Severn River Basin District Flood Risk Management Plan 2021 to 2027

December 2022

This is a joint plan prepared by the following risk management authorities:

Bath & North East Somerset Council
Bristol City Council
Cheltenham Borough Council
Coventry City Council
Derbyshire County Council
Dudley Metropolitan Borough Council
Dŵr Cymru Welsh Water
Environment Agency
Gloucester City Council
Gloucestershire County Council
Herefordshire Council
Lower Severn (2005) Internal Drainage Board
Natural Resources Wales
North Somerset Council
North Worcestershire Water Management
River Lugg Internal Drainage Board
Sandwell Metropolitan Borough Council
Severn Trent Water
Shropshire Council
South Gloucestershire Council
Staffordshire County Council
Stroud District Council
Telford & Wrekin Council
Tewkesbury Borough Council
Warwickshire County Council
West Northamptonshire Council
Wolverhampton City Council
Worcester City Council
Worcestershire County Council

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

Flood risk is expected to increase as a result of the impacts of climate change. With a rapidly changing climate, the need to plan together to improve the overall resilience of our local places is more important than ever before. Flood risk in the Severn River Basin District (RBD) in England is widespread. Our mapping indicates that there are 193,729 people currently at risk of flooding from rivers and the sea, and 328,847 people at risk of flooding from surface water. The main sources of flooding affecting the RBD are fluvial, surface water and sewer. In many locations, multiple sources of flooding interact.

Since 2015, several significant and prolonged flood events have affected a substantial part of the Severn RBD in England. Over the past few years we have seen some of the highest river levels ever recorded on our gauges in the River Severn catchment, including on the River Wye, River Teme and River Lugg. Communities, businesses, infrastructure, rural areas and the environment have been impacted. Intense rainfall over localised areas has also caused significant surface water flooding to properties and highways. Many of these widespread and localised flood events have each affected hundreds of properties and have required significant recovery efforts over many months. In March 2020, we experienced the highest tides along the Severn Estuary since 1936 and the highest tides on the Wye Estuary since 1981.

The Severn RBD is partly in England and partly in Wales. Partnerships and collaboration are key, both within England and across the England/Wales border. The more we work and plan together, the more we can achieve for local people, places and our environment.

Over the last 3 years we have worked with Lead Local Flood Authorities (LLFAs) and other partners to develop Flood Risk Management Plans (FRMPs). This second cycle Severn RBD FRMP covers the part of the Severn RBD that is in England. Natural Resources Wales (NRW) will be producing a separate FRMP to cover the whole of Wales. Over 25 LLFAs and other risk management authority partners, including NRW, have joined us in developing this second cycle Severn RBD FRMP. We have successfully worked together to produce the second cycle FRMP despite the challenges from flooding 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 FRMPs 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:

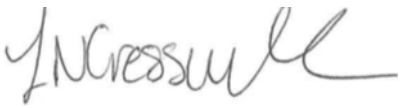
- identify actions that will reduce the likelihood and consequences of flooding

- improve resilience, which is the capacity of people and places to plan for, better protect, respond to, and to recover from flooding and coastal change, while informing the delivery of existing flood programmes
- work in partnership to explore wider resilience measures – including nature-based solutions, property flood resilience and sustainable drainage systems
- plan and adapt to a changing climate through developing longer term, adaptive approaches

We've developed the Flood Plan Explorer to support these plans. Having plans accessible on this online, map-based tool means we can stimulate even more opportunities for collaboration and co-operation across all we do.

We've listened to what you told us during the FRMP consultation that we carried out between October 2021 and January 2022. We've also listened to your views on the draft River Basin Management Plan so to better align the plans where possible. Measures (actions) in the Severn RBD FRMP help contribute to wider benefits for local places including climate mitigation and adaptation, nature recovery as well as integrated water management. Strengthening our working together in partnership to deliver actions that will help with climate resilience and an integrated catchment approach that provides multiple benefits are key parts of this final FRMP.

I'm pleased we have this opportunity to share the final FRMPs. This is an important milestone but not the end. We cannot do any of this alone and you've told us you want to get involved – please do.



Louise Cresswell
Acting Director of Operations (Midlands)
Environment Agency

Contents

Introduction to the Severn River Basin District FRMP

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

- Severn River Basin District Second Cycle Flood Risk Management Plan Habitats Regulations Assessment – a report on the findings of the habitats regulations assessment (HRA)
- Severn 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
- Severn 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 Plan (FRMP) is a plan to manage significant flood risks in the Flood Risk Areas (FRAs) identified in the Severn River Basin District (RBD). Producing the FRMP for these areas is a requirement of the 'Flood Risk Regulations 2009'. There are 10 FRAs in the Severn RBD:

- FRAs for main rivers and the sea – shown under the heading: Environment Agency Flood Risk Areas for main rivers and the sea and in Figure 1
- FRAs for surface water - shown in Table 1 and Figure 2

The approach to identifying FRAs is outlined in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

It's 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're in an FRA or not. For example, RMAs carry out flood risk management interventions such as warning and informing and capital investment and maintenance programmes. This second cycle FRMP has therefore been expanded to also show what is happening in other areas of the RBD that are outside of FRAs. This is similar to how the first cycle of FRMPs covering the period 2015 to 2021 were developed. The FRMP also signposts to other local plans and strategies that are likely to provide information on local actions for areas at risk of flooding.

The Severn RBD is partly in England and partly in Wales. The first cycle Severn RBD FRMP covered the whole RBD. This second cycle FRMP covers the part of the RBD that is in England. Natural Resources Wales (NRW) will be producing a separate FRMP to cover the whole of Wales.

The Environment Agency worked together with other RMAs in the RBD to develop the first cycle FRMP. This was in order to create a plan to manage the risk from all sources of flooding. The second cycle FRMP will build on this approach.

The ambition is for the second cycle FRMP to be a strategic, place-based plan that shows what is happening in flood risk management across the RBD. It's closely aligned with the:

- government's '25 Year Environment Plan'
- 'National Flood and Coastal Erosion Risk Management Strategy for England' (FCERM Strategy)

It's also aligned with the Environment Agency's 'FCRM Asset Management Strategy 2017-2022'. This is currently under review for republishing to cover 2021-2025, and beyond.

Two important elements of FRMPs are the objectives for managing flood risk and the measures proposed to achieve those objectives. The second cycle FRMP will encourage closer ways of working between RMAs that will help to achieve its revised objectives and measures. These revised objectives and measures align with the ambitions of the FCERM Strategy. They also support achieving wider environmental and growth ambitions of society. The second cycle FRMP is also aligned with the 'Severn River Basin Management Plan: updated 2022'. Together, these plans set the strategic goals and approaches to managing water and flood risk within the RBD. More information on the background to FRMPs, the Flood Risk Regulations and how FRAs were identified is in the 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

Contributors to the FRMP

The Environment Agency has worked with Lead Local Flood Authorities (LLFAs) and other RMAs to develop this second cycle FRMP. This second cycle FRMP covers the following sources of flood risk:

- fluvial
- tidal
- surface water
- sewer

The Environment Agency and those LLFAs with a surface water FRA within their administrative area must produce a FRMP. Other RMAs without FRAs have also contributed to this second cycle FRMP. This is to show what is happening to manage the risk of flooding across the Severn RBD in England. The RMAs involved in this second cycle FRMP are listed in Table 1 and under the heading: Other RMAs that have contributed to the FRMP.

More RMAs have been involved in the development of this second cycle FRMP than were involved in the first cycle FRMP. Developing the FRMP has been impacted by the extraordinary events of the past 3 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 relevant place-based measures from the first cycle FRMP that have not been completed - either individually or aggregated
- included new measures - mostly reflecting where we already had plans to work in the period 2021-2027, several of which have been developed using a strategic place-based approach
- included water and biodiversity objectives wherever possible in measures

We have engaged with NRW during the development of the second cycle FRMP. We have identified the measures in which they would like to be involved.

Our ambition for the period 2021-2027 is to continue to drive catchment-based delivery in the Severn 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'.

Working in partnership is the most effective way to address the issues of flooding and climate change and to deliver multiple benefits. During the period 2021-2027 the Environment Agency and RMA partners will continue to work together to produce strategic plans such as the:

- evolving drainage and wastewater management plans - led by water companies
- review of the local flood risk management strategies - led by LLFAs
- review of the 'Severn Estuary Shoreline Management Plan' - led by the relevant Coastal Groups

We also intend to continue developing and strengthening our working with others to identify, develop and deliver solutions that will increase resilience to flooding and climate change and aid nature recovery in the River Basin District. Further information on partnership working is in the Managing Flood Risk Section. The FRMPs are not intended to cover the detail of this partnership working.

Environment Agency FRAs for main rivers and the sea

There are 5 FRAs identified as being at significant risk of flooding from main rivers and the sea that are in, or cross into, the Severn RBD. These are:

- Bath
- Bristol

- Henley-in-Arden
- Gloucester
- Weston-Super-Mare

The Weston-Super-Mare FRA spans both the Severn and South West RBDs. It is described solely within the second cycle 'South West River Basin District Flood Risk Management Plan'.

LLFAs with surface water FRAs within their administrative boundary

There are 5 FRAs identified as being at significant risk of flooding from surface water that are in, or cross into, the Severn RBD. These are shown in Table 1.

Table 1: a list of the FRAs at risk of flooding from surface water and their LLFAs

Flood Risk Area name	LLFA name(s)
Bristol	Bristol City Council
Cheltenham	Gloucestershire County Council
Coventry	Coventry City Council, Warwickshire County Council
Redditch	Worcestershire County Council
Wolverhampton	City of Wolverhampton Council, Staffordshire County Council

The Wolverhampton FRA for surface water spans both the Severn and Humber RBDs. It is described solely within this second cycle Severn RBD FRMP.

Other RMAs that have contributed to the FRMP

RMAs without FRAs in England have contributed to this FRMP. These are:

1. Bath and North East Somerset Council
2. Cheltenham Borough Council
3. Derbyshire County Council
4. Dudley Metropolitan Borough Council
5. Dŵr Cymru Welsh Water
6. Gloucester City Council
7. Herefordshire Council
8. Lower Severn (2005) Internal Drainage Board

9. Natural Resources Wales
10. North Somerset Council
11. River Lugg Internal Drainage Board
12. Sandwell Metropolitan Borough Council
13. Severn Trent Water
14. Shropshire Council
15. South Gloucestershire Council
16. Stroud District Council
17. Telford & Wrekin Council
18. Tewkesbury Borough Council
19. West Northamptonshire Council
20. Worcester City Council
21. RMAs involved in the following partnerships where not yet mentioned:
    - Coventry, Solihull & Warwickshire Resilience (CS&W Resilience)
    - North Worcestershire Water Management
    - South Worcestershire Land Drainage Partnership

Whilst not all RMAs have been involved in the development of the FRMP, they are all valuable partners in the delivery of measures to reduce flood risk.

Relevant plans and strategies

In preparing the FRMP, RMAs reviewed the first cycle FRMP objectives and measures together with existing and evolving national and local plans and strategies. For this FRMP, relevant plans and strategies include the:

- 'National Flood and Coastal Erosion Risk Management Strategy for England' (FCERM Strategy)
- 'Severn River Basin Management Plan: updated 2022' (RBMP 2022)
- 'Bristol Local Flood Risk Management Strategy'
- 'Bristol Surface Water Management Plan'
- 'Bristol Avon Flood Strategy' (emerging)
- 'Bath & North East Somerset Local Flood Risk Management Strategy'
- 'The Black Country Local Strategy for Flood Risk Management'
- Coalbrookdale Rapid Response Multi-Agency Plan
- 'Coventry City Council Local Flood Risk Management Strategy'
- 'Coventry Surface Water Management Plan'
- Dŵr Cymru Welsh Water 'Drainage & Wastewater Management Plan' (evolving)
- Environment Agency 'FCRM Asset Management Strategy 2017-2022' (currently under review for republishing to cover 2021 – 2025, and beyond)
- 'Gloucestershire County Council Local Flood Risk Management Strategy'
- Gloucestershire County Council Surface Water Management Plans
- 'Herefordshire Council Local Flood Risk Management Strategy'
- Ironbridge Temporary Flood Barriers Multi-Agency Plan
- 'North Somerset Local Flood Risk Management Strategy'

- 'Severn Estuary Shoreline Management Plan'
- draft 'Severn Estuary Flood Risk Management Strategy'
- Severn Trent Water AMP 7 Business Plan (OFWAT approved)
- 'Severn Trent Water's Climate Change Adaptation Report'
- Severn Trent Water 'Drainage and Wastewater Management Plan' (evolving)
- Severn Trent Water 'Sustainability Report 2021'
- 'Shropshire Council Local Flood Risk Management Strategy' (being updated)
- Shropshire SuDS Guidance Document for new developments
- 'South Gloucestershire Council Local Flood Risk Management Strategy'
- Telford & Wrekin Climate Change Action Plan
- 'Telford & Wrekin Council Local Flood Risk Management Strategy'
- 'Telford & Wrekin Local Plan'
- 'Warwickshire County Council Local Flood Risk Management Strategy'
- 'Warwickshire Surface Water Management Plan'
- Wessex Water's Drainage and Wastewater Management Plan (evolving)
- 'Worcestershire County Council Local Flood Risk Management Strategy'
- 'Worcestershire Surface Water Management Plan'
- Strategic Flood Risk Assessments (various)

Many Local Flood Risk Management Strategies are likely to be reviewed and updated in the period 2021-2027.

Approach to Objectives and Measures

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

- 'Flood Risk Regulations 2009'
- 'National Flood and Coastal Erosion Risk Management Strategy for England' (FCERM Strategy) and 'Roadmap'
- Government's '25 Year Environment Plan'

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

In drawing the measures together for the second cycle FRMPs, RMAs have:

- revisited the priorities
- ensured there is a shared understanding of the main flood risks and how best to manage them

This second cycle FRMP includes measures for:

- FRAs in the RBD
- areas that fall wholly within management catchments (Management Catchment level)
- areas that span across or cover more than one management catchment (RBD level)

A ‘management catchment’ is a 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 RBD. The management catchments in the Severn RBD are listed in the ‘Overview of the Severn RBD’ section. Including these in this second cycle FRMP is consistent with how we presented measures in the first cycle FRMP. Our mapping of measures in management catchments will help the Environment Agency and RMA partners to identify opportunities where we can work together, and with others, to provide multiple benefits and to take a catchment-based approach.

You can find more information about the second cycle objectives and measures within the Second cycle objectives and measures section.

The first cycle Severn RBD FRMP contained many measures that reflected the day to day activities carried out by RMAs. Day to day activities have not been included as measures in this second cycle FRMP. For example, the individual measures in the first cycle FRMP that related to maintenance activities set out in the draft ‘Severn Estuary Flood Risk Management Strategy’ have not been included. These, and the other day to day activities, will however be continuing in the period 2021-2027. They are now captured in the national level measures the Environment Agency and LLFAs carry out as part of their routine day to day work that are relevant to all FRMPs. You can find information about these national level measures in the interactive mapping tool - Flood Plan Explorer.

The Severn RBD

Overview of the Severn RBD

The Severn River Basin District (RBD) is one of 10 RBDs that are wholly or partly in England. The Severn RBD spans the England and Wales border and lies mainly within England. This Flood Risk Management Plan (FRMP) covers the English portion of the Severn RBD only. You can find out more about the flood risk management planning process in Wales by visiting Natural Resources Wales.

The Severn RBD extends from the uplands of Wales, down through valleys and rolling hills to the lowlands and the Severn Estuary. The RBD covers an area of over 21,000 kilometres squared. The water bodies of the Severn RBD are made up of:

- 7,512km of river
- 76 lakes
- 36 canals
- 40 ground water bodies
- 545km2 of estuary

The Severn is the longest river in Britain, stretching 350km from its source in Wales to the mouth of the Bristol Channel. Its main tributaries in England include the following rivers:

- Vyrnwy
- Teme
- Warwickshire Avon
- Wye
- Bristol Avon

The RBD in England is divided into 8 management catchments with 5 catchments within England:

- Shropshire Middle Severn
- Worcestershire Middle Severn
- Warwickshire Avon
- Severn Vale
- Bristol Avon & North Somerset Streams

Three management catchments straddle the border between England and Wales:

- Severn Uplands
- Teme
- Wye

These catchments range from energetic upland streams to slower rivers in the lowlands. They include sandstone and limestone aquifers used for public water supply in the Midlands.

The Severn RBD is home to around 4.55 million people. Major urban centres in England include:

- Bristol
- Gloucester
- Shrewsbury
- Worcester
- Coventry
- parts of the West Midlands conurbation

Outside urban centres, the RBD is mostly rural, with land managed for agriculture and forestry.

The RBD has a particularly rich diversity of wildlife and habitats, supporting many species of global and national importance. For example, the Severn Estuary and its surrounding area are protected for their:

- bird populations
- habitats
- migratory fish species - such as Atlantic salmon, shad, lamprey and eel

The area has a wealth of designated and undesignated heritage assets. The floodplains of the Severn and its tributaries have acted as a focus for human activity from the prehistoric

period onwards. The Severn RBD's historic riverside towns include Shrewsbury, Hereford, Worcester and Tewkesbury. These include concentrations of:

- medieval and post medieval scheduled monuments
- listed buildings
- registered parks and gardens
- conservation areas

There are also internationally recognised World Heritage Sites at Ironbridge Gorge and the City of Bath.

Designated landscapes include Areas of Outstanding Natural Beauty (AONB) such as:

- the Mendip Hills
- Cotswolds
- Shropshire Hills
- Malvern Hills
- Wye Valley

The local economy of the RBD is supported by:

- business
- transport
- health
- tourism
- recreation
- manufacturing
- mineral industries
- operation of commercial ports

Examples include manufacturing at Avonmouth, and sand/gravel extraction within the Severn Valley.

Important infrastructure includes the rail and motorway network. Motorways provide links from the South West to the West Midlands, Wales and London. The proposed HS2 route links London to Birmingham. Existing commercial ports and the canal network also provide important infrastructure – such as:

- Kennet & Avon Canal
- Gloucester & Sharpness Canal

Growth and development pressures within the RBD are particularly associated with the major towns and cities. This is also an increasing issue for the wider settlement network of market towns and villages. Other development pressures include wind energy and transport infrastructure.

For this second cycle FRMP, within or crossing into the Severn RBD there are:

- 5 FRAs for significant risk of flooding from main rivers and the sea (Figure 1 shows the 4 FRAs described in the Severn RBD FRMP)
- 5 FRAs for significant risk of flooding from surface water (Figure 2)

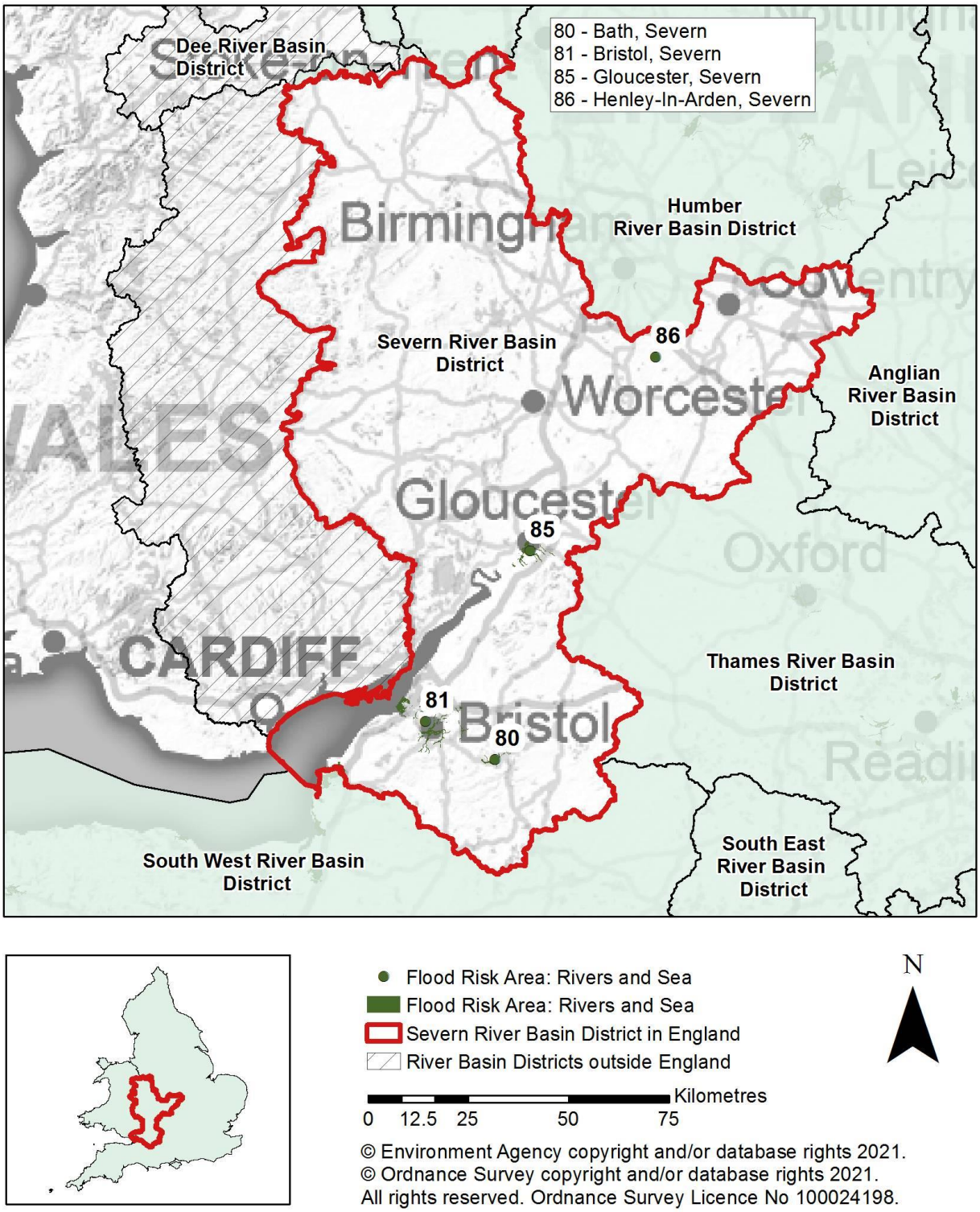


Figure 1: FRAs for significant risk of flooding from main rivers and the sea in the Severn RBD.

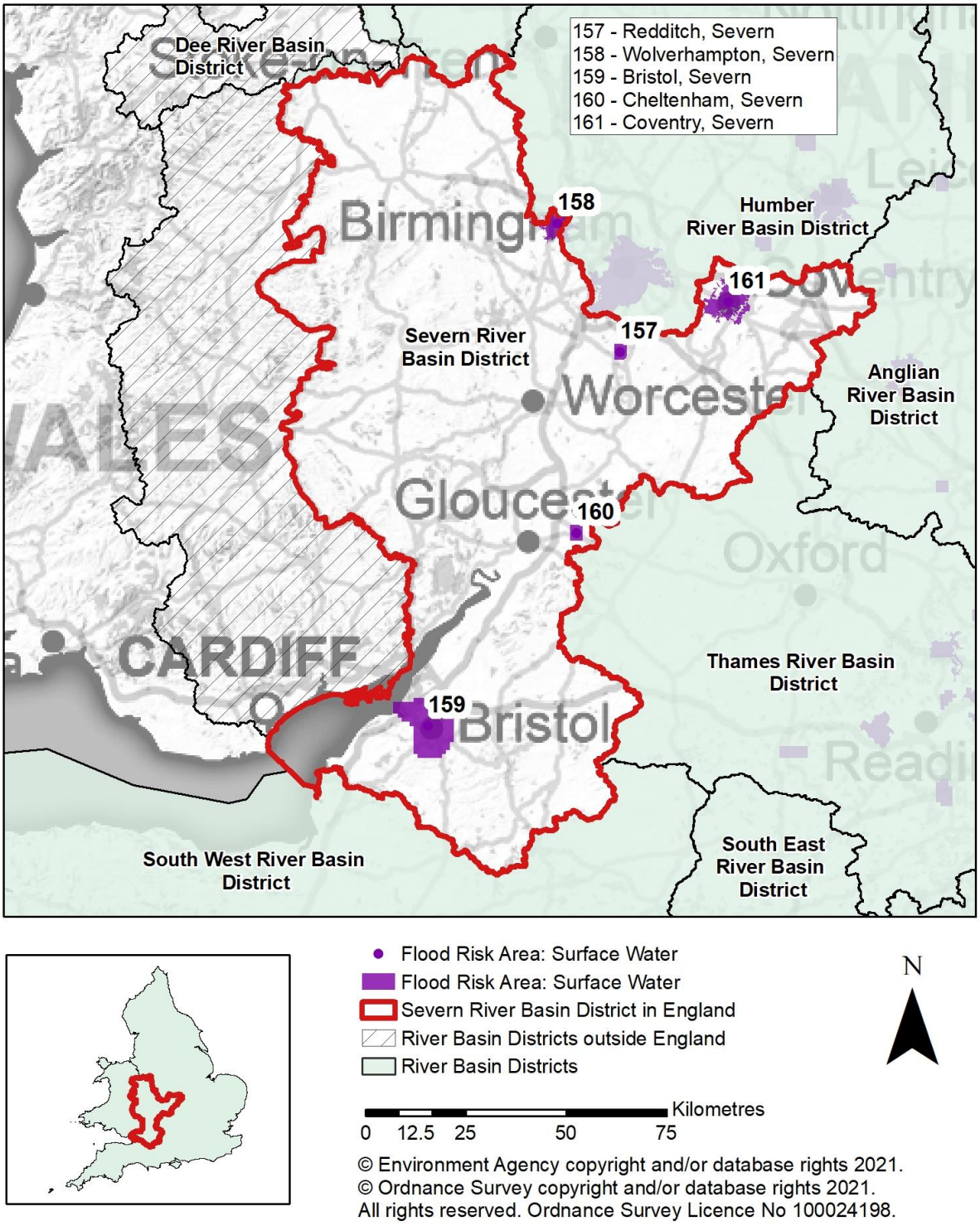


Figure 2: FRAs for significant risk of flooding from surface water in the Severn RBD

The location of these FRAs is set out in the Introduction to the FRMP section.

