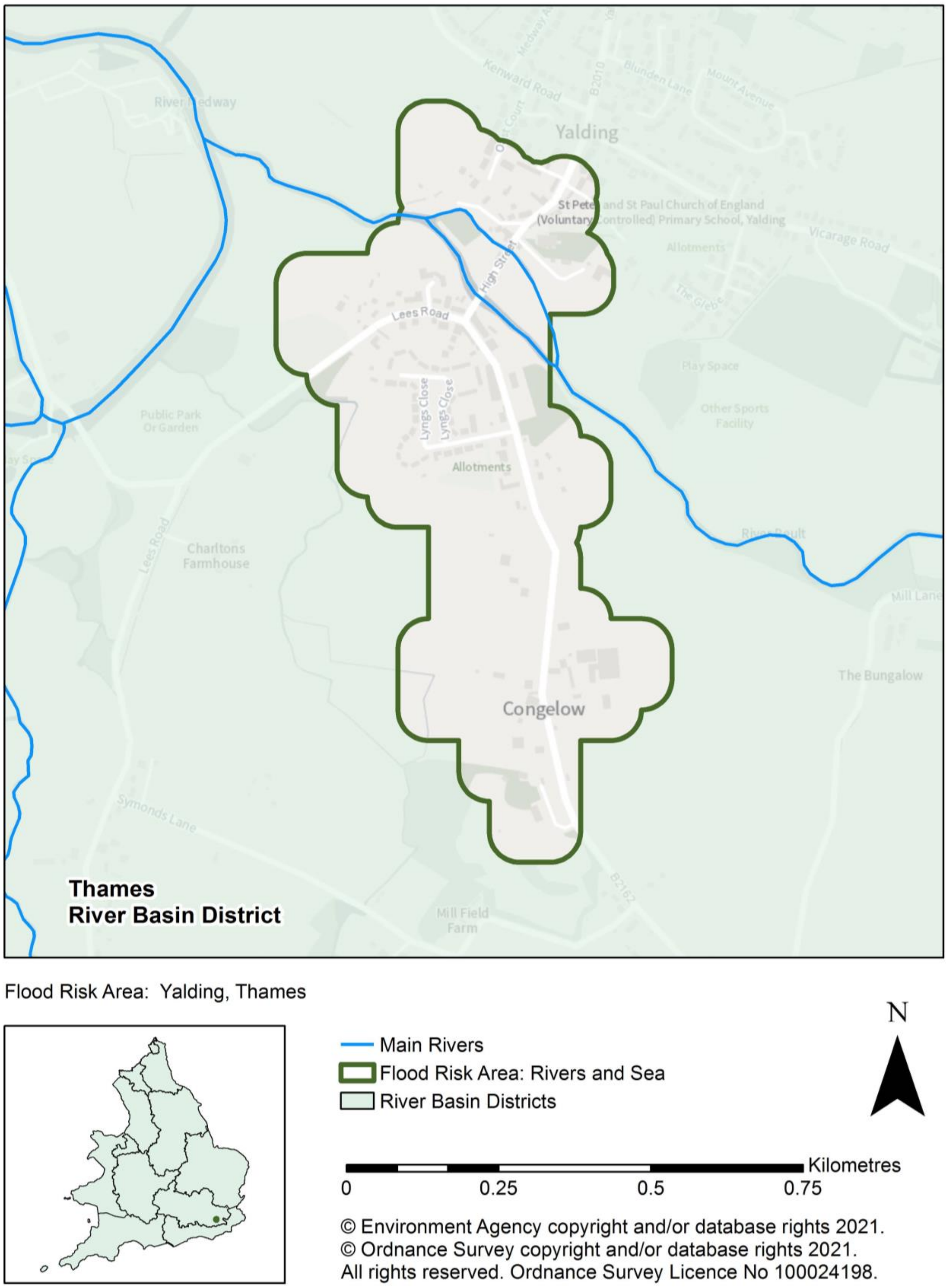


Figure 46: Map showing the Yalding Flood Risk Area Boundary and its location in England

The Yalding Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and in the centre of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Yalding Rivers and Sea (RS) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea.

There are Risk Management Authorities (RMAs) operating in Yalding RS FRA, including:

- Environment Agency
- Lead Local Flood Authority (LLFA): Kent County Council
- Unitary District/Borough Council: Maidstone Borough Council
- Regional Flood and Coastal Committees (RFCCs): Southern RFCC
- Two Highways Authorities: National Highways (manage major motorways), Kent County Council
- Water and Sewerage Company: Southern Water
- Department for Communities and Local Government through local planning authorities

Environment designations

The Yalding RS FRA covers the small village of Yalding in Kent and includes the communities of Laddingford, Hunton, and Benover. Yalding was originally a Saxon village. It is a rural environment due to its fruit farming industry with a mix of orchards, fruit production using polytunnels as well as some improved pastures. It was a good location for the farming industry due to its proximity to the river Medway for transporting fruit, providing easy shipping access to the sea. Historically, the area also had a strong iron industry due to being close to navigable channels for shipping goods to nearby villages such as cannons. A key characteristic of the village is the old Town Bridge which is the main crossing point over the river Beult.

In the Yalding RS FRA, there is one site with a special environment designation. The River Beult is of particular significance as, despite heavy modifications to its channel, 30km of its channel is designated as a SSSI. It is habitat to nationally scarce insects. It is at risk of pollution from agricultural runoff and is in poor ecological condition. Restoration of the channel to one of natural geomorphology will improve the ecological status as well as ‘slowing the flow’ and delaying the peak of the flood from reaching the Yalding FRA.

The full details for this designation can be found on the Defra MAGIC map database.

Topography, geology, hydrogeology, land use

The topography of the RS FRA is characterised by the Low Weald. This is an extensive, low lying area which historically has been used for hop growing. Hops were favoured in this area due to the regular flooding that maintained soil fertility and were not seriously impacted by flooding if it occurred during the growing season. Downstream of Yalding and the confluence of the three rivers, the Medway valley becomes narrow and steep sided, causing a bottleneck to flood flow.

The Medway rises in the Ashdown Forest area of Sussex. It flows west to east as far as Yalding, before turning north towards Maidstone and then into the estuary, joining the Thames estuary at Sheerness.

The Beult rises from the Lower Greensand aquifer south of Ashford, flowing east to west, joining the Medway at Yalding.

The Teise is the smallest of the three rivers and rises to the south in an area known as the High Weald.

Most of the properties at risk are in areas of 10 to 12 metres above ordnance datum (mAOD). Parts of the Medway catchment boundary rise to approximately 120 mAOD.

The underlying geology at Yalding, the Low Weald and most of the Beult catchment is Weald Clay. The northern flank of the Beult catchment is known as the Greensand Ridge and is underlain by iron rich limestone of the Hythe Beds formation. Parts of the Upper Medway and Teise catchment are low permeability sandstones of the Ashdown Formation.

Both the Hythe and Ashdown Beds are low permeability aquifers which provide springflow to the catchment. Neither provide significant risk of groundwater flooding in the catchment.

The Weald Clay which occupies much of the catchment has a high runoff potential, particularly during winter when soil moisture is high.

Watercourses

The Yalding RS FRA sits at the confluence of three principal watercourses: the Medway, Beult, and Teise.

All three watercourses are heavily modified across the Low Weald. Channels have been straightened and historically were subject to dredging which has led to steep sided incised channels. The FRA is at a confluence of these three rivers and occupies a wide floodplain.

The Medway is navigable downstream from Tonbridge and so levels are maintained artificially by a series of locks.

The Teise also has weirs and sluice gates that were installed to manage river levels for agricultural purposes. Changing agricultural practices means most of these structures are now redundant.

A few properties within Yalding village are also at risk from overland flow and surface water flooding.

All three rivers respond at different rates and flood events can last several days. As the community is at the lower end of the Middle Medway flood risk management area, a considerable period of flood warning is normally available.

The Medway catchment, including the Beult and Teise, covers an area of 1,386km2, most of which drains through Yalding. The main flood management structure is the Leigh Flood Storage area located upstream from Tonbridge. This was primarily designed to reduce flood risk from the Medway to Tonbridge Town Centre and, due to inflows from other tributaries downstream from Tonbridge, the benefit of the Leigh Flood Storage Area reduces with distance downstream.

Flows in the Medway increase downstream from Tonbridge due to inflows from other tributaries such as the River Bourne, Somerhill Stream and Alder Stream.

Records of flood incidents in the Yalding area go back many decades with flood events occurring in the 1920s, 1933, 1947, 1958, 1960s (1960, 1963, 1968), 1970s (1974, 1979), 1999, 2000, 2002/03, 2013, 2019/20.

Current flood risk

The main source of flood risk within the Yalding RS FRA is from main rivers.

Description of Risk Statistics

The information below has been calculated using Flood Risk and Hazard maps.

These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment which could have an impact at local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRAs. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood hazard and risk maps show that in the Yalding RS FRA some 483 (88.3%) people live in areas at risk of flooding from main rivers. The flood hazards and risk maps show an estimated 547 people living within the Yalding RS FRA. Of those in the area, 483 (88.3%) are at risk of flooding from fluvial sources.

Also at risk of fluvial flooding within the Yalding RS FRA include:

- 1 service (25%)
- 11 non-residential properties (92%)
- 39.37 hectares of agricultural land (93%)
- natural environment: 0.52 hectares of Sites of Special Scientific Interest (100%)
- historic environment: 0.013 hectares of Scheduled Ancient Monument (100%) and 33 listed buildings (66%)
- 1 licensed water abstraction site (100%)

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

Taking further action to reduce risk will require an additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

Surface water flood risk

Surface water flooding occurs when heavy rainfall cannot soak into the ground or exceeds the capacity of local drainage networks and water flows over ground. Due to the complex nature of these factors, surface water flooding can be very difficult to predict and gauge precise locations for the flood risk. A small area is at risk from surface water, which runs off the Greensand Ridge on the northern boundary of the area. This is an arable area and so can also deposit large amounts of silt onto roads and into properties.

The flow routes are normally aligned to very minor spring fed watercourses that stem from the Greensand Ridge.

Groundwater flood risk

Both the Hythe and Ashdown Beds are low permeability aquifers which provide spring flow to the catchment. Neither provide significant risk of groundwater flooding in the catchment.

How the risk is currently managed

Fluvial flood risk within the Yalding RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

The Flood and Water Management Act 2010 requires risk management authorities to work together to manage flood risk. The Environment Agency lead on the management of risks of flooding from fluvial and tidal sources and have a 24/7 incident response team ready to proactively monitor, prepare for, and inform the public of main river and tidal flooding. The

Environment Agency work in partnership with the Met Office to provide flood forecasts and flood alerts and warnings.

There are multiple hydrometric monitoring sites across the fluvial watercourses which inform the Environment Agency incident response team on when to issue flood alerts and warnings. There are multiple Flood Alerts and Flood Warnings to cover the entire Yalding FRA too. Please visit the flood warning information service to view the monitoring sites close to your area.

The community has a Flood Plan and some residents can help with deploying sandbags and Property Flood Resilience (PFR) to residents in need of assistance.

The Parish Council leads a Community Flood Group to implement the community flood plan when required with support from the Environment Agency and partners.

Fluvial flood risk is currently managed through the Medway Flood Plan. There are three themes:

- Capital Investment & Maintenance
- Natural Flood Management
- Community Resilience

All properties at very significant risk or that could provide evidence of previous flooding were eligible to receive property flood resilience measures. The Environment Agency delivered measures to over 90 properties in the area. Residents who accepted the measures are now able to use them on receipt of a Flood Warning message.

Natural flood management (NFM) is led by Natural England and the South East Rivers Trust. The greatest benefit is considered to be derived by concentrating efforts in the headwaters of the smaller, rapidly responding tributaries. NFM work has been completed on the Alder Stream upstream of Five Oak Green and the Hoggs Stream upstream of Headcorn. It is recognised that the benefit to the Yalding FRA is small given its location at the confluence of three large catchments.

Community Resilience is led by Kent County Council. They have engaged with the local communities, and as part of community flood plans, have measures in place to enable the Parish to implement road closures. This restricts vehicles entering flood water and creating bow waves into properties. The Environment Agency also delivers sandbags to the community when the likelihood of flooding is high as part of the Medway Flood Operational Plan. The cost of the deployment is met by partners.

The Environment Agency also works collaboratively with Kent County Council, Maidstone Borough Council and local communities under the Medway Flood Partnership. The focus is to improve flood management from all sources within the Middle Medway area.

Further information can be found in the Medway Flood Action Plan and the Medway Catchment Flood Management Plan.

Flood defences

There are no formal flood defences for this area. The main flood management structure on the Medway is the Leigh Flood Storage Area (LFSA) located upstream from Tonbridge. This was designed to reduce flood risk to Tonbridge and the level of benefit reduces with distance downstream. Other options specific to Yalding were investigated but none proved to be technically feasible, apart from the Property Flood Resilience (PFR) option which was delivered to eligible properties in 2019/20.

An area of meadow named The Lees is situated between Yalding village and the River Medway. This area floods during most winters and is an important area of floodplain storage that provides the community with time to prepare for the onset of flooding.

Hydraulic modelling

The Medway Model incorporating the Beult and Teise is a 2-D hydrodynamic model completed in 2015. It includes scenarios whereby peak flows during the 100Yr return period event are increased by 35% and 70%, which are two more likely scenarios estimated for the Thames River Basin area.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Yalding RS FRA

Measures have been developed which apply specifically to the Yalding RS FRA. The measures created as part of the Flood Risk Management Plans are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Yalding FRA.

