



Humber River Basin District Flood Risk Management Plan 2021 to 2027

December 2022

This is a joint plan prepared by the following Risk Management Authorities:

Anglian Water

Barnsley Metropolitan Borough Council

Birmingham City Council

Calderdale Council

City of Bradford Metropolitan District Council

City of Wolverhampton Council

City of York Council

Derby City Council

Derbyshire County Council

Doncaster Metropolitan Borough Council

Dudley Metropolitan Borough Council

East Riding of Yorkshire Council

Environment Agency

Hull City Council

Kirklees Council

Leeds City Council

Leicester City Council

Leicestershire County Council

Lincolnshire County Council

North East Lincolnshire Council

North Lincolnshire Council

North Yorkshire County Council

Nottingham City Council

Nottinghamshire County Council

Rotherham Metropolitan Borough Council

Sandwell Metropolitan Borough Council

Severn Trent Water

Sheffield City Council

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Sow & Penk Internal Drainage Board

Staffordshire County Council

Stoke-on-Trent City Council

Wakefield Council

Walsall Council

Warwickshire County Council

Worcestershire County Council

Yorkshire Water

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

Widespread flooding was experienced in winter 2015 whereby a reported 17,000 properties across the north of England were affected by storms Desmond, Eva and Frank, making December 2015 the wettest month ever recorded. Since then, there has been flooding in numerous areas within the Humber River Basin District.

These floods have had significant impacts on communities, businesses, infrastructure, rural areas and the environment. In addressing current and future flood risk, partnerships are key. The more we plan together, the more we can deliver together for local people, places and our environment.



Over the last 3 years we have worked in partnership with Lead Local Flood Authorities and other partners to develop these Flood Risk Management Plans (FRMPs). This has been a challenging time with winter 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 measures (actions) that will reduce the likelihood and consequences of flooding
- to 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. These include nature-based solutions, property flood resilience and sustainable drainage systems
- plan and adapt to a changing climate through developing longer-term, adaptive approaches

In many cases the measures (actions) in the plans help contribute to wider benefits for local places including climate mitigation and adaptation, nature recovery as well as integrated water management.

We've developed the [Flood Plan Explorer](#) to support these plans. This means we can stimulate even more opportunities for working together and co-operation across all we do.

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

The Environment Agency knows the next 5 years will be both exciting and challenging. We need to innovate and adapt, making sure our thinking and actions change faster than our climate. The [Flood and Coastal Erosion Risk Management Strategy Roadmap to 2026](#) (Strategy Roadmap) will help us do that by providing practical ways in which flood and coastal investments can contribute to wider priorities including local nature recovery, carbon reduction and more integrated water solutions that also help with drought resilience.

I'm pleased we have this opportunity to share the final FRMPs: 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. We must continue to work in partnership and keep putting communities at the centre of what we do so they can adapt and thrive.

A handwritten signature in dark ink that reads "S. Longstone". The signature is written in a cursive, slightly slanted style.

Sue Longstone, Director Operations North, Environment Agency.

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Introduction to the FRMP

You should read this Flood Risk Management Plan (FRMP) with [Part A: National Overview of Flood Risk Management in England for Second Cycle FRMPs](#). Part A is a high-level overview of the FRMP and flood risk management in England.

You can find all the FRMP documents for the [Humber River Basin District](#) on GOV.UK. The plan is supported by the:

- Humber River Basin District Second Cycle Flood Risk Management Plan Habitats Regulations Assessment – a report on the findings of the habitats regulations assessment (HRA)
- Humber 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
- Humber 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 FRMP is a plan to manage significant flood risks in the Flood Risk Areas (FRAs) identified within the Humber River Basin District (RBD). Producing the plan for these areas is a requirement of [The Flood Risk Regulations 2009](#). However, it is recognised that there are areas at risk of flooding outside of these FRAs. Therefore, the Environment Agency and other risk management authorities (RMAs) will continue to plan for and manage the risk of flooding to all communities. This is regardless of whether they are in an FRA or not. For example, RMAs carry out flood risk management interventions such as warning and informing and capital investment and maintenance programmes. Therefore, this plan has been expanded to show what is happening across the RBD, and as well as FRAs includes measures for the RBD, Strategic Areas and Management Catchments. This is similar to how the [first cycle of FRMPs](#) were developed. The first cycle of FRMPs covered the period 2015 to 2021. 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. Some of these local plans and strategies have been referenced in the [Developing the FRMP](#) Section and where appropriate have also been referenced in the FRA descriptions.

The Environment Agency and other RMAs, in particular Lead Local Flood Authorities (LLFAs) worked together 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 that the FRMP is a strategic, place-based plan which shows what is happening in flood risk management across the RBD. It is closely aligned with the:

- Government's 25 Year Environment Plan – [A Green Future: Our 25 Year Plan to Improve the Environment](#) (25 YEP)
- [National Flood and Coastal Erosion Risk Management Strategy for England](#) (FCERM strategy)

The second cycle FRMP will encourage ever 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 FRMP is also aligned with the [River Basin Management Plan for the Humber RBD](#) updated 2022 (RBMP 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 '[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 the FRMP. The Environment Agency and those LLFAs with a surface water FRA within their administrative area must produce a FRMP. These FRAs are listed below and in Table 1 respectively. Other RMAs without FRAs have also contributed to the FRMP. This is to show what is happening to manage the risk of flooding across the Humber RBD.

This second cycle FRMP for the Humber RBD identifies measures across the RBD for: FRAs, Strategic Areas, Management Catchments and River Basin District implementation levels.

Strategic Areas are areas with a similar geography or strategic ambition, where it is important to consider flood risk management across administrative boundaries and river catchments. For example, the Humber Estuary Strategic Area lies within the Humber RBD and bounds the Anglian RBD at Saltfleet. It is therefore discussed entirely within the Humber plan. The Fens & Lowland Strategic Area meanwhile straddles the Humber and Anglian RBD boundary and is therefore included in both plans.

Management Catchments are based on Water Framework Directive (WFD) management catchments and have been used so that we can take a catchment-based approach when developing measures. There are 16 management catchments within the Humber RBD which are listed below.

The second cycle FRMP measures for the Humber RBD cover all sources of flood risk and have been developed with contributions from other RMAs as listed below. This includes contributions from RMAs that do not have FRAs and have therefore volunteered to be part of the FRMP development. Whilst the ambition of the plan is to be a strategic place-based

plan that covers all sources of flood risk, there may be places and flood risk management activities that are not included. This is due to the strategic nature of the second cycle FRMP and does not change anything planned for those places. All RMAs across the Humber RBD will continue to plan for and manage the risk of flooding as appropriate. You can find information about national-level measures that the Environment Agency and LLFAs carry out, as part of their routine day-to-day work, in the interactive mapping tool – [‘Flood Plan Explorer’](#).

Developing the FRMP has been impacted by the extraordinary events of the past few 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

Our ambition for the period 2021-2027 is to continue to drive catchment-based delivery in the Humber 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 Shoreline Management Plans - 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 can be found in the [Managing Flood Risk Section](#). The FRMPs are not intended to cover the detail of this partnership working.

Environment Agency Flood Risk Areas for main rivers and the sea

- Beeston (Broxtowe)
- Bentley
- Bingley, Shipley and Baildon
- Brigg
- Brighouse
- Burton upon Trent
- Cleethorpes
- Derby
- Dunscroft
- Fazeley
- Gilberdyke
- Goole
- Grimsby
- Gunthorpe
- Hebden Bridge
- Hedon
- Hessle
- Huddersfield
- Immingham
- Kingston upon Hull
- Leeds
- Leicester
- Long Eaton
- Loughborough
- Louth
- Mirfield
- Mytholmroyd
- Newark-on-Trent
- Nottingham
- Selly Park
- Sheffield
- Sparkhill
- Stainforth
- Thorne and Moorends
- Thorngumbald
- Todmorden
- West Bridgford
- York

LLFAs with Surface Water FRAs within their administrative boundary

Table 1: LLFA Surface Water FRAs

Flood risk area name	LLFA name(s)
Birmingham	Birmingham City Council, Dudley Metropolitan Borough Council, Sandwell Metropolitan Borough Council, Solihull Metropolitan Borough Council, Walsall Metropolitan Borough Council
Chesterfield	Derbyshire County Council
City of Bradford	City of Bradford Metropolitan District Council
City of Sheffield	Sheffield City Council
Derby	Derby City Council
Hinckley & Burbage	Leicestershire County Council
Kingston upon Hull and Haltemprice	East Riding of Yorkshire Council, Hull City Council
Leeds	Leeds City Council
Leicester	Leicester City Council, Leicestershire County Council
Loughborough	Leicestershire County Council
Mansfield	Nottinghamshire County Council
Nottingham	Nottingham City Council, Nottinghamshire County Council
Oakham*	Rutland County Council
Wolverhampton**	City of Wolverhampton Council, Staffordshire County Council

*The Oakham FRA for surface water spans both the Humber and Anglian RBDs. It is described solely within the [second cycle Anglian RBD FRMP](#).

****The Wolverhampton FRA for surface water spans both the Severn and Humber RBDs. It is described solely within the [second cycle Severn RBD FRMP](#).**

Strategic Areas

- Humber Estuary
- Fens & Lowland

Management Catchments

- Aire and Calder
- Derbyshire Derwent
- Derwent (Humber)
- Esk & Coast
- Don and Rother
- Dove
- Hull and East Riding
- Humber TraC (Transitional and Coastal Waters)
- Idle and Torne
- Louth Grimsby and Ancholme
- Lower Trent and Erewash
- Soar
- Swale, Ure, Nidd and Upper Ouse
- Tame Anker and Mease
- Trent Valley Staffordshire
- Wharf and Lower Ouse

Other RMAs that have contributed to the FRMP

Lead Local Flood Authorities

- Barnsley Metropolitan Borough Council
- Calderdale Council
- City of York Council
- Doncaster Metropolitan Borough Council
- Kirklees Council
- Lincolnshire County Council
- North East Lincolnshire Council
- North Lincolnshire Council
- North Yorkshire County Council
- Rotherham Metropolitan Borough Council
- Derbyshire County Council
- Stoke-on-Trent City Council
- Wakefield Council
- Warwickshire County Council

- Worcestershire County Council

Water Companies

- Yorkshire Water
- Anglian Water
- Severn Trent Water

Other Risk Management Authorities, Boards, Partnership and Groups

- South Derbyshire District Council
- Ancholme Internal Drainage Board
- Black Drain Drainage Board
- Doncaster East Internal Drainage Board
- Lindsey Marsh Group of Internal Drainage Board
- Sow & Penk Internal Drainage Board
- Trent Valley Internal Drainage Board
- Isle of Axholme and North Nottinghamshire Water Level Management Board
- Scunthorpe and Gainsborough Water Level Management Board
- Ancholme Catchment Partnership
- Living With Water Partnership
- Moors for the Future
- Staffordshire Civil Contingencies Unit
- VIA East Midlands
- North Yorkshire Moors National Park Authority

It should be noted that whilst not all RMAs, boards, partnership and groups within the Humber RBD were involved in the development of the FRMP, they are all valuable partners in the delivery of measures to reduce flood risk.

Developing the FRMP

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](#)
- [Humber River Basin Management Plan: updated 2022 \(RBMP 2022\)](#)
- [Anglian River Basin District Flood Risk Management Plan](#)
- [Kingston upon Hull and Haltemprice Flood Risk Management Plan](#)
- [Humber 2100+ Strategy](#)
- Local Flood Risk Management Strategies
- Surface Water Management Plans for the LLFAs
- Evolving [Drainage and Wastewater Management Plans](#) (DWMPs) for:
 - Yorkshire Water
 - Anglian Water

- Severn Trent Water

In some instances, additional strategies and plans which are relevant to this FRMP are referenced in the corresponding FRAs.

Approach to Setting Objectives

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

- [Flood Risk Regulations 2009](#)
- [National Flood and Coastal Erosion Risk Management \(FCERM\) Strategy for England](#) 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 objectives and measures together, RMAs have:

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

The Humber River Basin District

Overview of the Humber RBD

The Humber River Basin District is 1 of 10 river basin districts across England. This river basin district covers an area of 26,100 square kilometres and extends from the West Midlands in the south, northwards to North Yorkshire and from Staffordshire in the west to part of Lincolnshire and the Humber Estuary in the east. It ranges from the upland areas of the Peak District, South Pennines and the North York Moors with their internationally important peat lands, across the Derbyshire and Yorkshire Dales and the fertile river valleys of the Trent and Ouse, to the free-draining chalk of the Yorkshire and Lincolnshire Wolds.

There are 16 management catchments that make up the river basin district which include many interconnected rivers, lakes, groundwater and coastal waters. Further details on these management catchments are provided in the [Second Cycle Objectives and Measures](#) section in this document.

In total more than 12.3 million people live and work in towns, cities and villages within the district. The population is split between the large urban conurbations of the great cities of the Midlands and West Yorkshire and small communities within very rural areas. The main urban centres in the district include:

- Birmingham
- Leeds
- Bradford
- Sheffield
- Hull
- Grimsby
- Derby
- Leicester
- Nottingham

The Humber RBD has a rich diversity of wildlife and habitats, supporting many species of global and national importance. There are 31 Special Areas of Conservation (SAC) sites, 9 Special Protection Areas (SPA) and 4 Ramsar sites (Designated wetlands sites). These include the Humber Estuary, Lower Derwent Valley, Derbyshire, Malham Tarn and Midland Meres and Mosses. There are more than 2,750 Sites of Special Scientific Interest (SSSIs) and 23 National Nature Reserves (NNR).

Cultural heritage has a high profile in the river basin district with approximately 4,000 Scheduled Ancient Monuments (SAM) and numerous registered parks and gardens, listed buildings and heritage sites. There are three World Heritage Sites: Derwent Valley Mills, Saltaire and Studley Royal Park (including the ruins of Fountains Abbey). This river basin district is also rich in archaeology and there are 10 historic battlefields.

The main economic sectors in the region include:

- manufacturing
- agriculture
- business services
- health
- wholesale and distribution

Manufacturing contributes to the economy along with some mineral abstraction, including some deep coal mines, potash mines and numerous gravel workings. Agriculture is critical for the rural economy of the district and supports natural and cultural assets that help underpin both the region's tourism and quality of life for those who live and work in the district.

Within the Humber RBD there are:

- 38 FRAs for significant risk of flooding from main rivers and the sea (Figure 1)
- 12 FRAs for significant risk of flooding from surface water (Figure 2)
- 2 SAs for significant risk of flooding mainly from main rivers and the sea

The number and type of these FRAs differs from the [first cycle Humber RBD FRMP](#). Within the first cycle plan there were only three FRAs, which were associated with significant risk of flooding from surface water. These were:

- Kingston upon Hull and Haltemprice Flood Risk Area
- West Midlands Flood Risk Area
- Leicester Principle Urban Area Flood Risk Area

The Kingston upon Hull and Haltemprice Flood Risk Area has been refined for the second cycle Humber RBD FRMP as a result of updated modelling and other new flood risk information. This FRA is also closely aligned with the works of East Riding of Yorkshire Council, East Riding's Kingston upon Hull and Haltemprice Flood Risk Management Plan and Hull City Council.

The West Midlands Flood Risk Area spanned across the Humber and Severn RBDs. This Flood Risk Area 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 Leicester Principle Urban Area Flood Risk Area has also been refined for the second cycle Humber RBD FRMP as a result of updated modelling and other new flood risk information. This is now captured as the Leicester Surface Water FRA.

Further details 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](#)'. Each of these defined FRAs are discussed in more detail in the [Second Cycle Objectives and Measures](#) section in this document.

For further information about the Humber RBD, please read the accompanying [Humber 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 Humber RBD.