The number and type of these FRAs differs from the first cycle Severn RBD FRMP. The first cycle plan had two FRAs, both for significant risk of flooding from surface water. These were the:

- West Midlands FRA
- Bristol FRA

The West Midlands FRA spanned across the Severn and Humber RBDs and information was provided in the first cycle Humber RBD FRMP. The West Midlands FRA has been refined during the development of this second cycle of planning. Some parts of that area are now included in 2 new FRAs for significant risk of flooding from surface water: Birmingham and Wolverhampton. The Bristol Surface Water FRA has also been refined for the second cycle as a result of updated modelling and other new flood risk information.

The first cycle Severn RBD FRMP did not include any FRAs for significant risk of flooding from main rivers and the sea. New FRAs for this risk of flooding have been added in this second cycle FRMP.

Each of the second cycle FRMP defined FRAs, except the Birmingham Surface Water FRA, are discussed in more detail in the 'Flood Risk Area objectives and measures' section. There is negligible overlap of the Birmingham Surface Water FRA into the Severn RBD. This FRA is therefore discussed in more detail in the second cycle Humber RBD FRMP.

For further information about the Severn RBD, please read the accompanying 'Severn River Basin District Second Cycle Flood Risk Management Plan – Strategic Environmental Assessment: environmental report'. This includes information on topics such as the landscape, geology and cultural heritage of the Severn RBD.

The main flood risk issues and changes in the Severn RBD

Flood risk in the Severn River Basin District (RBD) in England is widespread and originates from a range of sources, either individually or in combination. Flood risk is expected to increase as a result of the impacts of climate change.

Sources of flooding include:

River (fluvial) flood risk

River channels are sufficient to take varying flows of water for most of the year. River flooding occurs when the amount of water in a river channel exceeds its capacity. This can happen, for example, when heavy rain falls on an already waterlogged catchment or

where blockages within the channel cause water to back-up. The water level rises above the riverbanks and spills into the river's floodplain, where historically properties, businesses, heritage assets and infrastructure have been built, and land farmed. Flooding can either develop gradually or rapidly according to how steeply the ground rises in the catchment and how fast water runs off into surface watercourses.

Fluvial flooding in the Severn RBD occurs both from watercourses designated as main river, and from ordinary watercourses. Fluvial flooding events have been recorded throughout the RBD since the thirteenth century. Due to its size, RBD-wide events are rare, though large parts of the RBD have been affected during individual incidents. Recent major events that had impacts over large parts of the RBD include 2007 and winter 2019/2020.

The main sources of river flood risk in the RBD are from:

- prolonged rainfall
- torrential rainfall
- rapid snow melt

Continuous heavy rainfall over a long time causes major and widespread flooding, especially when this follows earlier rainfall and the ground is already wet. Torrential rainfall can cause flash flooding in smaller river catchments. Rapidly melting snow can cause major and widespread flooding such as that seen in 1947.

The speed and duration of river flooding in the RBD can vary greatly. In the upper parts of catchments, where the topography is steeper, watercourses can respond rapidly to high levels of rainfall.

There are 19 'rapid response catchments' in the Severn RBD that could be susceptible to extreme flash flooding. In these catchments, a river or stream can react very rapidly to rainfall and generate large flood depths or velocities of water that pose an extreme threat to life. There is often little or no time to warn of the impending danger, and so it is important that communities and partners can recognise the risk and respond effectively. As a result, Rapid Response Catchment Action Plans have been put in place for these areas.

Longer, more sustained flooding, is experienced in the middle to lower lengths of the larger watercourses such as the rivers:

- Wye
- Severn
- Warwickshire Avon
- Bristol Avon

Here the topography is much flatter, for example the floodplain in the lower Severn valley is up to a mile wide. The geology comprises mudstones and clays. These have low permeability and can become easily saturated.

Within the RBD there are many examples of flood defences that reduce the risk of flooding to:

- major urban areas
- local communities
- agricultural land
- infrastructure
- heritage assets
- the environment

Defences in the RBD take the form of:

- earth embankments
- flood walls
- outfall structures
- attenuation areas
- engineered channels
- demountable/temporary barriers
- individual property flood resilience measures

Defences have been updated from time to time, generally in response to flood events. Natural flood management measures have also been carried out across the catchment that slow the flow and reduce flood risk.

In addition to the direct impact on homes and businesses, flooding can be very disruptive to communities within the areas affected. Road flooding causes access issues and travel disruption. Water can take many weeks to drain from the floodplain and this delays the recovery of the communities affected by flooding. Such impacts have occurred, for example, in 2014 and 2020.

A summary of the risk of flooding from rivers and sea in the RBD is shown in the Second cycle summary of flood risk for the Severn RBD section.

The Risk of Flooding from Rivers and the Sea map shows the chance of flooding from rivers and the sea. This is presented in categories that take account of flood defences and the condition that they are in.

Coastal and tidal flood risk

The Severn RBD covers 545 kilometres squared of the Severn Estuary. Catchments of rivers such as the Severn, Wye and Bristol Avon all feed into the Severn Estuary.

The Severn Estuary has one of the highest tidal ranges in the world and has been a focus for human activity for many centuries. Its floodplains:

- cover 50,000 hectares of land
- provide a home for around a quarter of a million residents
- contain £14 billion of important infrastructure

Combined high tides and a sea surge during storms in the Severn Estuary can cause severe flooding. Tidal flood risk affects:

- the whole Severn Estuary
- the Bristol Avon
- areas of North Somerset
- the lower reaches of the River Wye

Areas adjacent to the Severn Estuary are relatively flat with very little elevation. This means that tidal inundation can affect large areas with brackish water. The influence of the sea is dominant in the lower reaches of the Severn Estuary, with wave action increasing flood risk south of the Severn Bridges. The influence of the river is greater north of Sharpness, with the greatest flood risk near Gloucester caused by high fluvial flows. Many of the areas adjacent to the Severn Estuary are provided with a level of protection by defences.

The confluence areas where the rivers enter the Severn Estuary are at risk from combined tidal and fluvial flooding. High water levels in the Severn Estuary can also indirectly contribute to flooding by preventing local watercourses from draining into the river.

To date, actual tidal flooding in the RBD has been rarer in occurrence than fluvial flooding. Brockweir, on the Wye Estuary, has however regularly been affected by tidal flooding even when fluvial levels are low. The most recent tidal events affecting property have occurred in 1999 and March 2020. March 2020 saw the highest tides along the Severn Estuary since 1936 (Sharpness gauge) and the highest tides on the Wye Estuary since 1981 (Avonmouth gauge). The upper end of the estuary, towards Gloucester, has more often been affected by high tides combining with fluvial flooding, including in 2014.

The Environment Agency has a responsibility to create important coastal habitats that have been lost as a result of the presence of flood and coastal defences in the Severn Estuary. Over the past 10 years new coastal habitats such as Steart Marshes in Somerset have been created as part of our ongoing habitat creation programme.

A summary of the risk of flooding from rivers and sea in the RBD is shown in the Second cycle summary of flood risk for the Severn RBD section.

Further information on tidal flood risk and management of tidal flooding can be found in the 'Severn Estuary Shoreline Management Plan' and the draft 'Severn Estuary Flood Risk Management Strategy'. The Risk of Flooding from Rivers and the Sea map shows the chance of flooding from rivers and the sea. This is presented in categories that take account of flood defences and the condition that they are in.

Coastal erosion

In the Severn RBD, the coastal boundary starts at the railway bridge at Sharpness.

Coastal erosion is a natural and ongoing process that has been happening for thousands of years. Wave action increases the erosion risk south of the Severn Bridges. With sea levels continuing to rise well into the next century, the rate of coastal erosion in some places will accelerate.

Coastal erosion is managed by a range of partners. The Environment Agency has the coastal Strategic Overview in England. The coastal overview joins up coastal management activities to ensure flooding and erosion risk is managed effectively. The overview encourages authorities to work together in partnership to achieve effective management of coastal flooding and erosion risks. Work to tackle coastal erosion is the responsibility of district or unitary councils. Local authorities have operational powers relating to managing coastal erosion under the 'Coast Protection Act 1949' and the 'Flood and Water Management Act 2010'. Local Authorities lead on coastal risk management activities and undertake works on coastal erosion where they are best placed to do so. This is undertaken in collaboration with the Environment Agency.

Erosion can threaten the stability of flood defences along the Severn Estuary, including in the area above Sharpness to Gloucester that is upstream of the coastal boundary. Monitoring carried out through the South West Regional Coastal Monitoring Programme and by local groups such as Advance the Line provides information on erosion. Additionally, the Environment Agency and local authorities visually inspect flood defences, especially after storms. The risk to the defences from erosion is reviewed and issues are monitored. Action is taken where erosion threatens the stability of a flood defence and the public investment can be justified.

Surface water (pluvial) flood risk

Surface water flooding is usually the product of short duration but intense storms. It occurs when the ground is unable to absorb the high volume of water that falls on it in a short period of time. This results in overland flow and ponding in depressions in the topography. Water running off moderately to steeply sloping areas, such as in the upper river catchments, can lead to high surface flow velocities. Surface water run-off can be exacerbated by local influences such as soil type and land use. Particularly within urban areas, the ground is unable to absorb water due to the non-permeability of many surfaces such as paved roads. Surface water run-off can cause flooding directly, or indirectly via the overwhelming of drainage systems.

There are many areas across the RBD that are at risk of surface water flooding. Historically, all counties in the RBD have had locations that have been affected, often in combination with other sources of flooding such as sewers and watercourses. Surface water flooding is often short lived and localised.

Most recently, surface water flooding in June 2016 affected parts of Dudley, Sandwell, Gloucestershire and Warwickshire. In 2020, several surface water flooding events affected parts of the RBD, both in summer and winter months. Thunderstorms in June 2020 resulted in surface water flooding in:

- Gloucestershire
- Shropshire
- Staffordshire
- Warwickshire
- West Midlands
- Worcestershire

Approximately 300 properties in the Telford & Wrekin Council area were flooded after thunderstorms in August 2020. A short period of intense rainfall that fell on saturated ground in December 2020 resulted in significant surface water flooding in Gloucestershire. This affected over 200 properties and highways across all districts of the county.

Measures that have been carried out in locations across the RBD to reduce flood risk include:

- new drainage infrastructure
- surface water attenuation
- natural flood management
- property flood resilience measures

A summary of the risk of flooding from surface water in the RBD is shown in the Second cycle summary of flood risk for the Severn RBD section.

Further information on the risk and management of surface water flooding can be found in the Local Flood Risk Management Strategies listed in the 'Relevant plans and strategies' section.

Groundwater flood risk

Groundwater flooding tends to arise after periods of sustained rainfall and can last for long periods of time. Groundwater is naturally stored in the ground below the water table level. Sustained high rainfall means more water will infiltrate into the underlying rocks and strata and cause the water table to rise above normal levels. Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from abnormal springs. It can also be caused by water moving through the superficial sediments near to rivers, where the sediments allow the movements of water more readily than less permeable sub-surface rocks.

Reports of groundwater flooding across the Severn RBD are not common, though some areas are known to have been affected by a high water table. There have been relatively few number of reports of localised groundwater flooding occurring compared with other sources of flooding. A small number of reports have been made of groundwater flooding in isolation. Generally though, where groundwater flooding has occurred it has been in combination with other sources of flooding. This can make it difficult to distinguish groundwater flooding from these other sources.

In some areas, groundwater has become a re-emerging issue where industry has reduced, and the volumes of water being abstracted from groundwater sources has fallen. This includes in parts of Coventry and the Black Country.

Further information on the risk and management of groundwater flooding can be found in the Local Flood Risk Management Strategies listed in the relevant plans and strategies section.

Sewer flood risk

In villages, towns and cities within the RBD, rainwater falling onto impermeable areas usually drains into:

- surface water sewers
- sewers containing both surface water and wastewater, known as combined sewers

During times of heavy rainfall the capacity of these sewers can be exceeded, resulting in ‘sewer flooding’.

Modern sewer systems are designed to cope with rainfall events that have a 3.3% annual probability. This design standard recognises the influence of road gully design, which holds back more intense rainfall. Historically many sewers in the RBD were built to the standards of protection that prevailed at the time and have less capacity. These sewers are not therefore able to accommodate rainfall events with a 3.3% annual probability. Urbanisation and climate change are increasing the risk of the sewer system becoming overloaded.

Sewers can also be affected by high water levels in watercourses and rivers. This can occur where river water enters manholes, or more often when sewer outfalls become submerged.

Sewer flooding has occurred in locations across the RBD due to capacity related issues. This includes in several FRAs where the risk of flooding from surface water or rivers and the sea is significant nationally, such as Coventry, Cheltenham and Gloucester. Examples of other locations that have been affected by capacity related sewer flooding include:

- Alcester
- Leamington Spa
- Slimbridge
- Stroud
- Telford
- Worcester

Sewer flooding in the RBD due to capacity related issues often occurs at the same time as surface water and/or river flooding. Recent such events include those that occurred in June 2016 and February 2020.

Any town or village in the RBD could also be at risk of sewer flooding as a result of the following causes:

- backing up of wastewater due to temporary problems within the sewer network - such as blockages or collapses
- equipment failure - such as pumping stations

Sewer systems are designed not to block up, but some locations can be susceptible to blockages. If the wrong things are flushed down toilets (such as wipes, sanitary products and nappies) or washed down sinks (cooking fats and oils) then this can increase the chance of a sewer blocking. Blockages can occur in small as well as large diameter sewers.

Sewer flooding in the RBD is managed by Severn Trent Water, Dŵr Cymru Welsh Water and Wessex Water. There has been, and continues to be, significant investment by the water companies to reduce sewer flooding in the RBD. This includes:

- a major £20 million sewerage strategy/scheme in Leamington Spa
- over £10 million on a major sewer flood alleviation scheme in Gloucester
- over £7 million invested in various locations in Cheltenham

In more recent times solutions have given more focus on developing partnership working initiatives to manage surface water more effectively to alleviate the risk of both sewer and surface water flooding. For example, surface water and sewer flooding schemes completed at

- Chesholme Road, Coventry
- Slimbridge, Gloucestershire
- Ketley in Telford

Water companies in the RBD are currently developing long-term strategic Drainage and Wastewater Management Plans (DWMPs) for publication in spring 2023. Drafts for formal consultation were published in summer 2022. The aim is that these DWMPs will align with and support other strategic plans to facilitate collaborative/partnership working. Local Flood Risk Management Strategies, produced by Lead Local Flood Authorities, also include information on sewer flooding in the area they cover.

Canal flood risk

There are 36 canals within the Severn RBD. The majority are owned and operated by the Canal & River Trust (formerly British Waterways). In some areas of the RBD, canals interact with rivers in several locations, such as in Droitwich and Stroud.

There have been occasions in the Severn RBD of flooding from:

- Breaching and overtopping of canals – such as in Bathampton
- Vandalism of canal infrastructure – such as in Worcester

The Canal & River Trust (the Trust) is not a designated Risk Management Authority (RMA) within the Flood and Water Management Act (2010). The Trust though has various responsibilities to manage the canals and waterways for which it is a navigation authority. The Trust aims to manage water levels within a 'normal operating zone' that is specific to a certain location and thus reduce the risk of overtopping. The Trust manages and maintains its network to reduce risks of asset failure.

Further information on the risk and management of canal flooding can be found in the Local Flood Risk Management Strategies in the 'Relevant plans and strategies' section, and by visiting Canal & River Trust.

Reservoir flood risk

Within the Severn RBD there are 132 reservoirs in England and 135 reservoirs in Wales. They have been built:

- to feed canals
- to reduce flood risk
- to irrigate farmland
- for fisheries
- to provide water supply - for either drinking water or (historically) for industrial processes

They have a limited effect on flood flows downstream, although they can help to locally attenuate flood waters. This includes the reservoirs at Lake Vyrnwy and Llyn Clywedog in the headwaters of the Rivers Vyrnwy and Severn in Wales that provide a river regulation function. Clywedog is primarily designed to boost low flows along the River Severn to support the environment and balance abstractions downstream, with a small portion of Lake Vyrnwy also available. Both reservoirs also provide some flood mitigation for local areas. There is only a limited flood benefit in the upper reaches of the Severn.

The likelihood of flooding from a reservoir is far lower than for other types of flooding. Legislation ensures reservoirs are regularly inspected by trained civil engineers and owners are legally required to do essential safety works. There are very high safety standards for reservoirs in the UK which makes the likelihood of a failure very low. There has been no reservoir flooding in England resulting in a loss of life since 1870, when a reservoir at Rishton, Lancashire failed.

Reservoir flooding in the Severn RBD is unlikely for the reasons given above. As a worst case scenario, mapping indicates that in the RBD (including Wales) approximately 260,000 people live in areas at risk of reservoir flooding.

Also in areas at risk of reservoir flooding are:

- 37,000 non-residential properties
- 730 key services
- 3,360 listed buildings and

- 6,000 hectares of Special Areas of Conservation (SAC)

The mapping has assumed reservoirs are full at the time of breach, that there are no emergency reservoir operating measures and that lots of different reservoirs fail at the same time. Numbers are therefore precautionary.

The flood risk from reservoirs map shows the maximum extent of flooding, depth and speed of flow in the unlikely event that a reservoir fails.

Land management and flooding

Much of the RBD is rural in character, with land managed for agriculture and forestry. This includes:

- improved grassland for extensive beef and sheep farming
- large dairy farms
- some arable and specialist horticulture such as orchards and fruit

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 can impact on food production.

The major woodland use types in the RBD are coniferous and deciduous woodland distributed throughout the catchment. This includes around Ironbridge Gorge and the Wyre Forest, much of which is ancient woodland.

The catchment is also characterised by urban centres that are built along the Severn and its tributaries. These population centres vary from small to medium in the upper catchments to large urban and sub-urban areas in the lowland floodplains.

The way in which land is used and managed can significantly impact on flood risk.

Compacted fields reduces permeability and increases rate of surface water run-off. Fields can also be churned up during ploughing making it easier for particles of soil to be mobilised during rainfall events. Increased sediment can cause siltation and blockages in receiving ditches and culverts. In some more rural areas of the RBD, surface water run-off from land and increased sediment from soil mobilised during rainfall events has increased the risk of flooding in downstream towns, villages and highways.

In urban areas, a key challenge is the non-permeability of many surfaces that reduce the ability of water to filter into the ground. Not all development is subject to planning procedures or the development control process, and therefore its impact on flooding is less likely to be controlled. Urban creep, such as property extensions, is an example of this. Urban creep increases the amount of hard surfaces in towns. Non-permeable surfaces have resulted in surface water flow over land and an increase in the volume of water that has to run off into drains.

The coastal areas around the Severn Estuary have a very particular challenge. They lie at or near sea level. Much of the land has been reclaimed and is heavily reliant on ancient systems of drainage ditches.

Changes in land use and land management practices are reducing flood risk in the RBD. Field scale research has shown that good soil husbandry reduces the risk of soil damage and increases the retention of water in the soil profile. This can result in lower volumes of runoff from fields.

There is growing evidence that natural flood management helps to slow down or even reduce flood flows. NFM measures implemented upstream of areas of flood risk, including in the headwaters of catchments, can complement conventional flood or sea defences to enhance flood and coastal resilience by:

- reducing flood risk
- helping communities to recover faster
- building resilience into hard defences
- reducing the impacts of climate change

Natural flood management and nature based solutions can also have other multiple benefits. These, and the various types of NFM, are described in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

Communities and businesses, including landowners and farmers in the countryside, have an important role to play in managing and reducing flood risk and increasing their resilience to floods. A combination of incentive, advisory and regulatory measures help farmers and other land managers protect the environment. The introduction of the Environmental Land Management Scheme may offer greater opportunities to maximise both environmental benefits and reductions in flood risk.

In urban areas, retrofitting sustainable drainage systems (SuDS) has helped to manage the rate of surface water runoff from the urban environment, reducing the risk of flooding. Other activities being actively investigated/delivered with communities are to manage a greater proportion of runoff generated in urban environments at source through green infrastructure. The types of measures include:

- green roofs
- rain gardens
- front garden planter boxes
- permeable paving
- disconnection to gardens
- disconnection to other permeable areas

These changes in land use and changes in land management practices are also helping to improve water quality.

Further information on the risk of flooding from land can be found in the Local Flood Risk Management Strategies in the Relevant plans and strategies section.

Managing flood risk across the Severn River Basin District

Often locations in the Severn RBD are at risk from more than one source of flooding. These can interact making analysis and solutions difficult. Due to the integrated nature of flooding, managing flood risk requires many organisations to work in partnership together and with other stakeholders and local communities. Flood risk management multi agency partnership groups exist in all counties in the Severn RBD in England. The RMAs have worked together to reduce the risk to many thousands of properties. Our work includes measures to prevent, prepare for, protect against and recover from flooding. Information on the day to day activities carried out by the Environment Agency and Lead Local Flood Authorities (LLFAs) can be seen in the national level measures in the interactive mapping tool - Flood Plan Explorer.

In 2019, partners spanning the River Severn Catchment came together to form the River Severn Partnership. This multi-sector Partnership covers a large area of the RBD and is taking a holistic approach that will provide multiple benefits (see Case Study: River Severn Partnership).

The Environment Agency works with Natural Resources Wales (NRW) to manage flood risk in the Severn RBD. We do take different approaches but we share data and regularly liaise on the planning and delivery of flood risk management services to ensure that flood risk is managed appropriately. For example, we work together to forecast and warn for floods as they pass through the Severn/Wye catchment. We continue to actively engage with NRW and other cross border partners to establish effective ways of working that enable delivery of multiple benefits for people, places and the environment. NRW is a partner in the River Severn Partnership.

The Environment Agency and many other RMAs work with partners in the River Basin District including:

- catchment partnerships
- landscape partnerships
- catchment based groups
- non-government organisations
- Flood Action Groups
- Coastal Groups and Partnerships
- other active community organisations

We value the contribution these partners make, including in:

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

The Environment Agency operates and maintains a large existing asset base in the Severn RBD, to protect communities and infrastructure from flooding. We take a strategic

and planned approach to long-term asset investment choices and interventions to ensure that we maximise the value realised over the lifetime of these assets. This second cycle FRMP includes several measures relating to the development of strategic asset management plans for groups of assets that will reflect:

- future demand and climate change scenarios
- operation and maintenance needs over the lifetime of assets
- decommissioning, disposal or renewal at the end of the lifetime of assets

The Regional Flood and Coastal Committees (RFCCs) have an important statutory role in flood and coastal erosion risk management. In the Severn RBD these are the English Severn and Wye RFCC and the Wessex RFCC. More information can be found in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

Case Study: River Severn Partnership

In 2019, partners spanning the River Severn Catchment came together to form the River Severn Partnership. The multi-sector Partnership is taking a holistic 'source to sea' approach to bring about real change across the catchment. This integrated approach to environmental, social and economic decision making and investment has quickly gained ministerial support. The River Severn Partnership covers an area that includes:

- the Welsh reservoirs that support the Severn
- the main River Severn corridor
- the River Severn's major tributaries - the Rivers Teme, Warwickshire Avon and the Wye

The aim of the Partnership is: "To make the Severn Catchment Britain's most vibrant and resilient river network; where an exceptional quality of life, prosperous local economies and an outstanding natural environment is driven by a programme of innovation to reduce flood risk, secure future water resources and improve and deliver shared natural assets."

In July 2020, a ministerial announcement included the River Severn Partnership as one of 4 national pilots to develop and test Adaptation Pathway Plans - with the potential of £1.5million of funding support to enable delivery. An additional £10million has subsequently been secured by the Environment Agency. This is to test out this adaptive thinking and develop a Climate Resilience and Adaptation Strategy for the Partnership area up to 2100.

The Partnership is twin tracking delivery of long term plans to aid climate resilience and adaption across the catchment with short term delivery of projects to aid testing and learning. The Partnership has drawn together a pipeline of over 200 projects from across the partner organisations. These projects have been grouped together thematically and geographically to provide demonstrator programmes for delivery.