You can find information about all the measures that apply to the Yalding FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Yateley Rivers and Sea Flood Risk Area

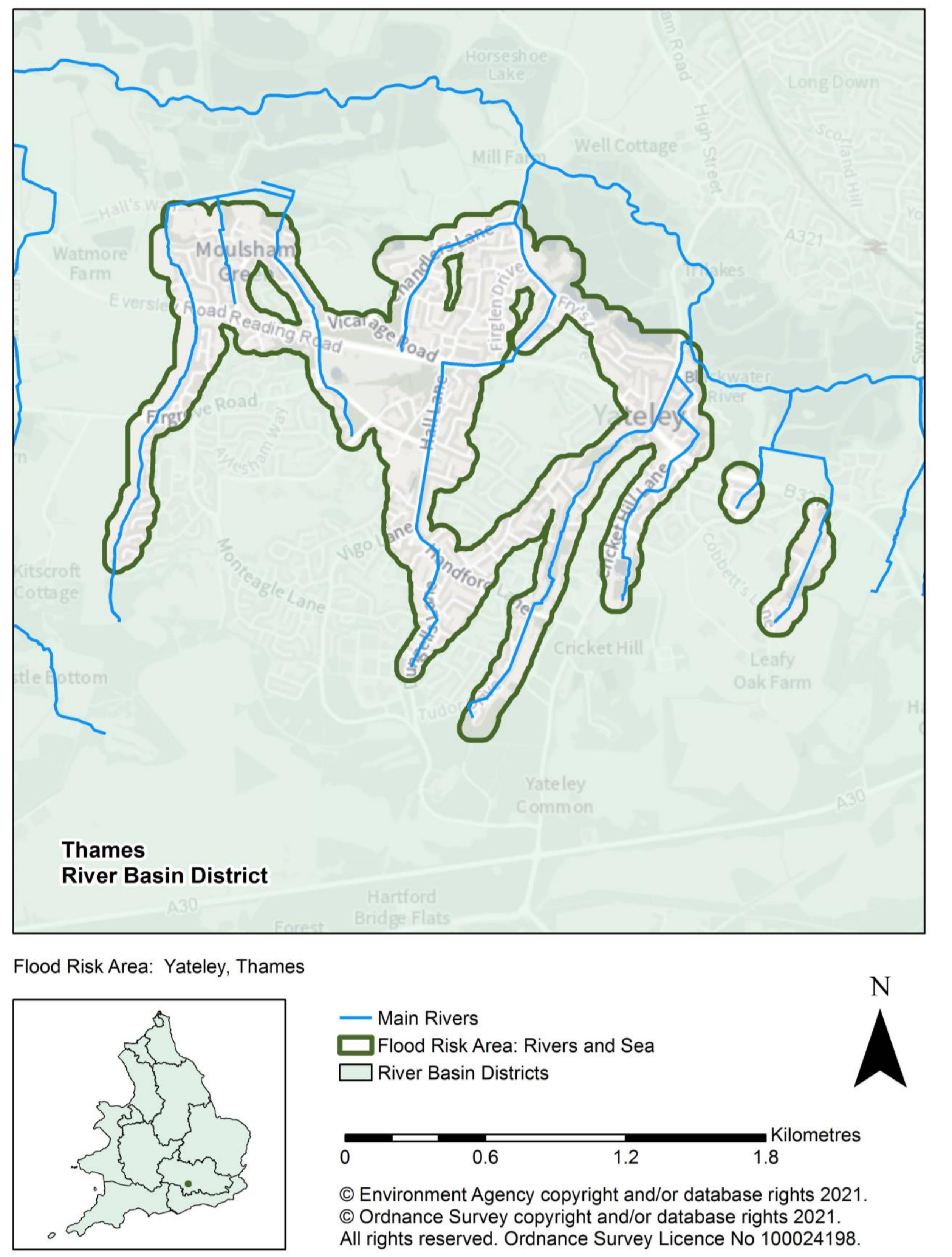


Figure 47: Map showing the Yateley Flood Risk Area Boundary and its location in England

The Yateley Rivers and Sea (RS) Flood Risk Area (FRA) is in the South East of England, and to the west of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It has been identified as a FRA because the risk of flooding from main rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Yateley Rivers and Sea (RS) FRA was not identified in 2011 for the first cycle of Flood Risk Management Plans (FRMPs).

The Environment Agency leads on the development and delivery of the FRMP for this FRA as the responsible authority for managing flood risk from main rivers and the sea. The Yateley RS FRA covers parts of Hampshire County Council.

There are Risk Management Authorities (RMAs) operating in Yateley RS FRA, including:

- Environment Agency
- LLFA: Hampshire County Council
- District councils: Hart District Council
- Regional Flood and Coastal Committee: Thames
- Highways Authorities: National Highways, Hampshire County Council
- Water and sewerage company: South East Water (water), Thames Water (sewerage)
- Department of Communities and Local Government through local planning authorities

Topography, geology, hydrogeology, land use

The topography of the Yateley RS FRA is relatively flat; most of the area lies 60 metres above ordnance datum (mAOD) and 70 mAOD. The topography of the area slopes upwards to the south-west of Yateley.

The underlying geology is sedimentary bedrock from the Windlesham Formation (sand, silt and clay) with superficial River Terrace Deposits (sand and gravel) in localised areas.

Because the porosity of clay is low, within clay area, this can result in slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

The Yateley RS FRA is located within the Blackwater (Hawley to Whitewater confluence at Bramshill) Water Framework Directive catchment.

The upstream Water Framework Directive catchments are Cove Brook and Blackwater (Aldershot to Cove Brook confluence at Hawley). The downstream Water Framework Directive catchment is Blackwater (Bramshill to River Loddon at Swallowfield).

The Yateley RS FRA is urban with a low proportion of arable land. The key urban area is Yateley town.

Partnership working

The Environment Agency is working collaboratively with other RMAs and partners through the Loddon Catchment partnership, hosted by the South East Rivers Trust, to better understand the catchment and to develop joint plans to improve the health of the local water environment. A better understanding of the catchment and the ideas and commitment of our partners means that we can be confident that together we can resolve the identified issues.

The priorities in this RS FRA include creating a ‘healthy, functioning and wildlife rich aquatic environment within the River Loddon Catchment, valued and cared for by everyone now and in the future’.

Current flood risk

The primary source of flood risk in the Yateley RS FRA is from Blackwater River which flows to the north of Yateley. Yateley town is located within the floodplain of Blackwater River and its tributaries, the largest being Castle Bottom Stream. This is a small and fast responding catchment with likely surface water and fluvial interaction. Some areas within the Yateley RS FRA are also at risk from other sources, including surface water.

The Blackwater River has its source to the west of Aldershot in Hampshire. The Blackwater River initially flows in an easterly direction towards the A331 before turning to flow in a northerly direction through Farnborough, Frimley, Blackwater and into Yateley. It then flows in a north-westerly direction through a mostly rural setting towards Swallowfield where it has its confluence with the River Loddon. The Blackwater River is mostly open channel through the FRA and is not designated as artificial or heavily modified.

Blackwater River has several tributaries which flow through the FRA. Most of the tributaries have their source in the Thames Basin Heaths flowing in a northerly direction through Yateley and have their confluence with Blackwater River north of Yateley.

Historically, the Yateley RS FRA has been impacted several times by fluvial flood events from the River Blackwater and its tributaries. Most recently, it was impacted by flooding in 2015.

Fluvial flood risk - description of risk statistics

The information below has been calculated using [Flood Risk and Hazard maps](). These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the FRA. Residential streets which would also be at risk of flooding are not included in the assessment. This could have an impact at a local and wider level. The length of the road or railway that is flooded provides only part of the consideration of flood risk to transport networks. The duration of flooding also needs to be considered as this will determine the length of time during which routes or services could be expected to be closed or restricted. The flood risks can be viewed on a mapping tool which shows the potential risk and impacts of flooding in the FRA. This data is static, with the information derived using existing data and risk assessment information compiled within the preliminary flood risk assessments (PFRAs) and published in December 2019.

The flood risk maps show that in the Yateley RS FRA 1,996 people (30.8%) live in areas at risk of flooding from main rivers. One service (2.4%) is in an area at risk of flooding from main rivers.

Also shown to be at risk of flooding from main rivers in the Yately RS FRA are:

- 70 (52.7%) non-residential properties
- 3.77ha (25.8%) of agricultural land
- 3 out of 10 listed buildings

Conclusions based on risk statistics

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA. An example of this is the Thames Valley Flood Scheme. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

How the risk is currently managed

Fluvial flood risk within the Yateley RS FRA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems, and flood risk modelling.

The Environment Agency is working in partnership including with Hampshire County Council to commission an update to the hydraulic model in Blackwater catchment (Aldershot to Swallowfield) to refine our understanding of how the area floods to inform future flood alleviation measures and spatial planning in Yateley. This modelling would include a consideration of the updated climate change allowances.

The Environment Agency is also working in partnership with Hampshire County Council to progress appraisal of preferred options of the North Yateley flood alleviation scheme.

The Environment Agency is part of the Hampshire and Isle of Wight Local Resilience Forum. There is a Multi-Agency Flood Plan (MAFP) which covers the FRA.

The Environment Agency uses flood modelling to understand the risk of flooding at a local and a national level. We are constantly reviewing our local modelling programme to ensure our flood models use a range of information including various climate change scenarios to help make them as reliable as possible.

The Environment Agency has temporary flood barrier plans in place nationwide. Temporary flood barriers offer a practical method of reducing the impact of flooding during smaller/more frequent floods, for instance in areas with a chance of flooding of up to 3.3% each year. Our ability to forecast flooding and/or the availability of such barriers at national level may hinder our ability to deploy the barriers.

The Environment Agency's flood warning and alert service is available in all parts of the FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Yateley RS FRA

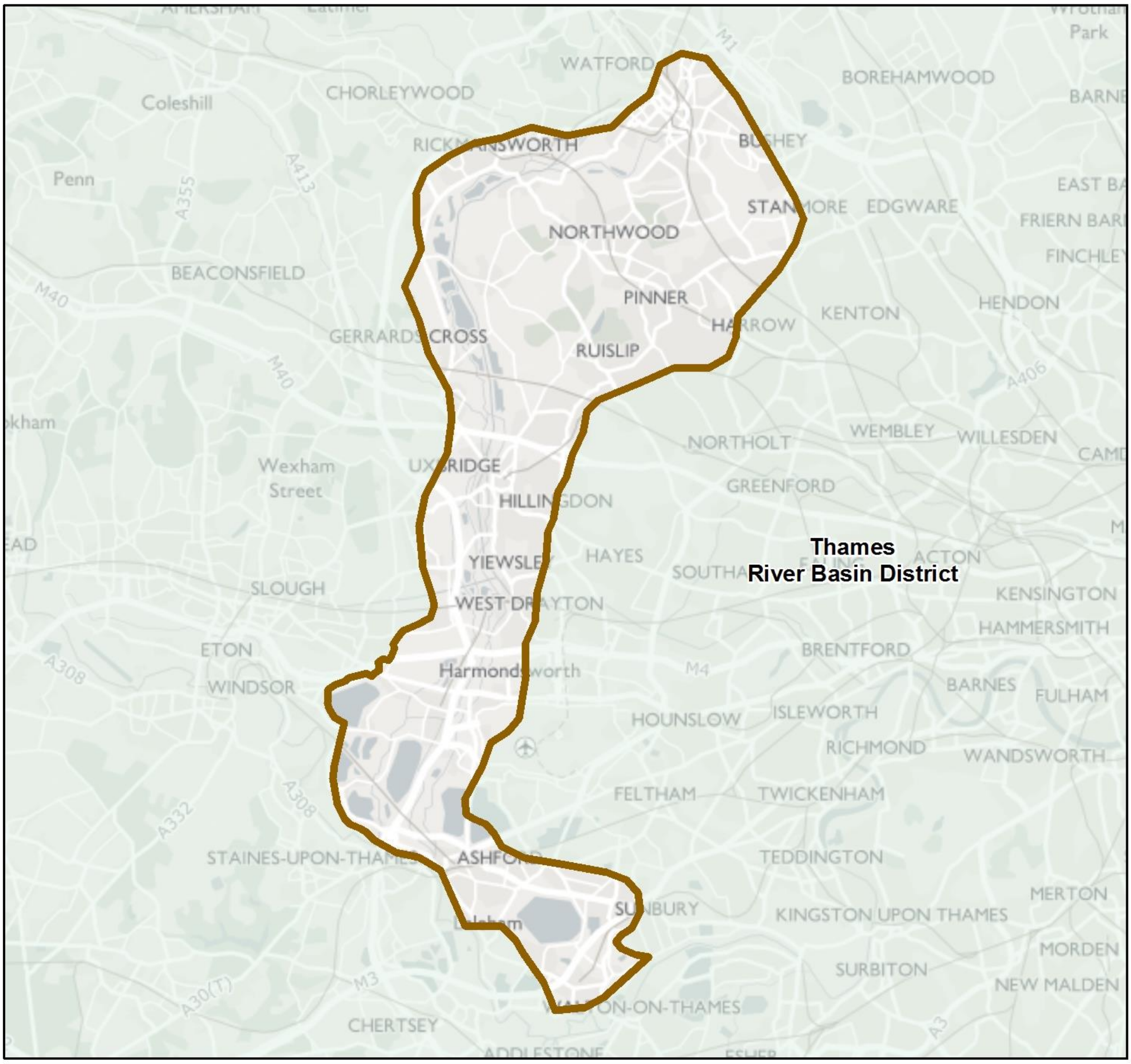
Measures have been developed which apply specifically to the Yateley FRA. The measures created as part of the FRMPs are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc. These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Yateley FRAs.

You can find information about all the measures that apply to the Yateley FRA in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

Strategic Area level objectives and measures

There are also 25 measures applicable to managing flood risk in the Strategic Areas in the Thames RBD. This is 4.6% of the total numbers of measures in this FRMP.

The Colne Valley Rivers and Sea Strategic Area



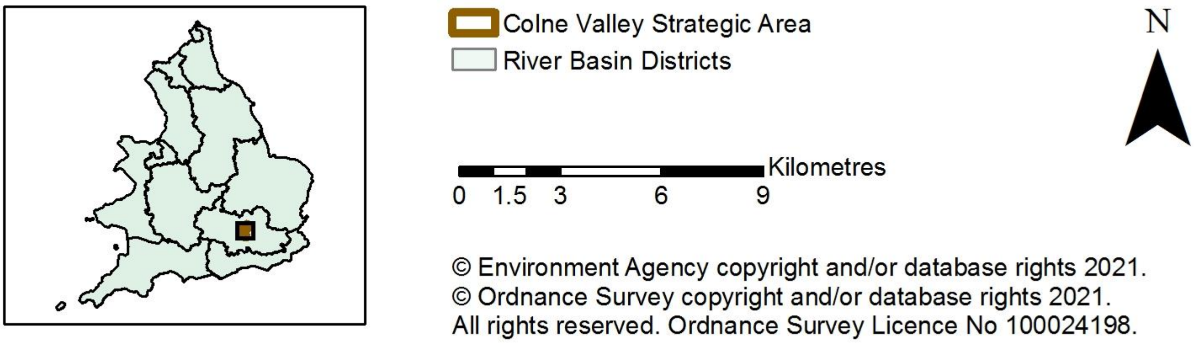


Figure 48: Map showing the Colne Valley Strategic Area Boundary and its location in England

The Colne Valley Rivers and Sea (RS) Strategic Area (SA) is in the South East of England, and to the east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It was identified based on a method created by the Hertfordshire and North London (HNL) Environment Agency area team.