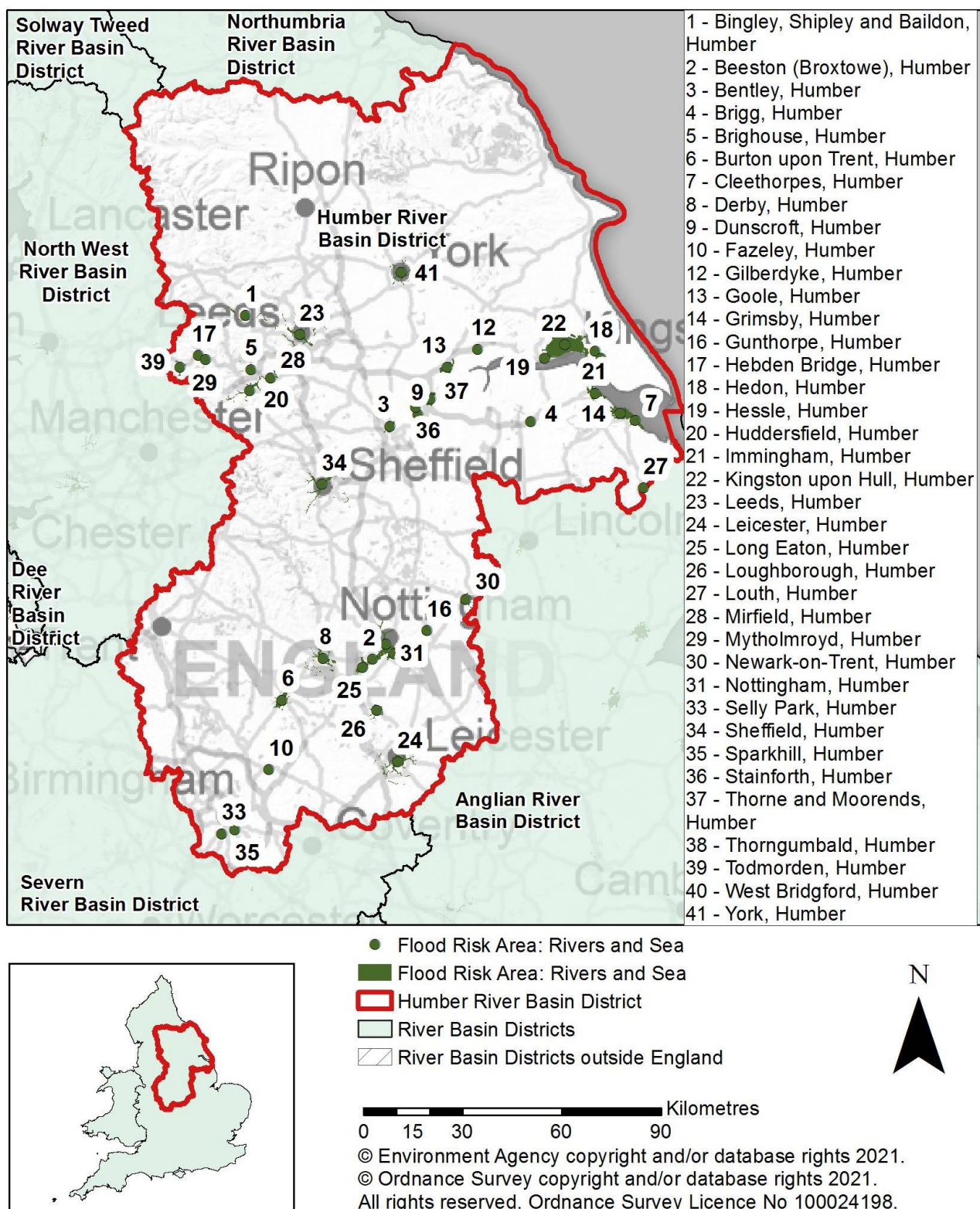


Figure 1: Rivers and Sea FRAs in the Humber RBD

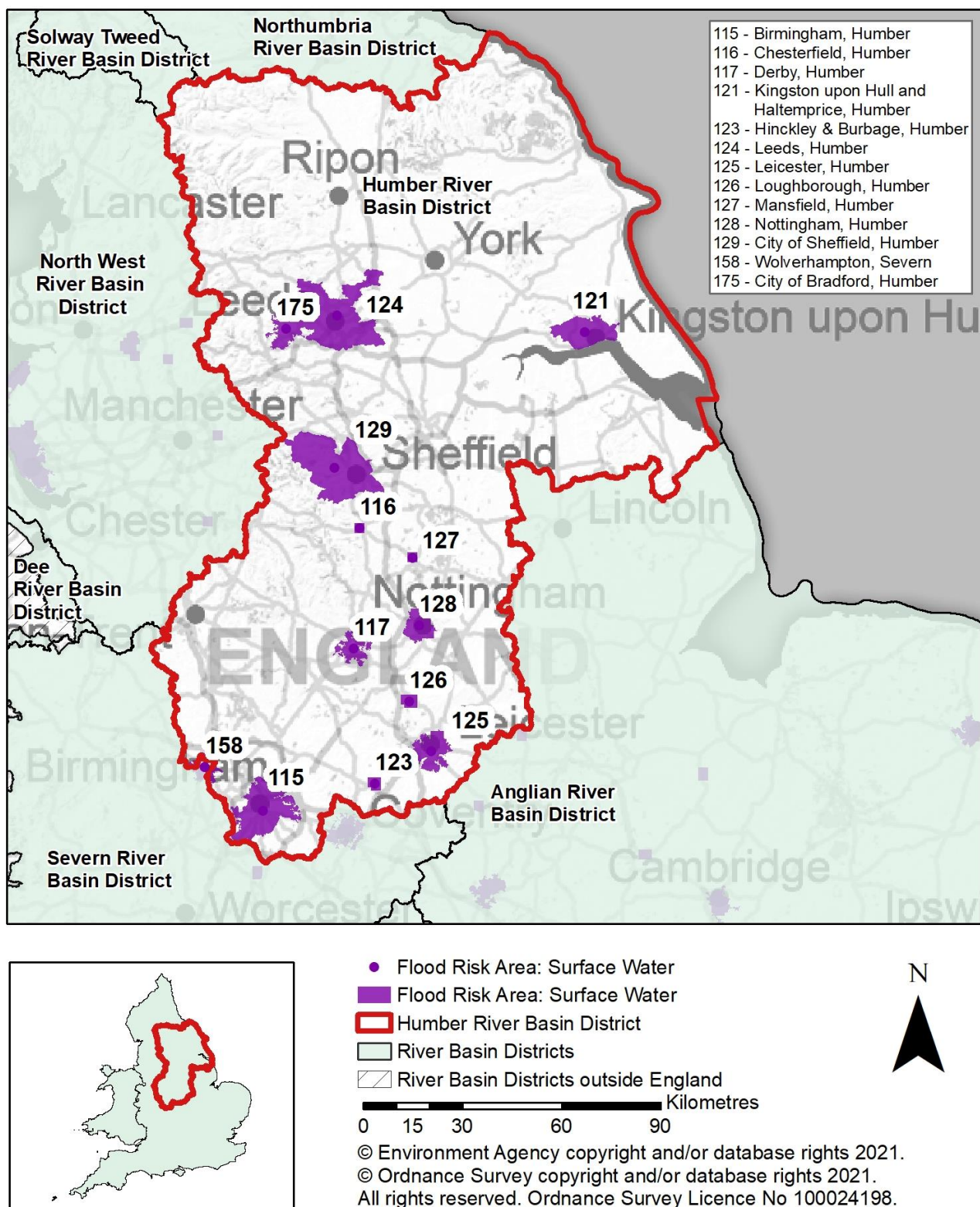


Figure 2: Surface Water FRAs in the Humber RBD

The Main Flood Risk Issues and Changes in the Humber RBD

Flooding and coastal erosion can have devastating impacts. The widespread flooding across England in summer 2007 included significant areas of the Humber River Basin District. It resulted in loss of life and major impacts on the health and well-being of people living and working in the areas affected. The December 2013 North Sea tidal surge event represented a coastal surge which affected the whole of the east coast of England. Winter 2015 to 2016 also brought widespread flooding. A reported 17,000 properties across the north of England were affected by storms Desmond, Eva and Frank making December 2015 the wettest month ever recorded. The total economic damages for England were estimated to be £1.6 billion. The RBDs worst affected were North West, Northumbria and Humber.

Flooding can also cause major disruption to energy, water, communications, and transport infrastructure. It can interfere with public services such as schools and hospitals and have significant indirect effects through disruption to travel or loss of income. Coastal erosion and landslides on the coast affect smaller areas of land than floods but cause permanent loss of property and infrastructure. Such losses can have significant impacts on the local economy outside of the directly affected area. Flooding and coastal erosion can also have significant impacts on the environment and on cultural heritage. It can cause pollution or damage to historic buildings and changes to habitats. However, for some habitats and heritage assets, managed flooding and/or deposits of material eroded from elsewhere are essential for their existence and health.

The Humber FRMP discusses flood risk which originates from a range of sources, either individually or in combination. The following sections below outline these flood risk sources.

Rivers and Seas Flood Risk

Around 1 million people are identified as living or working in areas at risk of flooding from rivers and the sea in the Humber RBD. Approximately 60,000 of these are in areas of high risk. This equates to 0.5% of the population.

The geography and topography of the river basin district is hugely variable, meaning that it is particularly susceptible to both large scale river flooding and at risk from tidal sources.

There are a number of extensive rivers in the river basin district, often with multiple tributaries. Large fluvial events have occurred across the river basin district, with some of these affecting multiple rivers at the same time.

The discharge from some of these rivers, particularly around the Humber Estuary, is also dependent upon tidal conditions. This means the rivers can become tide locked and unable to discharge river water during some high-tide periods. This creates higher water

levels when rivers are tide-locked leading to increased risk of overtopping or breaching of the defences.

Coastal surges can result in sea defences being overtopped when sea levels are high enough to combine with wind direction and wave heights. Surge tides are a particular threat when combined with strong North-easterly winds and high waves.

The Environment Agency undertake a national assessment of flood risk across the entire country, taking into account the likelihood of flooding and potential consequences known as the National Flood Risk Assessment (NaFRA).

The '[Risk of Flooding from Rivers and the Sea](#)' map is a summary version of the NaFRA that we publish on the government's website. It shows the chance of flooding from rivers and the sea presented in categories that take account of flood defences and the condition they are in.

The Flood Risk Regulations require the identification of areas where the risk of local sources of flooding is particularly high. This process, delivered through the preliminary flood risk assessment, identified 38 flood risk areas (FRAs) at risk of flooding from rivers and sea within the Humber River Basin District. Details of the Rivers and Sea Flood Risk Statistics are captured in the [Second Cycle Conclusions from the Hazard and Risk Maps for the Humber RBD](#) section in this document. A summary of risk per FRA is captured in the [Second Cycle Objectives and Measures](#) section in this document.

Surface Water Flood Risk

Approximately 1 million people are at risk of surface water flooding in the Humber RBD. Surface water flooding can occur in two ways.

It is usually caused when intense rainfall, often of short duration, is unable to permeate the ground or enter drainage systems quickly enough. It can also occur when there is moderate rainfall over longer periods of time. This means water builds-up to such an extent that it ponds on or flows across the land surface. This can cause considerable problems in urban areas. Surface water flooding can also originate in rural areas where high-intensity rainfall can run off fields without entering land drainage systems. Surface water can be hazardous as a result of its depth, velocity of flow and sometimes its sudden and unpredictable occurrence. It is difficult to warn people about and prepare for surface water flooding as it is dependent on many factors. This includes how empty the sewers are, how localised the rainfall is and how saturated the ground is beforehand.

The Flood Risk Regulations require the identification of areas where the risk of local sources of flooding is particularly high. This process, delivered through the preliminary flood risk assessment, identified 12 flood risk areas (FRAs) at particular risk of flooding from surface water within the Humber River Basin District. A summary of risk per FRA is captured in the [Second Cycle Objectives and Measures](#) section in this document.

The management of this risk is coordinated by LLFAs under the framework set by local flood risk management strategies (LFRMS). Further information on surface water management can be found in the relevant Lead Local Flood Authority [Local Flood Risk Management Strategies](#). Details of the Surface Water Flood Risk Statistics are captured in the [Second Cycle Conclusions from the Hazard and Risk Maps for the Humber RBD](#) section in this document.

Groundwater Flood Risk

Groundwater flooding occurs as a result of water rising up from the underlying rocks or from water flowing from springs. This tends to occur after much longer periods of sustained high rainfall. Generally, groundwater flooding occurs during the winter and spring when groundwater levels reach their peak and start to come above ground in low lying areas. Groundwater flooding takes longer to dissipate because groundwater moves much more slowly than surface water and will take time to flow away underground.

Locations where notable incidents have occurred include the Hull and East Riding catchment where springs from major aquifers on the edge of the Wolds rise to the surface; the coastal areas from Barton upon-Humber to Humberston and parts of the City of Nottingham where the gradual decline of water intensive industry has seen the water table rise with particular issues around the Old Basford area of the city. Localised groundwater flooding has also become a re-emerging issue in the Black Country and in Birmingham, due to the significant reduction in extraction of water for industry. As well as this, Malton and Norton in the Derwent Humber Management Catchment have experienced prolonged groundwater flooding, most notably in 2012 and 2015.

Sewer Flood Risk

In villages, towns and cities within the RBD, rainwater falling onto impermeable areas usually drains into surface water sewers, or 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 sewerage 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, so are not 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 storm water sewers 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. Examples of other locations that have been affected by capacity related sewer flooding include:

- Retford in the Idle and Torne Management Catchment
- Malton and Norton in the Derwent (Humber) Management Catchment
- Lowdham in the Lower Trent and Erewash Management Catchment
- Stoke-on-Trent in the Trent Valley Staffordshire Management Catchment

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, May 2018, November 2019, June 2020 and June 2021.

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, Yorkshire Water and Anglian Water. There has been, and continues to be, significant investment by the water companies to reduce sewer flooding in the RBD. This includes schemes undertaken to increase the capacity of sewers in several FRAs, such as £60m invested in Newark-on-Trent to upgrade sewers and the water supply network. In more recent times solutions have given more focus to developing partnership working initiatives to manage surface water more effectively to alleviate the risk of both sewer and surface water flooding. For example, sewer and surface water flood alleviation schemes at:

- Lodge Hill, Weoley Avenue in Birmingham
- Newark-on-Trent
- Fenton, Stoke-on-Trent
- the Living with Water partnership in Hull

Water companies in the RBD are currently developing long-term strategic [Drainage and wastewater management plans](#) 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

Canals are fed by reservoirs, or the wider catchment along them, to compensate for minor water losses due to leakage and evaporation and the water used as boats descend and ascend canal locks. Surface water run-off from areas near to canals also drains into them. Overflow weirs at intervals along canal banks maintain a fairly constant water level and these outfall into watercourses passing nearby or underneath.

Canals can alleviate flood risk due to the large storage volume represented by a small level increase along several kilometres of water body. They can also move water artificially within or between a catchment and delay the timing of flood peaks. However, canals constitute linear impoundments of significant bodies of water between locks and potential temporary closure points. Flood risk can arise if an embankment breaches where a canal is on ground above the level of nearby property, or a culvert beneath the canal collapses. The nature of this type of flooding, although very rare, means that it can be serious and happens without warning.

The Canal & River Trust is not a designated Risk Management Authority within the Flood and Water Management Act, 2010 but does have responsibilities for managing its infrastructure to minimise risk to others, including during incidents. The Trust aims to manage water levels within a 'normal operating zone' that is specific to a certain location and thus reduces the risk of overtopping. The Trust manages and maintains its network to reduce risks of asset failure. Some canals in the Humber RBD that are also main rivers are managed accordingly to minimise flood risk. Flood risk from canals is included in risk from main river and sea to allow us to consider catchments as one system.

Although typically much less variable than rivers, canal water levels can still respond relatively rapidly. Monitoring of levels and flows on main rivers by the Environment Agency is used to inform flood alerts and warnings. This monitoring also informs the Canal & River Trust where navigation along canals and rivers is unsafe and stoppages are in place.

Further information on the risk and management of canal flooding can be found by visiting the [Canal & River Trust](#).

Reservoir Flood Risk

The Environment Agency regulates large, raised reservoirs with regard to flood risk and provides guidance to reservoir managers. Enforcement action may be taken where improvements are needed.

There are 485 large and raised reservoirs in the Humber RBD that each hold at least 25,000 cubic metres (m³) of water above natural ground level. The hazard maps show the maximum area that might flood if a reservoir was to fail. While the chance of a reservoir failing and causing flooding is very low, the extent of flooding from a failure could be extensive and many miles from its source. This is because the local geography, such as valleys, can channel flood water long distances.

There are approximately 440,000 people, 1,400 services (including hospitals and schools), 400 km of primary roads, 260 km of railways and over 8,000ha of European designated wildlife sites at risk of flooding in the Humber River Basin District. These figures are the totals at risk and are not an indication of the risk from the failure of any individual reservoir. The Environment Agency regulates all reservoirs with a capacity of 25,000m³ or more under the Reservoirs Act 1975.

[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

The topography of the Humber River basin varies considerably. There are two distinct areas of high ground. These are the North York Moors and Cleveland Hills to the north east and the Pennines and Peak District which run to the west across six management catchments.

The headwaters of the River Esk in the north of the river basin are located in Westerdale in the Cleveland Hills at an altitude of between 300m and 400m Above Ordnance Datum (AOD) whilst the River Derwent reaches between 300m and 350mAOD.

The River Derwent (Derbyshire) rises in an upland moorland area of the Pennines with elevations of more than 630mAOD whilst the Upper Calder catchment peaks at 583mAOD at Black Hill near Holme. These areas are characterised by high gradients, steep valleys and narrow floodplains and result in highly reactive systems, with water levels and flows responding to rainfall quickly.

In contrast, to the east and south of the river basin many of the management catchments surrounding the Humber Estuary are characterised by large areas of low-lying land, parts of which are below sea level.

The river basin district is predominantly rural with more than 60% of its land used for agriculture. Farming types include pastoral (livestock) farming on the upland areas of the catchment, with mixed and arable farming in the lowlands. 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.

Land use and management is closely linked to flood risk management. Improved land drainage can speed up the rate at which water gets into rivers, and consequently can increase the flood risk. Conversely, impeding drainage to hold water on the land can help to manage flood risk.

Land management practices can help control erosion, increase soil moisture and reduce the transport of nutrients in field runoff. These include the use of buffer strips adjacent to watercourses, strip cropping, contour farming, fencing watercourses from livestock and reduced stocking densities. It has been shown that such practices reduce runoff at the

field scale, and this could benefit flood risk management through reducing the quantities of water, sediment and pollutants entering the watercourses.

Tree cover is approximately 3.4% of the river basin district, with remnants of the once-great Sherwood Forest in the Idle and Torne Management Catchment and Dalby Forest within the North Yorkshire Moors National Park and Derwent Management Catchment. The Yorkshire and Humber region contains more than 23,600ha of ancient woodlands, including Batty's Wood (West Yorkshire), Grass Wood (Wharfedale) and Martinshaw Wood (Leicestershire).

Large-scale deforestation of the moorland areas over many centuries has increased rainfall runoff and fluvial flows. This has placed established communities at increased risk of flooding. The National Forest aims to reforest 200 square miles in the centre of the river basin district, between Derby, Loughborough and Tamworth.

There is growing evidence that natural flood management (NFM) helps to slow down or even reduce flood flows. NFM 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 and multiple benefits. These and the various types of nature based solutions, 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.

Measures have been included in the Humber RBD Plan which focus on engagement with landowners to support and develop nature-based solutions projects to help manage or reduce flood risk.

Coastal Erosion

Coastal erosion occurs along the length of the river basin district and is dependent on the nature of the coastline. 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 sea flooding and coastal erosion where they are best placed to do so. This is undertaken in collaboration with the Environment Agency.

[Shoreline Management Plans](#) are non-statutory, high level planning documents. They are large scale assessments of the risk associated with coastal processes, and a policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner. They set the strategic direction for managing the coast over the next 100 years. SMPs identify the most sustainable approaches to managing coastal erosion and flooding risks in the short, medium, and long term.

Whilst the second cycle Humber FRMP has considered coastal erosion, it is covered in more detail within [Shoreline Management Plans](#) (SMPs). The FRMP has considered high level links with SMPs, in particular where coastal erosion risk is closely linked to managing flood risk from the sea.

Managing Flood Risk

Often locations in the Humber 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.

Regional Flood and Coastal Committees have an important statutory role in flood and coastal erosion risk management. In the Humber RBD these are the Yorkshire RFCC, Trent RFCC and Anglian-Northern RFCC. More information on RFCCs can be found in '[Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans](#)'.

Flood risk management multi-agency partnership groups exist in all counties in the Humber 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](#).

The Environment Agency and other RMAs work with many 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 Humber 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.

History of Flooding

This section of the FRMP provides a summary of significant flood events and their consequences since the first cycle FRMP in 2015. Significant is defined as an event which affected more than 20 residential properties by internal flooding. The [first cycle FRMP for the Humber River Basin District](#) contains information on historic flood events and their consequences before this date. 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](#)'.

There has been a long history of flooding within the Humber RBD. There have been recent significant events that have been experienced during the period of 2015 to 2021.

Table 2 below provides information on the impacts we are aware of, including:

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

Table 2: Historical Flood Events from all sources 2015 to June 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
December 2015	Yorkshire (6000)	main river, ordinary watercourse, surface water
March 2016	Warwickshire (70)	main river

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
June 2016	South Derbyshire (62), Bolsover (20), Melbourne (40), Breedon on the Hill (20), Gotham (20), Mansfield (20), Birmingham (200), Dudley (120), Staffordshire (30), Sandwell (220)	main river, ordinary watercourse, surface water, sewer
November 2016	New Mills & Whalley Bridge (30)	main river, ordinary watercourse, surface water
August 2017	North East Lincolnshire (20)	surface water
August 2017	Scarborough (70)	surface water
November 2017	Tintwistle (20)	surface water
May 2018	Birmingham (180), Walsall (120), Solihull (180), Worcestershire (250)	main river, ordinary watercourse, surface water, sewer
June 2018	Lancashire (60), Sutton-On-Trent (40)	surface water, ordinary watercourse
September 2018	Matlock (20), Doncaster (20)	surface water
June 2019	Arnold (50)	surface water, main river
June 2019	Richmondshire (240), Buxton (30), Whaley Bridge (30)	ordinary watercourse, surface water, main river
October 2019	Loughborough (40), Stoney Stanton (40) Staffordshire (90)	ordinary watercourse, surface water, main river

Date of flood	Location and approximate number of properties affected shown in brackets	Source of flood water
November 2019	Sheffield (80), Rotherham (150), East Riding (30), North Lincolnshire (50), Doncaster (800), Egmanton (20), Lowdham (100), Retford (30), Shireoaks (30), Worksop (310) Derbyshire wide (380), Derby (30)	ordinary watercourse, surface water, main river, sewer
February 2020	Appleby Magna (20), Cropwell Butler (20), Lowdham (80), Radcliffe on Trent (40), Tollerton (10), Derbyshire wide (100), Staffordshire (300), Yorkshire wide (1500), Bradford (70), Wolverhampton (20)	ordinary watercourse, surface water, main river
June 2020	Ilkeston (60), Ruddington (20), Beeston (90), Nottingham (50), Walsall (30), Sandwell (20), Staffordshire (30)	surface water, sewers, ordinary watercourse
December 2020	Yorkshire wide (50)	ordinary watercourse, surface water, main river
January 2021	Derbyshire wide (50), Yorkshire wide (200)	surface water and main river
June 2021	Solihull (200), Warwickshire (20)	surface water, sewer

Climate Change and the Humber RBD

This section sets out what we know are likely to be the implications of climate change in the Humber 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 and storms 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.