The English Severn and Wye Regional Flood and Coastal Committee (RFCC) continues to fulfil its statutory independent oversight role. This includes providing assurance and

consent to the Flood and Coastal Erosion Risk Management Grant in Aid investment programme, while advising on and guiding the flood risk activities within its catchments.

History of flooding

This section of the second cycle Flood Risk Management Plan (FRMP) provides a summary of significant flood events and their consequences since the first cycle FRMP in 2015. It covers the period 2015 to February 2021. Significant is defined as an event that affected more than 20 residential properties. The first cycle Severn River Basin District FRMP contains information on historic flood events and their consequences before 2015. More detailed information on why flood records and evidence are important and how they are used is in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

Since 2015, areas in the Severn River Basin District (RBD) have been affected from significant flood events in 2016, 2018, 2019, 2020 and 2021. These are from multiple sources. Some of these have been significant and prolonged events over large parts of the RBD, affecting many communities in several counties. Table 2 below provides information on the impacts we are aware of, including:

- location of flooding – entry is for counties where several communities have been affected
- the approximate number of properties flooded internally - rounded to the nearest 10
- the source of flood water

Where known, the approximate number of properties affected has been split down into homes, business and services affected by flooding.

Table 2: historical flood events from all sources 2015 – February 2021. Number of properties rounded to the nearest 10

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
February 2016	River Severn corridor and lower Severn floodplain (60) Warwickshire (10)	fluvial, surface water
March 2016	Warwickshire (70)	fluvial, surface water

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
June 2016	Dudley (120 homes, 1 care home, 12 schools) Sandwell (220) Warwickshire (10) Gloucestershire (30)	fluvial, surface water, sewer
June 2018	Newport (30)	surface water
October 2019	Herefordshire (130) Worcestershire (20) Gloucestershire (40)	fluvial, surface water, sewer
November 2019	Rivers Teme, Avon and Severn floodplains (160 homes including 40 at Evesham plus significant number of businesses)	fluvial, surface water
February 2020	Worcestershire (600) Shropshire (450) Herefordshire (700) Telford & Wrekin (80) Gloucestershire (50) Warwickshire (10) Wolverhampton (20) Staffordshire (300)	fluvial, surface water, sewer
March 2020	Gloucestershire (20)	tidal

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
June 2020	Nailsworth, Gloucestershire (10 homes, 40 businesses) Sandwell (20) Staffordshire (30)	surface water
August 2020	Telford & Wrekin (150) Staffordshire (10)	surface water
December 2020	Gloucestershire (270 homes, 50 businesses, 1 school)	fluvial, surface water
January/February 2021	Shropshire (100), Telford & Wrekin (50), Worcestershire (120)	fluvial, surface water

Climate change and the Severn RBD

This section sets out what we know are likely to be the implications of climate change in the Severn River Basin District (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 as this changes the most up-to date information should be used.

Coastal flood risk

As sea levels rise, it means 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 likely to vary considerably 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 Severn RBD does not have its own sea level rise allowances, the South West RBD allowances are applied.

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

Allowance	Sea level rise
Extreme (H++)	1.90m**
Upper end	1.62m
Higher central	1.21m

* 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 sets out how much we expect peak river flows might increase by 2125 for management catchments.

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

RBDs cover large areas. We know that some areas will be more affected by climate change than others. The range of increases for the Severn RBD for the upper end scenario for 2080s epoch (2070-2125) is from 59% to 96%. This range reflects a difference in anticipated change across management catchments within the RBD.

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, it means that 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 2125 for management catchments in the Severn RBD. The range of increases for the Severn RBD for the upper end scenario for the 2070s epoch (2061-2125) is from 40% to 45%.

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: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans’.

Progress review of implementing the first cycle FRMP

This section assesses the achievements and what has happened across the Severn River Basin District (RBD) since the first cycle Severn RBD Flood Risk Management Plan (FRMP) was produced in 2015. It describes how the first cycle FRMP was reviewed.

It reports on the status of the measures and a summary of progress made towards achieving the objectives in the 2015 FRMP. It gives reasons if progress has not been made.

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 flood risk management plan have not been implemented

The Environment Agency and LLFAs followed these steps to complete the review within the Severn RBD:

1. The status of each measure was reviewed and assigned an estimated implementation status as of 31 March 2021.
2. For measures assigned an implementation status of 'not started' or 'superseded' reasons were given why they have not been progressed.
3. Additional measures were identified that have implemented since 2015 which have made a material difference to achieving the first cycle FRMP objectives.
4. Assessed 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 estimated implementation status since 2015 of all the measures published in the first cycle Severn RBD FRMP, as of 31 March 2021. Chart 1 also shows this in more detail.

Table 4: implementation status of measures for the Severn RBD

Progress	Number of measures
Ongoing	338
Ongoing construction	7
Completed	124
Superseded	36
Not started - proposed	32
Not started - agreed	16

The doughnut chart below entitled 'implementation status of measures for the Severn RBD' shows the proportion of measures by implementation status.

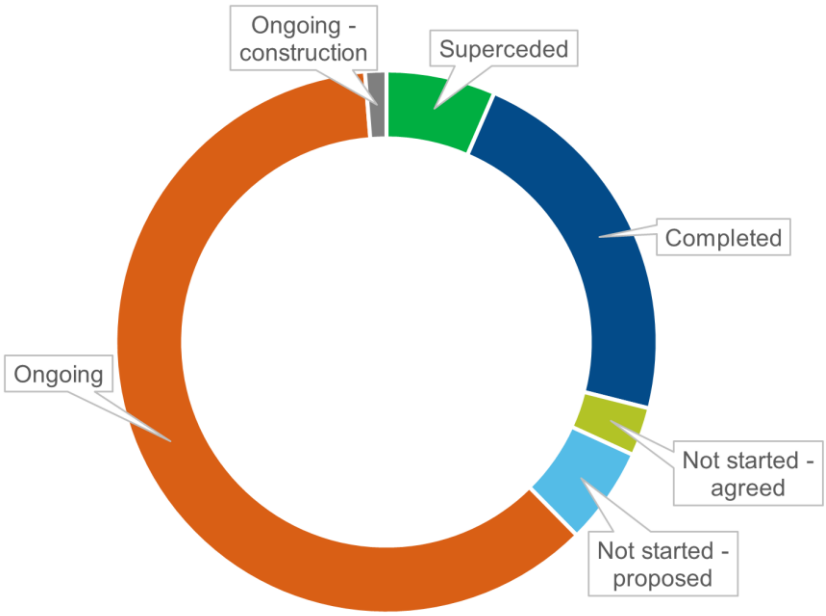


Chart 1: implementation status of measures for the Severn RBD

22% of the measures published in the first cycle FRMP have been completed.

1% of the measures are ongoing in construction.

61% of the measures are ongoing. Of these ongoing measures, 82% are day to day activities that have been carried out by risk management authorities in 2015-2021. 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. 18% of the ongoing measures are outside of day to day activities.

16% of the measures proposed in the first cycle FRMP have not been implemented. The reasons for this are:

- it does not yet have funding
- it has been postponed
- it has been replaced by another measure
- it has been included in another piece of work
- point not reached where the measure is needed
- further work showed it was not viable
- relevant legislation not implemented

The doughnut chart below entitled 'reasons for not progressing measures in the Severn RBD' shows the breakdown of reasons for measures that have not been progressed and their frequency.

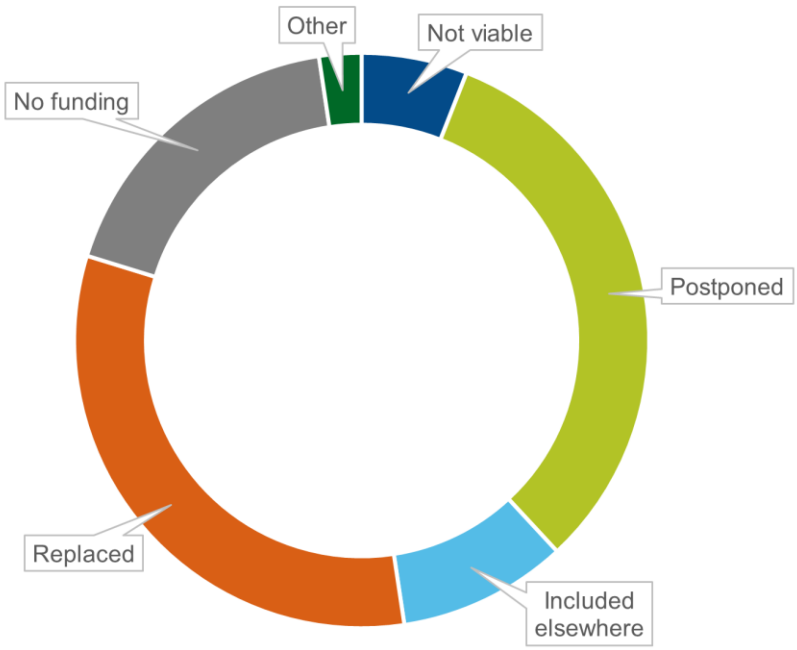


Chart 2: reasons for not progressing measures in the Severn RBD

Each measure included in the published first cycle Severn RBD 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 2009' (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

Completed measures that have contributed to preventing flooding

44% of the completed first cycle FRMP measures have contributed to preventing flooding. Examples include:

- Producing Surface Water Management Plans for Bristol, Northamptonshire and for the Bath and North East Somerset Unitary Authority
- Producing the South Gloucestershire Climate Change Strategy Action Plan to inform strategic planning documents – Bristol Flood Risk Area measure
- Publishing of 'West of England Sustainable Drainage Developer Guide' in 2015 - Bristol Flood Risk Area measure
- Inputting into Strategic Flood Risk Assessments to inform the spatial planning process
- Improving evidence base through
    - survey of flood risk management assets
    - modelling
    - mapping
    - recording of information on flood incidents

Completed measures that have contributed to protecting against flooding

31% of the completed first cycle FRMP measures have helped to protect individuals, communities, and the environment against the consequences of flooding.

This includes measures for works on the ground that have been completed by the Environment Agency and other risk management authorities. These measures were allocated funding on the 2015-2021 capital investment programme and have significantly reduced flood risk to approximately 5400 residential properties. They are a mixture of:

- new and restored raised defences
- flood storage
- property flood resilience measures
- increased capacity culverts/replaced culverts

They include:

- the Badsey Brook flood storage area (see Case Study: Badsey Brook flood risk management scheme)
- construction of the new and improved tidal flood defences at Congresbury Yeo
- improved raised defences at Leominster
- restored tidal earth flood embankment at Upper Framilode
- flood storage area in Wrington – Bristol Flood Risk Area measure
- property flood resilience measures in Chew Magna

Completed first cycle FRMP measures also include maintenance activities, such as:

- improvements to trash screens
- installation of webcams to monitor assets
- producing and maintaining Flood Risk Asset Registers
- supporting a local community in taking action to stop bank erosion
- improving inspection reporting
- improving information on websites relating to riparian responsibilities

In addition, the following measures in the first cycle FRMP have resulted in activities that have helped to protect from flooding:

- natural flood management measures in Stroud (see Case Study: NFM in Severn and Avon Catchments)
- reservoir on site plans and maintenance

Completed measures that have contributed to preparing for flooding

25% of the completed first cycle FRMP measures have helped to prepare people for flooding. These include:

- engaging with communities to raise awareness and to prepare for flooding – such as in catchments that respond rapidly to heavy rainfall
- improving information on flood risk on websites, including how homes and businesses can prepare for flooding
- improving flood forecasting and warning, such as:
    - implementing a flash flood forecast in Chew Magna

    - installing community water level gauges to warn of rising levels in rapid response catchments
    - improving flood warning service for
        - Sea Mills to Conham
        - Leominster
        - Upton-upon-Severn
        - Slad Brook, Stroud

Case Study: Badsey Brook flood risk management scheme

The Badsey Brook flood risk management scheme reduces flood risk to over 300 homes and businesses in Broadway, Childswickham and Murcot. Built in 2018, the scheme is a flood storage area that is regulated under the Reservoirs Act 1975. The storage area is dry most of the time but can hold up to 135,000 cubic metres of water in periods of high rainfall - the size of approximately 54 Olympic swimming pools. This provides protection against a flood event with a 1.3% chance of occurring in any given year. The storage area filled and retained water in November 2019, protecting communities against the flooding that would otherwise have occurred. The scheme has also enhanced the river channel and lessens the volume of water getting into the sewerage network, so reducing the risk of sewer flooding.

Before construction, an archaeological excavation was undertaken in collaboration with Worcestershire County Council. This revealed that the site had been the focus of human activity for millennia. A significant number of finds dating from the Late Mesolithic period (c.6,500 BC) were recovered, with evidence of settlement from the Bronze Age through to the early medieval period (6th – 8th century AD).

This innovative partnership scheme was led by the Environment Agency. It attracted £2million in government funding and £1.2million in Local Levy funding towards total costs of £4.1million. The scheme would not have been possible without the additional £900,000 in contributions raised by the local community and partners including Worcestershire County Council, Wychavon District Council and Severn Trent Water.

Ongoing measures that have contributed to managing flood risk

Ongoing measures in the first cycle FRMP that are the day to day activities carried out by RMAs have also contributed to managing flood risk in the first cycle FRMP review period.

Day to day activities carried out in 2015-2021 that have contributed to preventing flooding include:

- determining approximately 850 Flood Risk Activity Permits (between 2016-2021, as 2015 data not available)
- carrying out our roles as statutory consultee in the planning process
- continuing our modelling programme
- continuing our publishing of updates to flood risk mapping

- continuing monitoring of the Severn Estuary via the South West Regional Coastal Monitoring Programme

Day to day activities carried out in 2015-2021 that have contributed to protecting from flooding include:

- repairing and refurbishing flood risk management assets – includes projects in the 2015-2021 capital investment programme that are additional to the completed measures above, and which have significantly reduced the risk of flooding to approximately 6000 homes
- continuing of routine maintenance of flood risk management assets
- reservoir management and regulation
- capital schemes (see 'additional measures implemented since 2015' section)
- incident response including:
    - monitoring and operating defences
    - erecting demountable and temporary barriers
    - clearing debris from watercourses to allow water to flow freely

Day to day activities carried out in 2015-2021 that have helped people to prepare for flooding include:

- maintenance and improvement of river recording gauges used to warn and inform - such as replacement of ultrasonic flow gauge at Montford
- improvements to flood forecasting models - such as for the River Chelt in Cheltenham
- continued maintenance and improvement of the Environment Agency's flood warning service
- continued working with and training of flood wardens - such as the Flood Wardens in Tewkesbury Borough
- In flood events:
    - the Environment Agency has monitored rainfall and river levels, and professional partners have worked closely to use this information as an integral part of decision making for their emergency response
    - the Environment Agency has forecast and issued flood warnings for river flooding on numerous occasions throughout 2015-2021 - including issuing flood warnings to many thousands of people during winter floods in 2015/16 and 2019/20
    - the Environment Agency along with partners have provided briefings to the media and stakeholders to help keep the public informed

Whilst none of the completed first cycle FRMP measures specifically relate to recovery and review, the following day to day activities carried out in 2015-2021 have aided communities to recover from flooding:

- a package of 68 projects included on the 2015-2021 capital investment programme to repair flood risk management assets damaged during flooding in 2019/20 – these reduce flood risk to a further 2000 properties

- engagement during flooding – such as over 150 visits by Environment Agency staff to 71 communities during the 3 weeks of the worst flooding in winter 2019/20
- engagement after flooding – RMAs have continued to work together to hold site visits and drop in events with communities, including flooded businesses, affected by flooding (see case study: Engaging during Covid-19)
- RMAs continue to work together during and after flooding to help communities recover from flooding, and to review flooding incidents to help further improve our response

Our efforts to warn, inform and protect community and businesses have been recognised – such as recognition for the Environment Agency in the Mayor of Shrewsbury Awards in November 2020.

Case Study: Engaging during Covid-19

The Environment Agency, together with other risk management authorities and communities, have taken advantage of video calling technology and platforms to continue engaging during restrictions due to Covid-19. This has facilitated meetings that have been as inclusive and interactive as possible in the circumstances.

After the flooding in February 2020, the Environment Agency worked with partners:

- the National Flood Forum
- Shropshire Council
- Telford & Wrekin Council
- Worcestershire County Council
- other partners including District Councils and Severn Trent Water

to pilot a series of virtual pre-booked recovery drop-in sessions for residents in affected areas. This reached around 100 households that might otherwise have missed out on having these conversations.

Additional measures implemented since 2015

Measures have been implemented that have emerged since the publication of the first cycle FRMP. Therefore, these were not included in the first cycle FRMP.

Activities to prevent flooding that have been implemented since 2015 include:

- setting up the River Severn Partnership (see Case Study: The River Severn Partnership)
- producing the 'Sustainable Drainage Systems (SuDS) Handbook' – setting out the role of SuDS in achieving sustainable development across 7 LLFAs in the West Midlands

Activities to help protect against flooding include projects completed by RMAs as part of the 2015-2021 capital investment programme across the RBD. These projects include:

- watercourse, sewer and highway drainage improvements
- flood attenuation and storage schemes
- raised flood defences

These additional projects have significantly reduced flood risk, including to approximately 1000 homes. Examples include schemes at:

- Much Wenlock – flood storage
- Whaddon, Cheltenham – flood storage
- Wellington, Telford – flood attenuation, delivered as part of development
- Hagley – sewer capacity improvements

Natural flood management measures delivered in 4 catchment scale projects and 2 community led projects have also helped to reduce flood risk (see Case Study: NFM in Severn and Avon Catchments).

RMAs have been working in partnership to reduce flood risk. An example is Severn Trent working in collaboration with LLFAs and the Environment Agency to deliver 26 schemes within their operating area spanning the Severn and Humber RBDs. This has benefitted over 850 properties.

Activities to help prepare for flooding include:

- the Environment Agency working with universities to explore how we can best engage with young people to raise awareness of flood risk
- exploring novel and creative ways of raising awareness of flood risk – such as through artwork on flood defences at Upton-upon-Severn

Activities carried out in response to flooding include: LLFAs and District Councils have carried out a substantial amount of work to administer Defra Property Flood Resilience (PFR) repair grant schemes in locations in Shropshire, Telford & Wrekin, Worcestershire, Herefordshire and Gloucestershire. Following criteria set by Defra, grants of up to £5,000 have helped property owners in eligible communities affected in certain floods to make their repairs more resilient to future floods.

Case Study: NFM in Severn and Avon Catchments

The English Severn and Wye Regional Flood and Coastal Committee has been pioneering natural flood management (NFM) projects in the Severn River Basin District (RBD) since 2014. Councils, landowners, communities, environmental organisations and the Environment Agency have worked together between 2015 and 2021 to implement projects in:

- Gloucestershire: The Stroud Rural Suds Pilot Project - led by Stroud District Council. 684 NFM structures have been implemented on 29.5km of watercourses within the Frome catchment

- Shropshire: Slow the Flow Project - led by Shropshire Council. The project has focussed on interventions to reduce flood risk in the Corvedale and Rea Brook catchments and enhanced 20km of watercourse
- Warwickshire: Stour Catchment – led by the Shipston Area Flood Action Group. The catchment covers 36 watercourses and 7 flood risk communities. The project is an excellent example of community action and leadership
- Herefordshire: River Wye and Lugg NFM Project – led by Herefordshire Council. Extensive reaches of the main rivers are of high conservation importance, designated as SSSI or SAC. The project has worked with 140 landowners since 2018, and delivered a wide variety of NFM measures across 7 catchments
- Worcestershire: led by Worcestershire County Council. The project has developed NFM initiatives in 4 watercourses of 3 different types of catchment: rural Cotswold escarpment, forestry and urban
- Bristol Frome: NFM assessments have been completed on the Ladden Brook, Upper Bristol Frome, Bradley Brook and Folley Brook (2018-2021). The Frome Reconnected Project has used the assessments to develop a wider programme of NFM interventions across these catchments. This informed the successful Bristol City/Frome bid into the Flood and Coastal Resilience Innovation Programme, which will deliver NFM interventions 2022-2026
- there have also been community led NFM projects in Gloucester (River Twyver) and Hereford (Yazor Brook)

Defra has funded the majority of these projects to test how well NFM measures work to reduce the peak of a flood and bring wider benefits by working with nature. NFM measures that have been put in place include large wooden structures to form ‘leaky dams’, attenuation and diversion, tree planting and soil management. Multiple benefits that come from practices such as aeration of soil can encourage infiltration and also improve the quality of grass. The three-year Defra funded Natural Flood Management Programme has proven the benefits of NFM on both water management and habitat within a catchment. The projects have left a legacy of shared land management between communities, landowners and partner organisations.

How well these measures have achieved the first cycle FRMP objectives

The FRR require the FRMP to include details of objectives for the purpose of managing flood risk and measures to set out how the objectives will be achieved. First cycle FRMP objectives were grouped into categories:

- social
- economic
- environmental

Information on these objectives for the first cycle Severn River Basin District FRMP can be found in Part B of the first cycle FRMP.

Overall, the measures included in the first cycle FRMP have successfully contributed to objectives set out across all categories. This has delivered a great improvement to the social, economic and environmental well-being of the River Basin District.

The first cycle FRMP showed which objective category/ies each measure would help to deliver. The following describes measures under the objective category that they primarily benefit. 12.5% of the completed measures have contributed to achieving more than one of the objective categories and the total of the percentages shown below therefore totals greater than 100%.

71% of completed measures have contributed to achieving social objectives by:

- improving our evidence base and working in partnership to better manage flood risk
- reducing or preventing an increase in harm to life as a result of flooding
- reducing the likelihood of death or serious injury resulting from rapid inundation or deep and fast flowing water
- improving community awareness and resilience to flooding
- reducing or preventing an increase in the number of properties affected by flooding – such as measures completed through our roles as statutory consultees in development
- reducing disruption resulting from flooding to key services and critical infrastructure
- improving the quality of the flood warning service

35% of completed measures have contributed to achieving economic objectives by:

- improving our evidence base and working in partnership to better manage flood risk
- encouraging sustainable development that manages flood risk appropriately – such as through our statutory consultee roles, including producing Sustainable Drainage Developer Guides for developers
- raising awareness of flood risk and engaging people, businesses and organisations to encourage them to take action to manage the risks they face
- reducing the cost of flood damage for residential and commercial properties
- reducing or preventing an increase in the economic losses from flooding to agricultural land in the catchment – such as maintaining and refurbishing flood defences and providing flood warnings
- reducing flood risk to infrastructure – such as through the new drainage system in Scotland Lane, Stockwood (a Bristol Flood Risk Area measure) that has helped to protect an important transport route
- reducing or preventing an increase in the economic damages from flooding to cities, towns and commercial property in the catchment (including trade and tourism) – such as through the new Badsey Brook flood storage area which reduces flood risk in Broadway
- providing an effective and sustained response to flood events – such as through:
    - production of Multi Agency Flood Plans
    - improved flood forecasting and warning
    - establishing working groups to promote and coordinate flood response and preparedness

- reducing the risk of flooding from reservoirs to people, property, infrastructure and the environment

7.5% of completed measures have contributed to achieving environmental objectives by:

- encouraging more natural management of the river and its floodplain to help deliver Water Framework Directive target of good ecological status
- contributing to integrated catchment water management and/or a sustainable drainage approach
- creating habitat through flood risk management activities

Examples of measures contributing to the environmental objectives include:

- NFM projects (see Case Study: NFM in Severn and Avon Catchments)
- schemes involving nature based solutions in:
    - Bradford on Avon
    - Southmead Green Streets
- 10.8 hectares of intertidal habitat provided as part of the construction of the new and improved tidal flood defences at Congresbury Yeo
- river restoration on the River Chelt
- reducing the risk of flooding to the environment from reservoirs
- improving understanding of the impact of flooding on the environment and on heritage sites

Some completed measures that were not identified as being in the environmental objective category when the first cycle FRMP was published have also contributed to environmental objectives – such as the Badsey Brook Flood Risk Management Scheme and the scheme to improve the flood defences at Leominster that have provided environmental enhancements.

In addition to the completed measures, the Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project (ongoing in construction) is contributing to meeting social, economic and environmental objectives (see case study below).