This is a different approach than what was used during the first cycle of the Flood Risk Management Plans (FRMPs). The Colne Valley Strategic Area was defined using a spatial analysis buffer on the main rivers.

Stretches of river were included based on the locations of the following data sets:

- flood zones, urban areas
- EA communities at risk
- development pressure (based on planning and permitting applications)
- capital projects pipeline
- natural flood management opportunities
- neighbourhood flood vulnerability
- social flood risk indexes

The Colne Valley Rivers and Sea Strategic Area covers sections of the River Colne and its tributaries from Watford in the north to Spelthorne in the south. This is an area of significant fluvial flood risk, especially in the urban areas along the river network. Factors that contribute to the strategic importance of this area include the high rates of development occurring along the river system, planned large infrastructure projects, flood alleviation projects along the River Pinn, and the importance of managing risk along the River Colne and tributaries to alleviate and avoid exacerbating flood risk issues in the River Thames catchment.

The Colne Valley RS SA sits within council areas which the Environment Agency is working with. The Environment Agency is the responsible Risk Management Authority (RMA) for this SA and will take the lead on the development and delivery of the FRMP measures for this SA.

The Environment Agency works collaboratively with partners and communities to improve the water environment as RMAs. Please refer to the Thames River Basin section of this FRMP for more information.

There are Risk Management Authorities running in Colne Valley RS SA, including:

- Environment Agency
- Seven Lead Local Flood Authorities: Hertfordshire County, London Borough, Harrow, London Borough Hillingdon, Surrey County Council, Windsor and Maidenhead Borough Council, Slough Borough Council, Buckinghamshire County Council
- Seven District Councils/Boroughs: Hertsmere District Council, Watford District Council, Three Rivers District council, Spelthorne District Council, London Borough Hillingdon, London Borough Harrow and Windsor and Maidenhead Borough Council

- Regional Flood and Coastal Committee (RFCC): Thames RFCC
- Five Highways Authorities: Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980) alongside Hertfordshire, Surrey and Buckinghamshire Highways Agencies for the surrounding areas within the SA. National Highways manage major motor ways, like the M40 and M25.
- Water and Sewerage Company: Thames Water
- Department of Communities and Local Government through local planning authorities

Growth and development

Growth and development within the Colne Valley RS SA is expected to be high, which if not planned carefully could place more pressures on water management and flood risk. However, development could also create opportunities to reduce flood risk and minimise vulnerability to climate change. Population growth is one of the drivers for housing need. The London Boroughs of Harrow and Hillingdon and Spellthorne District Council cover most of the geographic area for this SA. Collectively the Office of National Statistics estimated the mid-2019 population in these three districts as 657,874, and the projected population by 2035 is estimated to be 676,030, an increase of 18,156. These figures are an under-estimate for the SA, as there are small areas of Three Rivers District Council, Watford, and Hertsmere to the north and Windsor and Maidenhead to the south-west of the SA.

The London Plan (2021) sets ambitious housing targets for all the London Boroughs. Hillingdon and Harrow boroughs collective housing target for the 10 years up to 2028/29 is 18,850. Boroughs are required to incorporate these housing targets when preparing Local Plans. Spelthorne District Council are preparing a Local Plan which currently seeks to deliver 9,057 new homes up to 2037. There are major development schemes within this SA including strategic infrastructure, such as High Speed 2 (HS2) Rail Link and the Heathrow Airport Expansion. These will impact the nature of the area and how flood events behave and there are opportunities to improve flood risk through these schemes.

Environmental designations

Across the Colne Valley RS SA, there are special environmental designation areas, which include about 14 Sites of Special Scientific Interest (SSSI) and a handful of Special Areas of Conservation (SAC) and Local Nature Reserves (LNR). The full detail of these designations can be found on the Defra MAGIC Database.

Topography, geology, hydrogeology, land use

The Colne Valley RS SA has a mixture of both rural and urban areas; a medley of farmland, woodland and water with 200 km of rivers, canals and lakes as well as a mix of bustling towns, green spaces and waterways immediately west of London. It has a unique collection of watercourses, ranging from internationally rare chalk streams in the north to canals, rivers and lakes, which have been heavily influenced by gravel extraction and urban development in the south. The north of the SA is much more rural and extends south via a significant green corridor, including the Colne Valley Park, where rivers connect to the urban populations of north-west London. The Park covers 40 square miles. However, as the River Colne travels south towards its confluence with the River Thames, the area becomes built up and urban. Key urban areas include Watford, Rickmansworth, Pinner, Ruislip, Uxbridge, Hillingdon, West Drayton, and the M25 corridor to the west of Heathrow Airport.

As well as the River Colne, this SA includes:

- the Grand Union Canal
- a series of Lakes and two main tributaries
- the River Ash in Staines, which connects the lower reaches of the River Colne with the River Thames in Shepperton
- the River Pinn, which flows through the urban areas of Harrow and Hillingdon before joining the River Fray - a larger tributary of the River Colne in Yiewsley

The topography of the SA is strongly influenced by its location in the river valley. The River Colne rises in the Vale of St Albans, is fed by tributaries flowing from the Chilterns, and is a major tributary of the River Thames.

The floodplain area is mostly wide and flat and upstream tributaries are groundwater fed. At its highest point, the elevation within the SA is about 120 metres above ordnance datum (mAOD) at Oxhey Woods Nature Reserve. However, in the north of the SA there are some fluctuations in height: Rickmansworth, Watford, and Ruislip all sit around 45-60 mAOD. As the River Colne travels south towards the River Thames, the gradient of the land descends to about 15 mAOD. The topography of the land is one constraint to flow as the river travels from north to south, however in more urban and built-up areas, the river is constrained heavily by modifications, and this can impact the velocity of flows through the watercourse.

The underlying geology changes as you travel from north to south in the Colne Valley RS SA. In the northern region, in areas like Watford, the underlying geology is chalk. As you travel south, the underlying geology becomes clay. The clay formation begins at Rickmansworth; therefore, most of the SA has clay bedrock. However, as you travel south towards the River Thames, gravels can impact the behaviour of how water flows through the underlying geology.

Due to the low porosity of clay, infiltration rates are slow, which can result in increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding. Within chalk, sands and gravels, water can infiltrate quickly and move within and through these rocks. These areas become part of the major groundwater resources of the Thames River Basin. Water flows more slowly through the aquifers and is released at a slow rate into the rivers. Therefore, the impact of a heavy rainfall event can be delayed.

Partnership working

Across the SA, the characteristics of the river vary considerably. The northern section of this SA is a mixture of rural and urban areas as the river flows through Watford and towards north-west London. The way the river is perceived by local people, and the value they place on it, varies widely across the catchment. This is highlighted through local groups like the Colne Catchment Action Network, which is working to design and deliver the Watford 'Rediscovering the River Colne Plan'.

The priorities of this action group are to develop plans to improve the health of the local water environment and gain Water Framework Directive status improvement through using the catchment approach to enhance and expand the floodplain.

This chapter specifically focuses on a section of the River Colne and its tributaries as it travels south towards the River Thames. It is worth noting that it may be beneficial to read this chapter in conjunction with other sections of this FRMP including the London and Thames Estuary Rivers and Sea Flood Risk Area and the Greater London Surface Water Flood Risk Area, for information on risk from other sources.

Current flood risk

The main source of flood risk within this SA is from Rivers and Sea (RS). This can be referred to as 'fluvial' and tidal flooding. However, the Colne Valley is also impacted by surface water, groundwater and sewer flood risk. Therefore, this section will mainly focus on the fluvial risk within the SA but will also consider other sources of flooding.

Fluvial flood risk

The Colne Valley RS SA consists of the River Colne and its tributaries, focusing mainly on the River Ash and the River Pinn. Gradient is an important factor in determining the hydrological response and in steeper catchments water levels can rise quickly after rainfall, with little advanced warning. The River Colne and a lot of its tributaries behave in the same way, due to the heavily modified channels and urban locations.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SA.

The risk is presented in flood risk likelihood categories. They indicate the chance of flooding in any given year. Risk levels are defined below:

- 'high risk' means that each year an area has a chance of flooding of greater than 3.3%
- 'medium risk' means that each year an area has a chance of flooding between 1% and 3.3%

- ‘low risk’ means that each year an area has a chance of flooding of between 0.1% and 1%
- ‘very low risk’ means that each year an area has a chance of flooding of less than 0.1%

Table 17: summary of river and sea flood risk to people in the Colne Valley SA

Risk to people	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of people in SA	338,422	2,479	14,173	24,511	2,816
Number of services	2,728	27	144	206	35

Table 18: summary of river and sea flood risk to economic activity in the Colne Valley SA

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	13,687	359	982	947	229
Number of airports	1.0	1.0	0.0	0.0	0.0
Length of road (kilometres (km))	68.0	1.5	4.9	6.0	0.0
Length of railway (km)	72.0	1.8	3.5	3.7	0.6
Agricultural land (hectares (ha))	5071.6	404.0	326.8	190.4	39.4

One of the aims of this FRMP is to monitor large infrastructure schemes as a part of the measures the Environment Agency have created to ensure no deterioration is created by the changing land uses.

Table 19: summary of river and sea flood risk to the natural and historic environment in the Colne Valley SA

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of EU designated bathing waters within 50 metres (m)	0	0	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	12	2	1	1	1
Area of Special Area of Conservation (SAC) within area (ha)	0	0	0	0	0
Area of Special Protection Area (SPA) within area (ha)	525.1	113.0	4.0	0.9	0.1
Area of Ramsar site within area (ha)	525.1	113.0	4.0	0.9	0.1
Area of World Heritage Site within area (ha)	0.0	0.0	0.0	0.0	0.0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	1275.3	331.1	85.2	42.5	5.1
Area of parks and gardens within area (ha)	199.1	0.5	0.5	0.6	0.0
Area of scheduled ancient monument within area (ha)	24.8	0.5	2.9	2.2	0.3
Number of listed buildings within area	805.0	18.0	37.0	22.0	13.0
Number of licensed water abstractions within the area	110.0	25.0	4.0	15.0	3.0

Flooding within the Colne Valley SA is a complex system with many differing factors impacting the flood risk. There are 43,979 people living in the Colne Valley SA at risk from flooding from rivers and sea. Based on this information, it is concluded that the Environment Agency should take further action to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment, both now and in the future. The measures the Environment Agency have created within this FRMP aim to mitigate and alleviate this risk.

How the risk is currently managed

Fluvial flood risk within the Colne Valley RS SA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

In general, options to reduce the probability of flooding to these areas are constrained by previous channel alterations and lack of open space within the urban floodplain. Long-term planning actions are intended to restore some opportunities to reduce the probability of flooding as well as reduce its consequences by increasing the resilience of the urban environment.

Development

Redevelopment rates in some areas are very high and offer the opportunity to reduce the risk and the current reliance on flood defences. This includes making the urban environment more resilient and with a layout that offers more options for managing future flood risk and the impacts of climate change.

Under the National Planning Policy Framework, Local Planning Authorities are required to take a proactive approach to flood risk and climate change when planning strategically for their development needs. Prioritising the allocation of land in areas of lowest flood risk, before considering areas with higher levels of risk is one of the requirements of national policy. This can reduce the future risk of flooding and vulnerability to climate change and also minimise the potential future costs of flood alleviation and flood defence maintenance. Where, by exception, some development in areas of higher flood risk is necessary, Local Planning Authorities should outline in planning policies the standards expected to fully mitigate the risks. They should aim to achieve a reduction in flood risk ensuring that developments will be safe and there is no increase in flood risk elsewhere. In addition, policies should make provision for the possible future relocation of vulnerable development and infrastructure out of areas of increasing flood risk.

Flood defences

There are several important flood defences located with this SA, including managed river channels, river walls and raised embankments and culverted sections of main river. During a detailed assessment of assets along the Colne Valley, it was agreed that hard engineering flood defences can only be used as a part of the solution to mitigate flood risk. The Environment Agency is working in partnership to investigate options to reduce flood risk at a catchment scale across the Thames Valley. This approach will help to manage the increasing impacts of climate change, as well as protect communities and business that remain at risk.

Flood warning and community preparedness

The Environment Agency's flood warning and alert service is available for all parts of the SA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. Some of these areas are susceptible to rapid flooding from storm events. Emergency response and flood awareness are particularly important within this SA.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Colne Valley Rivers and Sea Strategic Area

Measures have been developed which apply specifically to the Colne Valley Strategic Area. The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc.

These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Colne Valley Strategic Area.