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

Allowance	Sea level rise
Extreme (H++)	1.90m**
Upper end	1.55m
Higher central	1.15m

* 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. A 'Management Catchment' is a designated river catchment designated under the Water Framework Directive (The Water Environment (Water Framework Directive) Regulations 2017); this subdivides river catchment areas for easier management within the River Basin District.

As river flows increase, 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 Humber RBD for the upper end scenario for 2080s epoch (2070-2125) is from 33% to 69%. 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 Humber RBD. The range of increases for the Humber 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 Humber River Basin District (RBD) since the first cycle 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 first cycle FRMPs. 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 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 Humber 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 been 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 of all the measures in the Humber RBD since 2015, as of 31 March 2021.

Table 4: Implementation Status of Measures for the Humber RBD

Progress	Number of measures
Ongoing	499
Ongoing construction	14
Completed	142
Superseded	129
Not started - proposed	109
Not started - agreed	17

The doughnut chart below entitled 'Implementation Status' shows the proportion of measures by implementation status.

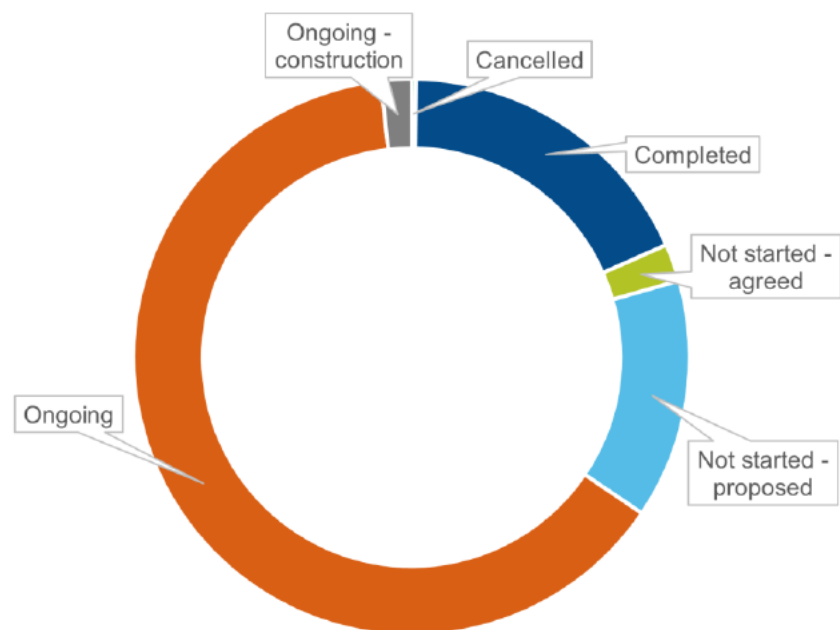


Chart 1: Implementation Status of Measures for the Humber RBD

- 16% of the measures published in the first cycle FRMP have been completed
- 2% of the measures are ongoing in construction
- 55% of the measures are ongoing

Of the ongoing measures:

- 52% are day-to-day activities which have been carried out by risk management authorities in 2015-2021. These day-to-day 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](#)'.
- 20% were attributed to other Management plans. Measures in first cycle FRMPs included duplicate actions, such as from the Shoreline Management Plans, Catchment Management Plans and Multi-Agency Flood Plans. To avoid further duplication these actions are not being transitioned to second cycle FRMPs as they will be considered through a separate review process.
- 28% of the ongoing measures are either outside of day-to-day activities or are not included in the above management plans

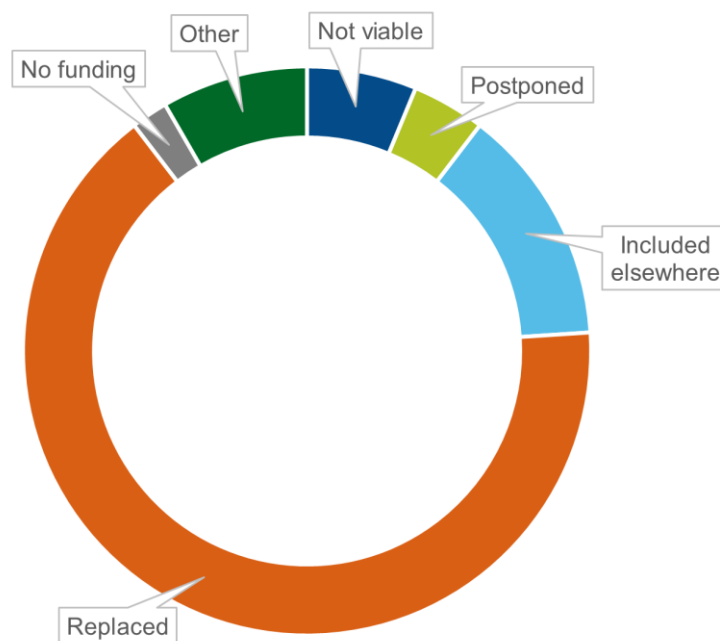


Chart 2: Reasons for Not Progressing Measures for the Humber RBD

27% of the measures proposed in the first cycle FRMP have not been implemented. The reasons for this are:

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

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

How these measures were implemented and the main outcomes achieved

The Flood Risk Regulations (FRR) state that the FRMP must include measures relating to: the prevention of flooding, the protection of individuals, communities, and the environment against the consequences of flooding, and 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, and recovery and review following flooding.

Completed measures that have contributed to preventing flooding

35% of completed measures have contributed to the prevention of flooding. Examples include:

- working with Local Authorities in the development of their Local Plans
- improving evidence base through survey of flood risk management assets, modelling and mapping
- investigating risk of flooding across the Borough of Rotherham. Mitigation measures identified were incorporated in the Local Flood Risk Management Strategy and Action Plan
- developing of planning policies to mitigate the impacts of extreme weather and climate change within the Birmingham Development Plan (adopted 2017), and adopting the Rea Valley urban Quarter supplementary planning document 2020 (also see case study)

Completed measures that have contributed to protecting against flooding

49% of completed measures have helped to protect individuals, communities, and the environment against the consequences of flooding. This includes measures for works on the ground which were allocated funding on the 2015-2021 capital investment programme, and have been completed by Risk Management Authorities such as the Environment Agency and Lead Local Flood Authorities. Types of projects include engineered flood risk management schemes, property flood resilience, asset capital maintenance and natural flood management.

These measures have reduced risk of flooding or coastal erosion across the Humber River Basin District. Examples include:

- flood risk reduction to properties and business in Derby, achieved by 'Our City Our River' flood alleviation project
- the £38m Foss Barrier Recovery Scheme, which reduces risk to 1200 properties
- phase 1 & 2 of a £18m scheme to repair and improve the tidal defences through Grimsby Docks. The scheme has reduced the risk of significant tidal overtopping and breach of the defences to better protect 12,179 properties in Grimsby
- Hull River Defences (Phase 1&2), which reduces risk to over 5,000 homes, as well as businesses and infrastructure in the city. The scheme has upgraded flood defences to restore a high standard of flood protection throughout Hull, with 3,500 metres of new defences installed
- development of the Isle of Axholme strategy, covering an area 45,000 hectares at risk of flooding, which included the refurbishment of Keadby pumping station
- Kolverley Grove Flood Defences, West Bromwich – works to repair the flood defences have reduced flood risk, including to 140 residential properties
- Leicester Flood Risk Management Scheme, involving the improvement of conveyance of flows along the River Soar, improving risk of flooding to approximately 2000 properties (also see case study)
- Louth Flood Alleviation scheme, two upstream flood storage reservoirs completed at a cost of around £7.2m and better protects properties in Louth from flood risk
- Mytholmroyd Flood Alleviation Scheme, which better protects 400 homes and businesses. This scheme included construction of new, raised and improved flood walls, the relocation of Caldene Bridge, widening of the river channel and flood proofing buildings
- Rising Brook, Rugeley Town Centre Flood Risk Management Scheme - a flood storage area that will store water from the Rising Brook during times of heavy rainfall. The £5.2 million scheme reduces the risk of flooding to more than 114 residential properties and 159 commercial properties
- cliff stabilisation in Scarborough which reduces risk to 380 homes and 38 businesses
- Selly Park North and South Schemes, Birmingham, which reduces flood risk, including to 332 homes
- Whitby Harbour works which reduces risk to over 370 homes

Completed measures that have contributed to preparing for flooding

10% of completed measures have helped to prepare people for flooding. Examples include:

- engaging with communities to raise awareness and to prepare for flooding, in areas such as Day Brook and Old Basford, and in catchments that respond rapidly to heavy rainfall, such as the Lower Calder and in Birmingham
- improving the flood warning service in the Humber River Basin District, examples including Scarborough, Whitby, Leicester Principal Urban Area, the Louth, Grimsby & Ancholme catchment and Leeds

Completed measures that have contributed to recovery from flooding

4% of the completed measures have helped to support communities to recover from flooding. This was for measures and activities of the Kirklees Local Flood Risk Management Strategy to be embedded into the response and recovery plans.

Outside of these measures, 2% of the completed measures did not fall into the categories of prevention, preparedness, protection, recovery and review.

Ongoing measures that have contributed to managing flood risk

In addition to the completed measures, the first cycle FRMP also included ongoing measures that reflect the day-to-day activities undertaken by RMAs which contribute to managing flood risk. These measures have continued throughout the period 2015-21.

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

- determining Flood Risk Activity Permits
- carrying out our roles as statutory consultee in the planning process
- continuing our modelling programme
- continuing our publishing of updates to flood risk mapping

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

- repairing and refurbishing flood risk management assets
- continuing of routine maintenance of flood risk management assets
- reservoir management and regulation
- delivery of capital schemes
- responding to incidents, including monitoring and operating defences, and 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:

- working with communities to raise awareness of flood risk, encouraging sign up to flood warning service and support resilience. Examples include community resilience capacity building, engaging with schools and young people about flood risk and resilience, and working with the farming community
- continuing maintenance and improvement of the Environment Agency's flood warning service
- ongoing increase of our coverage of providing a flood warning service for fluvial and tidal flooding in the highest risk areas as part of the national Flood Warning Expansion Project

- continuing to work with and training of flood wardens - we have facilitated a significant expansion in our flood warden network
- responding to incidents, including monitoring rainfall and river levels and issuing flood warnings to many thousands of people during flood events

The following day-to-day activities carried out in 2015-2021 have aided communities to recover from flooding:

- delivering projects included on the 2015-2021 capital investment programme to repair flood risk management assets damaged during flooding
- engaging with communities during flooding
- engaging with communities after flooding, working in partnership to hold site visits and drop in events with communities, including flooded businesses, affected by flooding
- working in partnership during and after flooding to help communities recover from flooding, and to review flooding incidents to help further improve our response

Case studies

The following case studies have been prepared to highlight successfully completed measures across the measure types of prevention, preparedness, protection, recovery and review.

Cottingham and Orchard Park Flood Alleviation Scheme (COPFAS)

Fully operational from 2020 onwards, Cottingham and Orchard Park Flood Alleviation Scheme (COPFAS), led by the East Riding of Yorkshire Council, in partnership with Hull City Council and the Environment Agency. The scheme intercepts surface water run-off from the west of the flood risk area (the Raywell Valley and Cottingham Parks watersheds), storing water in a number of lagoons so that it can be discharged in a controlled manner into the downstream urban drainage system.



Figure 3: Cottingham and Orchard Park Flood Alleviation Scheme

Developed in partnership with Hull City Council and the Environment Agency at a cost of £20 million. Funding was secured from FCERM Grant in Aid (circa £14m); £5m of Local Growth Fund via the Humber Local Enterprise Partnership; and a land contribution from Hull City Council worth circa £1m.

The scheme consists of two phases:

Phase 1: Orchard Park Lagoon and Wanless/Creyke Beck Flow Control

Comprises of improvements to Millhouse Beck and nearby ditches and watercourses, leading to a flow control structure in Creyke Beck. This connects via a syphon to a large lagoon at Orchard Park. To compensate for areas impacted by the lagoon construction, East Riding of Yorkshire Council and Hull City Council have improved community amenities in this area, refurbishing the open spaces and creating a public fishing pond near the lagoon.

Phase 2: Raywell Valley Lagoons

This phase involves the creation of eight lagoons in the Raywell Valley and improvements to highway drainage. All eight lagoons are linked together by culverts which allow any flood water to flow from one reservoir to the next to capture as much water as possible when necessary. All the lagoons which form a part of the scheme will normally remain dry, only to be filled during severe wet weather events.

The scheme provides the following benefits:

- reduced surface water flood risk to 5,741 residential properties and 333 commercial properties
- reduced risk of flooding to 233ha of land
- reduced surface water flood risk to 113,416m² of commercial floor space
- total capacity to hold back over 330,000 cubic metres of flood water

The new Council assets have already operated on numerous occasions. Following prolonged heavy rainfall in November 2019 the reservoirs prevented properties in Cottingham and the Orchard Park area of Hull from flooding. Image shows Orchard Park Lagoon in operation in 2019. COPFAS has been constructed to an annual exceedance probability (AEP) of 1.33% and an allowance has been made within the scheme for climate change.

COPFAS was the winner of the Smeaton Award 2020 from the Institution of Civil Engineers (ICE) for Phase 1 of the scheme. Phase 2 of the scheme was also shortlisted in the ICE Yorkshire and Humber Civil Engineering awards 2021 winning a Certificate of Excellence.

Holderness Drain Flood Alleviation Scheme

The area of Kingston upon Hull and Haltemprice was designated as a flood risk area as part of the Humber RBD FRMP in Cycle 1. As part of the FRMP, several measures were developed to address flood risk improvements within this area. One of these measures has resulted in the generation of the Holderness Drain Flood Alleviation Scheme which is currently being constructed.

The Holderness Drain Flood Alleviation Scheme (FAS) is a £28 million project to reduce flood risk for homes and businesses from the Holderness Drain.

The scheme involves work at two sites:

1. In East Hull there will be works to replace the existing pumping station with a new one.
2. At Castlehill there will be works to create an aquagreen (a versatile green space that can temporarily store excess water during a flood and then slowly release it back into the drainage system after the peak of the flood has passed - also called a 'flood storage area'). This will reduce the risk of flooding to existing homes, mainly in the North Carr and Sutton areas of Hull.

Together, both components of the scheme will provide a long term and more sustainable approach to managing water in the Holderness Drain catchment.

This is a partnership project, led by the Environment Agency and supported by our partners.

The Holderness Drain catchment covers an area of low-lying agricultural land which drains water from the Yorkshire Wolds through to the Humber Estuary, on the eastern side of Hull. Managing water in this catchment is particularly difficult as the land is flat and often below sea level at high tide. This means that water in the Holderness Drain empties into the Humber very slowly and needs to be assisted by pumping stations along the way. After periods of heavy rainfall, water levels in the Drain can remain high for many days, posing a risk of flooding to homes and businesses within the catchment.

Large areas of Hull and the East Riding of Yorkshire were badly flooded in July 2007 following heavy rainfall, with thousands of homes and businesses inundated. The North Carr and Sutton areas, on the eastern side of Hull, were particularly affected by these floods.

Following this traumatic event, MPs, local authorities and local people campaigned for more investment in flood protection. In response to this, the Environment Agency has continued to work with partners to find ways to reduce flood risk in Hull and the surrounding area.

A range of different options, including nature-based solutions were considered for the Holderness Drain catchment. The need to do something has become more urgent as the old pumping station in East Hull, built in 1949 to help to pump high water flows, has now reached the end of its working life and needs to be replaced.

Kirklees Culvert Programme

Within Kirklees there are Flood Risk Areas identified in both Mirfield in Huddersfield, both covering some smaller settlements surrounding the towns. Both of these contain measures related to working with RMAs to reduce the risk of flooding. To aid in the implementation of these measures, the Kirklees Culvert Programme has been devised.

Due to its geography, industrial and cultural heritage the Kirklees district contains thousands of stone culverts. Many culverts across Kirklees are 100-200 years old and at risk of suffering decay and consequently creating flood risk. This project is a Culvert Inspection and Repair Programme, assessing the condition of culverts across the Kirklees area and delivering benefits by repairing them to the required standard.

The Business case was approved in 2016 and construction began in 2017. This scheme has delivered outcome measures in each year since and will complete its final phase in 2021/22. Throughout the delivery of this scheme the specific works to be carried out have altered slightly, but the positive cost benefit ratio of the scheme has been maintained.

The first phase was to add culverts to the scheme based on their level of overall risk, then to survey these culverts to understand their condition. The second phase included repairing, replacing and daylighting culverts where possible.

Culvert improvement works are being undertaken on around 50 culverts across the Kirklees Council area, moving 936 properties to a lower flood risk band. All the culvert

works are on Ordinary Watercourses. The present value costs for this project are £1.7m with the whole life benefits of £19.7m.

Leeds Flood Alleviation Scheme

Leeds was not designated as a flood risk area as part of the first FRMP. However, as part of the Aire and Calder Management Catchment, several measures were developed to address flood risk improvements in the city of Leeds. One of these measures related to works on the Leeds Flood Alleviation Scheme.



Figure 4: Leeds Flood Alleviation Scheme 1

The Leeds Flood Alleviation Scheme Phase 1 (FAS) was built to protect the city against flooding from the River Aire. The scheme was led by Leeds City Council in partnership with the Environment Agency, Yorkshire Water Services, the Canal & River Trust and other stakeholders. Phase 1 of the project focused on the lower lengths of the river including the area of Holbeck. The project - which cost in total around £50m - commenced January 2015 and was officially opened in October 2017. The FAS has brought confidence for regeneration, economic growth and benefits to the people of Leeds for being the 'Best City for Health & Wellbeing' as well as protecting 3,000 homes and 500 existing businesses.

Expert engineers designed an innovative solution that helped maintain the connection between the river and city. Phase 1 saw the removal of the two main navigation weirs at Knostrop and at Crown Point and replaced them with new mechanical moving weirs, a UK first for flood alleviation purposes. Normally, these new mechanical weirs are in a raised position to allow barges to navigate up and down the river without compromising city views. However, in periods of dangerously high flood levels, the weirs are progressively lowered to reduce the height of the flooding to the lowest practicable level. Landscaped flood defences and the modification of existing buildings were also included in the design, to ensure the highest standard of flood protection is achieved in both the short and the long term.