Day to day activities in the ongoing first cycle FRMP measures that have been carried out in the period 2015-2021 have also contributed to achieving the above objectives. Additionally, the following activities have contributed to achieving the remaining first cycle FRMP objectives:

- RMAs and organisations coming together to form the River Severn Partnership - (see Case Study: The River Severn Partnership)
- publishing Local Flood Risk Management Strategies and section 19 investigations
- RMAs working together and with others in Warwickshire to support communities in a holistic approach to building resilience that includes resilience planning and nature based solutions

- inputting into the evidence base and development of Local Industrial Strategies and shaping subsequent action plans and infrastructure plans – such as the Shrewsbury Big Town Plan and Worcester City Masterplan
- developing place-based economic cases for investment in Local Authority areas in the River Severn Partnership area
- RMAs and partner non-governmental organisations working with others in Herefordshire and Shropshire to support sustainable agriculture and to manage catchment flood risk. This includes:
    - working with farm cluster groups formed in Shropshire to develop nature based solutions that will benefit:
        - land management
        - flood risk
        - water quality
        - ecological biodiversity flow paths
        - water resources
        - air quality
    - engaging with the agricultural community in the River Rea catchment to carry out farm level interventions and water management farm plans - when implemented these will help to increase resilience to Shropshire's agricultural economy and the local community
    - engaging with farmers through the River Lugg and Wye integrated Natural Flood Management projects to improve land and soil management practices
- supporting the following projects with Defra's Flood and Coastal Erosion Risk Management Grant in Aid funding to protect and enhance designated environmental sites:
    - River Clun SAC – has reduced the amount of sediment entering the SAC, nutrient input and naturalised the river habitat
    - River Teme SSSI – has restored rivers by removing weirs
    - Severn Estuary SAC – has unlocked the Severn to Shad fish
    - N2K Wye & Lugg – has restored habitat, removed barriers to fish and reduced rural diffuse pollution
    - Puxton and Stourvale Marshes, Kidderminster – has maintained water levels for habitat
- protecting listed buildings in Bewdley to help minimise harm from flooding (see Case Study: Hardwood Heritage Flood Door)
- flood risk management assets built and/or maintained by RMAs have reduced the risk of flooding in events such as the winter floods 2015/16 and 2019/20 to:
    - thousands of homes and businesses
    - services
    - agricultural land
    - the environment including heritage assets

Ongoing day to day activities will continue to be carried out during the second cycle FRMP period 2021-2027.

Case Study: Avonmouth Severnside Enterprise Area Ecology Mitigation and Flood Defence Project

The Environment Agency, South Gloucestershire Council and Bristol City Council are working in an innovative partnership to deliver the Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project.

The £80 million project will deliver a new flood defence scheme along a 17 kilometre stretch of coastline to protect local communities and reduce flood risk to at least 2,500 homes and businesses, now and in the future (figure 3). The project will create new habitats for important local wildlife and will help enhance and grow the Avonmouth Severnside Enterprise Area to reach its economic potential.

The construction phase of the project started in summer 2020 and is taking place in a number of separate stages between 2020 through to 2026/27. The sites which are currently identified as being at the highest risk of flooding will be tackled first.

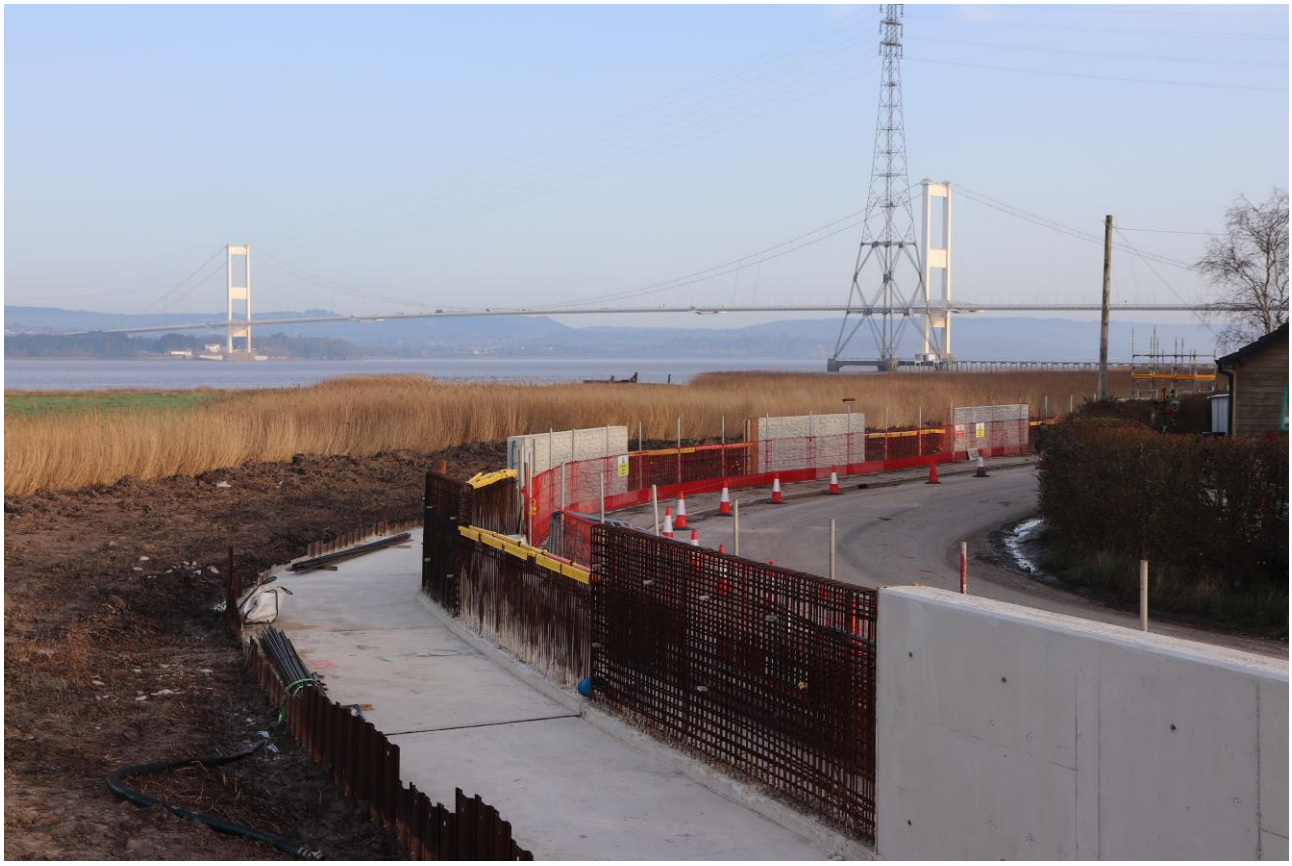


Figure 3: construction of the ASEA project

Case study: Hardwood Heritage Flood Door

Bewdley, Worcestershire is frequently impacted by fluvial flooding. The Environment Agency has installed property flood resilience measures in 44 properties, many of which had grade 2 listed status. Under this listed status it is very difficult to make any physical changes to the buildings. Modern day uPVC or composite flood doors were not acceptable. In 2015 a unique working partnership was formed to develop a passive

solution together and to gain approval for this via the listed consent process. This group comprised:

- the Environment Agency
- Wyre Forest District Council
- Historic England
- the Environment Agency's contractors

An exciting solution was found that more than met the challenge. The new Floodguard Heritage Door has modified timber cladding and door furniture that can replicate existing/historic features. It does not have any threshold at floor level to step over and so meets Disability Discrimination Act (DDA) regulations and conservation guidance. It has standard door locks for normal operation. For protection during flooding an additional operation of the handle activates the flood lock. A major innovative step was that this handle can be operated from the outside by neighbours or flood volunteers, but not de-activated leaving the home unprotected.

The door has undergone the first round of testing to PAS 1188 standards and been checked by the Building Research Establishment (BRE). Further testing is ongoing to ensure the door meets new British Standards. It has local council and Historic England support for use in listed buildings and is influencing Historic England policy relating to passive solutions to listed buildings. 14 flood doors have now been installed to 8 of the properties at highest risk of flooding. This working together strongly incorporates the key principles at the core of the new EA2025 5-year Plan by establishing and strengthening partnerships to join critical agendas and create resilient places.

Figure 4: fitted front door at Bewdley July 2020 (before left and after right)

Second cycle summary of flood risk for the Severn RBD

This section shows a summary of flood risk in the Severn River Basin District (RBD) in England from:

- rivers and sea
- surface water

The data in Tables 5 to 10 has been calculated from data available in December 2019. This data takes into account the presence and condition of defences. It shows the likelihood of flooding each year:

- high risk means that each year an area has a chance of flooding 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 between 0.1% and 1%
- very low risk means that each year an area has a chance of flooding less than 0.1%

Table 5 summarises the risk of flooding from rivers and the sea to people in the RBD.

Table 5: summary of river and sea flood risk to people in the Severn RBD in England

Risk to people	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of people in RBD	4,553,694	16,927	74,529	94,520	7,752
Number of services	29,934	300	918	828	69

There are 4,553,694 people in the RBD. Of these:

- 4.2% are in areas at risk of flooding from rivers and the sea
- 0.4% are in areas at high risk of flooding

There are 29,934 services in the RBD. Of these:

- 7% are in areas at risk of flooding from rivers and the sea
- 1% are in areas at high risk

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

Table 6: summary of river and sea flood risk to economic activity in the Severn RBD in England

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	178,855	1,961	7,594	7,852	588
Number of airports	2	0	0	0	0
Length of road (kilometres (km))	2,365	23	85	60	7
Length of railway (km)	1,254	17	45	33	10
Agricultural land (hectares (ha))	1,074,100	27,505	33,780	16,324	2,265

There are 178,855 non-residential properties in the RBD. Of these:

- 10% are in areas at risk of flooding from rivers and the sea
- 1.1% are in areas at high risk of flooding

Both the airports in the RBD are outside areas at risk of flooding from rivers and the sea.

There are 2,365 km of trunk roads in the RBD. Of these:

- 7.4% are in areas at risk of flooding from rivers and the sea
- 1% are in areas at high risk of flooding

There are 1,254 km of railways in the RBD. Of these:

- 8.4% are in areas at risk of flooding from rivers and the sea
- 1.3% are in areas at high risk of flooding

There are 1,074,100 hectares of agricultural land in the RBD. Of these:

- 7.4% are in areas at risk of flooding from rivers and the sea
- 2.6% are in areas at high risk of flooding

Table 7 summarises the risk of flooding from rivers and the sea to the natural and historic environment in the RBD.

Table 7: summary of river and sea flood risk to the natural and historic environment in the Severn RBD in England

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)	2	2	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	475	22	18	30	2
Area of Special Area of Conservation (SAC) within area (ha)	33,305	5,009	95	119	7
Area of Special Protection Area (SPA) within area (ha)	12,262	4,520	20	220	96
Area of Ramsar site within area (ha)	12,011	4,222	75	229	96
Area of World Heritage Site within area (ha)	3,417	89	146	48	0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	37,666	7,240	648	575	112
Area of registered parks and gardens within area (ha)	23,546	573	579	61	2
Area of scheduled ancient monument within area (ha)	4,829	121	198	52	2
Number of listed buildings within area	52,583	950	1,779	1,116	167
Number of licensed water abstractions within the area	3,262	995	314	55	9

It should be noted that some of the environmentally designated sites at risk within the RBD are reliant to some degree on flooding. It is needed to maintain their interest features. A substantial proportion of the total RBD figures for the natural environment relate to the Severn Estuary itself. Parts of the Severn Estuary are designated as Special Area of

Conservation (SAC), Special Protection Area (SPA), Ramsar site and Site of Special Scientific Interest (SSSI).

The 2 EU designated bathing waters in this RBD are both in areas at high risk of flooding from rivers and the sea due to their fundamental features.

There are 475 Environmental Permitting Regulations (EPR) installations in the RBD. Of these:

- 15.2% are in areas at risk of river and sea flooding
- 4.6% are in areas at high risk of flooding

There are 33,305 hectares of Special Area of Conservation (SAC) in the RBD. Of these:

- 15.7% are in areas at risk of flooding from rivers and the sea
- 15% are in areas at high risk of flooding

There are 12,262 hectares of Special Protection Area (SPA) in the RBD. Of these:

- 39.6% are in areas at risk of flooding from rivers and the sea
- 36.9% are in areas at high risk of flooding

There are 12,011 hectares of Ramsar sites in the RBD. Of these:

- 38.5% are in areas at risk of flooding from rivers and the sea
- 35.2% are in areas at high risk of flooding

There are 3,417 hectares of World Heritage Site in the RBD. Of these:

- 8.3% are in areas at risk of flooding from rivers and the sea
- 2.6% are in areas at high risk of flooding

There are 37,666 hectares of Site of Special Scientific Interest (SSSI) in the RBD. Of these:

- 22.8% are in areas at risk of flooding from rivers and the sea
- 9.2% are in areas at high risk of flooding

There are 23,546 hectares of registered parks and gardens in the RBD. Of these:

- 5.2% are in areas at risk of flooding from rivers and the sea
- 2.4% are in areas at high risk of flooding

There are 4,829 hectares of scheduled ancient monument in the RBD. Of these:

- 7.7% are in areas at risk of flooding from rivers and the sea
- 2.5% are in areas at high risk of flooding

There are 52,583 listed buildings in the RBD. Of these:

- 7.6% are in areas at risk of flooding from rivers and the sea
- 1.8% are in areas at high risk of flooding

There are 3,262 licensed water abstractions in the RBD. Of these:

- 42.1% are in areas at risk of flooding from rivers and the sea
- 30.5% are in areas at high risk of flooding

Table 8 summarises the risk of flooding from surface water to people in the RBD.

Table 8: summary of surface water flood risk to people in the Severn RBD in England

Risk to people	Total in RBD	High risk	Medium risk	Low risk
Number of people in RBD	4,553,694	29,736	52,863	246,248
Number of services	29,934	210	264	1,111

Of the 4,553,694 people in the RBD:

- 7.2% are in areas at risk of flooding from surface water
- 0.65% are in areas at high risk of flooding

Of the 29,934 services in the RBD:

- 5.3% are in areas at risk of flooding from surface water
- 0.7% are in areas at high risk

Table 9 summarises the risk of flooding from surface water to economic activity in the RBD.

Table 9: summary of surface water flood risk to economic activity in the Severn RBD in England

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk
Number of non-residential properties	178,855	2,684	3,354	13,567
Number of airports	2	2	0	0
Length of road (kilometres (km))	2,365	98	97	313
Length of railway (km)	1,254	89	56	135
Agricultural land (hectares (ha))	1,074,100	20,972	13,118	51,642

Of the 178,855 non-residential properties in the RBD:

- 11% are in areas at risk of flooding from surface water
- 1.5% are in areas at high risk of flooding

The 2 airports in the RBD are both in areas at high risk of flooding from surface water.

Of the 2,365 km of trunk roads in the RBD:

- 21.5% are in areas at risk of flooding from surface water
- 4.1% are in areas at high risk of flooding

Of the 1,254 km of railways in the RBD:

- 22.4% are in areas at risk of flooding from surface water
- 7.1% are in areas at high risk of flooding

Of the 1,074,100 hectares of agricultural land in the RBD:

- 8% are in areas at risk of flooding from surface water
- 2% are in areas at high risk of flooding

Table 10 summarises the risk of flooding from surface water to the natural and historic environment in the RBD.

Table 10: summary of surface water flood risk to the natural and historic environment in the Severn RBD in England

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)	2	0	0	1
Number of Environmental Permitting Regulations (EPR) installations within 50m	475	128	59	100
Area of Special Area of Conservation (SAC) within area (ha)	33,305	177	187	615
Area of Special Protection Area (SPA) within area (ha)	12,262	113	127	483
Area of Ramsar site within area (ha)	12,011	37	58	413
Area of World Heritage Site within area (ha)	3417	79	67	181
Area of Site of Special Scientific Interest (SSSI) within area (ha)	37,666	805	596	1,792

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Area of registered parks and gardens within area (ha)	23,546	551	268	906
Area of scheduled ancient monument within area (ha)	4,829	119	57	202
Number of listed buildings within area	52,583	551	346	1,386
Number of licensed water abstractions within the area	3,262	633	184	545

It should be noted that some of the environmentally designated sites at risk within the RBD are reliant to some degree on flooding. It is needed to maintain their interest features. A substantial proportion of the total RBD figures for the natural environment relate to the Severn Estuary itself. Parts of the Severn Estuary are designated as Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site and Site of Special Scientific Interest (SSSI).

1 of the 2 EU designated bathing waters in this RBD is in an area at low risk of flooding from surface water.

Of the 475 Environmental Permitting Regulations (EPR) installations in the RBD:

- 60.4% are in areas at risk of surface water flooding
- 27% are in areas at high risk of flooding

Of the 33,305 hectares of Special Area of Conservation (SAC) in the RBD:

- 2.9% are in areas at risk of flooding from surface water
- 0.5% are in areas at high risk of flooding

Of the 12,262 hectares of Special Protection Area (SPA) in the RBD:

- 5.9% are in areas at risk of flooding from surface water
- 0.9% are in areas at high risk of flooding

Of the 12,011 hectares of Ramsar sites in the RBD:

- 4.2% are in areas at risk of flooding from surface water
- 0.3% are in areas at high risk of flooding

Of the 3,417 hectares of World Heritage Site in the RBD:

- 9.6% are in areas at risk of flooding from surface water
- 2.3% are in areas at high risk of flooding

Of the 37,666 hectares of Site of Special Scientific Interest (SSSI) in the RBD:

- 8.5% are in areas at risk of flooding from surface water
- 2.1% are in areas at high risk of flooding.

Of the 23,546 hectares of registered parks and gardens in the RBD:

- 7.3% are in areas at risk of flooding from surface water
- 2.3% are in areas at high risk of flooding

Of the 4829 hectares of scheduled ancient monument in the RBD:

- 7.8% are in areas at risk of flooding from surface water
- 2.5% are in areas at high risk of flooding

Of the 52,583 listed buildings in the RBD:

- 4.3% are in areas at risk of flooding from surface water
- 1.1% are in areas at high risk of flooding

Of the 3,262 licensed water abstractions in the RBD:

- 41.8% are in areas at risk of flooding from surface water
- 19.4% are in areas at high risk of flooding

Second cycle objectives and measures

A full list of the objectives are in the 'Part A: 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 flood 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

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

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 (FPE). You can use flood plan explorer to discover information about all of the measures proposed as part of this plan. This information mainly includes:

- 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

FPE displays the approximate location of measures on a map, with more detailed spatial information displayed where available. FPE will also show how measures are progressing over the second planning cycle. You can find more information on how to use FPE within the tool itself, which will be updated with additional information over time. We plan for measure information to be downloadable soon.

National level objectives and measures

There are several measures that are applicable across England. The Environment Agency will seek to implement these national level measures as part of its routine day to day 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.

Lead Local Flood Authorities (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 day to day work in different ways depending on local priorities and resources. You should look at LLFA websites and their local flood risk management strategies for more information on how they carry out their day to day work.

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

Measures specific to the Severn RBD

The Environment Agency and over 25 LLFAs and other risk management authority (RMA) partners have contributed to developing this second cycle Severn River Basin District (RBD) Flood Risk Management Plan (FRMP). We have included 291 measures that are specific to the Severn RBD. Whilst the primary focus of the second cycle FRMP is to manage flood risk in nationally identified Flood Risk Areas (FRAs), we recognise that there are areas at flood risk outside of these. We have therefore also included strategic measures that apply to other areas at risk. It is not the aim of the FRMPs to address all local issues or describe all activities being planned by the Environment Agency and other RMAs in all areas. Some specific strategic activities are not included as they are covered by existing strategies. More information on these and local actions for areas at risk of flooding can be found in local plans and strategies signposted in the 'Relevant plans and strategies' section.

The FRMP is not intended to provide extensive details of the measures. The level of the detail that is included may vary depending on the planning or implementation stage measures are at.

Not all measures in the FRMP have secured funding and so they will not always be implemented. For some of these measures, RMAs can apply for FCERM Grant-in-Aid to help pay for the work, as set out in the government's Partnership Funding Policy. The Environment Agency administers this funding and allocates it in line with government policies and priorities.

The Severn RBD level objectives and measures

106 measures have been developed that apply specifically to:

- the whole Severn River Basin District (RBD) in England
- large areas of the Severn RBD
- large areas of the Severn RBD that cross into the Humber RBD, such as Environment Agency West Midlands Area boundary and Severn Trent Water boundary
- areas that span over more than one management catchment, such as counties

This is 36% of the total number of measures in this second cycle Flood Risk Management Plan (FRMP).

These measures have been developed in addition to measures that cover other spatial scales. You can find information about each of these measures in the interactive mapping tool - Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

Northamptonshire-wide measures that apply to the area of Northamptonshire that is in the Severn RBD have been included in the Anglian RBD FRMP. These can also be viewed on Flood Plan Explorer.

The Severn RBD management catchment level objectives and measures

As described in the 'Introduction to the Severn RBD FRMP' section, measures have been developed that apply specifically to areas within the 8 management catchments in the Severn River Basin District (RBD). There are 90 of these measures. This is 31% of the total number of measures in this second cycle Flood Risk Management Plan (FRMP). You can view the locations of these management catchments and all the measures in the interactive mapping tool – Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

These measures have been developed in addition to the measures that cover other spatial scales.

Flood Risk Area objectives and measures

There are 95 measures applicable to managing flood risk in the nationally identified Flood Risk Areas in the Severn River Basin District (RBD). This is 33% of the total number of measures in this second cycle Flood Risk Management Plan (FRMP). The full list of FRAs in the Severn RBD can be found in the 'Introduction to the Severn RBD FRMP' section. More information on how FRAs were identified can be found in the 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'. The FRAs are described below.

The Bath Rivers and Sea Flood Risk Area

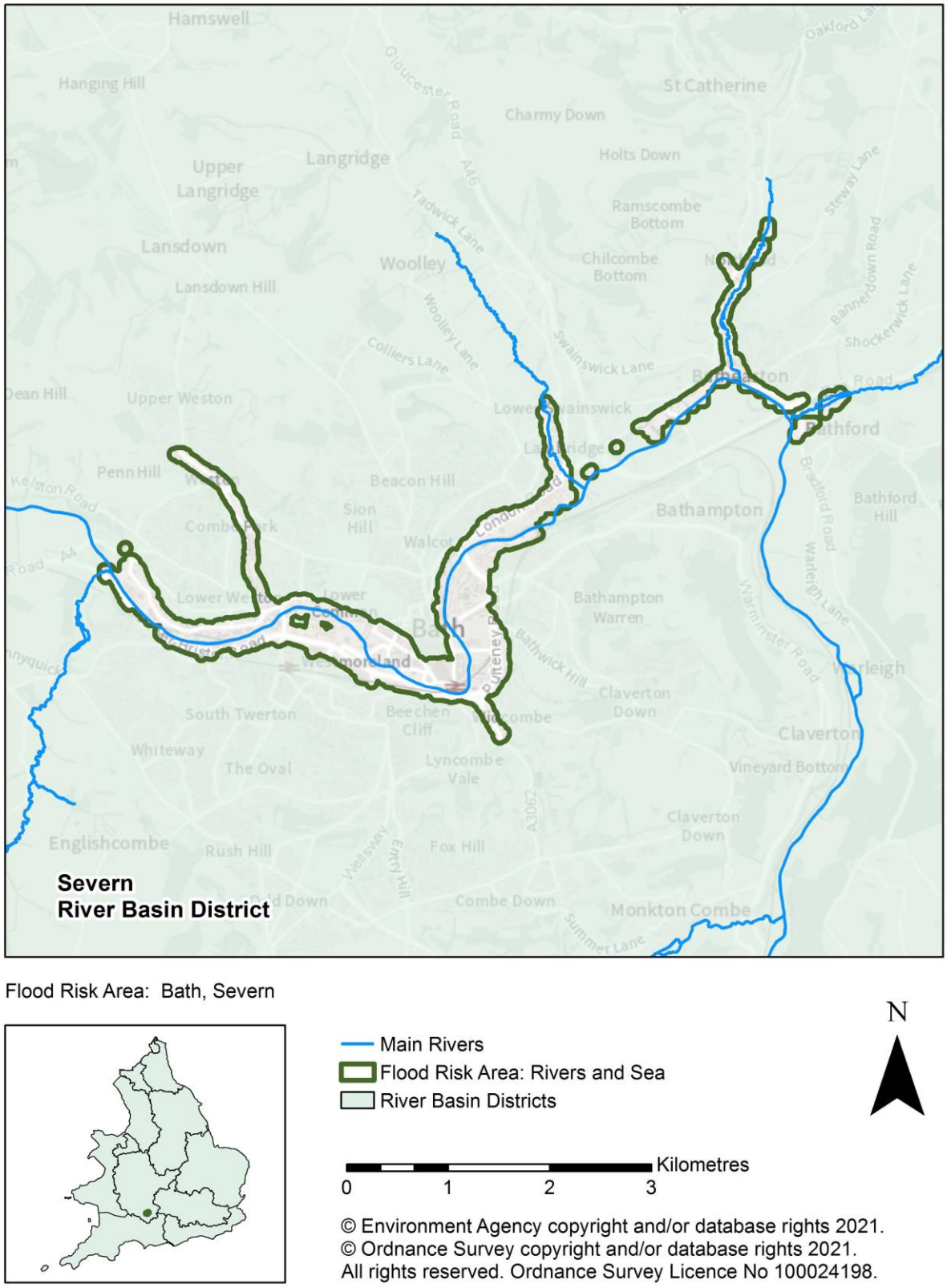


Figure 5: a map showing the boundary of the Bath Flood Risk Area

Introduction to the Bath Rivers and Sea Flood Risk Area

The Bath Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Bath and North East Somerset Council are the Lead Local Flood Authority whose remit includes flood risk from:

- surface water
- ordinary (smaller) watercourses
- groundwater

Wessex Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

Bath is the largest city in the county of Somerset and is a World Heritage Site. The catchment is mainly limestone and clays. The Bath FRA covers many of the urban districts of Bath which includes:

- residential properties
- businesses
- amenity areas

Although the majority of properties are at risk from the main River Avon, a significant number are at risk from tributaries and surface water flooding. Following significant flooding in the 1960s, the Bath Flood Defence Scheme was completed in 1974 to reduce the risk of flooding to the city.