You can find information about all the measures that apply to the Colne Valley Strategic Area in the interactive mapping tool - Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Middle Lee Rivers and Sea Strategic Area

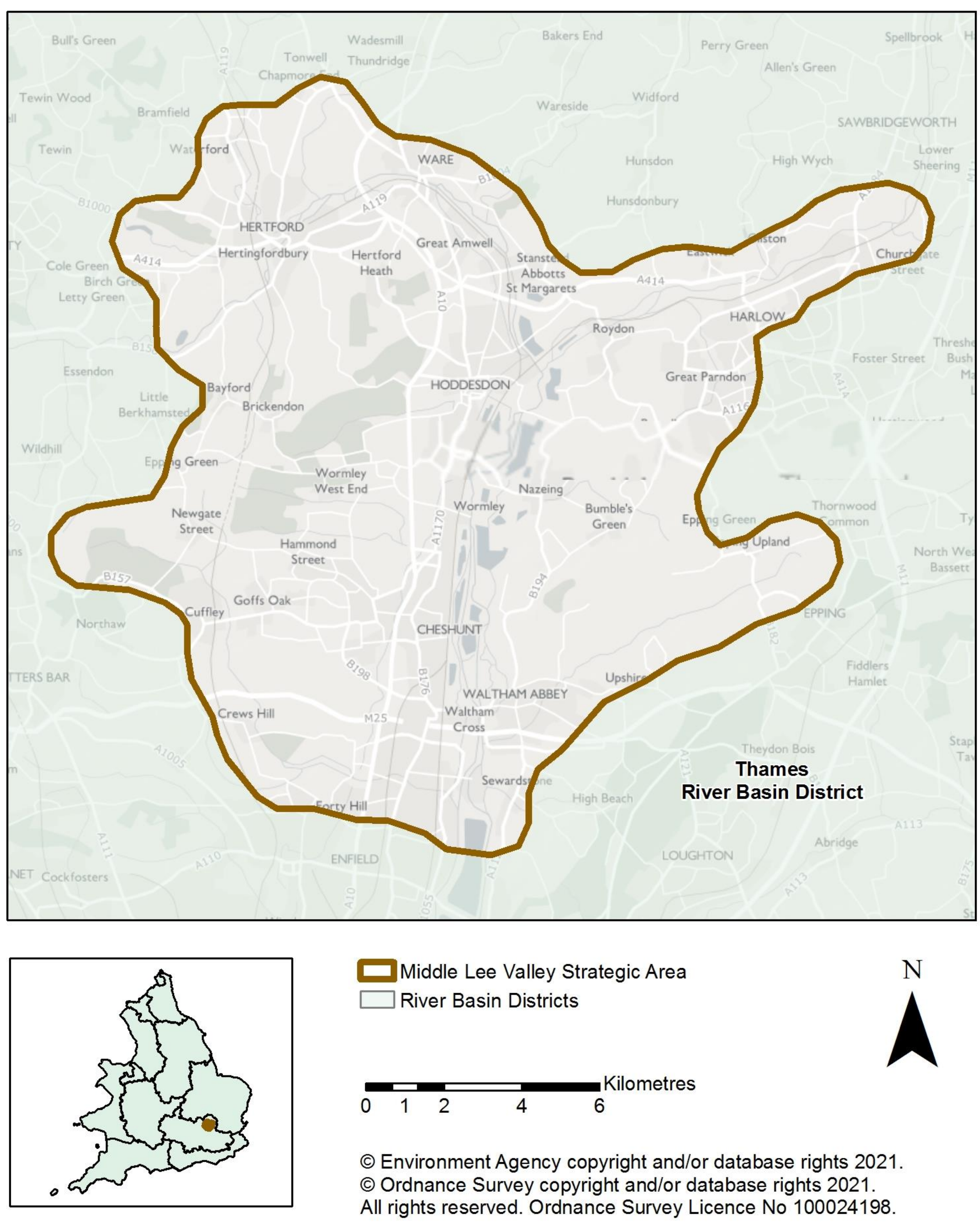


Figure 49: Map showing the Middle Lee Strategic Area Boundary and its location in England

The Middle Lee Valley Rivers and Sea (RS) Strategic Area (SA) is in the South East of England, and to the east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It falls within the Hertfordshire and North London Environment Agency area.

This is a different approach than what was used during the first cycle of the Flood Risk Management Plans (FRMPs). The Middle Lee Valley Strategic Area was defined using a spatial analysis buffer on the main rivers. Stretches of river were included based on the locations of the following data sets:

- flood zones, urban areas
- EA communities at risk
- development pressure (based on planning and permitting applications)
- capital projects pipeline
- natural flood management opportunities
- neighbourhood flood vulnerability
- social flood risk indexes

The Middle Lee Valley Rivers and Sea Strategic Area covers sections of the Upper Lee and Lower Lee Navigation Channel and the Lee tributaries, including the Stort, Mimram, Beane. This is an area of significant fluvial flood risk, especially in the urban areas along the river network. Factors that contribute to the strategic importance of this area include the high rates of development occurring along the river system, high number of people living at risk within the area, potential for national flood management and flood storage areas within the upper reaches of the catchment, and the importance of managing flood risk and water along the River Lee tributaries to alleviate and avoid exacerbating flood risk in the main channels and more urban Lower Lee. Interventions in the Middle Lee and Stort will have an impact on flood risk downstream and need to be considered alongside managing the risk locally.

The Environment Agency is the lead risk management authority (RMA) responsible for this SA. The Middle Lee Valley RS SA is mostly agricultural land and protected green belt with some dispersed urban areas, including Hertford, Ware, Bishops Stortford, and Harlow.

Despite heavy modifications to the Lee channels in the southern part of this SA, some of the Lee floodplain and the floodplains of its tributaries in the northern part of this SA include areas of national environmental importance.

The Environment Agency works collaboratively with partners and communities to improve the water environment as RMAs. Please refer to the Thames River Basin section of this FRMP for more information.

There are Risk Management Authorities operating in the Middle Lee Valley RS SA, including:

- Environment Agency
- Three Lead Local Flood Authorities: Hertfordshire County Council, Essex County Council, London Borough of Enfield

- Six District Councils/ Boroughs: East Hertfordshire District, Harlow District, Epping Forest District, Broxbourne District, Welwyn Hatfield District and London Borough of Enfield
- Regional Flood and Coastal Committee (RFCC): Thames RFCC
- Three Highways Authorities: Transport for London manages the TfL Road Network (or 'red routes') Hertfordshire County Council and National Highways manage major motor ways, like the M25
- Water and Sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Growth and development

Growth and development within this SA is expected to be high, which if not planned carefully, could place additional pressures on water management and flood risk. However, development could also create opportunities to reduce flood risk and minimise vulnerability to climate change. With the exception of Broxbourne, only a proportion of the geographical area of these district councils overlaps with the FRA, so this needs to be borne in mind when considering population and growth statistics below.

Population growth is one of the drivers for housing need. The mid-2019 population estimate for the five district councils (East Hertfordshire District, Harlow District, Epping Forest District, Broxbourne District and Welwyn Hatfield District) was 588, 826. By 2035, the population is projected to be 618,542, an increase of 29,716 people.

Looking at recently adopted or soon to be adopted Local Plans, collectively, these six district councils are planning to deliver approximately 71,236 new homes and provide 120,300 sq. m of new retail/commercial leisure floorspace up to 2033. Gilston Park Estate Garden Village within East Hertfordshire District (which lies adjacent to this SA) is one of the major schemes in this area and is set to deliver 10,000 new homes in a series of interlinking villages close to the Stort Valley. The Environment Agency is working with the Council and developers to achieve a safe, sustainable development and maximise opportunities for environmental betterment.

Environmental designations

There are several areas that hold environmental conservation designations located within this SA, including:

- Wormley-Hoddesdonpark Woods Special Area of conservation (SAC) -- made up of Wormley-Hoddesdon Park Woods North Site of Special Scientific Interest (SSSI) and Wormley-Hoddesdon Park Woods South SSSI
- Lee Valley Special Protection Area and Ramsar Site -- made up of SSSIs including Turnford and Cheshunt Pits, Waltham Abbey, Cornmill Stream and Old River Lea, Amwell Quarry
- Hunsdon Mead SSSI

- Rye Meads SSSI
- Chingford Reservoirs SSSI
- Northaw Great Wood SSSI

Topography, geology, hydrogeology, land use

Land use within this SA is mostly agricultural and protected green belt with some dispersed urban areas, including Hertford, Ware, Bishops Stortford and Harlow. The urban areas are mostly comprised of residential, commercial, business parks and industrial uses. The green spaces are made up of important wetland, grassland and woodland habitats.

Across the SA, the character of the river and drainage systems varies considerably. The upper reaches of the SA are characterised by mostly natural floodplains with dispersed market towns and villages. There are wide and extensive floodplains, particularly along the Rivers Lee and Stort, which provide natural storage that help reduce risks to local urban areas. The lower reaches of the SA are characterised by generally urban areas with some river flood defences.

The River Lee basin covers an area of approximately 1,420 square kilometres in the north of London and Hertfordshire. The source of the River Lee is in Central Bedfordshire, north-west of this SA, and the river joins the tidal River Thames downstream of Stratford in East London, south of this SA. The river catchment becomes smaller and more urban as it moves downstream. The Lee basin is a complex system with many controls on flow and a greater interaction between channels. Flow routes change depending on the scale of the flood event and preceding catchment conditions can affect the response of the tributaries. Therefore, it is difficult to predict the timing and volume of flows that will arrive downstream.

The Lower Lee Flood Relief Channel (FRC) is the most significant defence in the Lee catchment, comprising of over 45km of channel (excluding canals). The FRC, completed in the 1970s, extends from Ware to Walthamstow and was designed to safeguard against a ‘1947-scale’ flood event, estimated to be a 1.4% annual probability.

The topography of the SA is strongly influenced by the River Lee basin. Lower areas include the river valleys along the Lee, its tributaries and the Stort. The land rises higher between the river channels, particularly in the east and west of the SA.

The underlying geology of the south and north-east of the SA is clay. Within clay areas, the porosity is fairly low which can result in slow infiltration rates and increased surface water run-off. In urban areas, this can exacerbate the potential issues of surface water flooding. In the north-west of the SA, the underlying geology is chalk. Within chalk aquifers, water can infiltrate quickly and move within and through the rock. The groundwater in chalk areas flows slowly through the aquifers and is released at a slower rate, compared to overland and into the rivers. This can create a delayed response after a storm event and exacerbate flooding. The rivers in this section of the SA are chalk stream habitats which are rare, both in the context of the country, and internationally.

Partnership working

The Middle Lee Valley RS SA falls within the River Lea Catchment Partnership, which contributes to increasing understanding of the catchment and developing joint plans with the aim of improving the health of the local water environment.

Lee 2100 Programme

The Lee 2100 programme aims to develop and produce a new Flood Risk Management Strategy for the River Lee catchment for the short, medium and long-term. This will include both the Upper Lee and Lower Lee and their tributaries. The Strategy will be based on an integrated approach that considers the whole Lee catchment in terms of climate change, resilience and adaptation.

The Lee programme’s vision is to integrate different types of projects and collaborate with key stakeholders in the catchment to ensure that the flood and water environment are managed efficiently. It is anticipated that this integrated approach will help to attract funding from a wide range of partners by delivering additional benefits to flood risk reduction including economic growth and green space provisions.

The Lee Valley is also particularly valuable for its aquatic and wetland habitats and associated birds. Most of these are dependent on maintaining existing water management levels. It is expected that flood risk reduction schemes should look to incorporate and deliver environmental outcomes wherever possible. Therefore, there is a need to develop a Strategy that puts environmental enhancements at its core, alongside reducing flood risk.

Current flood risk

The main sources of flood risk within the Middle Lee Valley RS SA are fluvial and surface water. This section will focus on the fluvial flood risk within the SA, but it will also give a high-level overview of the other flood risk sources for context.

Fluvial flood risk

The SA is an area of significant fluvial flood risk, especially in the urban areas along the river network. Factors that contribute to the strategic importance of this area include the high rates of development occurring along the river system, the high number of people living at risk within the area, and the potential for natural flood management and flood storage areas within the upper reaches of the catchment. Additionally, this area's strategic significance is owed to the importance of managing flood risk and water along the River Lee tributaries to alleviate and avoid exacerbating flood risk in the main channels and more urban, lower River Lee. Interventions in the upper reaches of the River Lee and along the Stort will have an impact on flood risk downstream and need to be considered alongside local risk management.

The river system within this SA is quite complex. The northern portion of the SA is characterized by two main rivers: the Stort flowing in from the north-east, fed by its tributaries; and the Lee flowing in from the north-west, fed by larger tributaries. The two rivers meet in the middle of the SA, join into a broad series of channels (primarily the Old River Lee, the Flood Relief Channel, and the Lee Navigation), and then flow south, forming a ‘Y’ shape. Significantly, the southern-flowing portion of the river system features many tributaries, including the Turkey Brook and the Nazeing Brook, which contribute to a robust network of waterways.

In the upper portion of the Lee, before it meets the Stort, there are several important tributaries that flow into it: the Mimram, the Beane, the Rib and the Ash. Hertford sits at the confluence of all these rivers except for the Ash, forming a complicated system for flood risk management.

The Flood Relief Channel (FRC) and its associated structures (sluice gates, radial gates, and weirs) are critical to the management of flood risk along the middle and lower River Lee. From Ware to the confluence with the River Stort at Feildes Weir, the FRC and Lee Navigation share the same channel with reinforced banks and a natural bed. From Feildes Weir to the M25, the FRC is a separate channel with reinforced banks and flows through several lakes that were formed through historic mineral extraction. To the south of the M25 the FRC is a concrete-lined channel that is designed to efficiently convey water and reduce the probability of flooding in the Lower Lee Valley. Eighteen important structures (weirs, sluices, and gates) also operate within the FRC system with the purpose of conveying flood flows and maintaining appropriate water levels for navigation, recreation, conservation, and water abstraction.

Catchment response

The combination of concrete channel surfaces, steep catchments and clay soils cause the watercourses within this SA to respond rapidly and suddenly to rainfall and flood after storms. This is particularly evident at the confluences of the River Lee and its tributaries. If the downstream tributaries all reach peak flow levels simultaneously, it can result in large volumes of water quickly arriving further downstream where the Navigation Channel and FRC meet, causing flooding.

The urban nature of the catchment leads to rapid run-off of rainwater which can exacerbate the risks. Blockages in the watercourses, particularly in or near culverts and structures, can also increase the risk. Severe flooding is particularly likely in the summer months due to intense thunderstorm rainfall and in the winter months due to prolonged rainfall.

There is also a significant flood risk on the Lee tributaries, which are underlain by impermeable clay, with steep and small catchments, highly developed urban floodplains, and heavily modified channels, leading them to respond rapidly to rainfall. The tributaries on the east of the basin discharge directly into the FRC. Those on the west of the basin discharge directly into the Old River Lee or the Navigation Channel, from which flows are distributed to the FRC.

Fluvial flooding - risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SA.