Leicester River Soar Conveyance

Leicester was designated a flood risk area as part of the Humber FRMP in Cycle 1. As a result of measures outlined in the first FRMP, a series of Flood Risk improvement projects were undertaken across the city. The Leicester River Soar Conveyance project was carried out to reduce flood risk to properties next to the River Soar in Leicester and was a partnership project between the Environment Agency, Leicester City Council and the Leicester and Leicestershire Local Enterprise Partnership (LLEP).

The aim of the project was to create additional floodplain capacity, reduce potential barriers to flow of the river, and provide multi-functional green space and greater public access along the river corridor. Two key areas of the scheme included Ellis Meadows and Loughborough Road.

Ellis Meadows

One part of the scheme converted a former school playing field into a wetland and wildflower park complete with cycleway and boardwalk and reconnected the River Soar with its floodplain. Consisting of grass and decommissioned allotments, the public rarely used the site before this project; and ecologically it contributed very little.

Funded in 2013 and completed in 2016, the 7.4 hectares restored at Ellis Meadows formed the second phase of a larger natural flood management project for the city. Taking a blue-green infrastructure approach to managing flood risk through a combination of land lowering and reshaping, wetland creation, and vegetation management has reduced the flood risk for over 2,000 homes and businesses in Leicester.



Figure 5: Ellis Meadows wetland and wildflower park

A lake and wetland areas were created which are linked by a boardwalk, with wildflower meadows and trees planted around the edge of the site. The project has been nominated for awards and was highly commended by the Chartered Institute of Ecology and Environmental Management (CIEEM) at its 2018 awards for best practice in large-scale practical nature conservation.

Loughborough Road

Works were also carried out at Loughborough Road next to the River Soar to create a flood relief culvert and land lowering either side of the bridge to create additional floodplain capacity.



Figure 6: Loughborough Road flood relief culvert

The culvert was designed to prevent flood water building up on the upstream side of the bridge and causing a potential flood risk to existing properties in the Belgrave area. The culvert constructed also provides better public access along the river, as it forms part of the cycle route to the north of the city. Wetland habitats have been enhanced through the creation of ponds and wetlands either side of the bridge.

Rea Valley Urban Quarter

The Rea Valley Urban Quarter is the next phase in the regeneration of Birmingham. Central to this is an ambitious transformation of the River Rea into a green corridor with an environment that is resilient to climate change and ecologically rich. Birmingham City Council and the Environment Agency have been working together to ensure that reducing flood risk is a core component of the regeneration strategy.

A planning framework for the future transformation of the area has been set out in the Rea Valley Urban Quarter Supplementary Planning Document, adopted in December 2020. At the heart of this is the need to address the current flood risk. The SPD sets out an outline approach which includes a combination of:

- flood storage areas
- channel improvements
- sustainable urban drainage (SuDS) solutions

The SPD will support delivery of a business case for River Rea enhancement. It will also be an important material consideration in determining planning applications in the area, which will need to demonstrate how they contribute to the overall regeneration strategy.

Additional measures implemented since 2015

In addition to the aforementioned measures within first cycle FRMPs, a number of other measures have emerged since the publication of the first cycle plan. Types of projects include engineered flood risk management schemes, property flood resilience, asset capital maintenance and natural flood management. Examples of the types of additional measures include:

- Anlaby and East Ella Flood Alleviation Scheme, which reduces risk to over 4,495 homes and 74 commercial properties
- Birmingham City Council has developed a Hydraulic Maintenance of Structures database that will be used to prioritise maintenance and to develop and promote a FRM Capital Programme of works
- Burton upon Trent Flood Risk Management Scheme, which was the winner of an Institution of Civil Engineers West Midlands Judges' Award, 2021. This scheme reduces flood risk including to approximately 4250 homes and 1000 commercial properties, including heritage assets
- significant sea defence improvements, surface water, and combined flood alleviation schemes which reduce risk to 824 homes, 682 of which are better protected from tidal risk in Cleethorpes
- Cottingham and Orchard Park Flood Alleviation Scheme, a scheme which reduces risk to over 5,741 homes and 333 commercial properties (also see case study)
- Hessle Foreshore Tidal Defences, which reduces risk to nearly 4,500 homes in the Hessle and West Hull area, in addition to improving safety and preventing flooding on the A63, a busy stretch of road in East Riding
- prioritising flood resilience engagement activities in areas affected by significant floods in the Humber River Basin District
- Humber: Hull frontage, which reduces risk to over 28,000 homes. The scheme has upgraded the tidal flood defences along the city's estuary shoreline to reduce tidal flood risk to 0.5% chance of occurring in any given year, up to 2040, for the city
- Living With Water partnership in Hull, working collaboratively to deliver visionary solutions that build thriving resilient communities. This has included supporting an extensive programme of engagement activities that formed part of 'The Hulltimate Challenge' in 2019, as well as a programme of schools engagement
- Rawcliffe Bridge Embankment Repairs, which reduces flood risk to approximately over 850 homes
- working in partnership to reduce flood risk. An example is Severn Trent Water working in collaboration with LLFAs and the Environment Agency to deliver 26 schemes within Severn Trent's operating area spanning the Humber and Severn RBDs. This has benefitted over 850 properties
- West Park Penstock Improvement Works in Long Eaton. The scheme included improvements to the penstocks attached to the West Park Flood Storage Reservoir. The works were completed in 2015 and reduced flood risk to 660 properties

- setting up of catchment-based partnerships to reduce flood risk and improve the environment – such as the River Wharfe Flood Partnership, the Rea Catchment Partnership and the River Cole Partnership

How well these measures have achieved the first cycle FRMPs 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 FRMPs objectives were grouped into categories: social, economic, and environmental. Information on these objectives for the Humber River Basin District first cycle FRMPs can be found in Part A and Part B of the [first cycle FRMPs](#).

Overall, the measures included in the first cycle FRMP have successfully achieved the objectives set out across all of categories, delivering a great improvement to the social, economic and environmental well-being of the Humber River Basin district.

The first cycle FRMP showed which objective category or categories each measure would help to deliver. The following describes measures under the objective category which they primarily benefit.

46% 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%.

Completed measures that have contributed to Social Objectives

93% of completed first cycle FRMPs measures and our ongoing and additional activities completed in 2015-2021 have contributed to achieving social objectives by:

- working in partnership with RMAs and communities, as appropriate, to understand the risk of flooding from all sources of flooding
- working with partners to develop long term plans to manage the risks with direct involvement from the community in the decision-making process
- working in partnership with communities to build awareness of flood risk and engage with them to reduce the consequences of flooding by enabling them to take effective action before, during and after a flood
- supporting communities and individuals to make their property more resilient
- reducing flood risk and avoid loss of life to people and existing residential properties
- minimising the impact of flooding to community services and critical infrastructure
- avoiding inappropriate development in areas of flood and coastal erosion risk
- seeking opportunities to reduce existing and future risks through collaborative working on new and future development plans

Examples of measures contributing to achieving social objectives include:

- partnership working to understand the challenges faced by managing surface water flooding, sharing best practice and identifying opportunities to work collaboratively to seek funding for traditional and innovative solutions to reduce this risk
- partnership working to deliver actions in the local flood risk management strategies
- partnership working to deliver flood risk management projects and maintain existing assets, as detailed elsewhere in this document

Completed measures that have contributed to Economic Objectives

43% of completed first cycle FRMPs measures and our ongoing and additional activities completed in 2015-2021 have contributed to achieving economic objectives by:

- reducing the economic damage of flooding to non-residential properties
- continuing to maintain main river and existing assets, prioritising investment of public money where the risk of flooding, risk to life to people and economic damage are greatest
- minimising the risk of flooding to key transport links within the river basin such as railway lines, motorways, primary roads and trunk roads
- considering the value of agricultural land and the damages that can occur as a result of flooding within the economic appraisal of maintenance and investment options for flood risk management
- ensuring that flood risk management activities do not adversely affect the tourism industry, and where possible have enhanced the attractiveness of the river and coastal environment to visitors

In the Humber River Basin District, we have been working closely with the Local Enterprise Partnerships and Combined Authorities to deliver flood risk management schemes, in particular for areas where flooding can cause a significant economic impact.

Examples of measures contributing to achieving economic objectives include:

- working with Risk Management Authorities to deliver flood risk management projects and maintain existing assets, as detailed elsewhere in this document
- Burton upon Trent Flood Risk Management Scheme – the scheme will help to realise multiple benefits including regeneration of Burton Town Centre, improvements to hard and soft landscapes and benefits for local amenities and businesses
- Ellis Meadows in Leicester were developed in partnership between Leicester City Council and the Environment Agency. This involved working closely with flood risk team, parks, education, regeneration, and highways specialists to get overall agreement on the project (also see case study)
- Leeds City Flood Alleviation Scheme (Phase 1) reduces the risk of flooding to 3,500 homes, and safeguards 500 business and over 20,000 jobs in the city centre, as well reducing the risk to key infrastructure such as access routes to Leeds train

station, data and telecommunications infrastructure and electricity sub stations (also see case study)

- Perry Barr and Witton Flood Risk Management Scheme - under construction at time of writing (2021) to better protect approximately 1,400 properties. The scheme has created a large wet woodlands area, planted 23000 trees and enabled the regeneration of a deprived area by reducing flood risk. The flood scheme received recognition as a regional winner of the Royal Institute of Chartered Surveyors, Social Impact Awards 2020 – category ‘Infrastructure’
- Rising Brook, Rugeley Town Centre Flood Risk Management Scheme – the scheme has realised multiple benefits for the community and environment, including forming an integral part of the regeneration of Rugeley Town Centre, crayfish protection, footbridge repairs and creation of sports pitches. The project received an Institution of Civil Engineers West Midland Sustainability Award for the wider benefits achieved
- Sheffield Lower Don Valley Flood Alleviation Scheme reduces risk to 380 homes, as well as benefitting more than 500 businesses, safeguarding around 5000 jobs, and key roads in and out of the city
- Skipton Flood Alleviation Scheme was completed to reduce flood risk to 378 homes and 165 businesses in the town centre. The scheme also acts as a catalyst for the wider development of the South Skipton area, including new commercial floor space and housing
- Winteringham Ings and South Ferriby, a £13.8m scheme which protects around 150 properties, along with major businesses, agriculture and infrastructure, including the A1077 which is a vital link for south bank communities to the Humber

Completed measures that have contributed to Environmental Objectives

29% of completed first cycle FRMPs measures and our ongoing and additional activities completed in 2015-2021 have contributed to achieving environmental objectives by:

- working with others to achieve WFD objectives across the river basin district through our FCRM work or through funding contributions from FCERM Grant in Aid and/or local levy
- minimising the negative impacts of flooding to designated nature conservation sites throughout the Humber River Basin District, wherever possible contributing to the enhancement of such sites
- minimising the negative impacts of flooding to heritage assets and landscape value (SAM, listed buildings and historic parks and gardens), wherever possible enhancing such assets

Example of measures contributing to achieving environmental objectives include:

- Derwent Villages NFM project: completed, installing 149 interventions over 20 land holdings, 7km of enhanced waterbody and 17km new habitat created/enhanced

- Donna Nook, a £10m habitat improvement scheme, creating 106ha new intertidal habitat and allows flood risk activities to continue on the Humber which helps protect 90,000ha land and around 400,000 people, together with major industry and ports
- projects which have helped designated sites include river restoration strategy projects for SSSIs - Dove Valley and River Blythe, and river restoration project for SAC – River Mease
- The Great North Bog initiative is targeting peatland restoration and conservation across nearly 7000 km² of peatland soils, currently storing 400 million tonnes of carbon. Restoring these will have significant benefits to flood risk, targeting rapid response catchments and communities at risk as well as contributing to WFD improvements.
- in Leicester, Ellis meadows were created to manage flood risk through a combination of land lowering and reshaping, wetland creation, and vegetation management
- Natural Flood Management (NFM) measures delivered in a number of areas including Bishopdale, Brompton, Ilkley, Fillongley and River Bourne, Broughton, Harden, Marchington (and Scotch Brook), Earby, Boddington, Hardcastle Craggs, Gorpley and Wessenden and Marsden
- flood risk management projects that delivered environmental benefits include the Perry Barr and Witton Flood Risk Management Scheme, and the Dovecliffe Weir removal project at Egginton on the River Dove

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.

Measures contributing to Other Objectives

The first cycle of the Humber River Basin District FRMP included an objective to avoid loss of life and reduce the risk of flooding from reservoirs to people, property, infrastructure and the environment. Our day-to-day activity carried out in 2015-2021 to manage and regulate reservoirs has contributed to meeting this objective.

Second Cycle Conclusions from the Hazard and Risk Maps for the Humber RBD

The data in tables Table 5 to Table 10 has been calculated from data available in December 2019. This data takes into account the presence and condition of defences. The risk is presented in flood risk likelihood categories. These indicate the chance of flooding in any given year:

- high risk means that each year an area has a chance of flooding of greater than 3.3%
- medium risk means that each year an area has a chance of flooding between 1% and 3.3%
- low risk means that each year an area has a chance of flooding of between 0.1% and 1%
- very low risk means that each year an area has a chance of flooding of less than 0.1%

These details of the flood risk in the Humber RBD have been provided below in the context of Rivers and Sea Flood Risk and Surface Water Flood Risk.

Rivers and Sea Flood Risk Statistics

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 Humber RBD

Risk to people	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of people in RBD	12,329,529	59,933	335,549	570,295	86,979
Number of services	76,511	1,162	3,596	4,499	661

There are 12,329,529 people in the RBD. Of these:

- 8.5% are in areas at risk of flooding from rivers and the sea
- 0.5% are in areas at high risk of flooding

There are 76,511 services in the RBD. Of these:

- 13% are in areas at risk of flooding from rivers and the sea
- 2% are in areas at high risk of flooding

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 Humber RBD

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	485,247	10,039	27,552	30,632	4,865
Number of airports	5	1	0	0	0
Length of road (kilometres (km))	4,978	81	235	161	28
Length of railway (km)	3,175	122	327	179	49
Agricultural land (hectares (ha))	1,541,332	63,459	128,928	55,305	6,937

Of the 485,247 non-residential properties in the RBD:

- 15% are in areas at risk of flooding from rivers and the sea
- 2% are in areas at high risk of flooding

Of the 5 airports in the RBD, one is in an area at high risk of flooding from rivers and the sea.

Of the 4,978 km of roads in the RBD:

- 21% are in areas at risk of flooding from rivers and the sea
- 2% are in areas at high risk of flooding

Of the 3,175 km of railways in the RBD:

- 20% are in areas at risk of flooding from rivers and the sea
- 4% are in areas at high risk of flooding

Of the 1,541,332 hectares of agricultural land in the RBD:

- 17% are in areas at risk of flooding from rivers and the sea
- 4% 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 Humber RBD

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of EU designated bathing waters within 50 metres (m)	11	10	0	1	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	1,121	97	112	117	12
Area of Special Area of Conservation (SAC) within area (ha)	188,156	3,651	3,348	794	11
Area of Special Protection Area (SPA) within area (ha)	193,209	3,797	2,511	812	5
Area of Ramsar site within area (ha)	36,697	2,763	516	135	4
Area of World Heritage Site within area (ha)	8,594	701	393	158	3
Area of Site of Special Scientific Interest (SSSI) within area (ha)	212,573	7,488	4,779	1,035	28
Area of parks and gardens within area (ha)	29,336	1,106	727	179	17
Area of scheduled ancient monument within area (ha)	9,270	235	423	204	11
Number of listed buildings within area	53,028	1,721	2,419	1,788	262
Number of licensed water abstractions within the area	5,581	1,455	629	326	51

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.

Of the 11 EU designated bathing waters in this RBD, 91% are both in areas at high risk of flooding from rivers and the sea due to their fundamental features.

There are 1,121 Environmental Permitting Regulations (EPR) installations in the RBD. Of these:

- 30% are in areas at risk of river and sea flooding
- 9% are in areas at high risk of flooding

There are 188,156 hectares of Special Area of Conservation (SAC) in the RBD. Of these:

- 4% are in areas at risk of flooding from rivers and the sea
- 2% are in areas at high risk of flooding

There are 193,209 hectares of Special Protection Area (SPA) in the RBD. Of these:

- 4% are in areas at risk of flooding from rivers and the sea
- 2% are in areas at high risk of flooding

There are 36,697 hectares of Ramsar sites in the RBD. Of these:

- 9% are in areas at risk of flooding from rivers and the sea
- 8% are in areas at high risk of flooding

There are 212,573 hectares of Site of Special Scientific Interest (SSSI) in the RBD. Of these:

- 6% are in areas at risk of flooding from rivers and the sea
- 4% are in areas at high risk of flooding

There are 29,336 hectares of parks and gardens in the RBD. Of these:

- 7% are in areas at risk of flooding from rivers and the sea
- 4% are in areas at high risk of flooding

There are 9,270 hectares of scheduled ancient monument in the RBD. Of these:

- 9% are in areas at risk of flooding from rivers and the sea
- 3% are in areas at high risk of flooding

There are 53,028 listed buildings in the RBD. Of these:

- 12% are in areas at risk of flooding from rivers and the sea
- 3% are in areas at high risk of flooding

There are 5,581 licensed water abstractions in the RBD. Of these:

- 44% are in areas at risk of flooding from rivers and the sea
- 26% are in areas at high risk of flooding

Surface Water Flood Risk Statistics

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 Humber RBD

Risk to people	Total in RBD	High risk	Medium risk	Low risk
Number of people in RBD	12,329,529	78,329	157,569	833,050
Number of services	76,511	570	913	4,721

Of the 12,329,529 people in the RBD:

- 9% are in areas at risk of flooding from surface water
- 0.6% are in areas at high risk of flooding

Of the 76,511 services in the RBD:

- 8% 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 Humber RBD

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk
Number of non-residential properties	485,247	6,946	10,702	47,940
Number of airports	5	5	0	0
Length of road (kilometres (km))	4,979	174	203	645
Length of railway (km)	3,175	168	159	365
Agricultural land (hectares (ha))	1,541,334	27,468	20,859	89,543

Of the 485,247 non-residential properties in the RBD:

- 14% are in areas at risk of flooding from surface water
- 1% are in areas at high risk of flooding

The 5 airports in the RBD are all in areas at high risk of flooding from surface water.

Of the 4,979 km of roads in the RBD:

- 21% are in areas at risk of flooding from surface water
- 3% are in areas at high risk of flooding

Of the 3,175 km of railways in the RBD:

- 22% are in areas at risk of flooding from surface water
- 5% are in areas at high risk of flooding

Of the 1,541,334 hectares of agricultural land in the RBD:

- 9% 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 Humber RBD

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Number of EU designated bathing waters within 50 metres (m)	11	1	3	2
Number of Environmental Permitting Regulations (EPR) installations within 50m	1,122	285	230	309
Area of Special Area of Conservation (SAC) within area (ha)	188,156	1,541	1,064	8,911
Area of Special Protection Area (SPA) within area (ha)	193,209	1322	966	8,506
Area of Ramsar site within area (ha)	36,697	20	24	248
Area of World Heritage Site within area (ha)	8,594	222	136	469
Area of Site of Special Scientific Interest (SSSI) within area (ha)	212,573	2,408	1,625	10,770
Area of parks and gardens within area (ha)	29,336	676	370	1,358
Area of scheduled ancient monument within area (ha)	9,270	166	119	442

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Number of listed buildings within area	53,028	977	460	1,807
Number of licensed water abstractions within the area	5,581	706	297	887

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.