Twerton and Pulteney gates form part of the 1974 Bath scheme. During low flows, these sluices maintain the water level upstream. Pulteney has a single radial gate alongside a weir. Twerton has a vertical and a radial gate spanning the river. A minimum water level is required for navigation purposes, as well as for protecting the ancient foundations of buildings along the river corridor in the World Heritage area of Bath. However, during high flows, the sluice gates are opened. The operation is automatic and reacts to changes in river levels. Flood water arrives at the gate and continues downstream as it would do naturally. The gates are now over 40 years old and require significant (and increasing) investment to keep them operating reliably.

The Environment Agency and Bath and North East Somerset Council commissioned a high-level study in 2016 to consider the best long-term sustainable solution for managing flood risk in Bath. The ‘River Avon Options Appraisal’ report identified potential actions at a strategic level. This included replacement of Twerton and Pulteney gates and constructing new or improved flood walls.

To quantify the flood risk benefits and costs of each option and therefore identify where further work is best directed, hydraulic modelling and high-level cost estimates were undertaken. The study proposed a preferred way forward, which included additional raised defences and improvements to both Twerton and Pulteney gates. However, there is a significant funding shortage to progress all the improvements at the current time.

Current flood risk

The flood hazard and risk maps show that in the Bath FRA, 10,338 people (approximately 4,308 residential properties) live in areas at risk of flooding from rivers and the sea. Of these people, 4.95% live in areas considered to be at high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 1,001 non-residential properties
- 5.31km of roads including the A36 (Lower Bristol Road) and the A4
- 0.15km of railway
- 9.15ha of agricultural land
- 226 listed buildings
- 1.02ha of registered parks/gardens
- 1 licensed water abstraction site
- 202.9 ha of the City of Bath World Heritage Site

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Bath FRA.

Based on this information, Risk Management Authorities (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.

How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and other stakeholders. For example:

- Bath and North East Somerset Council
- Wessex Water
- the Bristol Avon Catchment Partnership

There are regular operational and strategic meetings organised by Bath and North East Somerset Council for the RMAs to discuss work programmes and resolve any operational issues.

The Environment Agency monitor river and rainfall conditions at 4 sites in and immediately adjacent to the FRA. These collect data on river levels (2 sites), river flows (2 sites) and rainfall (2 sites). This information is used to inform activities related to 6 flood warning

areas that cover the FRA, which enable people to receive a warning when flooding could occur.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. The main River Avon (lower) has a hydraulic model, dated 2017.

Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities, and
- the assessment and design of flood risk management works

The Environment Agency maintain flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. Bath and North East Somerset Council and Wessex Water similarly maintain assets that perform a flood risk management function on the drainage network.

At present, there is insufficient funding available to progress all potential schemes identified in the 2016 Bath 'River Avon Options Appraisal'. The current priority is to refurbish or replace the gates.

The Environment Agency has commenced work to replace/refurbish the gates at Twerton. This investment will maintain the current standard of protection and manage the risk of gate failure. Any work at Pulteney is likely to take longer as other sources of funding need to be identified. Various studies have demonstrated that the Environment Agency's Pulteney Radial Gate does not provide a significant flood risk management function. Bath and North East Somerset Council and the Environment Agency will continue to work closely together to identify opportunities to reduce flood risk in Bath in the future.

The Bath Quays Waterside Scheme is located downstream of Churchill bridge and is nearing completion. The scheme will reduce flood risk to 103 properties and Lower Bristol Road. Further details are available on Bath and North East Somerset Council's website.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. This means that flooding from rivers and will become more frequent.

Please refer to 'Climate change and the Severn RBD' for more information on what we know are likely to be the implications of climate change in the Severn RBD.

Objectives and measures for the Bath FRA

Measures have been developed which apply specifically to the Bath FRA. These measures have been developed in addition to those covering a wider geographic area but which also apply to the Bath FRA.

You can find information about all of the measures which apply to the Bath FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Bristol Rivers and Sea Flood Risk Area

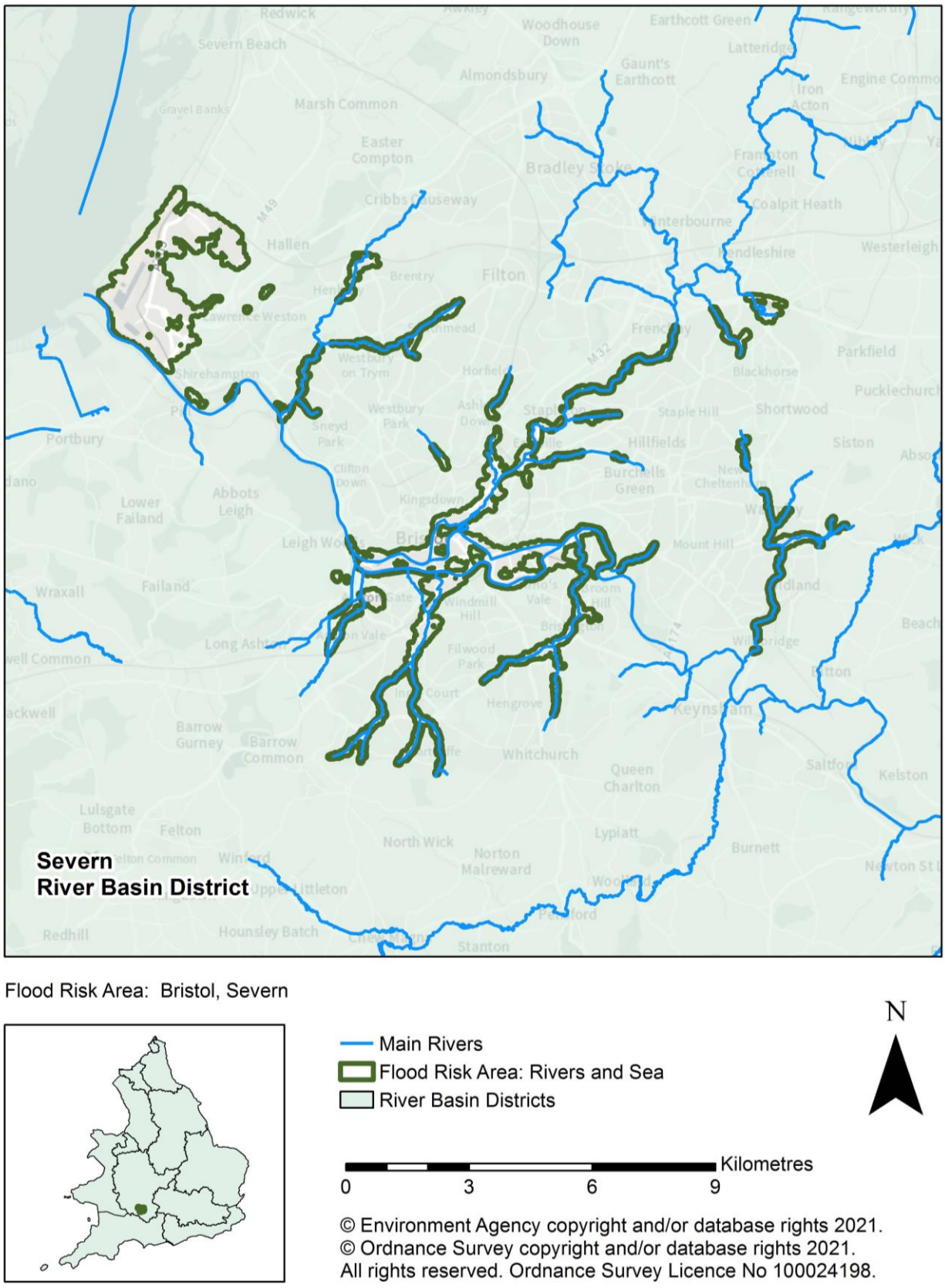


Figure 6: a map showing the boundary of the Bristol Rivers and Sea Flood Risk Area

Introduction to the Bristol Rivers and Sea Flood Risk Area

The Bristol Rivers and Sea Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Bristol City Council are the Lead Local Flood Authority (LLFA), whose remit includes flood risk from:

- surface water
- ordinary (smaller) watercourses
- groundwater

Wessex Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

The Lower Severn Internal Drainage Board (IDB) manage water levels and drainage within their drainage district. In the FRA this covers parts of Avonmouth with rhynes which discharge to the Severn Estuary.

The Bristol FRA covers mainly urban areas along the main River Avon in Bristol City Centre, the Bristol Frome and its tributaries, the Longmoor and Colliters Brooks, River Malago, Pigeonhouse Stream and Brislington Brook. The area also covers:

- the River Trym and the largely industrial area of Avonmouth downstream of the city centre
- the Conham Vale Stream and Siston and Warmley Brooks upstream of the city (in South Gloucestershire)

Bristol is at risk of flooding from the following sources:

- tidal
- fluvial (river)
- surface water
- groundwater

Free flow of river and surface water is difficult during high tides due to the high tidal range. Bristol is bisected by the main River Avon and bordered by the Severn Estuary, which has one of the highest tidal ranges in the world.

The Severn Estuary is a European Marine Site comprising of the Severn Estuary Special Area of Conservation (SAC) and Special Protection Area (SPA). The fringes of the Severn Estuary SPA and SAC and the Severn Estuary Site of Special Scientific Interest (SSSI) lie within the FRA. The Severn Estuary SSSI forms part of a larger area of estuarine habitat which includes the:

- Upper Severn Estuary SSSI

- Taf/Ely Estuary SSSI
- Bridgwater Bay National Nature Reserve and SSSI

The Severn Estuary is also on the list of Wetlands of International Importance under the Ramsar Convention (Ramsar site).

There are several other environmental designations at risk of flooding including:

- the Horseshoe Bend (Shirehampton) SSSI
- Ancient Woodland at Badocks Wood and along the River Frome
- 9 Scheduled Ancient Monuments

Current flood risk

The worst recorded flood event was in July 1968 when 7 people were killed and 805 properties were flooded. Since then, there have been several near misses, most recently in 2020 and 2014 when tidal levels overtopped the main River Avon (new cut) into the Floating Harbour at Junction Lock. Several roads across the city and one property at Sea Mills were flooded.

The flood hazard and risk maps show that in the Bristol FRA, 23,776 people live in areas at risk of flooding from rivers and the sea. Of these people, 4.7% are considered to live in areas of high risk. This compares with 6,769 people in the Bristol Surface Water FRA (see 'The Bristol Surface Water Flood Risk Area' section) who live in areas at risk from surface water flooding. Of these people, 21.5% live in areas considered to be at high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 3361 non-residential properties, including hospitals, schools and colleges and public utilities
- 14.83km of roads - including the A4 through the Avon Gorge and other key arterial routes in the city centre (including Cumberland Road, Cattlemarket Road, Clarence Road, Commercial Road)
- 12.46km of railway
- 36.37ha of agricultural land
- 7.81ha of registered parks and gardens
- 206 listed buildings
- 1.96ha of Scheduled Ancient Monuments
- 14 Environmental Permitting Regulations installations
- 12 licensed water abstraction sites
- areas of environmental designated sites - including 25.57ha of the Severn Estuary SAC, 23.84ha of both the Severn Estuary SPA and Ramsar site, and 24.99ha of the Severn Estuary SSSI

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Bristol FRA.

Based on this information, Risk Management Authorities (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.

How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and stakeholders. This includes:

- Bristol City Council
- South Gloucestershire Council
- the Lower Severn IDB
- Wessex Water
- the Bristol Avon Catchment Partnership

There are regular operational meetings organised by Bristol City Council for the RMAs to discuss work programmes and resolve any operational or management issues. For further information see the section ‘The Bristol Surface Water FRA’.

Tidal and fluvial flood risk is managed by an extensive and complex combination of flood alleviation assets. This includes raised defences, flood bypass channels and associated control structures. These are managed by several operating authorities, including the Environment Agency. In many places these assets are over 200 years old.

There has, and continues to be, a programme of work to refurbish these assets to ensure they continue to perform. In many areas this flood mitigation infrastructure brings residual flood risk to an acceptable level. However, there are locations where the residual flood risk from tidal, fluvial and/or surface water remains above that which we would aspire for an urban area such as Bristol. In these locations we are working in close partnership with the relevant RMAs, in particular Bristol City Council and Wessex Water, to fully understand the risk and develop options for improvements.

The main defences through Bristol include the Northern Storm Water Interceptor, which diverts high river flows from the Bristol Frome at Eastville away from the city into the tidal Avon. The Floating Harbour in the centre of the city has a vital role in protecting the city from combined tidal and fluvial flooding. The gates at Junction Lock and Netham prevent water from the tidal main River Avon from entering the Floating Harbour.

In addition to these, there are also:

- flood walls at Cumberland Road and Totterdown
- diversion channels/tunnels to the south of the Avon on the Longmoor, Colliters and Brislington Brooks
- the Southern Interceptor Tunnel

Another flood risk management scheme in the FRA is the Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation Flood Defence project. This is a partnership scheme between:

- Bristol City Council
- South Gloucestershire Council
- the Environment Agency

It's a major scheme that will better protect the Enterprise Area and nearby residential and commercial communities until at least 2098, taking account of sea level rise.

The Environment Agency monitor river conditions at 12 sites in or near the FRA. This information is used to inform activities related to 17 fluvial flood warning areas that cover the FRA which enable people to receive a warning when flooding could occur. The Environment Agency also monitor tidal water levels at Avonmouth, and this is used to inform activities related to a further 7 tidal flood warning areas in the Bristol FRA.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. We have detailed hydraulic models for all the main river catchments.

Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

The Environment Agency maintain flood risk management assets like river channels, flood defence walls or embankments, throughout the FRA. Bristol City Council, Wessex Water and the Lower Severn IDB similarly maintain assets that perform a flood risk management function on the drainage network.

Bristol City Council and the Environment Agency are currently looking at the short, medium and long-term strategy for managing flood risk on the Bristol Avon and the Bristol Frome rivers to better protect the city centre.

The impact of climate change and future flood risk

Climate change and increasing development pressures have been identified as the main drivers for increase in flood risk.

Rainfall intensity is expected to increase in the future and causing higher river flows and levels. Sea levels are also expected to rise. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often. This means that flooding from rivers and the sea will become more frequent.

Please refer to Climate change and the Severn RBD section for more information on what we know are likely to be the implications of climate change in the Severn River Basin District.

Objectives and measures for the Bristol Rivers and Sea FRA

Measures have been developed that apply specifically to the Bristol Rivers and Sea FRA. A number of these measures also apply to the Bristol Surface Water FRA, led by the LLFA. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Bristol Rivers and Sea FRA.

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

The Bristol Surface Water Flood Risk Area

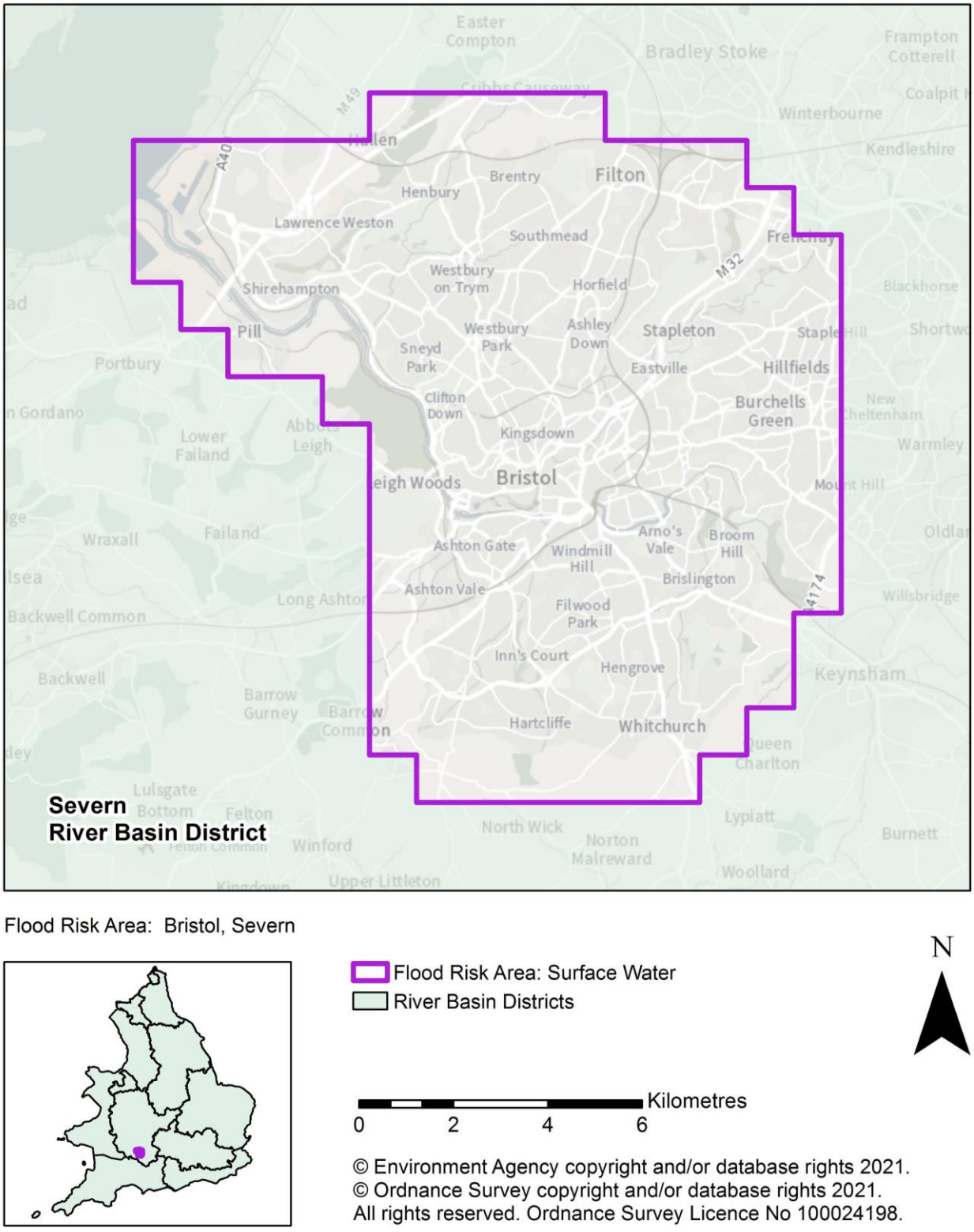


Figure 7: a map showing the boundary of the Bristol Surface Water Flood Risk Area

Introduction to the Bristol Surface Water Flood Risk Area

The Bristol Flood Risk Area (FRA) 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).

Bristol City Council takes the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA as it is the Lead Local Flood Authority (LLFA) responsible for considering flood risk from 'local' sources. These local sources of flooding are:

- surface water
- ordinary (smaller) watercourses
- groundwater

The Environment Agency's remit covers flood risk from main rivers and the sea as described in the section: Bristol Rivers and Sea FRA above.

Wessex Water is the water and sewerage company that owns, operates and maintains the sewerage network and wastewater treatment infrastructure in the FRA.

The Lower Severn Internal Drainage Board (IDB) manage water levels and drainage within their drainage district. In the FRA this covers parts of Avonmouth with rhynes that discharge to the Severn Estuary.

The Bristol FRA covers the urban area of the City of Bristol which is a relatively dense urban extent. The city is characterised by an economic central hub surrounded by Victorian and Georgian aged character areas, with more modern (post WWI) areas beyond. Several of the older neighbourhoods are themselves characterised by dense terraced housing, often served by a combined sewer network.

The city's riverscapes are dominated by its geography and land use. The city (and adjoining local authority areas) slopes down towards the city centre. Much of the upper reaches are dominated by steep sided valleys, with clay and mudstone as the underlying geology. There's low infiltration potential and so these catchments respond quickly to rainfall. Some areas of the city, such as Easton and Stoke Bishop, have soils with good infiltration potential.

The lower parts of the city are dominated by the main Rivers Avon and its tributary, the Bristol Frome. The Avon and its associated Floating Harbour (a unique inland impounded harbour) flow through the city centre with the Harbour in particular characterising the city centre.

The main River Avon is tidally influenced as it flows into the Severn Estuary at Avonmouth, some 10km downstream of the city centre. The Severn Estuary has one of the highest tidal ranges in the world, at approximately 14m. Such tidal variation influences the dominant flood risk from the Avon (tidal) but also impacts local flood risks through tide locking of tributaries and surface water outfalls. For example, the flood risk posed from the

main rivers Malago and Colliter's Brook are subject to tide-locking and the joint probability between tidal and fluvial flooding.

The Severn Estuary is a European Marine Site comprising the Severn Estuary Special Area of Conservation (SAC) and Special Protection Area (SPA). The fringes of the Severn Estuary SPA and SAC and the Severn Estuary Site of Special Scientific Interest (SSSI) lie within the FRA. The Severn Estuary is also on the list of Wetlands of International Importance under the Ramsar Convention (Ramsar site).

There are several other environmental designations at risk of flooding including:

- several SSSIs - Pen Park Hole, Avon Gorge and Ashton Court
- sites of Ancient Woodland
- 8 Scheduled Ancient Monuments

Like many cities, the waterways, land use and therefore flood risks have been heavily influenced by human interaction. In the city centre, the main River Avon and Floating Harbour dominate the landscape and features of the historic centre. Further downstream, the Avon flows to the Severn Estuary at Avonmouth. The landscape includes a local residential community and significant industrial and employment land surrounding the Bristol Port Company estate.

The city of Bristol grew around the main River Avon and later the Floating Harbour. The introduction of the Harbour enabled some management of flood risk from tidal and fluvial sources. The various waterways through the city have been heavily urbanised and, in many cases, culverted, at least in part.

The largely dense urban environment, coupled with its geography and geology, results in high levels of flood risk from surface water sources. Through the 20th century, and in response to various flood events, large-scale interceptors were constructed to reduce the risk of flooding from some of the main rivers through the city. This includes the:

- Northern Stormwater Interceptor on the rivers Frome, Boiling Wells Stream and Cranbrook
- Southern Interceptor Tunnel which reduces the risk from the rivers Brislington Brook, Malago and Pigeonhouse Stream

Groundwater flood risk is not a high risk across the city. However, some areas of known high groundwater are in lower-lying areas of the city, specifically at Avonmouth and Ashton. In other locations across the city, the risk from groundwater flooding is generally sourced from local springs that do not typically constitute a significant flood risk but can be difficult to manage.

For further information of the risk of flooding from rivers and sea see the section 'Bristol Rivers and Sea FRA' above.

Current flood risk

The flood hazard and risk maps show that in the Bristol Flood Risk Area, 6,769 people live in areas at risk from flooding from surface water. Of these people, 21.5% are at high risk.

Also shown to be in areas at risk of flooding from surface water are:

- 300 non-residential properties - including community centres, hospitals, schools and colleges, retail parks and public utilities
- 8.12km of roads - including parts of the M49, M5, M32, A4, A3029, A4032 and A4044
- 14.20km of railway
- 285.23ha of agricultural land*
- 13 Environmental Permitting Regulations installations
- 7 licensed water abstraction sites
- 39 listed buildings
- 0.52ha of Scheduled Ancient Monuments
- 52.79ha of registered parks and gardens
- areas of environmental designated sites - including 5.51ha of the Severn Estuary SAC, 0.46ha of both the Severn Estuary SPA and Ramsar site, and 16.9ha of SSSIs

*Based on Agricultural Land Classification map. In reality a large proportion of the land shown in the map as being agricultural land is built up area.

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Bristol FRA.

Based on this information, Risk Management Authorities (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.

The impact of tidal and fluvial flooding to the city centre from the Avon is considered particularly important to manage given the status of central Bristol as an economic and tourism hub for the West of England region. Measures to address this risk are covered in the ‘Bristol Rivers and Sea FRA’.

How the risk is currently managed

The management of surface water and ordinary watercourse flood risk is led by Bristol City Council (as LLFA, Local Planning Authority, Highways Authority and Harbour Authority) in collaboration with Wessex Water and the Lower Severn Internal Drainage Board.

The co-ordination of flood risk management is clarified in the ‘Bristol Local Flood Risk Management Strategy’. The Bristol Flood Risk Management Working Group is the primary mechanism used to co-ordinate management between the relevant RMAs. This group is chaired by Bristol City Council (LLFA) with regular membership from officers in the

Environment Agency and Wessex Water. The group also has representatives from other relevant teams (for example Highways Authority, Harbour Authority, Civil Protection Unit) or RMAs such as the Lower Severn Internal Drainage Board.

If required, in addition to the Working Group, a Flood Risk Management Strategic Board is in place for issues raised by exception.

Governance is also in place for specific flood risk management schemes in the city, notably the Avonmouth and Severnside Enterprise Area Ecology Mitigation and Flood Defences project and the 'Bristol Avon Flood Strategy' (see 'Bristol Rivers and Sea FRA' section for more information).