The risk is presented in flood risk likelihood categories. These indicate the chance of flooding in any given year. Risk levels are defined as follows:

- ‘high risk’ means that each year an area has a chance of flooding of greater than 3.3%
- ‘medium 'means that each year an area has a chance of flooding between 1% and 3.3%
- ‘low 'means that each year an area has a chance of flooding of between 0.1% and 1%
- ‘very low risk’ means that each year an area has a chance of flooding of less than 0.1%

Table 20: summary of river and sea flood risk to people in the Middle Lee SA

Risk to people	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of people in SA	276,951	1,616	8,352	20,534	5,264
Number of services	1,880	19	75	169	54

Table 21: summary of river and sea flood risk to economic activity in the Middle Lee SA

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	9,750	117	599	1,150	311
Number of airports	0.0	0.0	0.0	0.0	0.0
Length of road (kilometres (km))	67.2	0.6	4.0	2.4	1.0
Length of railway (km)	59.6	2.8	5.6	4.6	2.4

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk	Very low risk
Agricultural land (hectares (ha))	15,750.9	635.9	472.2	440.3	80.6

Table 22: summary of river and sea flood risk to the natural and historic environment in Middle Lee SA

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of EU designated bathing waters within 50 metres (m)	0.0	0.0	0.0	0.0	0.0
Number of Environmental Permitting Regulations (EPR) installations within 50m	20.0	2.0	1.0	5.0	0.0
Area of Special Area of Conservation (SAC) within area (ha)	336.0	0.3	0.6	0.0	0.0
Area of Special Protection Area (SPA) within area (ha)	271.8	206.7	24.6	11.4	28.8
Area of Ramsar site within area (ha)	271.8	206.7	24.6	11.4	28.8
Area of World Heritage Site within area (ha)	0.0	0.0	0.0	0.0	0.0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	994.5	240.5	30.3	73.4	31.6
Area of parks and gardens within area (ha)	811.5	61.0	38.1	17.2	7.9
Area of scheduled ancient monument within area (ha)	103.7	6.9	8.3	37.0	2.6
Number of listed buildings within area	1505.0	35.0	123.0	106.0	13.0

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of licensed water abstractions within the area	147.0	16.0	11.0	14.0	6.0

The Middle Lee Valley RS SA is a complex system with many differing factors impacting the flood risk. 35,766 people living in the Middle Lee Valley RS SA are at risk of fluvial flooding. Based on this information it is concluded that the Environment Agency should take further action to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment, both now and in the future. The measures the Environment Agency have created within this FRMP aim to mitigate and alleviate this risk.

Canal flood risk

The Lee Navigation Channel is managed by the Canal & River Trust. It runs vertically through this SA. Several sections of the Lee Navigation carry flood flows as part of the Lee Flood Relief Channel system, including at Ware and Tottenham.

A portion of the River Stort is managed by the Canal & River Trust. For more information refer to the Canal and River Trust website for the River Stort.

How the risk is currently managed

Fluvial flood risk within the Middle Lee RS SA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

Flood defences

There are many important flood defences located within this SA, as discussed in the section above. Together, the Lee Flood Relief Channel and the associated sluice gates, radial gates and weirs, form an integrated flood alleviation scheme that reduces the risk of flooding in the area. Flood Storage Areas hold flood waters in the upstream catchment, including in the Rags Brook, Theobolds Brook, Cobbins Brook and Turkey Brook in this SA. There are only a few stretches of raised defences within this system, as the underlying gravels prevent this type of structure. Instead, most defences provide additional storage or conveyance of water to efficiently move it through the lower River Lee basin and reduce the probability of flooding.

Along the tributaries, long-term adaptation through redevelopment is a main strategy. This includes re-creation of river corridors to ensure space for natural river flow and water attenuation as well as defences that are sustainable as part of an overall catchment plan. The impacts of climate change will require adaptation of the existing defences over time.

Rather than replacing them like-for-like, it will be necessary to seek a different combination of flood storage, river defences, and floodplain attenuation.

Flood storage and natural flood management

Within the upper reaches of the SA, the existing undeveloped floodplain is the most important asset in managing flood risk. Therefore, it will be crucial to maintain the capacity of the existing natural floodplain to retain water and maintain the conveyance of watercourses in towns and villages. In the lower area of the SA, one of the best options to reduce the probability of flooding is to increase attenuation through the addition of flood storage capacity, especially along the tributaries. Large flood storage areas may not be feasible in this region due to land and economic constraints, so focus has shifted from reliance on large flood storage areas to the cumulative benefits of many smaller storage areas within the catchment. As part of the process of increasing attenuation, re-establishing river corridors through restoration of parts of river channels and removal of artificial bank lining and culvert sections are options that could benefit the overall health and resilience of the watercourses.

Hydraulic modelling

Most rivers in the Middle Lee have detailed flood modelling and associated flood mapping. Improvements to these models are being carried out. [At time of writing, this has not been finalised].

Development

Redevelopment rates in some areas of this SA are very high, but this can be positive as it provides opportunities to reduce current levels of risk and reliance on flood defences. Redevelopment can include measures that increase resilience and provide options for managing not just current risk but also the impacts of climate change. Existing undeveloped river corridors provide room for water, which is important for enabling climate change adaptation, along with corridors and undeveloped floodplains being safeguarded from inappropriate development.

Under the National Planning Policy Framework Local Planning Authorities are required to take a proactive approach to flood risk and climate change when planning strategically for their development needs. Prioritising the allocation of land in areas of lowest flood risk, before considering areas with higher levels of risk is one of the requirements of national policy. This can reduce the future risk of flooding and vulnerability to climate change and minimise the potential future costs of flood alleviation and flood defence maintenance. Where some development in areas of higher flood risk is necessary, Local Planning Authorities should outline in planning policies the standards expected to fully mitigate the risks. They should aim to achieve a reduction in flood risk ensuring that developments will be safe and there is no increase in flood risk elsewhere. In addition, policies should make provision for the possible future relocation of vulnerable development and infrastructure out of areas of increasing flood risk.

Property flood resilience

Property Flood Resilience (PFR) is being offered to properties at risk of fluvial flooding in Lower Nazeing in 2021 as part of a joint Environment Agency / Essex County Council project. [At time of writing, this has not been finalised].

Flood warning and community preparedness

The Environment Agency's flood warning and alert service is available along the majority of the rivers within this SA. The service aims to provide advance warning to people of the risk of flooding from rivers and the sea. There are flood warning areas within this SA. Emergency response and flood awareness are particularly important within this SA because the catchments react very quickly to rainfall.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Middle Lee Valley Rivers and Sea Strategic Area

Measures have been developed which apply specifically to the Middle Lee Strategic Area.

The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc.

These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Middle Lee Strategic Area.

You can find information about all the measures which apply to the Middle Lee Strategic Area in the interactive mapping tool Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

The Oxford to Cambridge Arc Strategic Area

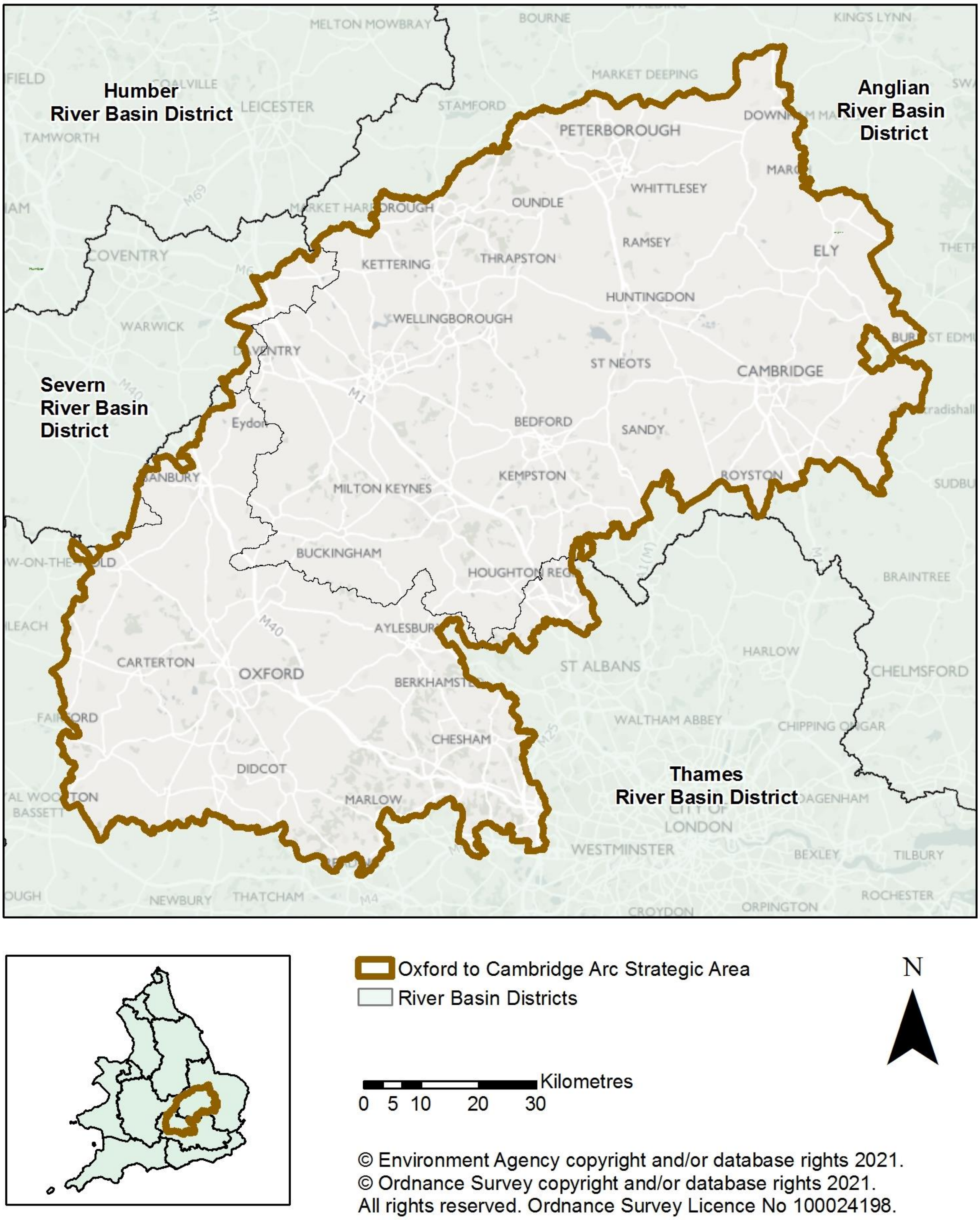


Figure 50: Map showing the Oxford to Cambridge Arc Strategic Area Boundary and its location in England

The Oxford to Cambridge Arc strategic area (the Arc) is in the South East of England. It falls within part of the Thames and Anglian RBD and can be found in both plans. It is a globally significant area between Oxford, Milton Keynes and Cambridge.

It is formed of five ceremonial counties:

- Oxfordshire
- Bedfordshire
- Buckinghamshire
- Northamptonshire
- Cambridgeshire

The Oxford to Cambridge (OxCam) Arc is the name given to a cross-government initiative that supports planning for the future up until 2050 and represents a unique opportunity to put the Government’s 25 Year Environment Plan into action. The Strategic Area was not identified using the standard Flood Risk Area method identified by Defra, but was recommended for inclusion given its nationally significant importantance.

This chapter focuses on describing how the Environment Agency, in partnership with relevant Risk Management Authorities (RMAs) is working with communities to manage flood risk in the Oxford to Cambridge Arc SA.

There are several Risk Management Authorities operating in the Oxford to Cambridge Arc strategic area including:

- Environment Agency
- Nine Lead Local Flood Authorities: Oxfordshire, Buckinghamshire, Bedford, Central Bedfordshire, Luton, North Northamptonshire, West Northamptonshire, Cambridgeshire and Peterborough
- 18 Local Planning Authorities: Buckinghamshire Council, Bedford, Cambridge City, Central Bedfordshire, Cherwell District, City of Peterborough, East Cambridgeshire District, Fenland District, Huntingdonshire District, Luton, Milton Keynes, North Northamptonshire, Oxford City, South Cambridgeshire District, District, South Oxfordshire District, Vale of White Horse District, West Oxfordshire District, and West Northamptonshire
- Internal drainage boards: Alconbury and Ellington IDB, Bedfordshire & River Ivel IDB, Benwick IDB, Bluntisham IDB, Botany Bay IDB, Buckingham and River Ouzel IDB, Burnt Fen IDB, Bury Brook IDB, Cawdle Fen IDB, Conington & Holme IDB, Creek Farms IDB, Curf & Wimblington IDB, Euximoor IDB, Farm Care Ltd IDB, Feldale IDB, Haddenham Level IDB, Hobbs Lot IDB, Holmewood & District IDB, Hundred Foot Washes IDB, Hundred of Wisbech IDB, Kings Lynn IDB, Ladus Fen IDB, Littleport & Downham IDB, Manea & Welney IDB, March & Whittlesey IDB, March 3rd IDB, March 5th IDB, March 6th, March East IDB, Middle Fen & Mere IDB, Needham Burial & Birdbeck IDB, Nightlayers IDB, North Level IDB, Old West IDB, Over & Willingham IDB, Padnal & Waterden IDB, Ramsey IDB, Ramsey 1st IDB, Ramsey 4th IDB, Ramsey Upwood & Gt Raveley IDB, Ransonmoor IDB, Sawtry IDB, Sears Farm IDB, Skeggins Farm IDB, South Holland IDB, Stitches IDB,

Sutton & Mepal IDB, Swaffham IDB, Swavesey IDB, Upwell IDB, Waldersey IDB, Warboys Somersham & Pidley IDB, Waterbeach IDB, Welland and Deepings IDB, White Fen IDB, Whittlesey & District IDB and Woodwalton IDB
- Three Regional Flood and Coastal Committees: Thames, Anglian Great Ouse, Anglian Northern
- Ten Highways Authorities: Lead Local Flood Authorities and National Highways
- Two Water and Sewerage company: Anglian Water and Thames Water

Environmental designations

There are 20,000 Hectares of SSSI designated land across the Arc, with under half of it being in favourable condition.

The OxCam Arc also encompasses the Chilterns, Cotswolds and North Wessex Downs Areas of Outstanding Natural Beauty (AONB). These AONBs only cover a small part of the land area, however they represent important landscapes that are protected to conserve and enhance their natural beauty.

Topography, geology, hydrogeology, land use

The topography of the Strategic Area is strongly influenced by the Cotswolds to the west, the Chilterns to the south and the lowlands of the Cambridgeshire fens to the East.

The lower areas include the north-east of Cambridgeshire (where land drops below sea level in parts and is wildly below 5m above ordnance datum). Elsewhere, the land rises up to above 200 metres above ordnance datum (mAOD), for example in the Cotswolds and the Chilterns.

The geology tends to run in bands south-west to north-east. Along the south-east of the Arc, there is Chalk, which is home to valuable Chalk Streams.

The next band north is the Upper Greensand. Following that, the geology is dominated by a series of Clays including the Kimmerridge and Oxford. Moving into North Oxfordshire and Northamptonshire there is a less structured pattern. Geology includes the Great Oolite, Inferior Oolite, Upper Lias and Middle Lias.