6 of the 11 EU designated bathing waters in this RBD are in an area at risk of flooding from surface water.

Of the 1,122 Environmental Permitting Regulations (EPR) installations in the RBD:

- 73% are in areas at risk of surface water flooding
- 25% are in areas at high risk of flooding

Of the 188,156 hectares of Special Area of Conservation (SAC) in the RBD:

- 6% are in areas at risk of flooding from surface water
- 0.8% are in areas at high risk of flooding

Of the 193,209 hectares of Special Protection Area (SPA) in the RBD:

- 6% are in areas at risk of flooding from surface water
- 0.7% are in areas at high risk of flooding

Of the 36,697 hectares of Ramsar sites in the RBD:

- 0.8% are in areas at risk of flooding from surface water
- 0.05% are in areas at high risk of flooding

Of the 212,573 hectares of Site of Special Scientific Interest (SSSI) in the RBD:

- 7% are in areas at risk of flooding from surface water
- 1% are in areas at high risk of flooding

Of the 29,336 hectares of parks and gardens in the RBD:

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

Of the 9,270 hectares of scheduled ancient monument in the RBD:

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

Of the 53,028 listed buildings in the RBD:

- 6% are in areas at risk of flooding from surface water
- 2% are in areas at high risk of flooding

Of the 5,581 licensed water abstractions in the RBD:

- 34% are in areas at risk of flooding from surface water
- 13% are in areas at high risk of flooding

Second Cycle Objectives and Measures

A full list of the objectives is in the [‘Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans’](#).

In developing the FRMP, the RMAs have:

- drawn **conclusions** from the hazard and risk maps and other sources of information - this helps us all to understand the risks or opportunities
- **taken account** of the likely impact of climate change on the occurrence of floods
- selected appropriate **objectives** from the national list to reduce the adverse consequences of flooding for human health, economic activity and the environment (including cultural heritage), and reduce the likelihood of flooding
- identified the likely approach (the measures) to achieve these objectives using the categories: **preparing, preventing, protecting and recovery and review**

In addition to measures developed for the nationally identified FRAs, the Humber RBD FRMP also includes measures for:

- areas of the RBD that span across or cover more than one Management Catchment – [River Basin District level measures](#)
- locations that fall wholly within [Management Catchments](#)
- [Strategic Areas](#) - which can span across River Basin Districts

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’](#).

Measures that have been included in the second cycle are strategic, and the level of detail that is included may vary depending on the planning or implementation stage measures are at. 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, or to provide extensive details of the measures. 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 [Developing the FRMP](#) section.

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.

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.

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](#)'.

These national level measures apply to the whole of the Humber RBD area and are in addition to any measures which have been developed locally for each FRMP.

River Basin District level objectives and measures

51 measures have been developed that apply to areas of the RBD that span across or cover more than one Management Catchment, for example counties. 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.

Management Catchment level objectives and measures

193 measures have been developed that apply to locations within the 16 management catchments in the Humber RBD. These measures have been developed in addition to measures that cover other spatial scales. You can find information about all of the measures that apply to the management catchments in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

Further details of the management catchments can be found on the [Catchment Data Explorer](#) as well as within the [Humber River Basin Management Plan: updated 2022](#).

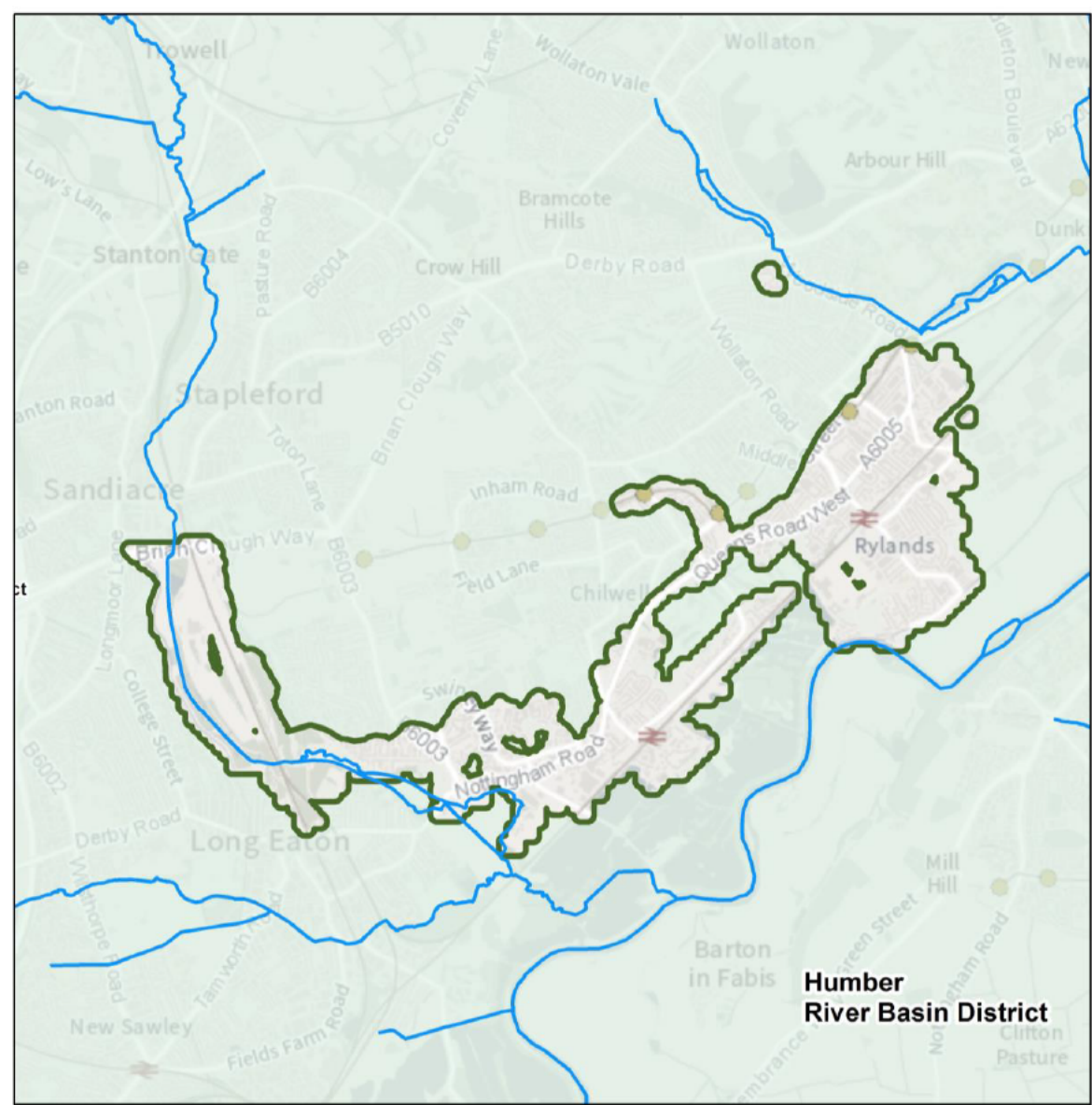
Flood Risk Area level objectives and measures

There are 149 measures applicable to managing flood risk in the nationally identified FRAs in the Humber RBD. The full list of FRAs in the Humber RBD can be found in the Introduction of this Plan. More information on how FRAs were identified can be found in the '[Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans](#)'. The FRAs are described below.

Within the FRA boundaries there may be included locations that are not connected to the main FRA. There may be also locations of 'dry islands', which are shown to be outside of the FRA. The reason for these seemingly anomalous areas relates to the methodology used to identify the FRA boundaries, which is detailed in Part A of the FRMP report. It is important to note, however, that measures included for the FRA, particularly any that may be associated with flood warning and evacuation procedures, are likely to apply to the whole FRA and will not be limited to the area shown in the FRA boundaries.

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.

The Beeston (Broxtowe) Rivers and Sea Flood Risk Area



Flood Risk Area: Beeston (Broxtowe), Humber



- Main Rivers
- Flood Risk Area: Rivers and Sea
- River Basin Districts

0 1 2 3 Kilometres

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Figure 7: A map showing the boundary of the Beeston (Broxtowe) Flood Risk Area

Introduction to the Beeston (Broxtowe) Flood Risk Area

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

The Environment Agency is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this Flood Risk Area (FRA).

The Lead Local Flood Authority (LLFA) Nottingham County Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The Beeston (Broxtowe) FRA covers the Beeston and Broxtowe area and extends into areas including:

- Chilwell
- Toton
- Attenborough
- Beeston Rylands

The area is characterised by a compact town centre surrounded by residential suburbs, businesses and amenity areas with the River Trent (main river) skirting the southern edge of the FRA.

Beeston is located on an area of low hills in the lower River Trent valley. The River Erewash flows southwards through the FRA and joins the River Trent via the Attenborough Nature Reserve Gravel pits (a SSSI), to the South of the FRA.

Much of the city is built on Triassic sandstones and mudstones which are relatively permeable. The Trent valley is floodplain alluvium, and gravel extraction activities in the FRA is common.

As mentioned, the Attenborough Nature reserve Site of Special Scientific Interest (SSSI), is located within Beeston (Broxtowe) FRA.

In addition, there are various Local Wildlife Reserves and sites such as:

- Toton Fields
- Toton Sidings
- Nottingham Road Carr
- Chilwell Manor Golf Club

There are also several Scheduled Ancient Monuments and listed buildings.

Flooding from rivers can occur as a result of the channel capacity being exceeded, a blockage occurring, or as a result of surcharge from culverted sections. There are extensive flood protection assets maintained by the Environment Agency in the FRA, which include raised defences and outfalls.

The Beeston and The Erewash Canals are owned and maintained by the Canal & River Trust. The Beeston Canal runs from Beeston through Nottingham and joins the River Trent at Meadow Lane lock. The Erewash Canal starts at the Langley Mill basin, runs southwards adjacent to the River Erewash and joins the River Trent at Trent Lock.

Beeston is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Beeston has grown. Severn Trent Water has a hydraulic model of the sewerage system and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken schemes to increase the capacity of the sewers in Beeston to reduce the risk of sewer flooding.

Current flood risk

Beeston (Broxtowe) is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but potentially could increase flood risk from another source.

The [flood hazard and risk maps](#) show that in the Beeston (Broxtowe) (Rivers and Sea) FRA there are approximately 16,855 people living in areas at risk of flooding from rivers. Of these, 2.3% are in areas of high-risk.

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

- 526 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 0.56 km of roads
- 7.4 km of railway lines
- 24 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency maintains flood risk management assets, for example river channels, flood defence walls or embankments, throughout the FRA. These include Beeston Weir, raised defences which form part of the Nottingham Left Bank flood risk

management scheme. In addition, assets along the River Erewash include flood banks in the Toton Fields area, which provide flood protection for parts of Sandiacre and Long Eaton.

Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Canal & River Trust maintains the Beeston and Erewash Canals as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Nottinghamshire Local Resilience Forum (Nottinghamshire LRF) is a multi-agency partnership made of representatives from: local public services, the emergency services, local authorities, the NHS, the Environment Agency and others. Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Trent and the River Erewash.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Trent and River Erewash, along with their 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

The Nottingham Left Bank flood risk management scheme was completed in 2012. The £45 million scheme reduces the risk of flooding to 16,200 homes and businesses along a 27 kilometre stretch of the River Trent, from Sawley to Colwick, which includes the Beeston (Broxtowe) FRA. It also provides additional protection to key infrastructure at the heart of the communities along the Trent.

The impact of climate change and future flood risk

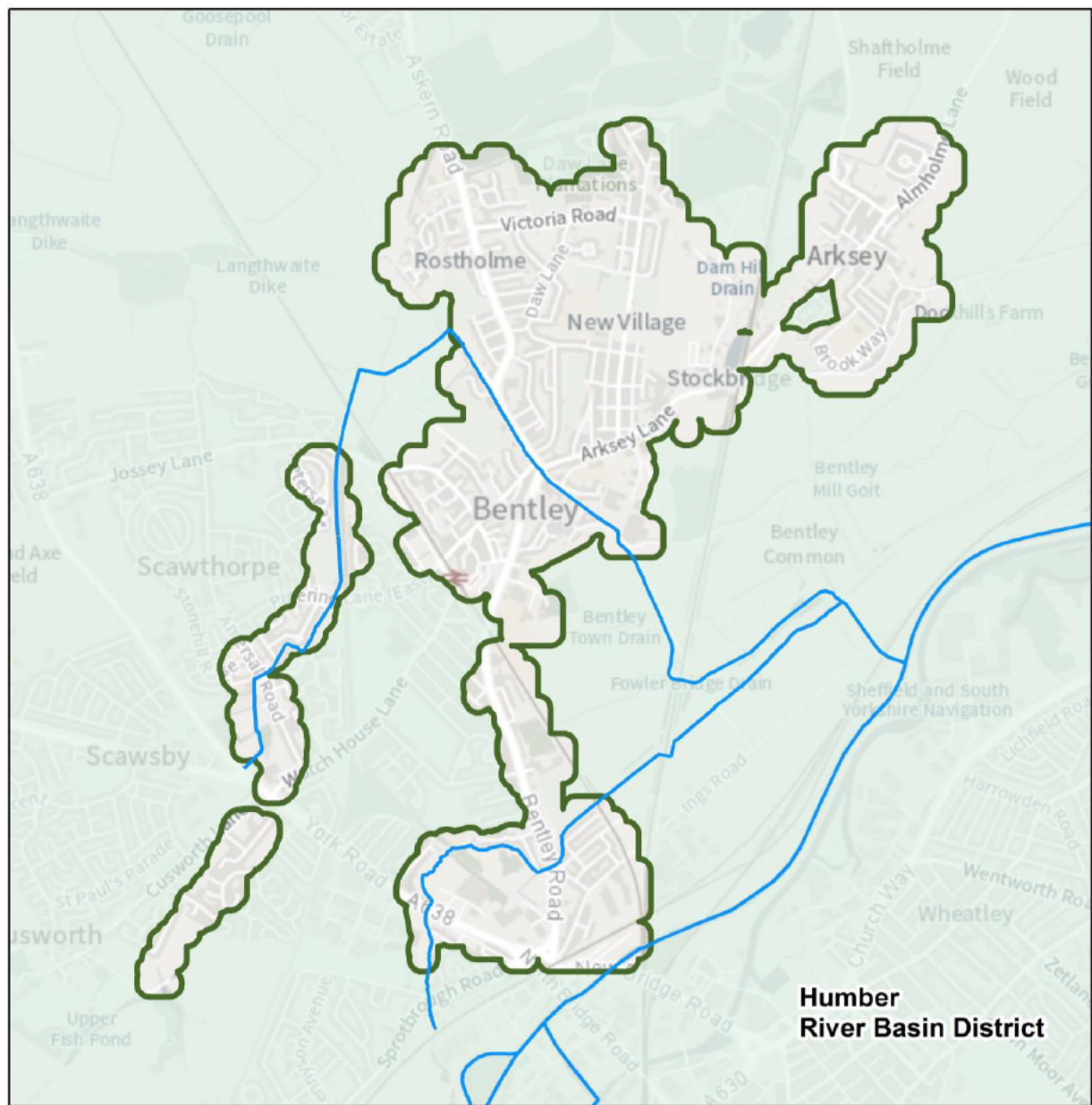
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Beeston (Broxtowe) (Rivers and Sea) FRA

Measures have been developed which apply specifically to the Beeston (Broxtowe) (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Beeston (Broxtowe) (Rivers and Sea) FRA. You can find information about all the measures which apply to the Beeston (Broxtowe) (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Bentley Rivers and Sea Flood Risk Area



Flood Risk Area: Bentley, Humber

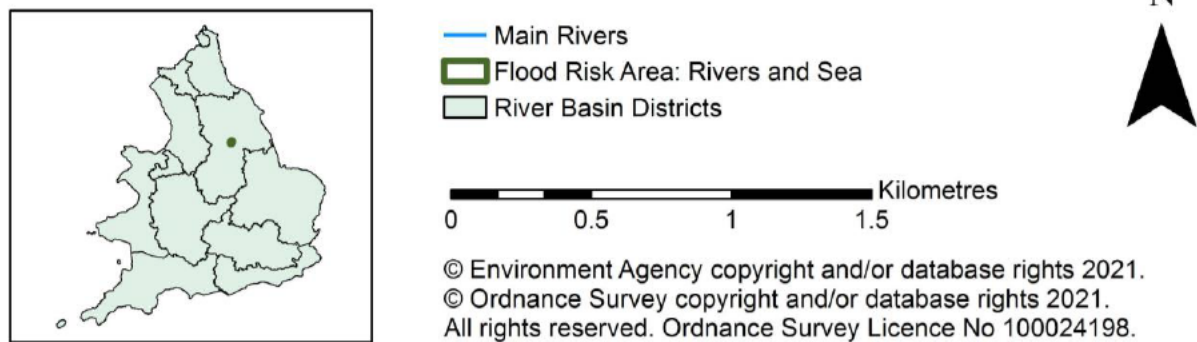


Figure 8: A map showing the boundary of Bentley Flood Risk Area

Introduction to the Bentley Flood Risk Area

The Bentley Rivers and Sea 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 FRMP for this FRA.

Doncaster Council are the Lead Local Flood Authority whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Bentley FRA covers some businesses and residential properties that are within the immediate area of the River Don as well as some of the dykes and drains in the surrounding area of the town.

Much of the Bentley FRA lies on a bedrock of gravelly sandstone with some calcareous mudstone. This is overlaid by river terrace deposits and Hemingbrough glaciolacustrine formation. The predominant soil is classified as slowly permeable, seasonally waterlogged, fine loamy, and fine loamy over clayey, and clayey soils. There are also a few areas of the FRA with stoneless clayey and fine loamy over clayey soils and other areas with stoneless clayey fine silty, and fine loamy soils affected by groundwater.

The FRA is a mix of urban and agricultural land and includes wildlife sites such as:

- Arksey Pond
- Moat Hill
- Daw Lane Plantation

There are also several listed buildings, particularly around Arksey and Moat Hill has both a scheduled ancient monument and been designated as a heritage at risk site.

Bentley was originally a village 2km north of the River Don, however through the early 20th century residential development expanded south and west of the village along the Bentley Road corridor and north along the A19 road. Following further urbanisation Bentley village became a suburb of Doncaster, situated on the left bank of the River Don. Today, the majority of Bentley is designated as Flood Zone 3 on the [Environment Agency Flood Map for Planning](#) which limits future urban development in the area.

The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Don and the Ea Beck.

Due to the underlying geology, Doncaster's 2015 Strategic Flood Risk Assessment designated the Bentley FRA as having a 0-50% chance of groundwater flooding. If impacted, groundwater flooding would be widespread, affecting large areas of low-lying land and would be closely related to the River Don and Ea Beck baseflow.