As shown on the Bristol City Council's Flood Risk Asset Register, Bristol City Council has 2 rain gauges and 4 river level monitors within the FRA, one of which is on the tidal Main River Avon.

Bristol City Council, as the LLFA and Civil Protection Unit, have a specific Flood Plan that sets out the actions required in advance of and during a potential flood event.

Bristol City Council has, through its 'Surface Water Management Plan', completed surface water modelling of the FRA area. The model has been completed using Infoworks ICM software and is a 1D/2D linked model representing the ground surface, land use and the underground sewer network.

There are several schemes or assets that protect properties across the city from surface water flood risk. Examples of this include flood proof fencing in Withywood and a flood risk management-based storage basin in Southmead.

Many proposed developments and site allocations in the city are redevelopment or regeneration of brownfield land. As a result, with national and local policies in place that require developments to manage or reduce surface water runoff, such regeneration is likely to reduce the risk of surface water or sewer flooding to the city.

For further information on the schemes that reduce the risk of flooding from rivers and the sea in Bristol, see the 'Bristol Rivers and Sea FRA'.

The impact of climate change and future flood risk

As rainfall intensity increases, it means that surface water flooding will become more frequent. This is because higher rainfall totals will be seen more often. River flows are also expected to increase, leading to increased risk of fluvial flooding.

Please refer to 'Climate change and the Severn RBD' section for more information on what we know are likely to be the implications of climate change in the Severn RBD.

Objectives and measures for the Bristol Surface Water FRA

Measures have been developed which apply specifically to the Bristol Surface Water FRA. A number of these measures also apply to the Bristol Rivers and Sea FRA, led by the Environment Agency. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Bristol Surface Water FRA.

You can find information about all the measures that apply to the Bristol Surface Water FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Cheltenham Surface Water Flood Risk Area

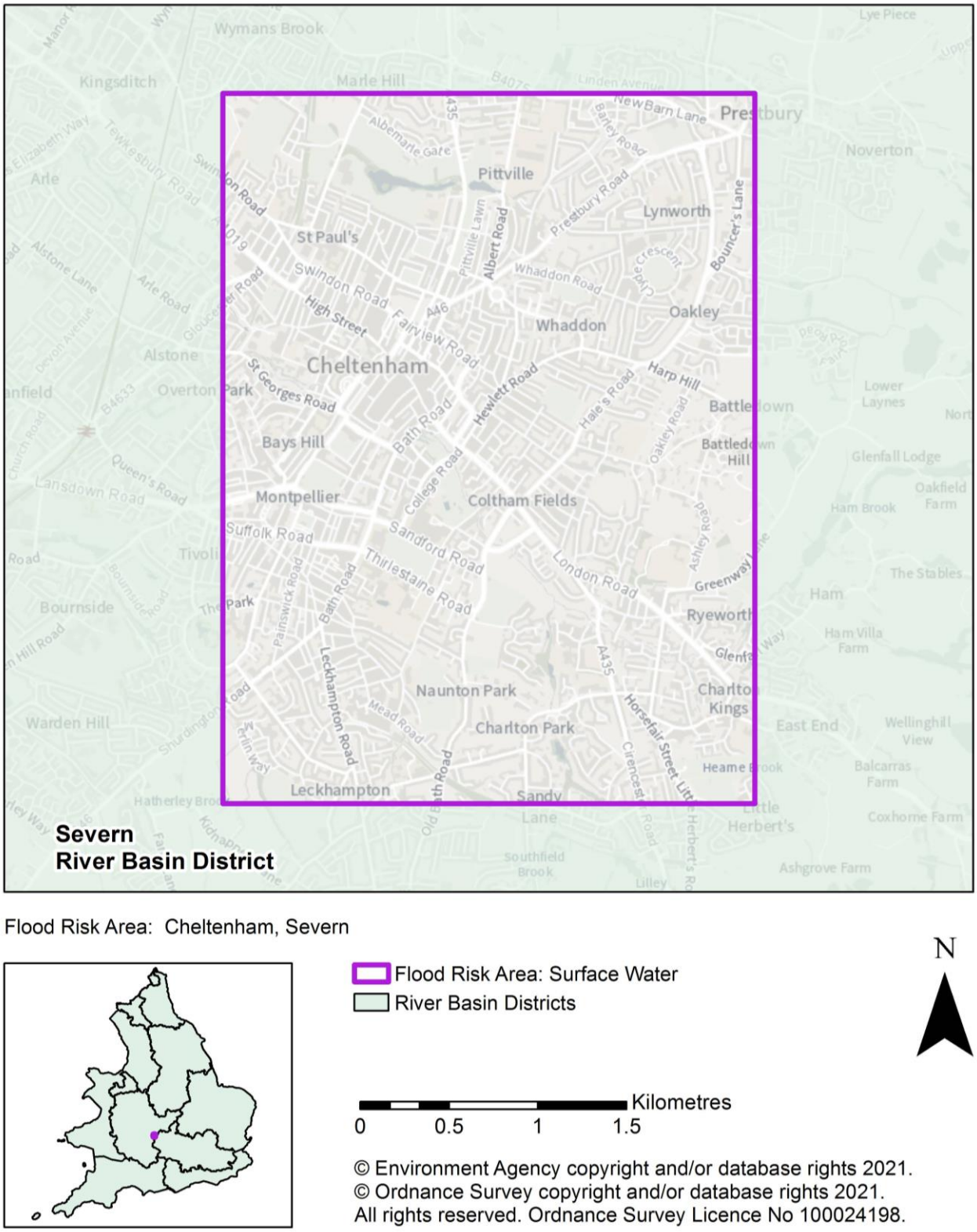


Figure 8: a map showing the boundary of the Cheltenham Flood Risk Area

Introduction to the Cheltenham Flood Risk Area

The Cheltenham FRA 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).

Gloucestershire County Council have led on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. They're the Lead Local Flood Authority (LLFA) responsible for managing flood risk from 'local' sources, including surface water.

The Environment Agency's remit includes managing flood risk from main rivers in the FRA.

Severn Trent Water is the water and sewerage company that owns, operates and maintains the sewerage network and wastewater treatment infrastructure in the Cheltenham FRA.

The Cheltenham FRA is located within the wider Cheltenham Borough. Cheltenham is one of Gloucestershire's major urban settlements situated between the Cotswolds and the Vale of the River Severn.

Cheltenham began as an Anglo-Saxon village over 1,200 years ago, becoming a market town in 1226. This was the basis of its economy until the 1700s, when its medicinal waters were discovered in a field to the south of the town.

By the late 1700s Cheltenham was one of England's leading spas, and by 1850 it was the largest town in Gloucestershire. In the 1900s the town grew rapidly, becoming a centre for business and administration.

Future development plans for the borough include a 'Cyber Central Garden Community' in west Cheltenham, and Elms Park, a mixed-use urban extension in north-west Cheltenham.

Located within the FRA are:

- 941 listed buildings
- approximately 31ha of registered parks and gardens (including Pittville Park)

Parts of the FRA overlap into the Cotswolds Area of Outstanding National Beauty (AONB).

Cheltenham town itself is relatively flat with gentle slopes down to the River Chelt which flows through the town centre. To the east of Leckhampton, Prestbury and Charlton Kings, the land rises steeply towards the escarpment of the Cotswold Hills AONB.

The bedrock beneath Cheltenham borough is mainly Lower Lias impermeable clay. A large proportion of any rain falling becomes runoff even when the soil is not saturated, and catchments respond relatively quickly to precipitation.

The high degree of urbanisation, coupled with the small size of the catchments and impermeable underlying rock, means that the greatest flood risk in the FRA is from high-intensity convective storms. This is more common during the summer season.

Surface water flood risk is spread throughout the FRA. However, there are several locations that experience more frequent flooding, such as:

- Charlton Kings
- Charlton Park
- Pittville
- Oakley
- Lansdown
- Leckhampton
- Whaddon

Some areas experience internal property flooding from surface water due to drainage networks becoming overwhelmed and surcharging.

The historic areas of the FRA predominantly drain into combined sewers. Some scattered sections of the town have separate surface water and foul water systems, such as Cromwell Road. Increased pressure is put on the combined sewer network due to localised surface water issues, as well as flows entering the FRA from the adjacent escarpment. This can cause surface water flooding due to the combined sewer network becoming overwhelmed and surcharging.

Highway drainage in the town is heavily dependent on the number and capacity of the highway gullies and the available capacity in the sewer network. Surface water flooding can occur because the:

- capacity of highway gullies is exceeded
- sewers into which the gullies drain are full

In addition, localised low spots like Prestbury Road accumulate surface water, with vehicles unable to pass.

Surface water flooding often occurs in combination with other sources of flood risk in the FRA. For example, several surface water outfalls discharge to the River Chelt and Wymans Brook, contributing to flows in those watercourses. When river levels are high, discharge from the surface water outfalls is restricted, which can back up and ultimately impact upon sewer and highway drainage. Sewer flooding in the FRA is exacerbated when surface water gets into the combined storm water and foul network.

Within the FRA there are 6 main rivers and several ordinary watercourses. A further 2 main rivers are on the periphery. Fluvial flooding has occurred in the FRA from overtopping of watercourses and surcharging of culverts. This has affected areas like:

- Cheltenham Town Centre
- Charlton Park

- Pittville
- Whaddon
- Prestbury

There's a flood risk management scheme on the River Chelt that reduces the risk of flooding for over 650 properties in the town centre. This consists of flood storage areas, improved channel capacity and flood walls. The River Chelt running through Charlton Kings has been designated as a rapid response catchment. This is due to its topography with runoff from the adjacent escarpment quickly entering the watercourse network.

Parts of the FRA are also at risk of flooding from 2 reservoirs, the undertakers for which are the Environment Agency and Severn Trent Water.

Current surface water flood risk

Major flood incidents have been experienced across Cheltenham Borough. These include in:

- summer 2007 – over 600 properties were flooded from surface water and other sources
- winter 2012
- June 2016 - at least 6 properties were flooded by surface water in Leckhampton
- June 2020 – heavy rainfall affected several properties in Oakley and Pittville

In December 2020, surface water flooding across the borough affected properties within several wards. These included:

- Charlton Kings
- College
- Leckhampton
- Lansdown
- Pittville (highway flooding)

The flood hazard and risk maps show that in the Cheltenham FRA, 8,563 people live in areas at risk of flooding from surface water. Of these people, 4.5% are in areas of high risk.

Also shown to be in areas at risk of flooding from surface water are:

- 809 non-residential properties - including community centres, Cheltenham Town Football Club, schools (Naunton Park Primary School) and colleges (Cheltenham College), and hospitals (Cheltenham General Hospital)
- 4.48km of roads - including parts of the A35, A40, A46, A435, B4532
- 2.47ha of agricultural land
- 86 listed buildings
- 10.38ha registered parks and gardens - Charlton Park, Naunton Park, Pittville Park and Pittville Pump Room

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of surface water flooding for the Cheltenham FRA.

Based on this information, Risk Management Authorities (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.

How flood risk is currently managed

Gloucestershire County Council (LLFA) manages flood risk from:

- surface water
- groundwater
- ordinary watercourses

Gloucestershire County Council does this in collaboration with other Risk Management Authorities (RMAs) and stakeholders in the FRA. These include:

- Cheltenham Borough Council
- the Environment Agency
- Severn Trent Water

The strategies relevant to the FRA are the 'Gloucestershire Local Flood Risk Management Strategy' and the 'Cheltenham Surface Water Management Plan'.

Gloucestershire County Council chairs the Gloucestershire Flood Risk Management (FRM) partnership group, which consists of representatives from the RMAs and other stakeholders.

Its main purpose is to help co-ordinate and implement FRM in Gloucestershire, and to develop and deliver the county's Local Flood Risk Management Strategy. Project teams are formed as needed to deliver specific work or projects, such as delivering a flood alleviation scheme or flood study.

During a significant flooding event, the Civil Protection Team responds alongside relevant stakeholders to deliver a co-ordinated response for the county, including in the FRA. The Gloucestershire County Council FRM Team chair post-event debriefs with representatives from all RMAs and other stakeholders. This is to:

- understand flood mechanisms
- realise lessons learnt
- understand what actions are needed to alleviate future flood risk

There are no surface water specific flood alerts or warnings covering the FRA. The Environment Agency monitors rainfall and river levels and provides a flood warning service for river flooding. There is one river flood alert and 3 river flood warning areas in the FRA.

The best available information that indicates areas of surface water flood risk in the FRA is mapping produced as part of the 'Cheltenham Surface Water Management Plan'. The

Surface Water Management Plan used the latest generation of integrated modelling software to produce a single model which captured all flooding mechanisms including from:

- watercourses
- culverts
- sewers
- surface water runoff

Separate modelling and mapping also exist that indicates areas at risk of river and reservoir flooding.

Cheltenham Borough Council and Severn Trent Water operate and maintain assets that perform a flood risk management function on the drainage network. Cheltenham Borough Council also maintain several other structures on ordinary watercourses in the FRA, such as trash screens.

The Environment Agency uses its permissive powers to operate and maintain FRM assets on the main rivers in the FRA. The responsibility for maintaining the reservoirs lies with their respective undertakers.

Work in the FRA that has been completed or is underway to reduce surface water flood risk, includes the:

- construction of the Whaddon (Priors and Oakley) FRM scheme, 2018 to 2019
- investigation of flood risk in Pittville and Oakley
- drainage survey commissions

The construction of the Whaddon (Priors and Oakley) FRM scheme was led by Gloucestershire County Council. The Whaddon area was identified in the 'Cheltenham Surface Water Management Plan' as being at significant risk of surface water flooding. The flooding was principally caused by excess surface runoff from the adjacent escarpment to the east. This exceeded the capacity of the culverted watercourses, which resulted in surface water runoff entering the urban environment. The scheme comprises 2 flood storage areas upstream of the urban area and has been designed to benefit 179 properties.

Gloucestershire County Council is currently investigating flood risk and potential options to reduce this in the Pittville and Oakley Wards. The flood risk is mainly pluvial, however there's some interaction between fluvial, surface water and sewer flooding so a holistic approach is being taken.

There's been frequent surface water flooding during rainfall events with only a low return period. Gloucestershire County Council commissioned drainage surveys to better understand the issues. Following on from extensive drainage surveys in the wards, several improvement measures were identified. Gloucestershire County Council plan to work with partners to progress those that are feasible.

Gloucestershire County Council will review modelling of the area to understand what properties are at risk of surface water flooding and, where possible, carry out works to reduce flood risk.

Work has also been undertaken in the FRA to reduce the risk of sewer flooding. Between 2014 and 2016, Severn Trent Water carried out a major scheme across various locations in Cheltenham. The £7m+ investment has reduced the risk of sewer flooding in high risk locations by increasing the capacity of the sewer network.

The impact of climate change and future flood risk

As rainfall intensity increases, it means that surface water flooding will become more frequent. This is because higher rainfall totals will be seen more often. River flows are also expected to increase, leading to increased risk of fluvial flooding.

Please refer to the Climate change and the Severn RBD section for more information on what are likely to be the implications of climate change in the Severn River Basin District.

Objectives and measures for the Cheltenham FRA

Measures have been developed that apply specifically to the Cheltenham FRA. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Cheltenham FRA.

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

The Coventry Surface Water Flood Risk Area

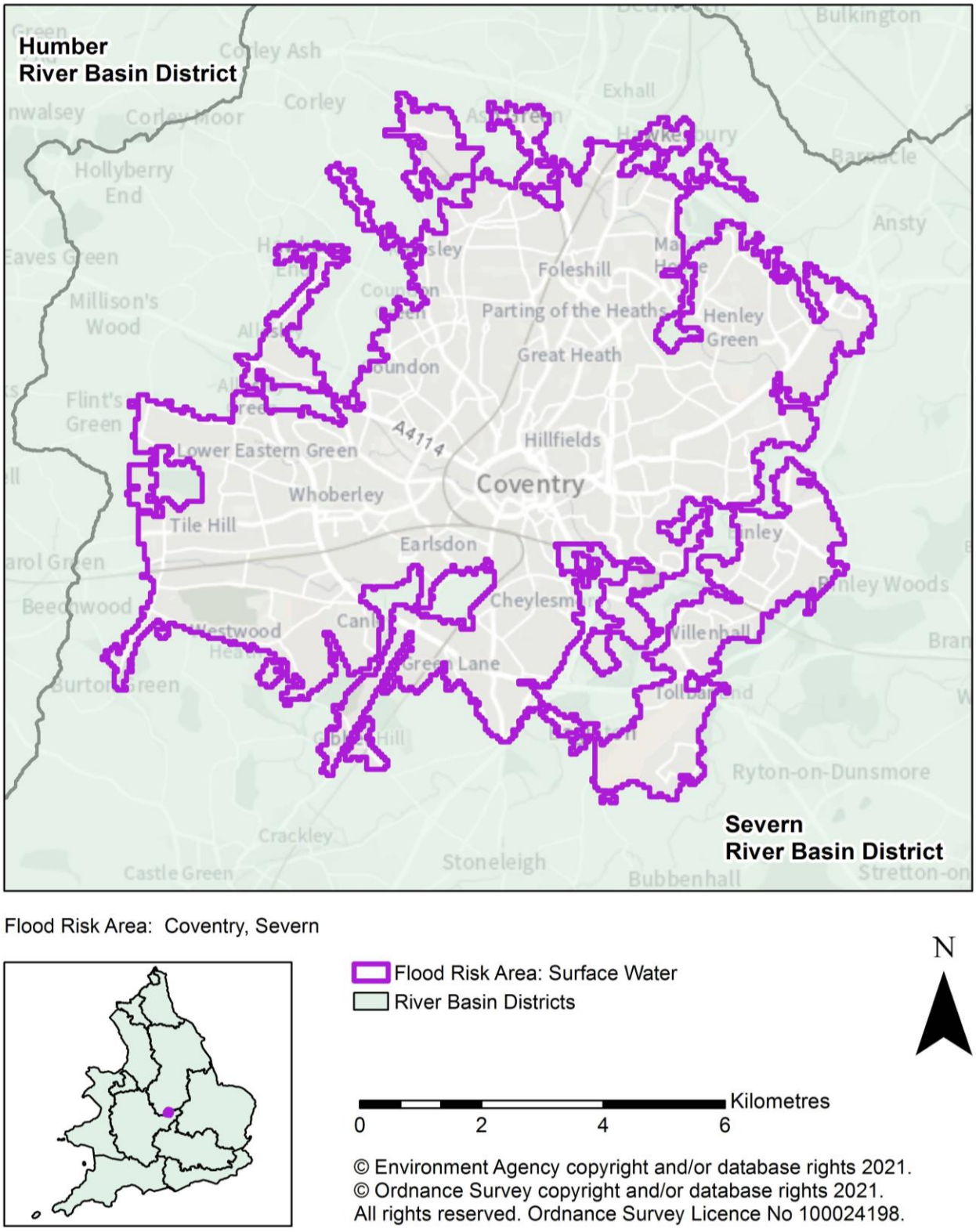


Figure 9: a map showing the boundary of the Coventry Flood Risk Area

Introduction to the Coventry Flood Risk Area

The Coventry FRA 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). It's located predominantly within Coventry City Council's administrative area, with some overlap into Warwickshire County, and negligible overlap into Solihull Metropolitan Borough.

The Lead Local Flood Authorities (LLFAs) of these 3 areas are responsible for the management of flood risk from local sources, including surface water. As the FRA is substantially in Coventry, Coventry LLFA have led on the development and delivery of the Flood Risk Management Plan (FRMP), with support from:

- Warwickshire County Council LLFA - for areas in Warwickshire
- Coventry Solihull & Warwickshire Resilience (CS&W Resilience) - on emergency response and recovery aspects
- Severn Trent Water - the water and sewerage company that owns, operates and maintains the sewerage network and wastewater treatment infrastructure in the FRA
- the Environment Agency - whose remit covers managing flood risk from main rivers

The Coventry FRA is substantially urbanised, mainly comprising of land uses that are:

- industrial
- commercial
- residential
- for greenspaces

Located within the FRA are several:

- listed buildings
- registered parks and gardens
- Scheduled Ancient Monuments

The FRA also has within it several:

- local wildlife sites
- local nature reserves
- ancient woodlands - including Willenhall Wood, Wainbody Wood, Ten Shilling Wood, Park Wood, Limbrick Wood, Pig Wood and Plants Hill Wood

There are 2 Sites of Special Scientific Interest (SSSI) located on the fringes of the FRA:

- Tilehill Wood SSSI - located towards the west and designated as a local nature reserve and ancient woodland
- Herald Way Marsh SSSI - located towards the south-east and designated as a local nature reserve

Coventry is within the headwaters of the Warwickshire Avon catchment with tributaries that include the:

- Canley Brook
- River Sherbourne
- River Sowe

Catchments respond quickly to rainfall, due to the:

- size of the catchment
- age of the development
- extent of urbanisation

The soil type in the FRA is predominantly clayey with impeded drainage. This can result in high rates of surface water runoff from greenspaces during heavy or intense rainfall events. This is particularly the case during seasonally wet periods when soils become waterlogged. The flat nature of the terrain in many areas means that such areas can be susceptible to widespread shallow ponding as the surface runoff cannot drain away easily. Surface water flooding can also occur because the intensity and volume of rainfall exceeds the design capacity of:

- the drainage network, including property drainage and gullies
- highway drains and the sewer network

Central Coventry, and the inner suburbs of Stoke (east), and Foleshill (north) are the oldest built areas. They're heavily urbanised with buildings typically drained by Victorian combined systems. From the 1920s onwards, suburban areas expanded outwards in all directions, increasingly drained by separate surface water sewers. These systems must now deal with escalating rainfall patterns due to climate change.

Since 2010, most new developments have included sustainable drainage systems (SuDS), with a focus on above ground attenuation where possible, reducing risk on and off site. In general, there's less risk in more recently developed areas due to greater considerations of flooding in planning policy and design standards. This includes considerations on the increasing impact of climate change. Additionally, there's been a greater focus in Coventry on flood resilience of new development.

The FRA includes 5 main rivers and several smaller watercourses. Many of the watercourses in the FRA have been culverted, particularly those in the centre of Coventry. The channels of these watercourses have been extensively developed. As set out in the '[Coventry Local Plan 2011-2031]', Coventry City Council now discourages culverting and encourages their removal (de-culverting) where possible. This is for flood risk and water quality benefits.

In addition to surface water flooding, the FRA is at risk of flooding from:

- sewers
- watercourses
- canals when high inflows exceed capacity

- groundwater
- reservoirs

Sewer flooding often occurs at the same time as surface water flooding. Excessive amounts of surface water draining to sewers can lead to sewers being overwhelmed. Sewer flooding can also occur due to blockages in the network.

High rainfall can exceed the channel capacity of watercourses. Lack of capacity of culverts and bridges to convey the water further increases the risk of out of bank flows and flooding.

Coventry is located on a major aquifer. Groundwater flooding may become more common in years to come due to:

- a reduction in abstraction by heavy industry
- the wider restoration of base flows resulting from the use of more infiltration SuDS

This now sees groundwater returning to natural, pre-abstracted levels.

The FRA includes the Coventry Canal and a small part of the Oxford Canal. Parts of the FRA are in the inundation areas of 3 reservoirs.

With regards to current and future development, the 'Coventry Local Plan 2011-2031' was formally adopted in December 2017. The map includes:

- brownfield allocations within the FRA - in accordance with local policy run off rates must be restricted to that of greenfield rates
- greenfield sites at the edge of the FRA - the Eastern Green and Keresley SUE make more space for water and reducing runoff rates

The Plan includes local policies EM4 and EM5 that set high standards for the management of surface water to reduce on-site and off-site flood risk. These are maintained alongside other local requirements and national standards. There are also multiple development allocations just outside of the FRA in Warwickshire that'll effectively extend Coventry's urban extent, such as:

- Westwood, Kings Hill and Whitley South – see 'Warwick District Local Plan 2011-2029'
- Development to North – see 'Nuneaton and Bedworth Borough Plan' 2011-2031

Current surface water flood risk

Historically, several flood incidents have occurred in Coventry, the majority having been one off incidents, such as blocked gullies. Flash flooding occurred in June 2003, causing flooding to approximately 11 houses and roads. In December 2008, surface water flooding affected:

- 25 properties
- an electrical sub-station

- a nursing home

There have been no surface water flooding events in Coventry over the last 6 years significant enough to warrant a Section 19 investigation, based on local thresholds. All flooding issues are investigated for internal reporting purposes.

On 27 May 2018 there was a significant regional event, where 2 hours of intense rainfall caused flooding from multiple sources across parts of the West Midlands. This also included nearby Solihull (section 19 report). Next to no rain fell in Coventry during this time, however RMAs have been actively seeking to understand and implement any lessons learnt from this event. This is because the FRA would have been similarly affected.

The flood hazard and risk maps show that in the Coventry FRA, 29,810 people live in areas at risk from surface water. Of these people, 7% are in areas of high risk.