Within chalk and limestone areas, water can infiltrate quickly and move within and through these rocks forming part of the major groundwater resources. This groundwater provides a significant baseflow component to the rivers. The impact of rainfall on main rivers will be spread out over a relatively long period of time. Within clay areas, there is slow infiltration rates and increased surface water run-off. In an urban area, this can exacerbate the potential issues for surface water flooding.

The tributary rivers in the Arc are in mostly rural areas. These tend to be picturesque streams which wind their way through small settlements including the internationally important chalk streams in the Chilterns. The main rivers run through large urban areas. The River Thames runs through Oxford and then out of the Arc into Reading, before it returns through Henley, Marlow and Maidenhead. The River Nene runs through the centre of Northampton and out through Peterborough. The Great Ouse runs through Buckingham, Milton Keynes, Bedford and St Neots.

The Arc is a largely agricultural landscape with 54% of the Arc being cultivated / disturbed land and 19.6% improved grassland. The Arc's agricultural picture mirrors that of England, arable to the East and livestock to the West. However, as mentioned the Arc has a higher proportion of more productive land – approximately 20% of England's Class 1 Agricultural land is within the Arc. Woodland cover in the Arc is concentrated in the Chilterns. The Chilterns cover the headwaters of both the River Thames and the Great River Ouse.

The primary source of flood risk across the Arc varies. However, fluvial flooding is the main risk across most of the Arc. There are 100,000 homes currently at risk of fluvial flooding and communities across the Strategic Area are also at risk of surface water flooding. This equals around 50,000 homes.

There are three main river catchments that flow within the Arc. These main rivers dominate the landscape, from the wide Thames Valley flowing through historic market towns, to the Ouse Washes which are an internationally important area for wildlife.

The three main river catchments are:

- the River Thames and associated tributaries including the Evenlode, the Cherwell, the Thame and the Ock
- the Great River Ouse and associated tributaries including the River Ouzel, River Ivel and the River Cam
- the River Nene and associated tributaries including the River Ise, Harpers Brook and Willow Brook

Partnership working

The Environment Agency works collaboratively with partners and communities to encourage strategic thinking around climate resilience, water management and biodiversity net gain. There are opportunities to deliver strategic flood alleviation across multiple river catchments whilst providing benefits to people including access and recreation.

Local Enterprise Partnerships have been created to shape the arc's economic plans in support of the vision and the UK's industrial strategy. A new strategic infrastructure board has also been created to build on the work of the Transport Forum to develop arc-wide strategic infrastructure plans covering transport, digital, utilities and flood management.

The OxCam Arc Area covers multiple Catchment Partnership areas:

- River Ock Catchment Partnership
- South Chilterns Catchment
- Evenlode Catchment Partnership
- River Thame Catchment Partnership

- Upper & Bedford Ouse Catchment Partnership
- Nene Valley Catchment Partnership
- Luton Lea Catchment Partnership
- Water Care Partnership
- Cherwell & Ray Catchment Partnership
- CamEO Catchment Partnership

Other relevant plans

This chapter should be read in conjunction with other relevant local plans. There are several relevant regional and local key policies which have been considered within the creation of the second cycle Flood Risk Management Plan (FRMP) and its measures, such as:

- Spatial framework policy paper
- Joint declaration
- Government response to National Infrastructure Commission report
- National Infrastructure Commission report (PDF)
- Government plan to transform Oxford-Cambridge Arc into UK's fastest growing economic region

Current flood risk

The main source(s) of flood risk within this strategic area described in the section below are fluvial and surface water flood risk.

Fluvial and surface water flood risk - overview of risk

Gradient is one factor in determining the hydrological response and in steeper catchments water levels can rise quickly after rainfall, with little advance warning. The main rivers are generally slow responding rivers. For example, flooding on the River Thames and in the Ouse Washes can last many weeks. Along these rivers are extensive floodplains with important floodplain grazing marsh/ floodplain meadow habitats. The rivers are dominated by wide river valleys, with gently sloping hills to the West of the area and very flat land to the East.

The faster impact river events tend to be focused on smaller villages high up in the catchments on smaller tributaries or from surface water flooding in the major urban centres. When Milton Keynes was set up as a new town, it was appreciated that building a new city meant far quicker run off of storm water into rivers than would naturally occur. For this reason, a strategic drainage network, comprising linear parks and balancing lakes was constructed. The Milton Keynes model is a demonstration of what managing surface water flood risk and reducing fluvial flood risk could look like.

There have been various large floods across the Arc in recent years. There was a large fluvial flood in Oxford in the winter of 2013/2014 and recently there has been extensive surface water flooding in Northamptonshire and Wellingborough.

Fluvial and surface water flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps. These were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SA.

The risk is presented in flood risk likelihood categories. These indicate the chance of flooding in any given year. The risk levels are defined as follows:

- ‘high risk’ means that each year an area has a chance of flooding of greater than 3.3%
- ‘medium risk’ means that each year an area has a chance of flooding between 1% and 3.3%
- ‘low risk’ means that each year an area has a chance of flooding of between 0.1% and 1%
- ‘very low risk’ means that each year an area has a chance of flooding of less than 0.1%

Table 23: summary of river and sea flood risk to people in the Oxford to Cambridge Arc SA

Risk to people	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of people in SA	3,750,818	16,663	72,583	50,356	15,683
Number of services	29,351	274	1,096	517	150

Table 24: summary of river and sea flood risk to economic activity in the Oxford to Cambridge Arc SA

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	140,473	1,074	5,390	3,276	1,109
Number of airports	3	0	0	0	0

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk	Very low risk
Length of road (kilometres (km))	1,995.9	13.9	104.1	25.4	12
Length of railway (km)	1035.4	15.4	105.5	31.7	6.4
Agricultural land (hectares (ha))	945,883	21,037.9	103,399.4	22,018.8	4,751

Table 25: summary of river and sea flood risk to the natural and historic environment in Oxford to Cambridge Arc SA

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of EU designated bathing waters within 50 metres (m)	0	0	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	248	17	23	8	3
Area of Special Area of Conservation (SAC) within area (ha)	2,967.3	683.5	307.3	4.1	2.4
Area of Special Protection Area (SPA) within area (ha)	4,630.4	4,394.7	129.7	17.7	2.7
Area of Ramsar site within area (ha)	5,249.6	4,480.6	346.7	17.7	5.1
Area of World Heritage Site within area (ha)	933.1	53.6	3	0.03	0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	20,246.3	6,121.4	1,237.2	89.7	42.5
Area of parks and gardens within area (ha)	20,731.5	507.6	534.7	60	11.4

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Area of scheduled ancient monument within area (ha)	5,550.8	364.3	502.7	153.9	23.2
Number of listed buildings within area	37,315	491	1,324	618	275
Number of licensed water abstractions within the area	2,460	632	696	125	21

Table 26: summary of surface water flood risk to people in the Oxford to Cambridge Arc SA

Risk to people	Total in SA	High risk	Medium risk	Low risk
Number of people in SA	3,750,818	38,894	61,814	307,972
Number of services	29,351	274	526	1,768

Table 27: summary of surface water flood risk to economic activity in the Oxford to Cambridge Arc SA

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk
Number of non-residential properties	140,473	2,157	3,936	14,416
Number of airports	3	3	0	0
Length of road (kilometres (km))	1,996	85.2	72.9	237.2
Length of railway (km)	1,035.4	52.1	40.3	106.1
Agricultural land (hectares (ha))	945,883.8	19,860.6	15,004.4	62,645.6

Table 28: summary of surface water flood risk to the natural and historic environment in the Oxford to Cambridge Arc SA

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk
Number of EU designated bathing waters within 50 metres (m)	0	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	248	83	37	66
Area of Special Area of Conservation (SAC) within area (ha)	2,967.3	35.5	36.3	169.8
Area of Special Protection Area (SPA) within area (ha)	4,630.4	36.3	55.5	316.2
Area of Ramsar site within area (ha)	5,249.6	42.2	70.1	380.6
Area of World Heritage Site within area (ha)	933.1	1.1	2.2	46
Area of Site of Special Scientific Interest (SSSI) within area (ha)	20,246.3	446.1	338.5	1,514.9
Area of parks and gardens within area (ha)	20,731.5	570.6	323.8	1,210.9
Area of scheduled ancient monument within area (ha)	5,550.8	125	93.1	362.7
Number of listed buildings within area	37,315	319	244	1,242
Number of licensed water abstractions within the area	2,460	551	167	390

There are currently studies underway looking to identify locations to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits. The area is working in three large river catchments so there is good potential to slow the flow of water in some tributary catchments to reduce flood peaks in smaller events. However, due to the large volume of water that flows through the catchments the partnership also needs to consider more engineered solutions.

There are two main pressures that are likely to change our current risk statistics in the future, these being widespread development and climate change. When considering any interventions designed today, the Environment Agency have to ensure their effectiveness within these possible futures. Taking further action to reduce risk will require further appraisal to assess whether they are socially and environmentally sustainable, technically viable and economically justified.

How the risk is currently managed

Fluvial flood risk within the OxCam Arc RS SA is currently managed through a series of approaches, including development planning and adaptation, flood risk assets, flood warning systems and flood risk modelling.

There are several important flood defences located with this strategic area, including in Aylesbury, Banbury, Bedford, Ely Great Ouse Flood Protection Scheme, Godmanchester, Kings Lynn, Marlow, Newport Pagnell, Ouse Washes, St Ives and the Hemmingfords and St Neots.

The Environment Agency and relevant partners are also working towards reducing the risk of flooding to as many properties as possible with schemes being developed.

These schemes include:

- the Oxford Flood Alleviation scheme
- River Nene storage and conveyancing study
- River Great Ouse Storage and conveyancing study
- The Bedford to Milton Keynes Waterway Park
- Thames Valley Flood Scheme

The Government have committed to developing a Spatial Framework for the Arc, a long-term strategic plan to help coordinate the infrastructure, environment and new developments in the area. They envisage growth of up to a million new homes up to 2050, which is a massive increase from current levels of around 1.6Mil dwellings. They are considering the creation of multiple development corporations to oversee these developments in various locations. MHCLG is creating a spatial framework to decide on these locations, consultation is underway with a draft spatial framework set to be published for consultation in autumn 2022. In the meantime, the Environment Agency is a statutory consultee on planning applications and provide advice on construction of new properties or re-development in at risk areas.

England has non-statutory technical standards produced by Defra for Sustainable Urban Drainage Systems (SuDS) to mitigate against this risk. Although SuDS are not mandatory for planning applications and on new developments, the revised National Planning Policy Framework states that major developments should incorporate SuDS unless it would be inappropriate to do so.

The UK Government provides guidelines and payments to landowners to create natural flood risk management features or farming ‘good practice’, which can involve planting field edges with flora that slows down the flow of water off the land.

The Environment Agency's flood warning and alert service is available in most parts of the strategic area. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often. Rainfall intensity is expected to increase in future which will cause river flows to increase. As rainfall intensity increases, surface water flooding will become more frequent.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Coastal flooding has a significant impact in Cambridgeshire, the eastern part of the Arc. Generally, models forecast a quarter of a metre rise in sea levels in the 21st century, although some forecast up to 2.5 metres. In the Arc, the predicted level increase would mainly impact land between Cambridgeshire and Peterborough with multiple settlements likely to be affected.

Population growth and the associated development of land for homes and businesses is a common pressure across the UK. However, with up to 1 million new homes planned to be built across the Arc by 2050, this pressure is heavily represented. To put this in context, according to Ministry of Housing, Communities & Local Government statistics in 2016, the OxCam Arc Authorities contained 1.5 million dwellings.

The Environment Agency have been working with The Infrastructure Transitions Research Consortium (a consortium of seven UK universities led by the University of Oxford) and is using their development models to spatially map the future development across the arc. The study is using high level flood modelling to look at which areas will be affected by flood risk, now and in the future, considering several climate change scenarios.

Whilst the Arc is set to be developed over the next 50 years, partners are committed to setting a long-term approach to managing flood risk. Like the Thames Estuary 2100 Plan, the Arc is intended to become a leading example of a climate adaptation strategy which enables practitioners and policy makers to plan, monitor and review how to adapt to flood risk over time.

When looking at flood risk during the development of the Arc, partners will need to ensure that decisions and evidence are based on assessing data at a catchment scale, be it smaller catchments or across river basins. Increased urbanisation, if not managed sustainably, enables the ground to reach saturation point faster, increasing overland flow and peak discharge. It will be even more important for local planning policies and decisions on planning applications relating to major development - developments of 10 dwellings or more, or equivalent non-residential or mixed development - to have regard to the SUDS planning guidance to ensure that sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate.

Additional opportunities to manage flood risk should be actively sought through the Government's Flood and Coastal Erosion Risk Management Policy Statement. This should be alongside the EA's National Flood and Coastal Erosion Risk Management Strategy for England and following the inclusion of Green Infrastructure Standards (a 25 YEP commitment) within the National Planning Policy Framework for a soft launch in spring 2021.

The Environmental Land Management Scheme also provides opportunities to build upon earlier initiatives aimed at creating natural flood risk management features or farming 'good practice'. Under this scheme, it is anticipated that farmers will be paid for work that enhances the environment, such as tree or hedge planting, river management to mitigate flooding, or creating or restoring habitats for wildlife. Farmers will therefore be at the forefront of reversing environmental decline and tackling climate change as they reshape the future of farming in the 21st century.

Hydraulic modelling

It is possible that areas within the Strategic Area could experience flooding in the future. As a result of larger flood extents and deeper depths of flood water due to the impacts of climate change, the level of protection provided by flood defences will likely decrease. There will also likely be additional maintenance needs and stresses on assets that function with a higher frequency than were designed.

Local planning authorities, developers and their agents should use climate change allowances in flood risk assessments to help minimise vulnerability and provide resilience to flooding and coastal change.

Details about impact on environment

There are two River Basin Management Plans: updated 2022, that cover the OxCam Strategic Area, these are the Thames River Basin District (RBMP 2022) and Anglian River Basin District (RBMP 2022).

There are parts of the strategic area which are classified as areas of water stress. Affinity, Anglian and Thames water companies all are classified as 'Serious' Water Stressed areas, using the 2013 Classification.

Groundwater and rivers supply water for local people. Defra's consultation on measures to reduce personal water use (2019) states that currently a person in England uses 141 litres of water per day on average. As of 2016 there were 3.8 million people living in the Arc which means that an estimated 535,800 m^3 of water is used per day by the public. This groundwater/river abstraction directly impacts on the amount of water available in the environment. This impacts the chalk streams in the catchment, which depend on an adequate supply of groundwater.