Yorkshire water pumping stations and Bentley Ings pumping station are fundamental to the sewer systems in Bentley. If these fail, it could cause sewer flooding to the FRA. Due to the impact of subsidence from historic coal mining, the Coal Authority contributed to the refurbishment costs and continue to contribute to the ongoing running costs of the pumping station.

Current flood risk

Bentley has suffered from several significant flood events over the years, including 1932 and 1947 from the main river overtopping the defences and 2007 which caused widespread flooding across the area.

Most recently, Bentley experienced severe flooding in November 2019, due to persistent heavy weather causing overtopping of the riverbanks of the River Don at several locations and overtopping from Ea Beck at Norwood Spillway. The flow gauge on the River Don at nearby Doncaster recorded a peak level of 6.31m and peak flow of 395 m³/s the highest record in 43 years. This caused 356 properties to have flooded in Bentley.

The [flood hazard and risk maps](#) show that in the Bentley (Rivers and Sea) FRA there are approximately 10,966 people living in areas at risk of flooding from rivers. Of these, 201 are in the high-risk category. Additionally, within the FRA there are:

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

- 387 non-residential properties
- 3.87km of road
- 2.44km of railway
- 45.61ha of agricultural land, and
- areas of scheduled monuments, parks and gardens, listed buildings and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Bentley FRA.

Based on this information, Risk Management Areas (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 Risk Management Authorities (RMAs) and other stakeholders for example Doncaster Council, Yorkshire Water and Danvm Drainage Commissioners.

Traditionally as defences have been overtopped in the area, they have been raised to provide further protection to the community. There is now a heavily managed system of defences in the area.

The gauging stations (Doncaster, River flow – continuous, Site ID: F0908) just upstream of New Bridge Road and (Bentley Ings Screen, Surface water level (including tide and lake level) – continuous, Site ID: L0962) provide information for Bentley flood alerts & warnings even though they are outside of the FRA.

There is also an effluent monitoring site for Bentley Sewage treatment works within the FRA, and river flow and level monitoring nearby at Doncaster and Bentley Ings pumping station.

The Bentley FRA is covered by the lower River Don catchment Flood Alert. There are 7 fluvial flood warnings that cover the FRA: 2 flood warnings for Ea Beck, 1 flood warning for North Swaith Dyke and 4 flood warnings for the River Don.

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. Since the devastating 2019 flooding across South Yorkshire, organisations have been working together to respond to the flood risk and climate emergency in South Yorkshire on a regional scale.

The South Yorkshire Catchment Plan is a vital part of this work. The plan brings key partners and priorities together to build a climate resilient region, to strengthen our capacity to act together over the long term and to provide a compelling programme for investors.

The plan will provide a strong, regional level ambition that benefits the communities of South Yorkshire and will set out how we tackle the causes of flooding, not just the symptoms. The plan is a chance to do things differently and become a national example of innovation and excellence.

We are also reviewing options for large nature-based solutions in the lower catchment, as discussed above, to help build climate resilience and make more space for water. We have an official investment request on our medium-term plan of £40million pounds for Source to Sea – nature-based solutions programme. This programme will still need external funding, but this signifies our ambition and our commitment to respond to the climate and nature emergency in South Yorkshire.

The impact of climate change and future flood risk

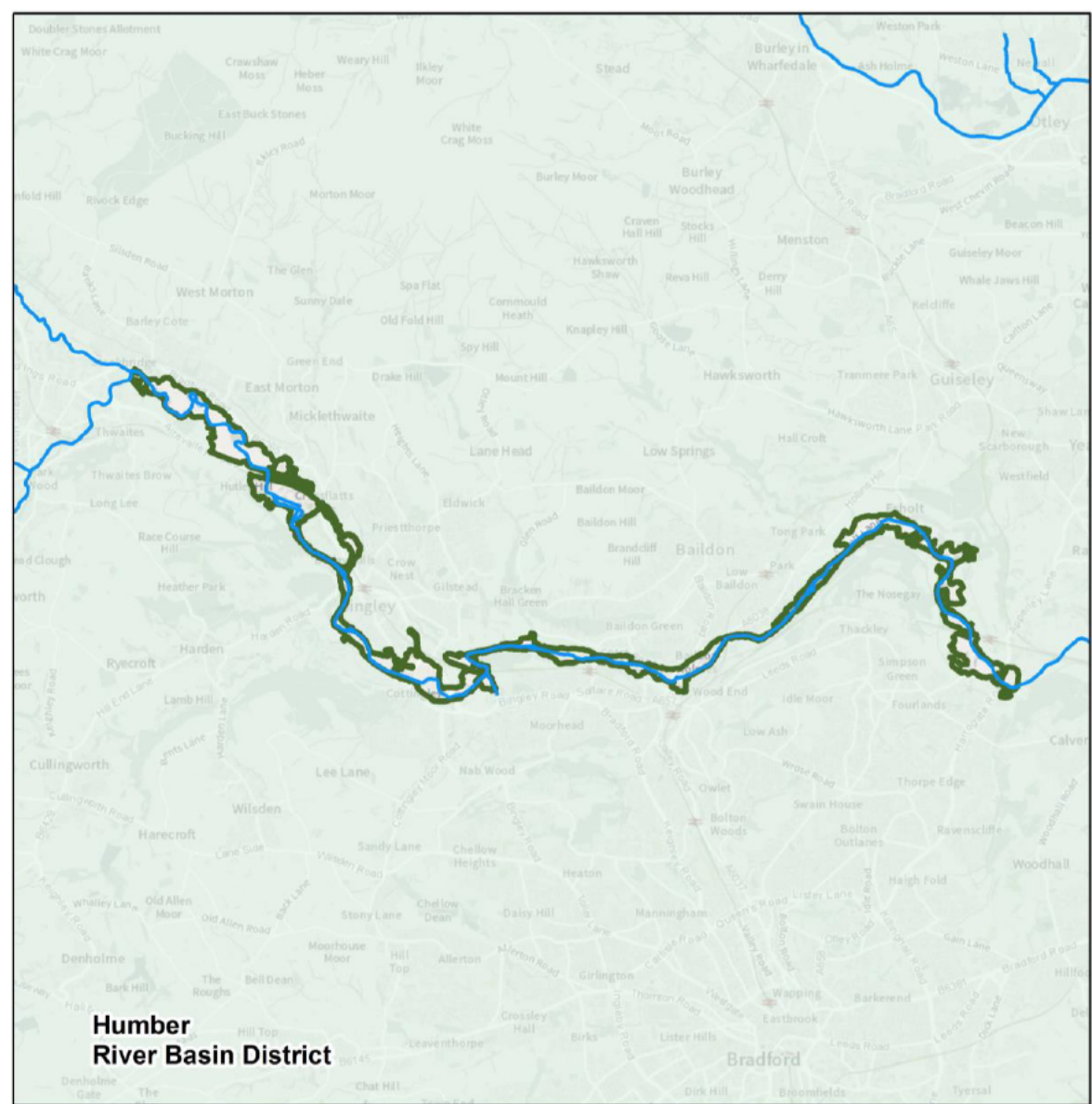
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Bentley FRA

Measures have been developed which apply specifically to the Bentley FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Bentley FRA. You can find information about all the measures which apply to the Bentley FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Bingley, Shipley and Baildon Rivers and Sea Flood Risk Area



Flood Risk Area: Bingley, Shipley and Baildon, Humber

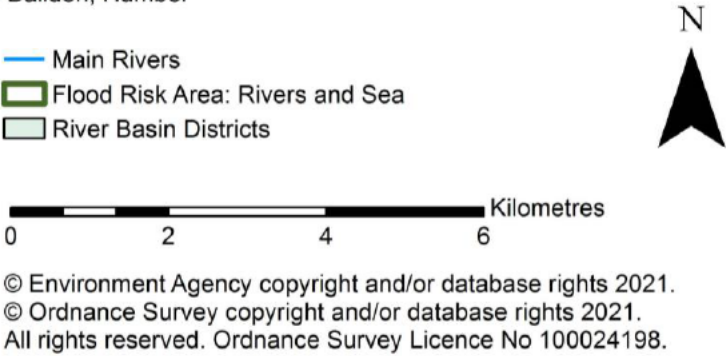


Figure 9: A map showing the boundary of Bingley, Shipley and Baildon Flood Risk Area

Introduction to the Bingley, Shipley and Baildon Flood Risk Area

The Bingley, Shipley and Baildon 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 FRMP for this FRA.

City of Bradford Metropolitan District Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The FRA covers businesses and residential properties that are within the immediate area of the River Aire and its tributaries in the FRA.

The Leeds and Liverpool canal lies within the FRA and is owned and maintained by the Canal & River Trust.

The predominant soil type for this area is seasonally wet deep loam. The properties of this soil type are slowly permeable, seasonally waterlogged, fine loamy over clayey, and clayey soils.

The Leeds to Liverpool Canal Site of Special Scientific Interest (SSSI) is located within the Bingley, Shipley and Baildon FRA. The Trench Meadows SSSI and Bingley South Bog are also in the vicinity. In addition to this, there are several Registered Parks, Ancient Woodlands, Listed Buildings, Scheduled Monuments and World Heritage Site within this area.

Parts of Bingley Town have been designated a Conservation Area. This is one of two conservation areas within the Bingley, Shipley and Baildon FRA, the other relating to the Leeds-Liverpool Canal.

Current flood risk

Several areas located in the Bingley, Shipley and Baildon FRA have suffered from flooding, including in December 2015 and February 2020.

The Bingley, Shipley and Baildon FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Aire. There can also be flood risk from the smaller rivers and becks, such as Nab Wood Beck, Cottingley Beck and Barnsley Beck.

The [flood hazard and risk maps](#) show that in the Bingley, Shipley and Baildon (Rivers and Sea) FRA there are approximately 1,009 people living in areas at risk of flooding from rivers and 450 are in the high-risk category.

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

- 162 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 0.89 km of roads including parts of the trunk road network
- 0.67 km of railway
- 94.77 ha of agricultural land
- Areas of environmental designated sites, listed buildings, parks and gardens and water abstraction points

Flood risk to the community can also come from surface water, drainage inundation and ordinary watercourse breaches.

Some areas in the Bingley, Shipley and Baildon FRA lie towards the base of a steeply sloping quick responding catchment that includes a range of land uses such as moorland, farmland and urban areas.

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Bingley, Shipley and Baildon FRA.

Based on this information Risk Management Areas (RMAs) have concluded that it is concluded that further steps should be taken to reduce the likelihood of flooding and the impact it can have on people, the economy and the environment both for now and the future.

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 Risk Management Authorities (RMAs) and other stakeholders, for example City of Bradford Metropolitan District Council, Yorkshire Water, Airedale IDB, Network Rail and the Aire Rivers Trust. There are several local community and volunteer groups who have an interest in the flood risk of the area and help provide additional support when required. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

Regular meetings are held between the Environment Agency and City of Bradford Metropolitan District Council regarding incident management, ongoing capital projects and future projects and investment. Recognising the need for a long-term strategic approach to managing flood risk across the Bradford district, Bradford Council have worked with the Environment Agency to establish a Bradford Flood Programme Board. The Boards aim is to focus on identifying and delivering cost-beneficial solutions for those communities at risk of frequent flooding within the district.

Much of the FRA is covered by the Middle River Aire catchment flood alert. There are seven flood warning areas within the FRA, with a proportion of these being issued frequently to a relatively small number of properties and other being reserved for more extreme flooding that would affect a larger number of homes and businesses.

The Environment Agency monitor river conditions at several sites in and surrounding the FRA, including river flow hydrometric monitoring sites at Bingley and Shipley.

Rain gauges are installed at Graincliffe Reservoir and Keighley (Marley) sewage works.

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

Water level and flow information is used to inform and calibrate mathematical modelling of the river network. The Bradford Aire Catchment Flood Alleviation Scheme (FAS) model covers the river Aire from the edge of Bradford Council boundary upstream of the FRA to the boundary downstream where Bradford borders Leeds. The model was updated in 2019 to account for data collected in the floods of the winter of 2015-16 and to inform the Bradford Aire Catchment FAS. Smaller watercourses in Bradford have also been modelled, but some of these models are simpler in nature and may use older modelling methods.

Since 2015 the Environment Agency has been working closely with City of Bradford Metropolitan District Council to create an extensive programme of works addressing the flood risk and the challenges of climate change, to reduce flood risk including in places that are currently undefended in and around the Bingley, Shipley and Baildon FRA.

Following the 2015 flood event, the Environment Agency and City of Bradford Metropolitan District Council assessed the viability of flood risk management projects at several locations affected by flooding. Of these Initial Assessments (IAs), 15 were completed throughout the Bradford District with 12 focusing on the River Aire in Bradford, which falls within the Bingley, Shipley and Baildon FRA.

The 12 IAs on the River Aire were the basis for the development of a strategic outline case called the Bradford Aire Catchment Flood Alleviation Scheme (FAS). This looked to provide a more detailed understanding of the costs, benefits and viability of flood risk management options for key locations along the River Aire throughout the Bradford District, including Bingley and the Baildon / Shipley area. The project looked at several options to reduce the risk of flooding including a catchment approach (for example, upstream storage) and linear defences (direct interventions such as flood walls and embankments), or a combination of the two.

The conclusion of the report is that only linear defences are viable. The report makes clear that the benefits of a catchment approach such as upstream storage are significantly

outweighed by the costs of construction, which are prohibitive. Upstream storage would only provide a minimal reduction in levels for the different locations at risk on the River Aire in the Bradford district. Linear defences would therefore still be required at the locations at risk, with only a minimal impact on the heights required.

Whilst linear defences are technically viable, the cost-benefit analysis shows that the cost of the linear defences are high when compared to the benefits they would provide. Before a flood risk management project is progressed, more work is required to try and reduce this gap (projects must demonstrate they are economically viable, (for example, have a cost-benefit ratio of at least 1, before progressing).

The projects also requires significant partnership funding to meet the full costs.

Without a significant improvement in the cost-benefit ratio of the projects, and significant external funding, the Bradford Aire Catchment FAS cannot progress further.

The Environment Agency and City of Bradford Metropolitan District Council remain committed to finding alternative solutions and funding sources for the Aire in Bradford. We are working together to assess options which will provide a lower level of protection but may be more economically viable. We are seeking innovative solutions and working with partners on other projects in the catchment which may also provide an opportunity to reduce flood risk.

The impact of climate change and future flood risk

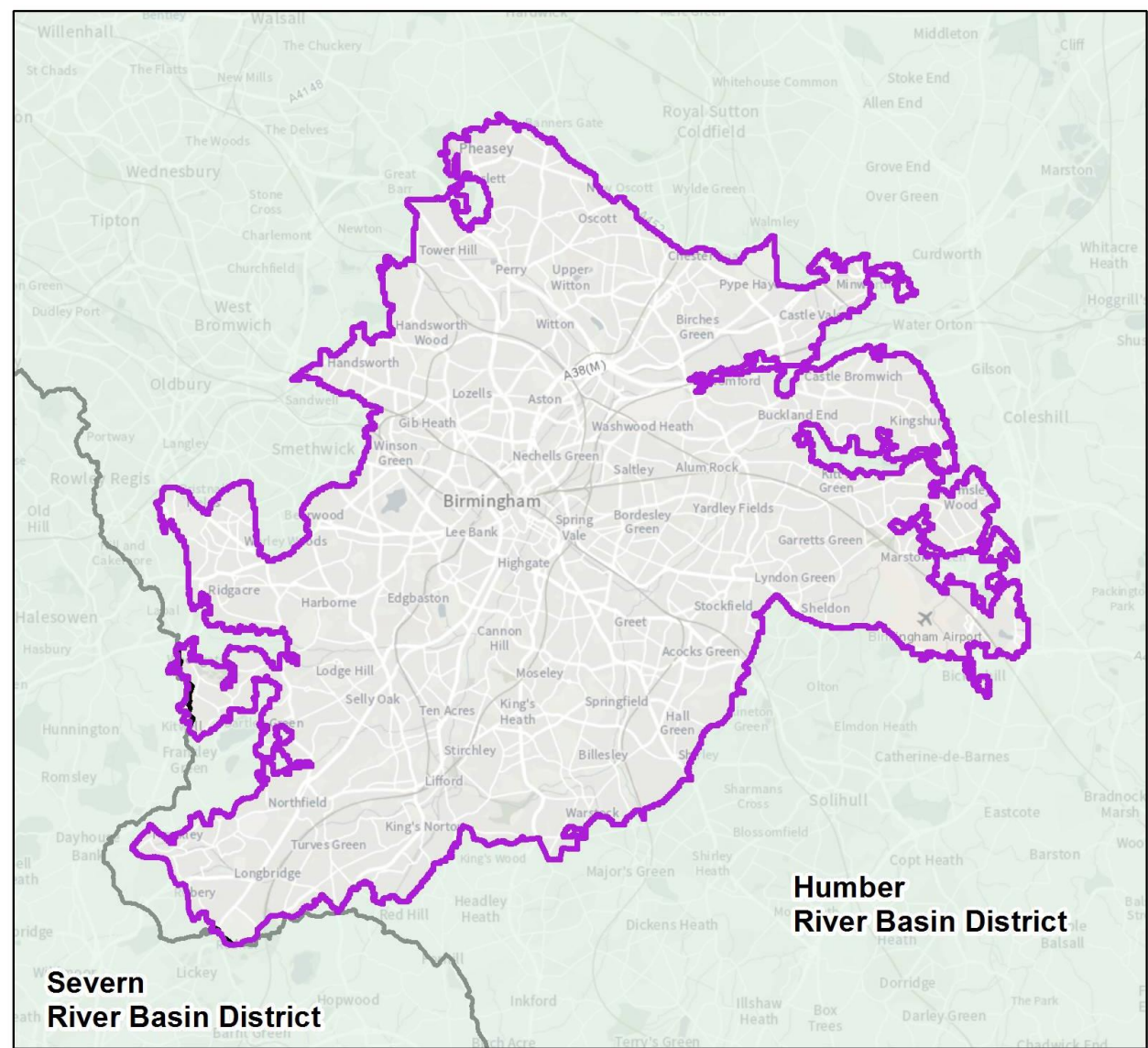
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Bingley, Shipley and Baildon FRA

Measures have been developed which apply specifically to the FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Bingley, Shipley and Baildon FRA. You can find information about all the measures which apply to the Bingley, Shipley and Baildon FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Birmingham Surface Water Flood Risk Area



Flood Risk Area: Birmingham, Humber

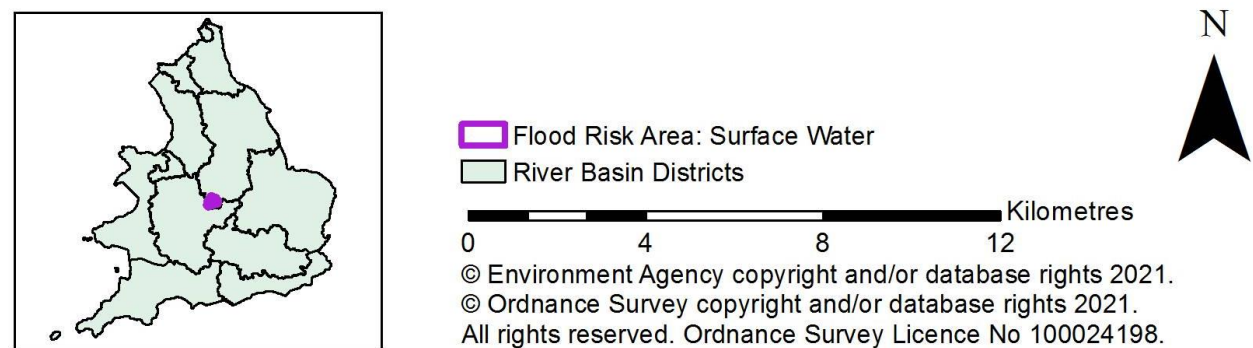


Figure 10: Map showing boundary of Birmingham Flood Surface Water Risk Area

Introduction to the Flood Risk Area

The Birmingham Surface Water 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).