Also shown to be in areas at risk of flooding from surface water are:

- 1726 non-residential properties - including 110 health, education, emergency and transport services
- 9km of roads
- 8.52km of railway
- parts of Coventry Airport
- 77ha of agricultural land*
- historic assets - including 24 listed buildings, 1.27ha of registered parks and gardens, 1.58ha of Scheduled Ancient Monuments
- 0.05ha of Sites of Special Scientific Interest
- 6 Environmental Permitting Regulations installations
- 10 Licensed Abstraction Points

*Based on Agricultural Land Classification map. In reality a large proportion of the land shown in the map as being agricultural land is built up area.

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of surface water flooding for the Coventry FRA. Based on this information, Risk Management Authorities (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.

How flood risk is currently managed

In their local co-ordination role, Coventry City Council manage the Coventry Flood Risk Management Group. This is made up of the RMAs listed in the Introduction alongside other organisations involved in local flood risk management. The group meets biannually. Relevant strategies for the FRA include:

- Local Flood Risk Management Strategy
- Surface Water Management Plan

There's also a multi-agency flood plan for Coventry that specifically outlines how multi-agency partners will work together to respond to and manage significant flooding incidents.

For the small parts of the FRA in Warwickshire, the equivalent strategies produced by Warwickshire County Council apply.

The main source of weather data within the FRA is Bablake weather station. This is an independent Met Office climatological station located in Coundon, to the north-west of the FRA. There are no surface water specific flood alerts or warnings covering the FRA. The Environment Agency monitors rainfall and river levels and provides a flood warning service for river flooding. There is one river flood alert and 9 river flood warning areas in the FRA.

The Coventry FRA is covered by the national Risk of Flooding from Surface Water mapping, which was originally published by the Environment Agency in 2013 on behalf of LLFAs. Modelling and mapping also exist, which indicates areas at risk of river and reservoir flooding.

Coventry City Council manages a Geographic Information System (GIS) based floods database, which includes records of historic surface water flood events.

As LLFAs, Coventry City Council and Warwickshire County Council manage asset registers and records for Coventry and Warwickshire respectively. In Coventry, the asset register includes important assets for surface water management, such as:

- highway drainage
- culverted watercourses
- associated trash screens

Both registers are continuously updated as further information becomes available.

Coventry City Council has an annual maintenance programme for cyclic cleansing, repairs and improvements for surface water assets under its control. Where surface water assets are outside the control of the Council, there's effective co-ordination with other RMAs and private asset owners where intervention is identified.

Severn Trent Water periodically carry out inspections and maintenance on their surface water and combined sewerage networks to ensure they are operating effectively.

The Environment Agency uses its permissive powers to carry out maintenance activities on main rivers, including activities relating to trash screens. The Canal & River Trust manages and maintains its network to reduce risks of asset failure. The responsibility for reservoir maintenance lies with their undertakers.

Since 2015 the following strategic steps have been important in the management of surface water:

- April 2015 – Coventry City Council and Warwickshire County Council became statutory consultees on major applications for the management of surface water

- February 2016 – final issue of the 'Coventry Surface Water Management Plan' published
- December 2017 – 'Coventry City Council Local Plan 2011-2031' adopted

Several flood risk improvement schemes have been undertaken, including:

- 'Chesholme Road Coventry Flood Alleviation Scheme' – a Severn Trent Water led scheme for the management of sewer and surface water flooding
- Broad Banner Lane junction improvements - part of the works to protect properties at Upper Eastern Green from multiple sources of flooding risk
- Canberra Road Trash Screen Replacement – a replacement trash screen to reduce flooding to several properties
- Bowness Close Trash Screen – a replacement trash screen to match updated design standards and reduce susceptibility to blockages

Other important work has included:

- community engagement to raise awareness of flooding and mitigation
- the promotion of nature based solutions - such as SuDS generally and natural flood management in certain targeted areas
- the investigation of surface water flooding across the FRA to identify mitigation opportunities

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in the future. It's expected that surface water flooding will become more frequent as higher rainfall totals will be seen more often. River flows are also expected to increase, leading to increased risk of fluvial flooding.

Please refer to the Climate change and the Severn RBD section for more information on what are likely to be the implications of climate change in the Severn River Basin District.

Objectives and measures for the Coventry FRA

Measures have been developed that apply specifically to the Coventry FRA. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Coventry FRA. These can be found in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Gloucester Rivers and Sea Flood Risk Area

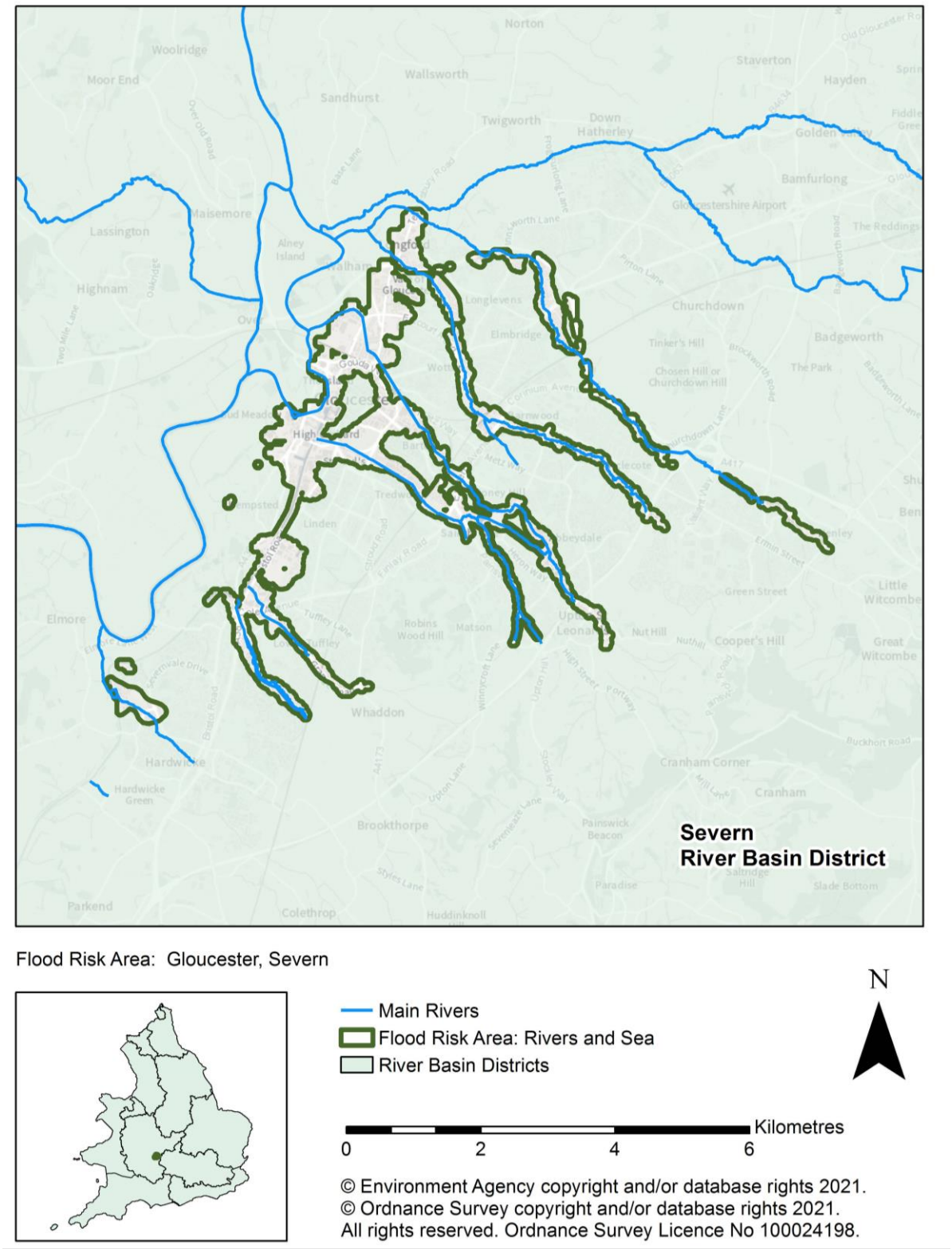


Figure 10: a map showing the boundary of the Gloucester Flood Risk Area

Introduction to the Gloucester Flood Risk Area

The Gloucester FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage). The Environment Agency takes the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Gloucestershire County Council is the Lead Local Flood Authority (LLFA), whose remit includes flood risk from surface water and ordinary watercourses.

Gloucester City Council, Tewkesbury Borough Council, Stroud District Council and the Lower Severn Internal Drainage Board each have a role in managing ordinary watercourses within different parts of the FRA.

Severn Trent Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

The city of Gloucester is a historic settlement founded by the Romans. It lies on the River Severn between the Cotswolds to the east and the Forest of Dean to the west. The Gloucester & Sharpness Canal runs through the industrial area of the city parallel to the River Severn. Gloucester is Britain's most inland port, linked via the Gloucester & Sharpness Canal to the Severn Estuary.

The FRA is predominantly urban in nature. Geologically, the FRA is formed from clay-like material which is relatively impermeable. The city area is generally flat and slopes gently away from the River Severn.

Gloucester and its surrounding area are rich in archaeology. Within the FRA, there are:

- 176 listed buildings
- several Scheduled Ancient Monuments (SAMs) including:
- Hucclecote Roman Villa
- Site of Kingsholm Palace
- St Oswald's Priory
- Wall N of Bishop's Palace
- St Mary's Gateway
- Glevum Roman Colonia
- Llanthony Secunda Priory
- several non-statutory designated sites including Local Wildlife Sites and Local Nature Reserves

There are no historic parks and gardens or nationally designated nature conservation sites within the FRA. The eastern fringe of the FRA falls within the Cotswolds Area of Outstanding Natural Beauty (AONB).

The River Severn is a designated main river, with a large catchment area upstream of the city of approximately 10,400km^2. There are a further 7 main rivers in the FRA. These have smaller catchments and are derived from springs that issue from the Cotswold limestone

aquifer to the east of the FRA in either Tewkesbury Borough Council or Stroud District Council area. They pass through mixed farmland before flowing through the city of Gloucester and then draining either to the River Severn or to the Severn Estuary through the Gloucester & Sharpness Canal. They are generally highly culverted where they flow through dense, urban areas. These ‘Gloucester tributaries’ are:

- Dimore Brook
- Daniels Brook
- Whaddon Brook
- Sud Brook, including its tributaries from Robinswood Hill and Winneycroft Farm
- River Twyver
- Wotton Brook, including its tributary from Coney Hill
- Horsbere Brook

The River Twyver and Sud Brook interconnect at Saintbridge pond.

The FRA is at risk of flooding from the 8 main rivers. River Severn flooding can be:

- fluvial, from water coming down the river from upstream
- tidal from water coming up the Severn Estuary
- a combination of the two

When channel capacity is insufficient for fluvial or tidal flood flows, water spreads into the natural floodplain. The greatest flood risk currently is from fluvial flooding.

The timing of River Severn flooding depends where in the Severn catchment the rain has fallen. Fluvial flooding from the River Severn can be caused by heavy or prolonged rainfall in the Welsh Mountains and the upper reaches of the catchment. This causes a significant amount of water to flow down the river toward the sea over several days. Sometimes there’s a quicker response due to rain falling on the Severn catchment more locally, for example in 2007. Tidal events affecting the FRA are rarer. High tides can exacerbate fluvial flooding by holding up water and raising water levels, for example in 2014.

The upper catchments of the Gloucester tributaries are in high ground to the east. In the city the watercourses receive surface water through many thousands of surface water outfalls. The geology and topography, and the abundance of impermeable surfaces in the urban areas, results in a relatively quick response in these rivers to heavy rainfall. Flooding occurs as a result of:

- channel capacity being exceeded
- constrictions at bridges and culverts causing backing up and overtopping
- blockages from debris or siltation within the channel

The effects of high flows in these rivers can be worsened by the elevated levels in the River Severn making it difficult for them to discharge.

Some locations in the FRA are at risk of both River Severn and tributary flooding.

There are several flood risk management assets in the FRA that provide a level of protection against main river flooding. These include:

- an Environment Agency-owned flood storage reservoir on the Horsbere Brook and an embankment locally at Cypress Gardens - protects approximately 350 properties
- a flood relief channel on the Daniels Brook - protects approximately 200 properties
- a flood relief channel on the Dimore Brook
- a splitter structure that diverts high flows from the River Twyver into a Flood Relief Channel - allows a controlled flow to pass along the River Twyver into the city
- Saintbridge Pond and the playing field at Saintbridge – reservoirs that attenuate flows from the Twyver Flood Relief Channel and the Sud Brook, helping to reduce flood risk downstream
- a flood wall at Llanthony and earth flood embankment at Sud Meadow - provides a low level of protection against River Severn flooding
- an earth flood embankment at the Rea - provides a level of protection against River Severn flooding for Hempsted
- several trash screens - protect culverts and structures from blockages

Additionally, although not a formal flood defence, the Quay wall at Gloucester Docks provides some protection from severe floods. On the periphery of the FRA there is a flood risk management scheme at Pool Meadow, Alney Island providing a level of protection for over 55 properties.

Other work that helps to reduce flood risk in the FRA includes:

- work in 2005/6 to improve flow of water from east to west channels of the River Severn on Alney Island, including:
    - removal of sections of the redundant Dock Branch Railway
    - lowering of a section of riverbank
    - removal of dredgings
- natural flood management interventions covering about 50% of the upper catchment of the River Twyver
- river restoration carried out in an area of the Sud Brook, which received an award from Gloucestershire CPRE, the countryside charity
- flood mitigation works carried out as part of development – such as works to alleviate flooding at Armscroft Gardens as part of the development of the Railway Triangle
- property flood resilience measures on individual properties in various locations in the City
- local authority attenuation ponds – such as Barnwood Park on the Wotton Brook and several areas off the River Twyver in Abbeymead

In addition to main river flooding, the FRA is also at risk of flooding from:

- ordinary watercourses - including the Black Ditch watercourse through Podsmead
- surface water
- sewer flooding

- high inflows exceeding the canal capacity during storm events
- reservoirs

This includes surface water run-off from high ground at Robinswood Hill and the Cotswold Escarpment upstream of Upton St Leonards. There is a high degree of interaction between the different sources of flooding.

Current flood risk

Historic records of flooding in Gloucester date back several hundred years. In 2007, over 1,100 residential properties are estimated to have flooded in the City from:

- fluvial
- surface water run-off
- surcharging of drainage systems
- sewer flooding

Many properties were first flooded by surface water or by watercourses that reacted quickly to the local run-off. Properties were subsequently flooded by the River Severn a few days later. Defences at Llanthony and nearby Alney Island were overwhelmed as River Severn levels exceeded their design. More recently, intense rainfall in December 2020 led to flooding from the River Twyver, Wotton Brook and Whaddon Brook affecting some roads and gardens. Some properties and roads were affected by:

- overland surface water flow
- drainage systems being overwhelmed and surcharging – including combined and surface water sewer networks, highway drains and gullies, pumping station
- ordinary watercourses overflowing

The flood hazard and risk maps show that in the Gloucester FRA, 15,369 people live in areas at risk of flooding from rivers and the sea. Of these people, 5.5% live in areas of high risk.

Also shown to be in areas at risk of flooding from rivers and the sea are:

- 793 non-residential properties - including education, health and transport services, an emergency response centre, and utilities including at Walham and Castlemead
- 4.20km of roads - including the A40, A38 and A417
- 0.25km of railway
- 116.2ha of agricultural land - predominantly grade 3, with small areas of grade 1 and 2*
- 70 listed buildings
- 4.71ha Scheduled Ancient Monuments

*Based on Agricultural Land Classification map. In reality a large proportion of the land shown in the map as being agricultural land is built up area.

Due to their location, most of the receptors are at risk mostly from flooding from the Gloucester tributaries.

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Gloucester FRA.

Based on this information, Risk Management Authorities (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.

How the risk is currently managed

The Environment Agency works with other RMAs and other stakeholders to co-ordinate and implement flood risk management in the Gloucester FRA. This includes via the Gloucestershire FRM partnership group.

The Environment Agency uses its permissive powers to inspect and maintain flood risk management schemes, trash screens and outfalls. It also carries out maintenance relevant to the reservoir function of the Horsbere and Saintsbridge reservoirs. It inspects the Gloucester tributaries prior to and after flooding for blockages. During flood events, it monitors, and where relevant operates, flood risk management assets.

Gloucester City Council owns and maintains several balancing areas across the FRA and carries out maintenance on main river channels where it is landowner.

Gloucester City Council and the Lower Severn Internal Drainage Board have roles in managing ordinary watercourses in the FRA. Severn Trent Water has a maintenance programme in place for public sewers and has carried out significant works to reduce sewer flooding in the FRA since 2007. The Canal & River Trust manages and maintains its network to reduce risks of asset failure. The responsibility for maintaining the reservoirs lies with their respective undertakers.

The Environment Agency has hydraulic models for the River Severn, the Severn Estuary and the Gloucester Tributaries. Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

Additionally, models that include these watercourses and the sewer network were developed as part of Gloucestershire County Council's Surface Water Management Plans. These simulate flooding mechanisms in an integrated way.

The Environment Agency monitors rain and water level gauges within and upstream of the FRA and uses these to provide a flood warning service for fluvial and tidal flooding in the FRA. There are 3 flood alerts and 5 flood warning areas that cover parts of the FRA.

The Environment Agency continues to work in collaboration with partners on several initiatives in Gloucester to provide multiple benefits. This includes to reduce flood risk and improve the environment.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in the future. This will cause river flows to increase. As sea levels rise, tidal flooding will become more frequent as higher water levels and storms will be seen more often. It is likely that flood risk in the FRA will increase with more properties becoming at risk.

Please refer to the Climate change and the Severn RBD section for more information on what we know are likely to be the implications of climate change in the Severn River Basin District.

Objectives and measures for the Gloucester FRA

Measures have been developed that apply specifically to the Gloucester FRA. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Gloucester FRA. These can be found in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Henley-in-Arden Rivers and Sea Flood Risk Area

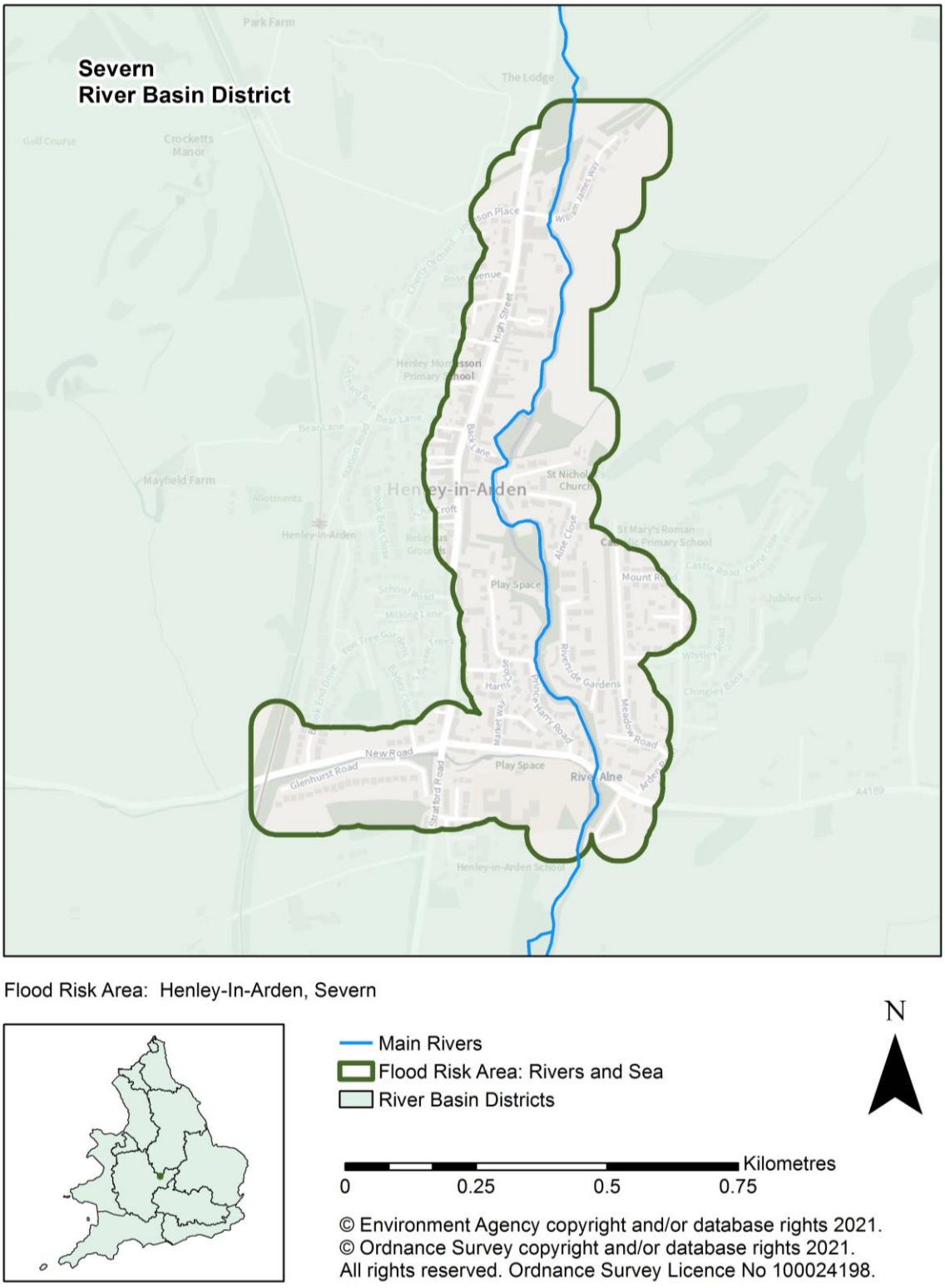


Figure 11: a map showing the boundary of the Henley-in-Arden Flood Risk Area

Introduction to the Henley-in-Arden Flood Risk Area

The Henley-in-Arden FRA has been identified as an FRA because the risk of flooding from rivers is significant nationally for people, the economy or the environment (including cultural heritage). The Environment Agency takes the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Warwickshire County Council is the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Severn Trent Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

Henley-in-Arden is a town located in Warwickshire 14km west of Warwick. It is primarily an urban community with surrounding agricultural land.

Henley-in-Arden is known for its variety of historical buildings, some of which date back to medieval times. There are 2 Scheduled Ancient Monuments within Henley-in-Arden:

- Beaudesert Castle (a 12th century motte with 2 baileys, 2 fishponds and associated ridge and furrow earthworks)
- the remains of a medieval market cross

There are 110 listed buildings and structures, most of which face onto the High Street between New Road and the line of the dismantled railway at the northern edge of the town. These listed buildings and structures include Grade II listed houses and a Grade I listed church of St. John the Baptist.

The River Alne in Henley-in-Arden is designated as a Local Wildlife Site (LWS). The FRA also includes the western most fringes of the Beaudesert Mount LWS. Towards the south, the fringes of Henley Meadows LWS are located within the FRA. Natural Environment and Rural Communities (NERC) habitats of principal importance are present in the form of deciduous woodland. There is a wide range of protected species and the River Alne is a Salmonid River and European Eel migratory route.

Henley-in-Arden is at risk of flooding from the River Alne. The River Alne is a main tributary to the River Arrow and flows through the town in a southerly direction to the confluence with the River Arrow at Alcester. Henley-in-Arden is at the top of the River Alne catchment and the head of main river is to the northwest at the Botley Mill Farm. The bedrock geology of the River Alne catchment consists largely of clay and marl-like material. There’s little superficial geology capable of storing water. The topography is moderately steep and, with the relative impermeability of the catchment, the Alne has a faster response than neighbouring rivers, such as the River Avon. The majority of the River Alne in Henley-in-Arden is open channel with weirs and bridge structures crossing the watercourse. Ordinary watercourses discharge into the River Alne in the FRA.

Fluvial flooding to roads, homes and businesses has occurred historically in the north-eastern part of the town, predominantly along:

- High Street
- Beaudesert Lane
- William James Way
- Alne Close
- Riverside Gardens

The mechanism of flooding has been identified as being:

- water overtopping the right bank of the River Alne upstream of the Bird in Hand Bridge and flowing down the road
- the surcharging of the William James Way and Beaudesert Lane culverts
- the overtopping of River Alne banks throughout the town

The A3400/Birmingham Road becomes impassable and cuts off the town. Fluvial flooding may also be impacted by ordinary watercourses not being able to discharge into the River Alne due to high water levels in the river.

A flood defence scheme was constructed in Henley-in-Arden in the late 1970s/early 1980s to reduce fluvial flood risk. The River Alne channel was widened, and 2 bypass flood relief channels were constructed downstream of Beaudesert Lane. Localised flood defences were constructed at Millfield Court. The scheme was designed to provide protection against a flood event with a 1% chance of occurring in any given year, to over 100 properties. The channel was considered to have sufficient capacity to contain flows with a 3% chance of occurring in any given year before the banks were overtopped. The flood embankment and wall at Millfield Court were rebuilt after the 2007 floods.

The River Alne upstream of Warwick Road was re-engineered as a two-stage channel to protect the houses in and around Prince Harry Road. This creates space to store flood water where the ordinary watercourse south of Warwick Road joins the River Alne. Refurbishment works in this area were undertaken in 2005.