Objectives and measures across the Oxford to Cambridge Arc SA

Measures have been developed which apply specifically to the OxCam Arc Strategic Area.

The measures created as part of the FRMPs are part of a strategic 6-year plan, which is reviewed annually. These measures describe short-term strategic actions but do not make up all the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc.

These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the OxCam Arc Strategic Area.

You can find information about all the measures which apply to the OxCam Arc Strategic Area in the interactive mapping tool - Flood Plan Explorer This includes information on which national objectives each measure helps to achieve.

The Roding Valley Rivers and Sea Strategic Area

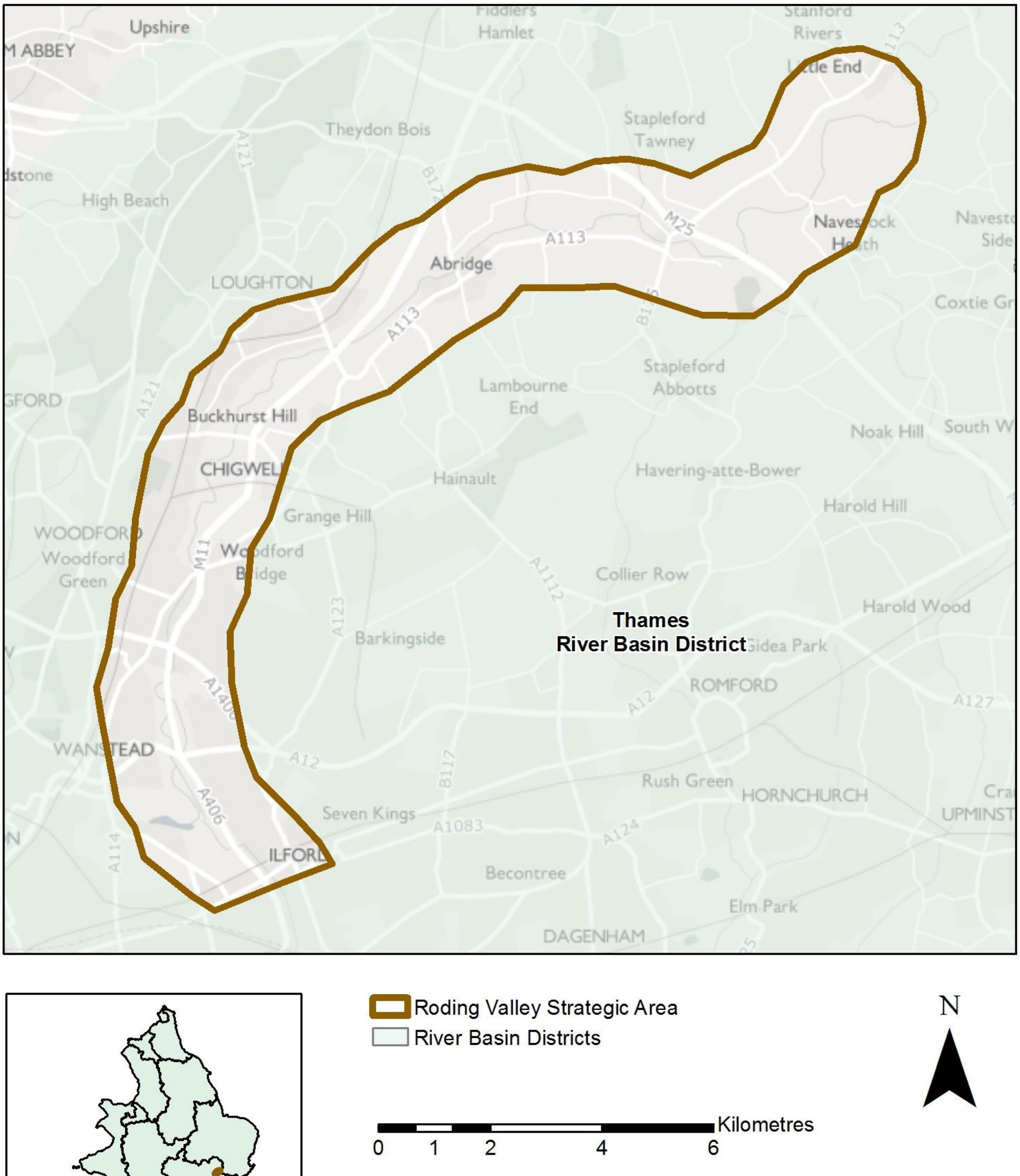


Figure 51: Map showing the Roding Valley Strategic Area Boundary and its location in England

The Roding Valley Rivers and Sea (RS) Strategic Area (SA) is in the South East of England and to the east of the Thames River Basin District (RBD). It will be reported solely by the Thames RBD. It was identified based on a method created by the Hertfordshire and North London (HNL) Environment Agency area team.

This is a different approach than what was used during the first cycle of the Flood Risk Management Plans (FRMP). The Roding Valley Strategic Area was defined using a spatial analysis buffer on the main rivers. Stretches of river were included based on the locations of the following data sets:

- flood zones, urban areas
- EA communities at risk
- development pressure (based on planning and permitting applications)
- capital projects pipeline
- natural flood management opportunities
- neighbourhood flood vulnerability
- social flood risk indexes

The River Roding Rivers and Sea Strategic Area covers a lower section of the River Roding and its floodplain from Epping Forest District in the north to the London Borough of Redbridge in the south. This is an area of significant fluvial flood risk, especially in the urban areas along the river network. Factors that contribute to the strategic importance of this area include the high number of people living at risk within the area, the opportunities presented by the River Roding Project, and the importance of managing risk along the River Roding to alleviate and avoid exacerbating flood risk issues in the River Thames catchment.

The Environment Agency works collaboratively with partners and communities to improve the water environment as Risk Management Authorities (RMAs).

There are Risk Management Authorities operating in the River Roding RS SA, including:

- Environment Agency
- Five Lead Local Flood Authorities: Essex County Council, London Borough of Redbridge, London Borough of Newham, London Borough of Havering and London Borough of Barking and Dagenham
- Four District Councils/ Borough: Epping Forest District, Brentwood District, London boroughs of Redbridge and Newham
- Regional Flood and Coastal Committee (RFCC): Thames RFCC
- Two Highways Authorities: Transport for London is the highway authority for all Greater London Authority roads (under the Highways Act 1980) alongside National Highways which manage major motor ways, like the M25.
- Water and Sewerage company: Thames Water
- Department of Communities and Local Government through local planning authorities

Environmental designations

The Roding Meadows Site of Special Scientific Interest (SSSI) is located within this SA. Portions of the following areas that hold environmental conservation designations and are located fully within this SA include Epping Forest (Site of Special Scientific Interest and Special Area of Conservation), and Curtismill Green (Site of Special Scientific Interest). The River Roding itself is also designated as a Site of Nature Conservation Importance between Chigwell and the River Thames.

Growth and development

Growth and development within this SA is expected to be highest to the southern urbanised section of the Roding Valley. If not planned carefully, development will place additional pressures on water management and flood risk. Development also creates opportunities to reduce flood risk and minimise vulnerability to climate change.

Population growth is one of the drivers for housing need. Looking at the two district councils with the largest geographical overlap with this SA, Epping Forest has a mid-2019 population estimate of 131,689 and Redbridge London Borough, 305,222. The Office of National Statistics estimate the population will increase to 138,983 for Epping Forest and 315,139 for Redbridge by 2035 (an overall increase of 17,211 for both districts).

Epping Forest District Council's emerging Local Plan is seeking to deliver 11,400 new homes up to 2033. Redbridge's adopted Local Plan (2018) has set itself a target to deliver 17,237 new homes by 2030 and Ilford to the south is identified as an Investment and Growth Area with a target to build 5,300 new homes. Brentwood and Newham have much smaller overlap areas with this SA but will also have potentially allocated land for development either within or close to the Roding Valley.

Topography, geology, hydrogeology, land use

The northern area of the SA is mainly comprised of rural land used for arable farming with some dispersed settlements. The middle portion of the SA is comprised of some agricultural land but is increasingly urban, moving southward towards densely populated urban centres of Greater London where land uses are mainly residential, manufacturing, and industrial.

Within the SA, the character of the watercourses, floodplain, and drainage system vary considerably. In the upper reaches of the River Roding, where the land use is more rural, natural floodplain retains flood water during heavy rainfall. However, in the lower, more urban areas of the SA, significant amounts of the natural floodplain have been developed, leaving little open space for storage of flood water. Additionally, the watercourses are typically modified into man-made channels into which rainwater flows quickly when there is surface water run-off, through the man-made drains. As a result, the level of the river can rise rapidly and cause flooding in surrounding areas.

The topography of the SA is strongly influenced by the River Roding. The topography is highest towards the edges of the SA and is lowest along the River Roding valley, which runs through the middle of the SA. Towards the south of the SA, the topography becomes flatter as the River Roding moves into the River Thames floodplain.

The underlying geology is clay. The porosity of clay is fairly low, which can result in slow infiltration rates and increased surface water run-off. In urban areas, this can exacerbate the potential issues for surface water flooding. As such, the River Roding has a flashy response to rainfall meaning water reaches the river quickly as rainfall tends to flow over the ground rather than soaking into it. The River Roding is particularly prone to flooding after large storms or periods of prolonged and heavy rainfall.

Partnership working

The Roding Valley RS SA falls within the Roding, Beam, and Ingreborne Catchment Partnership, which contributes to improving understanding of the catchment and developing joint plans with the aim of improving the health of the local water environment.

Current flood risk

The main sources of flood risk within this Roding Valley RS SA are fluvial and surface water. This section will focus on the fluvial flood risk within the SA, but it will also give a high-level overview of the other flood risk sources for context. For more information on surface water flood risk in this area, please refer to the Greater London Surface Water Flood Risk Area within this report.

Fluvial flood risk

The Roding Valley RS SA consists of the southern half of the River Roding and its tributaries.

Within the very upper reaches of this SA, the River Roding flows through undeveloped countryside as a predominantly natural river system. As the river flows south, through the SA, it encounters highly urbanised areas such as Woodford, Wanstead and finally Ilford, where the river becomes tidal and the SA boundary meets the boundary of the London and Thames Estuary Rivers and Sea Flood Risk Area. In these more urban areas, the River Roding and its tributaries have been modified to accommodate major transport infrastructure such as motorways, other major roads, railways and flood defences.

South of the SA, where the River Roding discharges into the River Thames at Barking Creek, the Barking Barrier protects the Roding catchment from tidal flooding, operating in conjunction with the Thames Barrier. To learn more about this area and the tidal risk along the lower reaches of the River Roding, refer to the Barking and Dagenham Embayment Flood Risk Management Strategy and also to the Thames Estuary 2100 Plan.

Details of the speed of the catchment response

Gradient is an important factor in determining the hydrological response in a SA as within steeper catchments, the water levels can rise quickly after a rainfall event with little advance warning. The River Roding and many of its tributaries behave in a similar way. Due to the heavily modified channels, the impermeable urban environment and minimally permeable underlying clay, the Roding catchment has a flashy response to rainfall. Water reaches the rivers quickly and rainfall tends to flow over the surface rather than soak into the ground. The River Roding is prone to flooding after large storms or prolonged heavy rainfall.

Fluvial flood risk - description of risk statistics

The information below has been calculated using Flood Risk and Hazard maps, which were developed and published for England by the Environment Agency. The data below only highlights features that are present within the SA.

The risk is presented in flood risk likelihood categories. These indicate the chance of flooding in any given year. The levels of risk are defined as follows:

- ‘high risk’ means that each year an area has a chance of flooding of greater than 3.3%
- ‘medium risk’ means that each year an area has a chance of flooding between 1% and 3.3%
- ‘low risk’ means that each year an area has a chance of flooding of between 0.1% and 1%
- ‘very low risk’ means that each year an area has a chance of flooding of less than 0.1%

Table 29: summary of river and sea flood risk to people in the Roding Valley SA

Risk to people	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of people in SA	104,508	609	2,342	3,574	1,372
Number of services	522	4	18	19	6

Table 30: summary of river and sea flood risk to economic activity in the Roding Valley SA

Risk to economic activity	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	3,780	27	111	110	19
Number of airports	0	0	0	0	0
Length of road (kilometres (km))	35.4	0.9	4.4	6.5	0.5
Length of railway (km)	17.0	0.2	0.1	0.0	0.2
Agricultural land (hectares (ha))	2,700.2	228.2	62.6	90.6	0.0

Table 31: summary of river and sea flood risk to the natural and historic environment in Roding Valley SA

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Number of EU designated bathing waters within 50 metres (m)	0	0	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	0	0	0	0	0
Area of Special Area of Conservation (SAC) within area (ha)	39.8	0.0	0.0	0.0	0.0
Area of Special Protection Area (SPA) within area (ha)	0.0	0.0	0.0	0.0	0.0
Area of Ramsar site within area (ha)	0.0	0.0	0.0	0.0	0.0
Area of World Heritage Site within area (ha)	0.0	0.0	0.0	0.0	0.0

Risk to the natural and historic environment	Total in SA	High risk	Medium risk	Low risk	Very low risk
Area of Site of Special Scientific Interest (SSSI) within area (ha)	96.3	15.7	1.5	1.2	0.0
Area of parks and gardens within area (ha)	183.8	7.7	15.7	3.5	1.2
Area of scheduled ancient monument within area (ha)	2.3	0.2	0.5	0.1	0.0
Number of listed buildings within area	175.0	1.0	7.0	8.0	0.0
Number of licensed water abstractions within the area	16.0	7.0	1.0	0.0	1.0

Flooding within the Roding Valley SA is a complex system with many differing factors impacting the flood risk. There are 30,849 people living in the Roding Valley SA who are at risk of flooding from rivers and sea. Based on this information, it is concluded that the Environment Agency should take further action to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment, both now and in the future. The measures the Environment Agency have created within this FRMP aim to mitigate and alleviate this risk.

Surface water flood risk

Surface water flooding happens in the Roding catchment when heavy rainfall exceeds the capacity of local drainage networks and water flows over the ground. The relatively flat topography of the SA and the urban land cover can compound surface water flood risk. Due to the capacity of the system and the flashy nature of how watercourses behave, water that flows over the ground during storm events can pond, which can result in surface water flooding. However, there are some areas within the SA where an installed drainage network, such as the Winn Valley Sewer, provides some protection from surface water flooding and discharges into the river. Development of the floodplains has reduced natural surface water drainage systems.