The following Lead Local Flood Authorities (LLFAs) have led on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA:

- Birmingham City Council
- Solihull Metropolitan Borough Council
- Dudley Metropolitan Borough Council
- Sandwell Metropolitan Borough Council
- Walsall Metropolitan Borough Council

They are the LLFAs responsible for managing flood risk from 'local' sources in the FRA. These local sources of flooding are surface water, groundwater and ordinary watercourses.

The Environment Agency's remit covers 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 FRA.

The Birmingham Surface Water FRA is a largely heavily urbanised area covering over a million people.

It is dominated by the City of Birmingham and covers parts of:

- Solihull Metropolitan Borough area
- Dudley Metropolitan Borough area
- Sandwell Metropolitan Borough area
- Walsall Metropolitan Borough area

The river system in the FRA largely falls within the River Tame catchment, including its tributaries the River Rea and River Cole.

Located in the FRA are:

- the Edgbaston Pool Site of Special Scientific Interest
- several nature conservation areas
- Scheduled Ancient Monuments – such as the Roman fort at Metchley, Weoley Castle and several moated sites
- approximately 1400 listed buildings
- 270 ha of registered parks and gardens

Large parts of the FRA are characterised by a long history of development and industrialisation. Many of the local rivers and brooks have been heavily modified. Several canals are located in the FRA, and the whole Birmingham Canal Navigations system

converges in the city centre at Gas Street Basin. These canals were built to transport coal, iron and other heavy goods. Groundwater has been extracted historically for industry and commerce; this has reduced significantly over the last 40 years with the decline in manufacturing.

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.

Surface water flooding in the FRA occurs due to natural and artificial influences. Quite a high percentage of the rain that falls in the upper Tame catchment runs off it because drainage is impeded by the overlying loamy clay soil. Water flows overland entering built up areas. Heavy rain also ponds or flows off impermeable 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.

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 sewers.

There are 16 main rivers in the FRA and numerous ordinary watercourses including unnamed streams and ditches. Many of these rivers and streams are susceptible to flooding. The fast run-off from the upper catchments and run-off entering the watercourses from the urban areas means there is a rapid response to heavy rainfall.

Historically flooding has been caused by channels not being able to take the high volumes of water and by blocked culverts. Siltation and blockage of key structures is a significant issue across several watercourses, with low energy summer flows and consistent fly tipping across the FRA proving detrimental. Various communities are at risk of flooding from watercourses in the FRA. Selly Park and Sparkhill have been identified as Flood Risk Areas where the flood risk from rivers is considered nationally significant. Further information on these Flood Risk Areas can be seen in [The Selly Park Rivers and Sea Flood Risk Area](#) and [The Sparkhill Rivers and Sea Flood Risk Area](#) sections of this document.

There is the potential for overtopping of canals as a result of high inflows exceeding the canal capacity during storm events.

Groundwater has become a re-emerging issue in the FRA. Groundwater levels have been rising back to natural water table levels. This is due to the cessation of pumping from wells, and abstractions not being as frequent as they once were.

The FRA is also at risk of flooding from reservoirs within and outside of the FRA.

Current surface water flood risk

Most recently, flash flooding affected properties across the FRA in 3 events in June 2016. In May 2018, intense, localised thunderstorms over the Birmingham conurbation caused surface water and fluvial flooding to 700 properties across:

- Birmingham
- Solihull
- Walsall
- Worcestershire

In June 2021, flash surface water flooding affected more than 200 properties in Solihull and caused significant highway flooding.

The [flood hazard and risk maps](#) show that in the FRA 90,731 people live in areas at risk of flooding from surface water. Of these, 5% live in areas of high risk.

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

- 6,239 non-residential properties, including 301 services
- 46.9 km of A roads
- 41.07 km of railway
- Birmingham Airport
- 157.89 ha of agricultural land*
- 9.49 ha Sites of Special Scientific Interest
- 2.63 ha Scheduled Ancient Monuments
- 64 listed buildings
- 42.95 ha of registered parks and gardens
- 30 Environmental Permitting Regulatory Sites
- 25 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 the 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. This includes the setting up of groups that manage flood risk at a strategic and operational level.

Relevant strategies for the FRA include:

- LLFA Local Flood Risk Management Strategies
- Surface Water Management Plans for Birmingham and Solihull
- Strategic Flood Risk Assessments

There are also multi-agency flood plans that cover the FRA. These specifically outline how multi-agency partners will work together 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, river flows and levels and provides a flood warning service for river flooding. There are 3 flood alert and 25 flood warning areas in the FRA. The river flood alerts issued take into consideration thunderstorms and the potential for surface water impacts.

Mapping exists that indicates areas at risk of surface water flooding in the FRA. This comprises local information developed for some parts of Birmingham as part of the [Surface Water Management Plan](#). 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 LLFAs in the FRA manage 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.

LLFAs across the FRA have a consenting and enforcing role in respect of watercourses. The responsibility for maintenance of watercourses lies with the riparian owners. Birmingham City Council clears high-risk grills and culverts that have a major impact on flood risk. Highway drainage is maintained by the Highway Authority.

The Environment Agency uses its permissive powers to operate and maintain flood risk management assets at several locations on the main rivers in the FRA. These include:

- flood storage areas
- raised defences
- a floodgate
- trash screens

Severn Trent Water has a maintenance programme in place for public sewers.

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 since 2015 to manage flood risk in the FRA include:

- the [Birmingham Development Plan](#) (2017) - contains a new suite of planning policies that include measures to help mitigate the impacts of extreme weather and climate change
- the [Rea Valley urban Quarter supplementary planning document](#) - adopted in 2020
- property flood resilience measures for properties noted to be at significant risk in some areas across the FRA
- Flood risk management schemes at Selly Park (North and South) - these are described in [The Selly Park Rivers and Sea Flood Risk Area](#) section of this document
- the Perry Barr and Witton flood risk management scheme - under construction at time of writing (2021) to better protect approximately 1,400 properties
- the Bromford and Castle Vale flood risk management scheme - under construction at time of writing (2021) to better protect more than 900 properties
- sewer flooding schemes in Birmingham such as:
 - Cartland Road / Ripple Road scheme in Stirchley
 - Lodge Hill, Weoley Avenue sewer and surface water flood alleviation scheme – a joint scheme delivered by Severn Trent Water and Birmingham City Council

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 Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Birmingham FRA

Measures have been developed that apply specifically to the Birmingham FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Birmingham FRA. You can find information about all the measures that apply to the Birmingham FRA in the '[Flood Plan Explorer](#)', an interactive

mapping tool. This includes information on which national objectives each measure helps to achieve.

The Brigg Rivers and the Sea Flood Risk Area

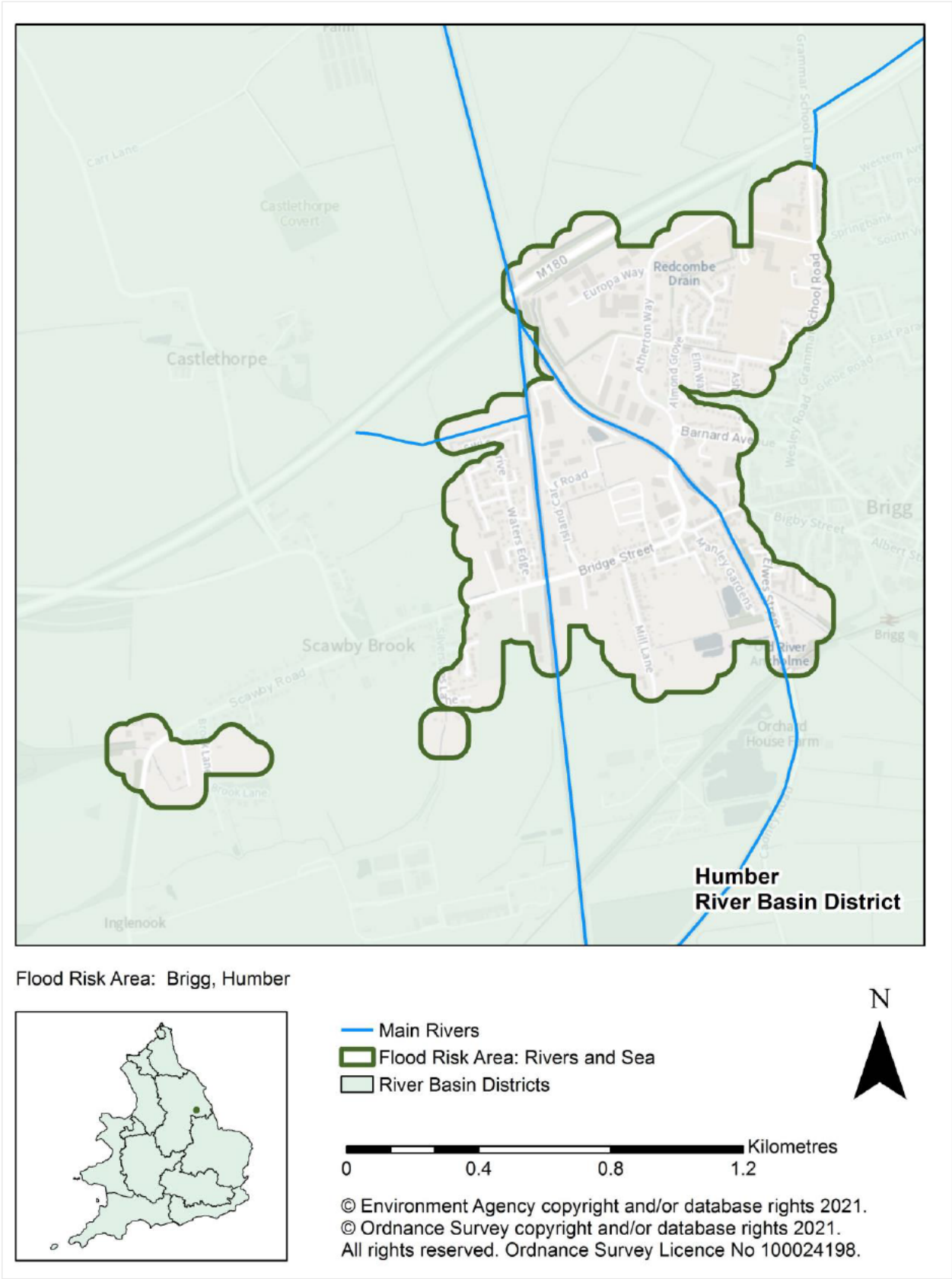


Figure 11: A map showing the boundary of Brigg Flood Risk Area

Introduction to the Brigg Flood Risk Area

The Brigg Rivers and Sea 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 FRMP for this FRA. North Lincolnshire Council are the Lead Local Flood Authority (LLFA) responsible for managing flood risk from 'local' sources. These local sources of flooding are:

- surface water
- groundwater
- ordinary watercourses

The Environment Agency's remit covers flood risk from rivers and the sea but have the strategic overview of all sources.

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

Ancholme Internal Drainage Board (IDB) is responsible for land drainage in this area.

The soil type is seasonally wet, deep clay with grade 2 and 3 agricultural land peripheral to the FRA.

There is a scheduled ancient monument 285m east of Castlethorpe House, which is listed as a moated site.

Brigg market town sits on a gravel spur of the Lincolnshire Wolds that juts out into the Ancholme valley, a tributary of the Humber. The Ancholme River runs south to north through its flat, low-lying flood plain.

Historically, this location provided a narrow crossing point of the river and its flood plain. Brigg town developed and its founding pre-dates its first mention in 1183.

The area surrounding the town was previously semi-flooded marsh. Drainage from the 1630's to 1820s transformed the whole of the valley into arable land. There are several clay ponds along the riverside in Brigg, where clay was formerly extracted for brick making.

The largest of the drainage channels is known as the New River Ancholme. This also served as a navigation route and was once an important transport and trade route to the Humber. Part of the original course of the river remains as a discontinuous length. It is known as the Old River Ancholme.

The town itself lies mainly on the east bank of the old river, with a small amount to the west. A portion of the west bank is cut off by the new river, forming an island-like piece of

land known as Island Carr. The town regularly suffers minor flooding, and flood plain development is an issue for local planning.

The Brigg FRA lies within the Ancholme operational catchment which includes the River Ancholme and its tributaries. The catchment is rural with agriculture being the main land use. As the river flows to the Humber Estuary, the land use changes, and industry dominates. The New River Ancholme still provides a navigable route to the Humber and has many other recreational uses.

The Ancholme catchment is designated as a drinking water protected area. This safeguards the drinking water supply at Cadney Reservoir.

The Brigg FRA covers the west of the town where the main rivers include the:

- Old River Ancholme
- New Ancholme
- Spring Dyke
- Redcombe Drain

Wrawby Catchwater lies to the northeast and ends at the periphery of the FRA. Scawby Brook is an Ordinary Watercourse of significance in this FRA.

The predominant flood source within the FRA is fluvial, although tidal risk is also significant given the low-lying nature of the catchment.

Current flood risk

Brigg has experienced significant flood incidents in:

- November 2019 - both the Old River Ancholme and the River Ancholme overtopped the defences
- November 2019 - the Scawby Brook channel capacity was exceeded

The [flood hazard and risk maps](#) show that in the Brigg (Rivers and Sea) FRA there are approximately 1,268 people living in areas at risk of flooding from rivers. Of these 82% are in areas of high risk.

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

- 113 non-residential properties including the Brigg Sewage Treatment Works
- 0.09km of roads - including parts of the M180 and A18
- 0.11km of railway
- 28.84ha of agricultural land

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Brigg 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 sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs). These include:

- Ancholme IDB
- North Lincolnshire Council
- Ancholme Catchment Partnership

The Environment Agency have the strategic overview of flood risk across the FRA. They provide the tactical management and operational delivery for the risk from rivers and the sea.

This is undertaken in collaboration with the North Lincolnshire Council as the LLFA and Ancholme IDB. Further support is given by Anglian Water who manage the sewerage network. The flood risk management investment is coordinated through the RFCC and more locally through a Strategic Flood Risk Board.

The fluvial flood risk to Brigg FRA is controlled by linear defences and through water level management upstream and downstream. The tidal flood risk along the southern Humber Estuary near South Ferriby is managed by:

- defences
- sluices
- outfalls

The land drainage water levels are managed by a series of pumping stations and associated drainage systems. The surface water flood risk uses a local network of open ditches and piped culverts. These discharge into the river or the land drainage system.

The Humber Local Resilience Forum (Humber LRF) is a multi-agency partnership made of representatives from local public services, such as:

- emergency services
- local authorities
- NHS
- Environment Agency

The LRF risk assessment working group produces a Community Risk Register for the Humber Sub-region. This provides a description of the risks and likelihood of them occurring. It also considers the impact they would have on the community and economy should they happen.

This assessment includes risks from flooding. The forum work in a multi-agency collaboration to manage flood incidents under the Civil Contingencies Act 2004.

The Environment Agency undertakes Hydrometric Monitoring at 2 locations within the FRA. This information is used to inform activities related to 3 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur. This data also informs the operational response during a flood incident.

Modelling and mapping of the Ancholme Catchment was carried out in 2009. This is currently being superseded by a new hydraulic model which is due to be completed in 2021. Improvements to the Humber Estuary flood risk modelling have been completed as part of the developing Humber 2100+ strategy.

Flood risk maps are published based on the outputs from 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 operates and maintains flood risk management assets on the main watercourses in the FRA. These largely consist of flood defence embankments and walls.

This work also includes routine inspection and clearance activities as well as regular repair, replacement and improvement of assets. Increasing this investment is focussed on increasing climate change resilience.

Flood risk improvement works that benefit the Brigg FRA completed recently by the Environment Agency include:

- new tidal defences at South Ferriby
- improvements to the tidal outfall at South Ferriby sluice
- erosion protection and repair works following the November 2019 incident

There are several schemes currently being developed to reduce the risk of flooding along the River Ancholme and Brigg. These are being promoted in collaboration by various agencies and are expected to involve a combination of:

- flood defence improvements
- temporary storage of excess flood water within the catchment
- local pumped and surface water drainage improvements

It is hoped that these will be constructed as part of the recently announced 2021 to 2027 government investment programme.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future which will cause river flows to increase.

As sea levels rise, it means that coastal flooding will become more frequent as higher water levels and storms will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber RBD.

Objectives and measures for the Brigg FRA

Measures have been developed which apply specifically to the Brigg FRA. These measures are in addition to measures covering a wider geographic area that also apply to the Brigg FRA.