Henley-in-Arden is also at risk of surface water flooding. Further information on surface water flooding can be found in Warwickshire County Council's 'Local Flood Risk Management Strategy' and 'Surface Water Management Plan'.

Current flood risk

Henley-in-Arden has a long history of flooding with events most recently in 2000 and 2007. In June 2007 the town experienced its worst flooding in recent times. It is estimated that 90-100 properties were flooded, 40% from fluvial and 60% from surface water. There were significant damages to both residential and commercial properties. Pubs, restaurants and shops were severely flooded and forced to close for significant periods. The A3400/Birmingham Road was damaged and impassable and so there was an effect on local businesses.

The flood hazard and risk maps show that in the Henley-in-Arden FRA 1,014 people live in areas at risk of flooding from rivers. Of these people, 30% are shown to live in areas of high risk.

Also shown to be in areas at risk of flooding from rivers are:

- 138 non-residential properties - including health, education and transport services
- 0.11km of railway
- 27.08 ha of grade 3 and grade 4 agricultural land*
- 49 listed buildings
- 0.25ha of Scheduled Ancient Monuments
- The A3400 and A4189 roads

*Based on Agricultural Land Classification map. In reality a large proportion of the land shown in the map as being agricultural land is built up area.

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Henley-in-Arden FRA.

Based on this information, Risk Management Authorities (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.

How the risk is currently managed

The Environment Agency uses its permissive powers to inspect the flood bank and flood wall at Millfield Court and to carry out cost-effective repairs as required. The riparian landowner undertakes routine maintenance of the flood bank. The Environment Agency maintains the engineered channel adjacent to Prince Harry Road to ensure the conveyance of the watercourse. The flood relief channels downstream of Beaudesert Lane are privately maintained.

The Environment Agency also uses its permissive powers to carry out general river maintenance. This includes vegetation management, and when locally reported, removal of river blockages that may increase flood risk.

There is a hydraulic model for the River Arrow and Alne that covers Henley-in-Arden (Halcrow, 2009). Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

The Environment Agency monitors rainfall in the River Alne catchment upstream of the FRA, and water levels from a gauge located within the FRA just upstream of William James Way. It provides a free flood warning service for the area which, if acted upon, can

reduce the impact of flooding. The Henley-in-Arden FRA is covered by one Flood Alert Area and one Flood Warning Area.

As part of the capital programme 2021 to 2027, the Environment Agency is assessing options for a flood risk management scheme to better protect the FRA from flood risk associated with the River Alne.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future, which will cause river flows to increase. Flood risk is expected to increase in Henley-in-Arden because of climate change.

Please refer to the Climate change and the Severn RBD section for more information on what are likely to be the implications of climate change in the Severn River Basin District.

Objectives and measures for the Henley in Arden FRA

Measures have been developed that apply specifically to the Henley-in-Arden FRA. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Henley-in-Arden FRA. These can be found in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Redditch Surface Water Flood Risk Area

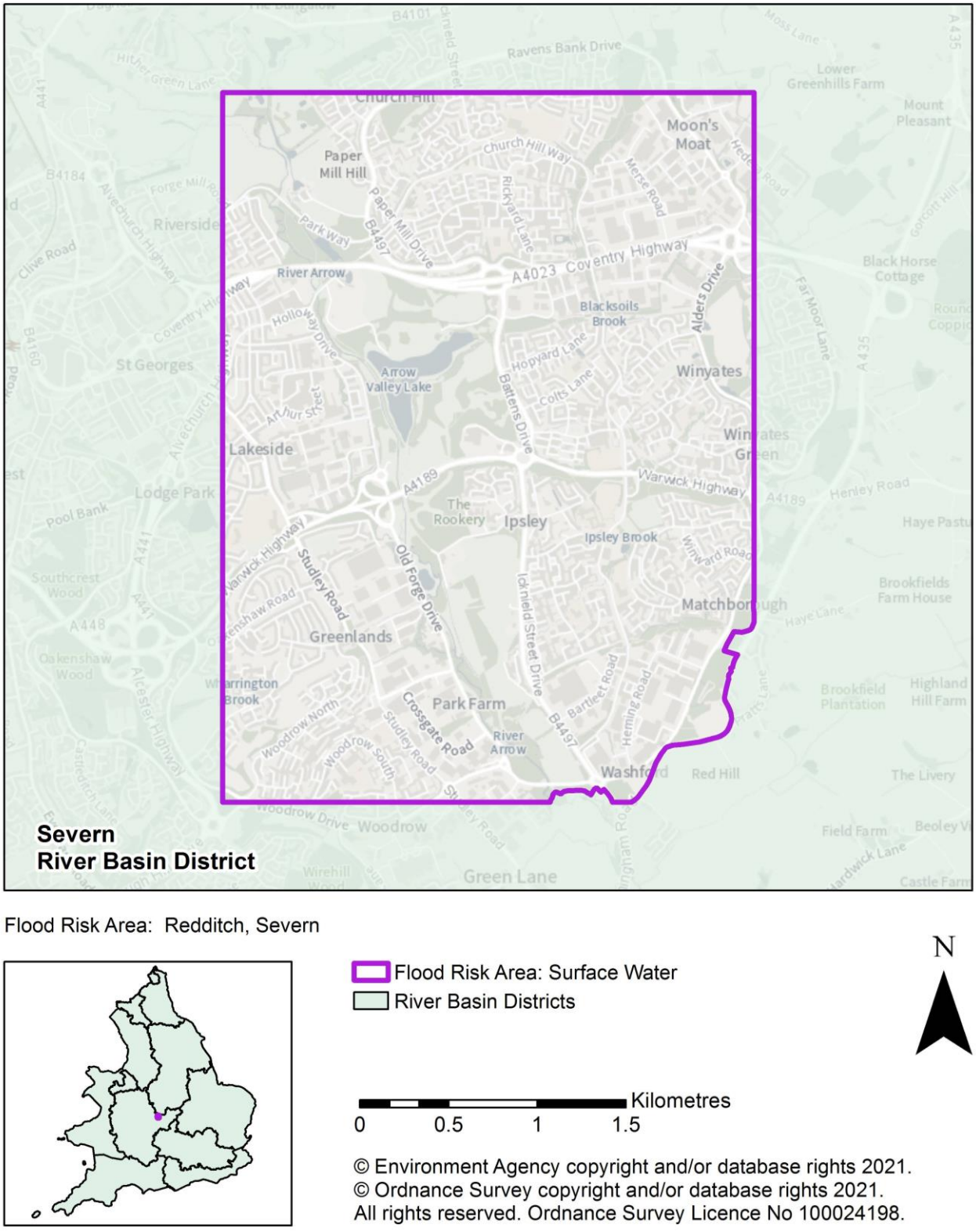


Figure 12: a map showing the boundary of the Redditch Flood Risk Area

Introduction to the Redditch Flood Risk Area

The Redditch FRA 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 Lead Local Flood Authority (LLFA), Worcestershire County Council, take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Severn Trent Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure for the FRA.

The Environment Agency's remit includes the management of flooding from the main river in the FRA.

Redditch is a 'new town' that rapidly expanded during the 1960s and 1970s to accommodate the Birmingham overspill. The area is characterised by clay soils that result in poor infiltration. The 2 main river catchments within Redditch are the River Arrow and Bow Brook. These catchments have several smaller sub-catchments within Redditch that are small in nature and respond rapidly to rainfall, leading to surface water run-off.

During the town's rapid expansion, and due to the lack of infiltration, the town became heavily reliant on drainage infrastructure, mainly sewers, but also several balancing ponds. The sewers can become overwhelmed from surface water runoff or blocked during flood events.

The Redditch FRA covers part of the town of Redditch. The main source of flood risk is surface water and sewer flooding, in addition to some risk of flooding from ordinary watercourse and the main river (River Arrow). There's also residual risk from reservoirs breaching or overtopping, mainly in the floodplain of the River Arrow. This is due to reservoirs upstream of the FRA, but also from Lodge Pool in Redditch, just to the west of the FRA boundary.

The Ipsley Alders Marsh Site of Special Scientific Interest (SSSI) is located on the eastern edge of the Redditch FRA.

The River Arrow itself is designated as a local wildlife site due to its natural lowland river nature of largely good, ecological quality.

The Arrow Valley Park Lake is also a local wildlife site. Proctor's Barn Meadows is designated as a local nature reserve and is located towards the north of the FRA.

Moons Moat Scheduled Ancient Monument (SAM) is within the Redditch FRA, between Arley Close and Exhall Close. Part of the grounds of Bordesley Abbey, another SAM, is also located on the north-western boundary of the Redditch FRA.

Current flood risk

Although there have not been any major flood events in Redditch since 2007, the countywide Surface Water Management Plan highlights a large concentration of 'floodspots' within Redditch.

There was severe disruption in Redditch due to surface water flooding in July 2007. Approximately 44 properties flooded due to a mixture of surface water and watercourse flooding.

The flood hazard and risk maps show that in the Redditch FRA, 4,233 people live in areas at risk of flooding from surface water. Of these people, around 14% live in areas of high risk.

Also shown to be at risk of flooding from surface water are:

- 573 non-residential properties - including schools and colleges
- 1km of roads
- 12ha of agricultural land
- 4ha of SSSI
- 7.3ha of SAMs

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Redditch FRA.

Based on this information, Risk Management Authorities (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.

How the risk is currently managed

Within Worcestershire, the county council as the LLFA works very closely with the district council drainage teams to effectively manage surface water flood risk. In north Worcestershire, including the Redditch FRA, the North Worcestershire Water Management undertake several flood risk duties and powers on behalf of the LLFA and Redditch Borough Council. This includes commenting on planning applications and management of ordinary watercourses.

Worcestershire County Council also leads on a local multi-agency group for Redditch that includes the:

- FRA
- whole town
- surrounding areas

The group also comprises of all the RMAs involved in managing flood risk in Redditch, including:

- Worcestershire County Council (LLFA and Highways Authority)

- North Worcestershire Water Management
- the Environment Agency
- Redditch Borough Council
- Severn Trent Water

The Redditch FRA is vulnerable to flooding from sewers. Severn Trent Water have a network of monitors in the sewer network to help manage flood risk from sewers.

The FRA is within the Environment Agency's Flood Alert Area for the River Arrow and River Alne. There are no main river flood warning areas within the Redditch FRA, and no flood warnings specific to surface water flooding. North Worcestershire Water Management have 3 river level monitoring stations within the FRA: one at Moons Moat and 2 on Winyates Way. This information is used primarily to inform immediate preparations for a flood event. The water level and flow information are also available to be used to inform and calibrate mathematical modelling of the ordinary watercourse network.

Mapping exists that indicates areas at risk of surface water flooding in the FRA. This has been produced by the Environment Agency as part of the national 'Risk of Flooding from Surface Water' dataset.

All RMAs maintain their respective flood risk assets in Redditch FRA. Redditch Borough Council have a drainage team who proactively monitor and maintain several key flood risk assets in the area.

Worcestershire Highways maintains highway drainage assets and Severn Trent Water similarly maintains flood risk assets within their drainage network. The Environment Agency uses its permissive powers to inspect flood risk management assets on the main river, and to carry out reactive blockage removal from the main river channel.

Several works and drainage schemes have been completed to reduce flood risk since the Redditch FRMP group was initiated. These include:

- flood bunds
- balancing areas
- swales
- ditch works

Examples of these can be seen at the following locations:

- Allensmore Close
- Black Soils Brook
- Bromsgrove Road
- Church Hill Brook
- Northleach Pond
- Salters Lane
- Yvonne Road

The Church Hill Brook scheme, for example, involved diverting approximately 150m of the watercourse, creating a meander to take it away from the properties. The excavated material was used to form a bund creating a balancing area that stores water and creates a wetland habitat to benefit the local wildlife. The balancing area also helps alleviate flood risk to properties downstream.

Further programmes and works are planned, as highlighted in the Redditch FRA measures in the Flood Plan Explorer.

The impact of climate change and future flood risk

As rainfall intensity increases, it means that surface water flooding will become more frequent. This is because higher rainfall totals will be seen more often. River flows are also expected to increase, leading to increased risk of fluvial flooding.

Please refer to the Climate change and the Severn RBD section for more information on what are likely to be the implications of climate change in the Severn RBD.

Objectives and measures for the Redditch FRA

Measures have been developed that apply specifically to the Redditch FRA. These measures have been developed in addition to those covering a wider geographic area, but which also apply to the Redditch FRA.

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

The Wolverhampton Surface Water Flood Risk Area

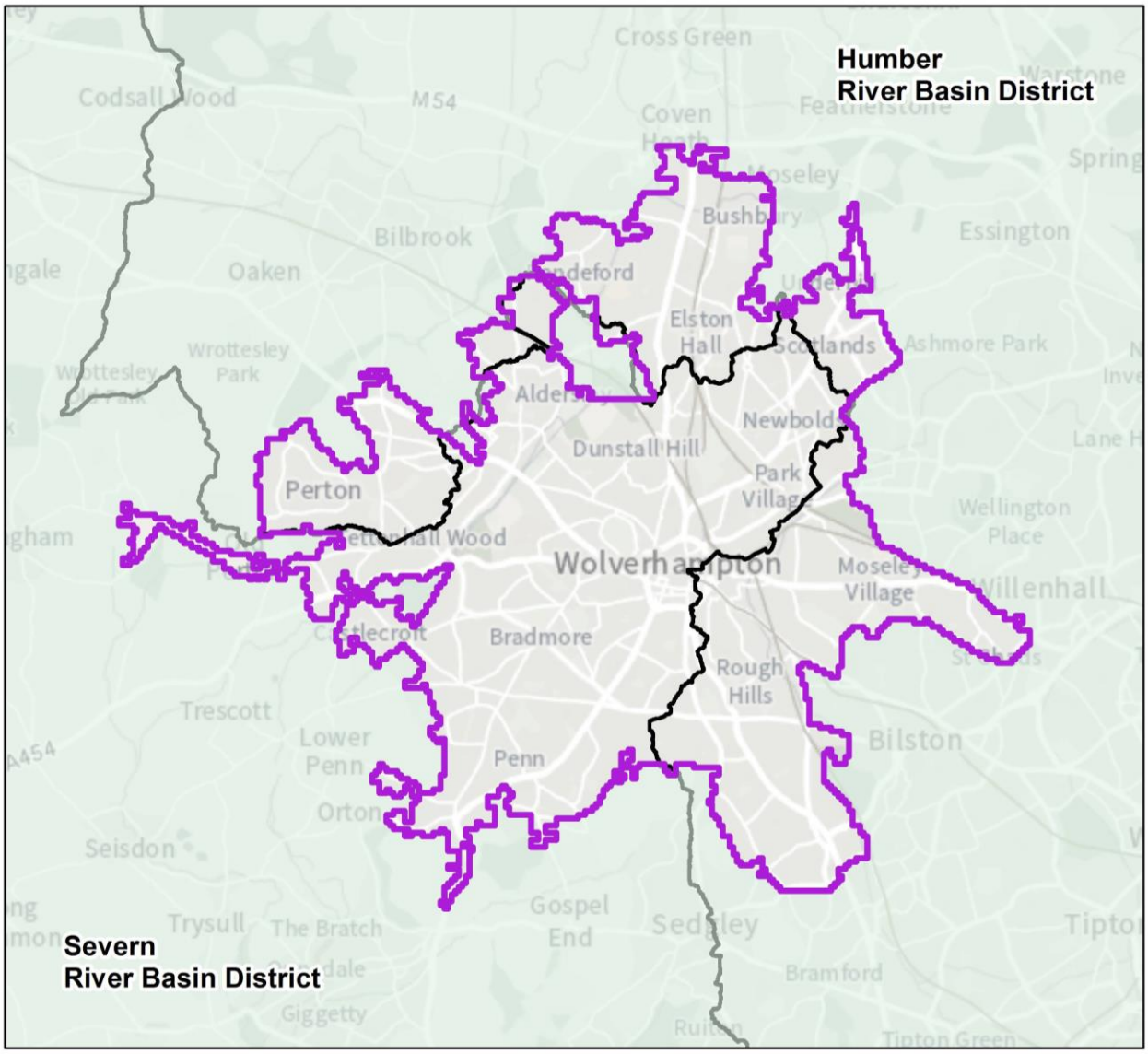


Figure 13: a map showing the boundary of the Wolverhampton Flood Risk Area

Introduction to the Flood Risk Area

The Wolverhampton FRA 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). This FRA spans both the Severn and Humber RBDs. It's described solely within this second cycle Severn RBD FRMP.

Most of the FRA is in City of Wolverhampton Council's administrative area. Small parts of the FRA are within the area administered by Staffordshire County Council. These Lead Local Flood Authorities (LLFAs) are responsible for the management of flood risk from local sources, including surface water. As the FRA is substantially in its administrative area, City of Wolverhampton Council LLFA has led on the development and delivery of the Flood Risk Management Plan (FRMP).

The Environment Agency's remit includes managing flood risk from main rivers in the FRA.

Severn Trent Water is the sewerage company that owns, operates and maintains the sewerage network and wastewater treatment infrastructure in the FRA.

The Wolverhampton surface water FRA is largely a heavily urbanised area covering over 300,000 people. The FRA also includes:

- several local wildlife sites
- the ancient woodland of Tettenhall Wood
- the Smestow Valley Local Nature Reserve
- 329 listed buildings
- 22.66 ha of registered parks and gardens

Wolverhampton lies on the western side of the Birmingham plateau, approximately 120m above sea level where land elevations fall away to the west and east. The FRA lies in the headwaters of the River Stour (through the Smestow Brook catchment) and River Tame catchments (western and eastern parts respectively). The northern edge drains into the River Penk. Smestow Brook and the Tame Tunnel (Wolverhampton Arm) are classified as main rivers. There are several ordinary watercourses within the FRA, including Waterhead Brook.

Large parts of the FRA are characterised by a long history of development and industrialisation. An extensive drainage network has been constructed throughout the FRA comprising:

- foul and combined sewers
- surface water sewers
- highway drains and gullies
- culverted watercourses
- privately owned drainage
- pumping stations

The drainage network is complex with a range of design capacities.

A high proportion of watercourses within the FRA have been culverted. An extensive network of historic canals was built to transport:

- coal
- iron
- other heavy goods

These include the:

- Birmingham Main Line Canal
- Staffordshire & Worcestershire Canal
- Wyrley & Essington Canal

Groundwater was extracted historically for industry, though this has reduced significantly over recent years with the decline in manufacturing.

The main flood risk in the FRA is from localised incidents caused by extreme surface water runoff and blocked gullies. Quite a high percentage of the rain that falls in the upper catchments runs off because drainage is impeded by the overlying rich loamy soil. The steep slopes in the headwater areas form flow-paths for surface runoff. Subsequently pluvial flooding (or ponding) occurs in low-lying areas, or in locations where there are obstructions to the flow paths. Heavy rain also ponds or flows off surfaces in the urban areas where it cannot soak into the ground. Urban drainage systems become overwhelmed or unable to discharge into receiving watercourses due to high water levels.

Reactive mitigation measures have been implemented in response to past flood events, usually with the construction of new drainage infrastructure.

Surface water flooding often occurs in combination with other sources of flood risk in the FRA.

Sewer flooding can occur when combined sewers and surface water sewers are overwhelmed by surface water runoff or can occur because of sewer blockages and collapses. Some blockages result from inappropriate items being disposed of into the sewers.

Historically, Wolverhampton has not suffered substantial flooding from watercourses. Incidences that have occurred have resulted from:

- blockages
- the surcharging of culverts
- watercourses backing up when high levels in receiving watercourses prevents drainage into them

Localised groundwater flooding has occurred in parts of the FRA. Groundwater levels have been rising back to natural water table levels due to the significant reduction in industrial groundwater extraction.

Canal flooding has been recorded in the FRA, though it's not clear if the flooding has been due to canal overtopping alone or if there have been interactions with ordinary watercourses. Parts of the south of the FRA are also at risk of reservoir flooding.

Current surface water flood risk

Flash flooding affected properties in the FRA during June 2016 and February 2020. Incidents of flooding were reported in 11 locations across the City of Wolverhampton Council area. These resulted from:

- surface water runoff
- water flowing out of highway gullies
- surcharging of manholes and sewers
- watercourses coming out of bank

The effects included:

- internal property flooding
- waterlogged gardens
- impassable roads

The flood hazard and risk maps show that in the FRA, 29,744 people live in areas at risk of flooding from surface water. Of these people, 6% live in areas of high risk.

Also shown to be in areas at risk of flooding from surface water are:

- 1241 non-residential properties - including 53 services
- 15.23km of roads
- 4.97km of railway
- 148.15ha of agricultural land*
- 25 listed buildings
- 3.23 ha of registered parks and gardens
- 8 Environmental Permitting Regulations installations
- 3 licensed water abstraction points

*Based on Agricultural Land Classification map. In reality a large proportion of the land shown in the map as being agricultural land is built up area.

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of surface water flooding for the FRA.

Based on this information, Risk Management Authorities (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.

How flood risk is currently managed

To ensure the effective management of all sources of flood risk, the LLFAs in the FRA have developed partnerships with Severn Trent Water, the Environment Agency and other key stakeholders over several years. The City of Wolverhampton has a collaborative working arrangement with Staffordshire County Council to provide flood risk management services on their behalf. A tiered approach to managing flood risk has been developed comprising the Black Country Strategic Flood Risk Management Board, and at local level individual project specific groups. Relevant strategies for the FRA include the:

- 'The Black Country Local Strategy for Flood Risk Management'
- 'Staffordshire Local Flood Risk Management Strategy'

There's also a local multi-agency flood plan that outlines how multi-agency partners will work together in Wolverhampton to respond to and manage significant flooding incidents.

There are no surface water specific flood alerts or warnings covering the FRA. The Environment Agency monitors rainfall and river levels and provides a flood warning service for river flooding. There are 3 flood alerts and one flood warning area in the FRA.

Mapping exists that indicate areas at risk of surface water flooding in the FRA. This comprises local information developed for some parts of Wolverhampton. It also includes national information produced by the Environment Agency in the 'Risk of Flooding from Surface Water' dataset. Modelling and mapping also exist that indicates areas at risk of river and reservoir flooding.

The Highways Authority in the FRA manages asset registers showing structures and features that are important to managing flood risk. This is along with the relevant risk management authority responsible for their maintenance. This includes assets important for surface water management, such as highway drainage and culverted watercourses.

The Highways Authority, with Local Authority landowners across the FRA, undertake maintenance of watercourses and culverts where necessary. Highway drainage is maintained by the Highway Authority. Severn Trent Water has a maintenance programme in place for public sewers.

The Environment Agency inspects flood risk management assets on the main rivers in the FRA and uses its permissive powers to maintain:

- a flood wall
- a flood embankment
- a trash screen

The Environment Agency also carries out tree management adjacent to Aldersley Road to reduce the risk of blockages.

The Canal & River Trust manages and maintains its network to reduce risks of asset failure. The responsibility for maintaining the reservoirs lies with their respective undertakers.

Measures to manage flood risk in the FRA include:

- the 'Black Country Core Strategy' was adopted for the city in 2011 and contains planning policies to help mitigate the impacts of extreme flooding and climate change, alongside improvements to the wider water environment
- Property Flood Resilience measures for properties noted to be at significant risk in some areas across the FRA

Multi-agency partners are continuing to work together during the period 2021 to 2027 to identify and deliver, if viable, measures to improve flood resilience and benefit the environment in the FRA.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future. It's expected that surface water flooding will become more frequent as higher rainfall totals will be seen more often. River flows are also expected to increase leading to increased risk of fluvial flooding.

Please refer to the Climate change and the Severn RBD section for more information on what are likely to be the implications of climate change in the Severn River Basin District.

Objectives and measures for the Wolverhampton FRA

Measures have been developed that apply specifically to the Wolverhampton FRA. Additionally, Staffordshire County Council measures have been developed that cover a wider geographic area, but also apply to the parts of the Wolverhampton FRA that fall within their administrative boundary.

You can find information about all the measures that apply to the Wolverhampton FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on 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: (RBMPs 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 these regulations 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 Severn RBMP 2022.

In a consultation in 2019/20, the Environment Agency sought views on:

- the challenges that our waters face
- the 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'.

Environment Agency catchment coordinators have been integral to developing measures for this second cycle FRMP. 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.

Over 25% of the measures in this second cycle Severn RBD FRMP will, or could, help achieve RBMP 2022 measures. For other measures it is too early to say whether they could help achieve RBMP 2022 measures, such as where schemes are being investigated. These measures, if they progress, also have the potential to contribute to RBMP 2022 and WFD objectives. We will seek to improve the wider water environment in flood risk management schemes that progress, where we can. Some measures in the FRMP will not provide opportunities to contribute to RBMP 2022 measures on the ground due to their fundamental nature – such as extending flood warning service, raising awareness of flood risk, modelling and other such measures.

By visiting the Severn RBMP 2022 you can find out more information on the objectives and measures for the Severn 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 Lead Local Flood Authorities (LLFAs) and other Risk Management Authorities (RMAs) to monitor progress in achieving all of the measures set out in the Flood Risk Management Plan (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 that 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'.

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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