Flood risk in the middle and upper reaches of the Roding Valley RS SA is primarily combined surface water and fluvial risk while the Lower Roding is also susceptible to the potential impacts of climate change due to tidal influence. As sea levels rise, there is a need for the Barking Barrier to be closed more frequently and for longer durations. This can increase the risk of fluvial flooding upstream as the river is prevented from discharging into the Thames due to the high tide levels.

How the risk is currently managed

Fluvial flood risk within the Roding Valley RS SA is currently managed through a series of approaches, including flood defences, development control, a flood warning system and the ongoing River Roding Strategy. Hydraulic modelling is used to help understand the extent and the impact of flood events.

River roding strategy

The [River Roding Flood Risk Management Strategy]() was originally adopted in 2012 and updated in 2015. It was created following major flooding in the Roding catchment in 2000. The strategy covers the River Roding from its source at Molehill Green in Essex to the tidal limit at the A118 at Wanstead and includes the major tributaries of the Cripsey Brook and Loughton Brook. The strategy sets out a 100-year plan of recommendations for the catchment including how to work with other stakeholders to secure funding to carry out flood alleviation project works. Thames Water and Transport for London are key partners in managing the risk.

The main recommendations of the River Roding Flood Risk Management Strategy are to:

- ensure the river is effectively managed and maintained
- improve surface water management in the area
- improve mitigation measures for flood risk in Woodford and reduce flood risk by building a large flood storage area near Shonks Mill, Essex

Shonks Mill Flood Storage Area - the River Roding project

The proposed flood storage area at Shonks Mill, near Navestock, Essex, will mitigate the increasing effects of flood risk due to climate change. It will consist of an earth embankment approximately 500m long, with a height of 4m above ground level, constructed across the floodplain adjacent to Shonks Mill Road. The embankment will include a passive control structure, which will allow the river to flow as normal until it reaches a certain level during times of flood and will then store water behind the embankment until the storm passes. The River Roding Project will also refurbish two stretches of existing flood embankments downstream in Woodford. This will provide an increased standard of protection to almost 600 properties downstream, mainly in the areas of Woodford, Ilford and Loughton. More information on the scheme and its progress as it is designed and then built can be found on the [Environment Agency consultation page]().

Flood defences

There are currently no formal flood defences on the River Roding north of the M25 but there are some natural raised embankments through Woodford that act as defences, and Ray Park in Woodford provides flood storage. There is also some flood alleviation and storage on the Cripsey and Loughton Brooks, as well as in a field near the Chigwell Road /

Broadmead Road junction. Downstream of the tidal limit of the Roding, at the A118, the Barking and Thames Barriers prevent the progression of tidal flood water upstream.

Hydraulic modelling

Climate change is potentially the most significant factor that will increase flood risk in the future. Climate change allowances, which are based on UK climate change projections that are regularly updated, are predictions of the anticipated change to:

- peak river flow
- peak rainfall intensity
- sea level rise
- offshore wind speed
- extreme wave height

There are different allowances for different epochs or time periods over the coming century.

Development

Development in the River Roding catchment has the potential to impact flood risk, either by reducing the area of natural floodplain or by increasing surface water run-off. The current strategies and local plans recommend the continued restriction of development in the floodplain and the incorporation of flood resistance and resilience measures through the planning system.

Under the National Planning Policy Framework, Local Planning Authorities are also required to take a proactive approach to flood risk and climate change when planning strategically for their development needs. Prioritising the allocation of land in areas of lowest flood risk first before considering areas with higher levels of risk is one of the requirements of national policy. This can reduce the future risk of flooding and vulnerability to climate change and also minimise the potential future costs of flood alleviation and flood defence maintenance. Where, by exception, some development in areas of higher flood risk is necessary, Local Planning Authorities should outline in planning policies the standards expected to fully mitigate the risks. They should aim to achieve a reduction in flood risk ensuring that developments will be safe and there is no increase in flood risk elsewhere. In addition, policies should make provision for the possible future relocation of vulnerable development and infrastructure out of areas of increasing flood risk.

Flood warning and community preparedness

The Environment Agency’s flood warning and alert service is available in all parts of the SA. The areas at highest risk of river flooding are Woodford, South Redbridge (Roding Lane), Ilford, and Loughton. These areas are covered by the Environment Agency's flood warning system for river flooding, provided by Flood Warnings Direct. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater.

The impact of climate change and future flood risk

Climate change is potentially the most significant factor that will increase flood risk in the future and rainfall intensity is expected to increase. This in turn will cause river flow levels to increase. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often.

For more information about the general impact of climate change on the Thames RBD, see the Thames RBD section of this report.

Objectives and measures for the Roding Valley Rivers and Sea Strategic Area

Measures have been developed which apply specifically to the Roding Valley Strategic Area.

The measures created as part of the FRMPs are part of a strategic six-year plan, which is reviewed annually. These measures describe short-term strategic actions, but do not make up all of the flood risk management work that is being carried out in the area. There is also a programme of works in place to fund specific projects, including physical works and schemes, modelling work, etc.

These measures have been developed in addition to measures covering a wider geographic area (Thames River Basin) but which also apply to the Roding Valley Strategic Area.

You can find information about all the measures which apply to the Roding Valley Strategic Area in the interactive mapping tool, Flood Plan Explorer. This includes information about which national objectives each measure helps to achieve.

Links between the FRMP and the RBMP 2022

Alongside flood risk management planning, the Environment Agency works with others to protect and improve the quality of the water environment. It does this through river basin management. The Environment Agency aims to co-ordinate the Flood Risk Management Plans (FRMPs) and the River Basin Management Plans: updated 2022 so that all organisations can do more for the environment. By developing the plans together, ways to achieve objectives for flood risk and drought management, and the water environment, including water quality and biodiversity, can be joined together wherever possible.

This is particularly important in order to achieve the main aim of the Water Environment (Water Framework Directive (WFD) England and Wales) Regulations 2017. The main aim of the WFD is to establish a framework for the protection of inland surface waters, estuaries, coastal waters and groundwater. You can find more information about this in the Thames RBMP 2022.

In a consultation in 2019/20, the Environment Agency sought views on the:

- challenges that our waters face
- choices and changes we all need to make to help tackle those challenges

Further information on the responses received can be found in the Challenges and Choices consultation summary report.

The Environment Agency has worked with Lead Local Flood Authorities (LLFAs) and other Risk Management Authorities (RMAs) to develop joint measures to reduce flood risk and improve the wider water environment. Aligning measures also helps to simplify the delivery of outcomes and make it more efficient.

By visiting the Thames RBMP 2022, you can find out more information on the objectives and measures for the Thames RBMP 2022.

How we will monitor implementation of the FRMP

For the duration of the second cycle (2021 to 2027), the Environment Agency will work with LLFAs and other RMAs to monitor progress in achieving all of the measures set out in the FRMP. This is a summary of the steps we will follow:

1. The implementation status of each measure in the FRMP will be reviewed and updated every year. This will be done by the authority responsible for implementing the measure.
2. This updated information will be collated by the Environment Agency and analysed to identify any trends in the data. This will allow the identification of possible common interventions which may help measure delivery.
3. Summary statistics will be produced to show how much progress has been made in that year.
4. These statistics and other key messages will be included in the annual report produced under section 18 of the Flood and Water Management Act (2010). This report is published each year and submitted to the relevant regional flood and coastal committee for review. It will also be available online to the public.
5. The updated status of each measure will also be viewable in Flood Plan Explorer.
6. At the end of the 6-year planning cycle, the FRMP will be reviewed and a summary of implementation progress over the duration of the planning cycle will be included. This is a requirement of the Flood Risk Regulations (2009).

Within the Environment Agency, teams will:

- Seek to embed strategic measures within their day job including in relevant documentation which highlights key goals and aims for each Environment Agency area.
- Aim to embed the annual reviews. This will be carried out via a board review process to ensure the measures we have created are still fit for purpose and fit for the changing pressures and demands in the area.
- Work collaboratively to integrate with other key strategic planning documents. This is including but not limited to, the River Basin Management Plan (RBMP 2022) and the Drainage and Wastewater Management Plan (DWMP).

By visiting the Part A document, you can find out more information on FCERM activities.

List of abbreviations

This list of abbreviations is intended as a reference tool. It includes the main abbreviations and terms used in the second cycle flood risk management plans.

Short form	Long form
AONB	Area of Outstanding Natural Beauty
CaBA	Catchment Based Approach
CDE	Catchment Data Explorer
Defra	Department for Environment, Food and Rural Affairs
DWMP	Drainage and Wastewater Management Plan
EIA	Environmental Impact Assessment
ELMS	Environmental Land Management Scheme
EPR	Environmental Permitting Regulations
FAG	Flood Action Group
FCERM	Flood and coastal erosion risk management
FPE	Flood Plan Explorer
FRA	Flood Risk Area (as identified under the Flood Risk Regulations 2009)
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
FRR	Flood Risk Regulations 2009
FWMA	Flood and Water Management Act 2010
HRA	Habitats Regulations Assessment

Short form	Long form
IDB	Internal Drainage Board
LEP	Local Enterprise Partnership
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MHCLG	Ministry of Housing, Communities and Local Government
MMO	Marine Management Organisation
NaFRA	National Flood Risk Assessment
NFM	Natural Flood Management
NNR	National Nature Reserve
NPPF	National Planning Policy Framework
NRW	Natural Resources Wales
PFRA	Preliminary Flood Risk Assessment
RBD	River Basin District
RBMP	River Basin Management Plan
RFCC	Regional Flood and Coastal Committee
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment

Short form	Long form
SEPA	Scottish Environment Protection Agency
SMP	Shoreline Management Plan
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
UKCP18	UK Climate Projections 2018
WFD	Water Framework Directive

Glossary

This glossary is intended as a reference tool. It includes the main terms used in the second cycle flood risk management plans and a short description of what they are.

25 Year Environment Plan

A plan produced by government which sets out goals for improving the environment, within a generation and leaving it in a better state. It details how government will work with communities and businesses to do this over the next 25 years.

Catchment

The area from which precipitation contributes to the flow from a borehole spring, river or lake. For rivers and lakes this includes tributaries (a river or stream flowing into a large river or lake) and the areas they drain.

Coastal erosion

The loss of land due to the effects of waves and, in the case of coastal cliffs, slope processes (such as high groundwater levels). This may include cliff instability, where coastal processes result in landslides or rock falls.

Flood Risk Area

Areas identified through the PFRA process where the risk of flooding is significant nationally for people, the economy or the environment (including cultural heritage).

Flood Risk Management Plan

A statutory plan prepared by the Environment Agency and LLFAs under the Flood Risk Regulations 2009. The plans are reviewed and updated every 6 years. The current plans cover the period 2021 to 2027.

Flood Risk and Hazard Mapping

Maps prepared under the Flood Risk Regulations 2009 to show potential risks and impacts of flooding in identified Flood Risk Areas. They are reviewed and updated every 6 years. The current maps use data and risk assessment data available in December 2019.

Flood Plan Explorer

A new, online, map-based tool which displays all of the measures proposed as part of the second cycle of flood risk management plans in England.

Fluvial flooding

Flooding from/of rivers.

Groundwater flooding

Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable layers are particularly susceptible.

Internal Drainage Board

A public body that manages water levels in areas known as internal drainage districts.

Internal Drainage District

Areas where there are special drainage needs, managed by internal drainage boards.

Lead Local Flood Authority

These are County, Unitary or Metropolitan Boroughs that are responsible for managing flooding from surface water, smaller watercourses and groundwater. There are 152 in England.

Local Flood Risk Management Strategy

Statutory strategies produced by Lead Local Flood Authorities under the Flood and Water Management Act 2010.

Main river

A watercourse shown as such on the main river map. They are usually the larger rivers and streams, and for which the Environment Agency has responsibilities and powers.

Management catchment

An amalgamation of a number of river water body catchments that provide a management unit.

National Flood and Coastal Erosion Risk Management Strategy

A statutory strategy prepared under the Flood and Water Management Act 2010, by the Environment Agency for England.

Ordinary watercourse

A watercourse that does not form part of a main river and is not shown on the main river map. LLFAs, district councils and internal drainage boards may carry out flood risk management work on ordinary watercourses.

Preliminary Flood Risk Assessment

The first stage in the six-year planning cycle to deliver the Flood Risk Regulations. The latest PFRAs were reviewed in 2017 for local sources of flood risk and 2018 for main rivers, the sea and reservoirs.

Preparedness measure

A measure (action) which aims to prepare people for flooding. Examples include flood forecasting and warning, flood emergency response planning and improving public preparedness for flooding.

Prevention measure

A measure (action) which aims to avoid putting people or the environment at risk of flooding. Examples include watercourse regulation, flood risk modelling and mapping and development planning and control.

Protection measure

A measure (action) which aims to better protect people from the risk of flooding. Examples include building flood defences, nature based solutions and asset maintenance.

Recovery and review measure

A measure (action) which aims to use learning from flood incidents. Examples include reviewing lessons learnt from flood response, supporting communities businesses and the environment to recover from flooding.

Reservoirs

A natural or artificial lake where water is collected and stored until needed. Reservoir owners and operators ('undertakers') must meet certain requirements under the Reservoir Act 1975.

River Basin District

Large river catchments in England. They cover an entire river system, including river, lake, groundwater, estuarine and coastal water bodies.

River Basin Management Plan

Statutory plans developed by the Environment Agency which set out how organisations, stakeholders and communities will work together to improve the water environment.

River flooding

Occurs when water levels in a channel overwhelms the capacity of the channel.

Services

Services include schools, hospitals, nursing/care/retirement homes, police stations, fire and ambulance stations, prisons, sewerage treatment works and electricity installations.

Sewer flooding

Flooding as a result of overloading of the sewerage system due to limited system capacity or failure of sewer asset.

Strategic Area

A locally defined area included in the Flood Risk Management Plans. They are areas with a similar geography or strategic ambition where it is important to consider flood risk management across administrative boundaries and river catchments.

Surface water flooding

Occurs when intense rainfall overwhelms local drainage capacities.

Tidal flooding

The temporary inundation of coastal areas during exceptionally high tides or storm surges.

Tide locking

Occurs when the level of the incoming high tide stops the river water from flowing out to sea. This can increase the risk of river flooding.

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