You can find information about all the measures which apply to the Brigg FRA in the '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Brighouse Rivers and Sea Flood Risk Area

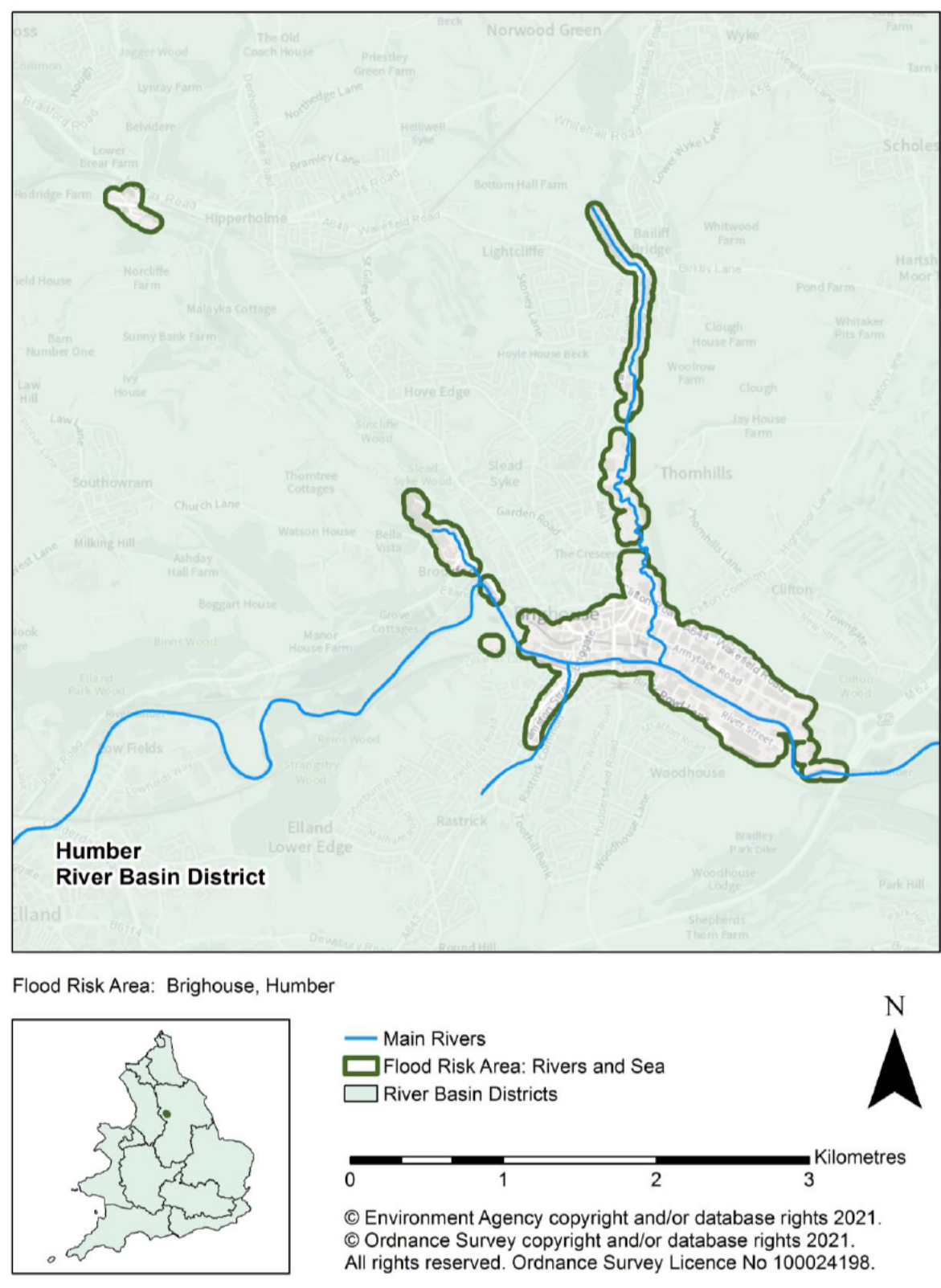


Figure 12: A map showing the boundary of Brighouse Flood Risk Area

Introduction to the Brighouse Flood Risk Area

The Brighouse Rivers and Sea 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 FRMP for this FRA.

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

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Brighouse FRA covers businesses and residential properties in the vicinity of the River Calder, Clifton Beck and Red Beck.

The Brighouse FRA lies on a mixture of mudstone, siltstone and sandstone bedrock with a mix of elland flags, greenmoor rock, grenoside sandstone and pennine lower coal measures formation. Much of the FRA also has an overlying superficial of alluvium. There are three predominant soil types within the Brighouse FRA:

- well drained coarse loamy soils over sandstone
- deep stoneless fine silty and clayey soils variably affected by groundwater
- slowly permeable seasonally waterlogged clayey fine loamy over clayey and fine silty soils

The Calder and Hebble Navigation that runs into the Brighouse FRA has been designated as a Local Wildlife site and there are several listed buildings mainly in the west of the FRA, around the Local Wildlife Site.

Brighouse is at risk from fluvial flooding from the River Calder and Clifton Beck and is also at risk from surface water flooding as a result of drainage systems not being able to discharge into the River Calder.

Flooding also comes from sewers, culverts and urban drainage infrastructure and the tributaries Clifton Beck and Red Beck may also cause flooding.

Current flood risk

Brighouse has a history of flooding. Businesses and the local community have been impacted by devastating flood incidents which have severely affected the local economy, most recently in 2012 and on Boxing Day 2015 and February 2020.

The flooding also adversely impacted local infrastructure, making the main route to the M62 and the roads to Elland, Huddersfield and Bradford impassable. Extensive parts of the flood defences along the River Calder throughout Brighouse were damaged. The

flooding in February 2020 caused a retaining wall between Phoenix Bridge and Clifton Road Bridge to collapse. Surface water flooding impacted on Brighouse town centre.

The [flood hazard and risk maps](#) show that in the Brighouse FRA some 595 people are in areas at risk of flooding from rivers of which 68% are in areas of high risk.

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

- 434 non-residential properties
- 0.17km of road
- 0.05km of railway
- 20.30ha of agricultural land
- areas of environmental permitting regulations, listed buildings and water abstractions and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Brighouse FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Calderdale Council and Yorkshire Water.

Following the devastating flooding experienced on Boxing Day 2015 the Calderdale Flood Recovery and Resilience Programme Board was set up which is led by Calderdale Council but includes all key partners such as the Environment Agency, Yorkshire Water, the Canal & River Trust, Network Rail, local councillors. The aim of the Board is to oversee the delivery of all the work contained in the Calderdale Flood Recovery and Resilience Programme, with its aim of reducing the risk of flooding within the borough of Calderdale and building the resilience of local communities to withstand the effects of any future flood events. Feeding into the board are four operational groups which include Flood Reduction and Investment, Natural Flood Management, Community Resilience and Resilient Infrastructure.

The Calderdale Flood Action Plan contains the actions that communities and partners feel are essential to help Calderdale recover from the floods and to improve resilience and reduce the risk of flooding over the next 20 years. The actions have been gathered through workshops, drop-in sessions and meetings held over summer 2016. Actions have been developed at a series of workshops with partners and the wider community and have been informed by local knowledge and specialist consultant modelling, use of existing data, and linking to strategic plans.

There are two continuous surface water level monitoring sites for the Brighouse FRA; one on Clifton Beck and one on the River Calder.

There is 1 flood alert and 3 flood warnings covering the River Calder within the Brighouse FRA.

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 for example river channels, flood defence walls or embankments throughout the FRA. At present, the Environment Agency own flood walls and embankments that line the River Calder that help protect Brighouse from flooding.

During the flooding in February 2020, the parapet between Phoenix Bridge and Clifton Road Bridge collapsed. This caused extensive flooding to the area. Phoenix Bridge was identified as a priority on the Environment Agency Asset Recovery Programme, and legato boxes were installed whilst a more permanent solution is developed.

The Environment Agency is working in partnership with Calderdale Metropolitan Borough Council (CMBC) to develop a Flood Alleviation Scheme (FAS) for Brighouse.

The primary strategic objective of the scheme is to significantly increase the capacity of the Brighouse community to cope with major floods. This will be achieved by reducing the risk of flooding to property and infrastructure as far as is practicable and affordable, whilst avoiding increases in flood risk elsewhere.

The project includes:

- extending operational life of assets along River Calder to a further 50 years
- replacing operational life expired assets along River Calder
- replacing temporary assets installed following December 2015 and February 2020 flood events
- installation of environmental focussed landscaping features in Wellholme Park to better use the park space as flood plain from Clifton Beck
- installation of environmental enhancements to Clifton Beck and upper catchment to aid slowing the flow and deliver wider environmental benefits

The main benefits of the scheme will be to reduce flood risk to 43 residential and 173 non-residential properties and to the highway network. Brighouse is on a crucial transport route for Calderdale linking the east of the borough to the motorway network via junction 25 of the M62.

Wider objectives include contributing to the economic regeneration of South Calderdale, which is centred on the town, and improving the local environment, making use of

partnership funding. Interventions within the Clifton Beck catchment that will slow the flow, increase biodiversity and sequester carbon are a significant component of the scheme.

Calderdale Council are developing a Town Investment Plan (TIP) for Brighouse, West Yorkshire. This plan is intended to drive forward inclusive, sustainable and resilient economic growth, and support recovery from COVID 19.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Brighouse FRA

Measures have been developed which apply specifically to the Brighouse FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Brighouse FRA. You can find information about all the measures which apply to the Brighouse FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Burton-upon-Trent Rivers and Sea Flood Risk Area

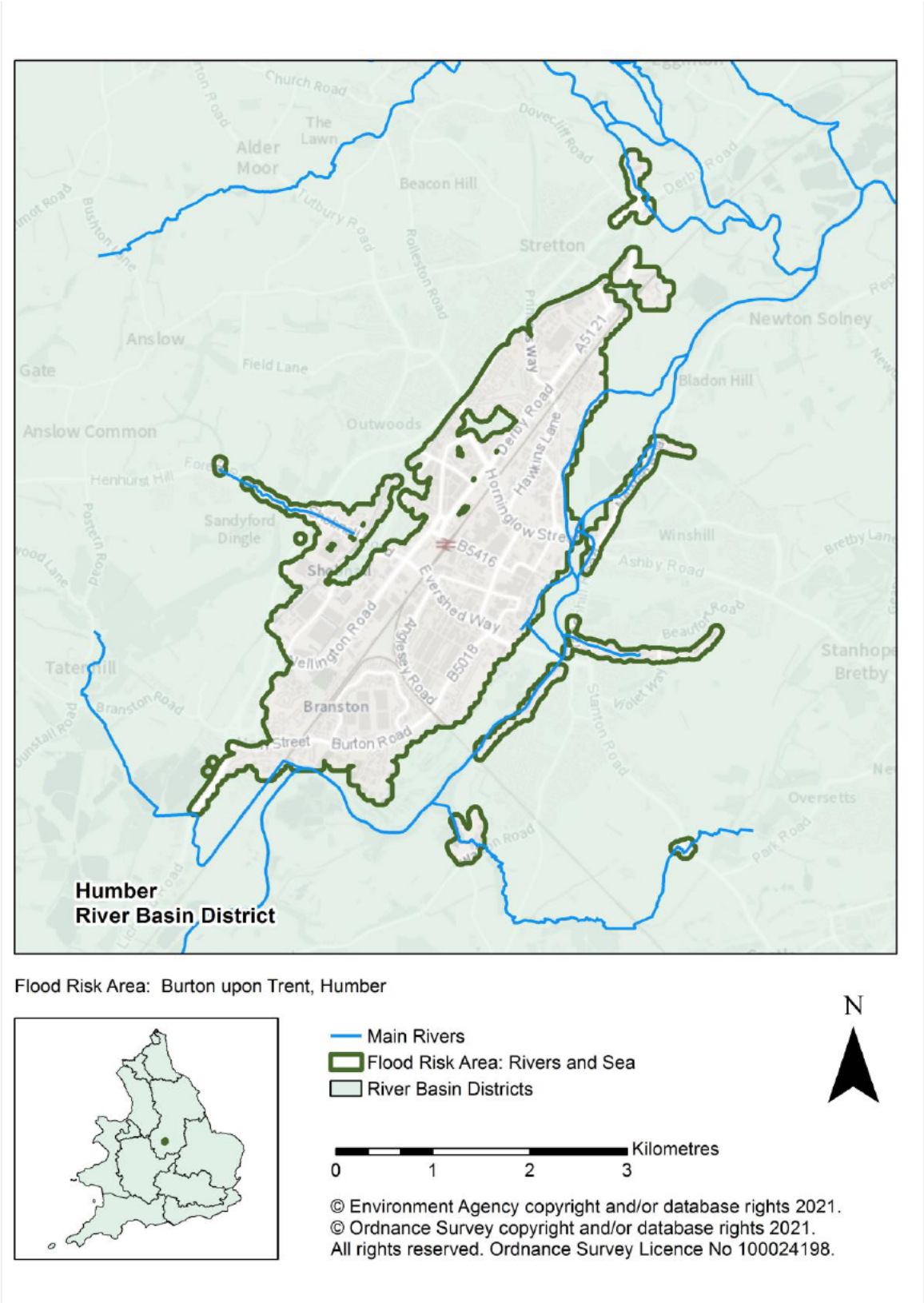


Figure 13: A map showing the boundary of Burton-upon-Trent Flood Risk Area

Introduction to the Burton-upon-Trent Flood Risk Area

The Burton-upon-Trent Rivers and Sea 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 takes the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Staffordshire 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.

Burton-upon-Trent is a large town in East Staffordshire located principally on the left (west) bank of the River Trent. The town has grown up around the brewing industry and over the last two hundred years there has been an expansion of urban development within the natural floodplain. Open green spaces of the River Trent Washlands adjoin the developed urban areas of the town. These provide a unique feature and valued recreation resource for residents.

The FRA is part of the National Forest.

Located in the FRA are:

- some ancient woodland
- all, or part of, 8 Local Wildlife Sites

Several designated heritage assets are in the FRA, including:

- listed buildings
- Burton Abbey – a Scheduled Ancient Monument

The main source of flood risk to the town is from the River Trent. This is the third longest river in the UK at 298 km. The river rises in the South Pennines on Biddulph Moor, north of Stoke on Trent and, by Burton-upon-Trent, drains a catchment of over 3000 km². Through Burton-upon-Trent the river carries extreme flows of approximately 470m³ /s in an event that has a 1% chance of occurring within any given year. There is a relatively slow response to rainfall and relatively low velocities of floodwater in the town. This is due to the low gradient along the main river and across the floodplain.

The FRA is also at flood risk from other main rivers:

- River Dove
- Tatenhill Brook
- Stapenhill Brook
- Stanton Brook
- Clay Mills Fleam

- Shobnall Brook (upstream of Horninglow Channel)

Flood risk management assets within Burton-upon-Trent include:

- flood walls and embankments
- operational assets including demountable defences and penstocks
- flapped outfalls and trash screens
- open channel and culverts
- a pumping station and flood storage area - owned and operated by the Local Authority

Additionally, some properties in the FRA have property flood resilience measures.

Assets include the 9.6km of flood walls and embankments that protect the west of the town from River Trent flooding. The area that benefits from these flood defences is located between Branston in the south and the Clay Mills Sewage Treatment works in the north. Without these defences the town would regularly experience flooding from the River Trent. A large area would be affected if the defences were breached or overtopped. The duration of the flood event could last several days.

The first formal flood defences protecting this area were constructed following a significant flood event in 1932. Some defences were raised, and several kilometres of new walls and embankments were constructed after thousands of properties were impacted by severe flooding in March 1947. The defences provided varying standards of protection. The Environment Agency has since carried out major improvement works to the defences, in two phases.

Phase 1 was completed in spring 2007. This involved the improving of around 5.5km of embankments and walls to extend their design lives, at a cost of approximately £6m.

Phase 2 was substantially completed in 2021. This involved the improving and raising of 3.6km of defences, and the upgrading of the pumping station. Approximately £25.6m has been invested in the phase 2 works, with funding from:

- Flood and Coastal Erosion Risk Management Grant in Aid
- the Greater Birmingham Local Enterprise Partnership
- Local Levy

During the construction of Phase 2, a serious flood event occurred that identified an additional related flood risk to Branston and the A38. This has now been incorporated into the scheme and further works are expected in 2021 and 2022.

In addition to providing protection from flooding, the Phase 2 works have delivered some enhancements to the public realm where they form part of, or are close to, the flood defences.

The town defences now provide protection against a River Trent flood with a 0.5% chance of occurring within any given year for:

- 4,246 homes
- 1,016 commercial and industrial premises - including the main shopping centre in Burton and several breweries
- the majority of the at-risk heritage assets
- much of the at-risk road and rail infrastructure

Additionally, a penstock owned and operated by the Environment Agency, prevents the River Trent backing up a small ordinary watercourse and flooding areas of Branston. To the east of the River Trent, there is an approximately 100m length embankment that provides a level of protection against flooding for the Winshill area.

The Shobnall Brook was diverted in the 1960s/1970s into a manmade concrete channel called the Horninglow Channel. This was constructed by East Staffordshire Borough Council to take the flow of the upstream Shobnall Brook around the outskirts of central Burton-upon-Trent and so alleviate flood risk in Burton from the Brook. The majority of the approximately 4km long Horninglow Channel is in the form of an open channel. It has the appearance of a watercourse but is currently classified as an open surface water sewer.

There is risk of ordinary watercourse, surface water and sewer flooding in the FRA. This flooding occurs due to:

- capacity of the drainage network being exceeded during heavy or intense rainfall – including
 - foul and combined sewers
 - surface water sewers
 - highway drains and gullies
 - culverted watercourses
 - privately owned drainage
 - pumping stations
- sewer misuse – risk of flooding from sewers due to the wrong things (such as fats, oils and un-flushable sanitary products) being discharged to sewers
- drainage systems backing up when unable to discharge to the River Trent when the river level is high

Pumping systems owned and operated by East Staffordshire Borough Council help to manage residual risk of water ponding in two locations when the River Trent level is high.

Staffordshire County Council and the Environment Agency have undertaken [awareness campaigns](#) to explain risks of flooding from all sources to residents.

During the period 2021 to 2027, Staffordshire County Council and the Environment Agency intend to produce a Surface Water Management Plan. This will update our understanding of flood risk and inform future local flood risk management.

There is also risk to parts of the FRA from reservoir inundation.

Current flood risk

Flooding from the River Trent has devastated the town on many occasions, with recorded events dating back to February 1795. The flood defences have protected much of the town from River Trent flooding, including in 2000 and during the very high-water levels in February 2020. The main areas where flooding occurs are on The Island off Burton Bridge and at Branston.

In February 2020, 18 properties and the A38 flooded in the area by Branston Water Park from:

- surcharging of the highways drainage system
- surcharging of the sewer drainage system
- overtopping of the Tatenhill Brook

300 properties in this area may be at risk in extreme flood events. The Environment Agency is progressing a scheme to reduce flood risk in this location.

The [flood hazard and risk maps](#) show that in the Burton-upon-Trent FRA 24,354 people live in areas at risk of flooding from rivers. Of these, 3.3% live in areas of high risk.

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

- 2,332 non-residential properties - including emergency services, education, health and transport services
- 9.24km of railway
- 10.56km of the major road network including the A5121, A511, A38, A5189, A444
- 105.94ha of agricultural land grade 2, 3 and 4*
- 123 listed buildings
- 1.15ha Scheduled Ancient Monuments (Burton Abbey)
- 5 Environmental Permitting Regulatory Sites
- 41 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.

With the defences in place, the number of properties, infrastructure and heritage assets at high to medium risk in Burton-upon-Trent is relatively small.

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Burton-upon-Trent 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 and maintain:

- the flood risk management scheme through the town
- the flood embankment at Winshill
- conveyance within the main river channels and culverts

Culverts and confined spaces are included in a CCTV inspection programme with frequency of inspections dependant on the level of risk. The results identify the need for localised desilting and asset repairs.

In addition to routine maintenance, unplanned intermittent maintenance may result:

- from inspections
- from reports from the public
- following flood events

Typical works include:

- access improvement
- repointing or re-profiling works
- embankment repairs
- vegetation management generally on the smaller channels - including tree trimming and in-channel vegetation management

During flood events demountable defences are deployed in the town centre, and asset performance and river conditions are monitored. Following flood events, inspection is undertaken of defences that have had water against them.

Discussions between the Environment Agency and Severn Trent Water are ongoing relating to the management of Shobnall Brook (Horninglow Channel).

The Environment Agency has a hydraulic model for the River Trent. 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 and water levels at Drakelow, within the FRA, and at Croxall on the Trent upstream of the FRA. It provides a free flood warning service for the area which, if acted upon, can reduce the impact of flooding. The Burton-upon-Trent FRA is covered by 1 Flood Alert Area and 3 Flood Warning Areas.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future. This will cause river flows to increase. It is likely that flood risk in the FRA will increase with more properties becoming at risk.

The defences through the town have been designed to protect against the flood with a chance of occurring of 0.5% in any given year. It is likely that, without capital intervention,

the standard of protection offered by the defences will be reduced over time due to the impact of climate change.

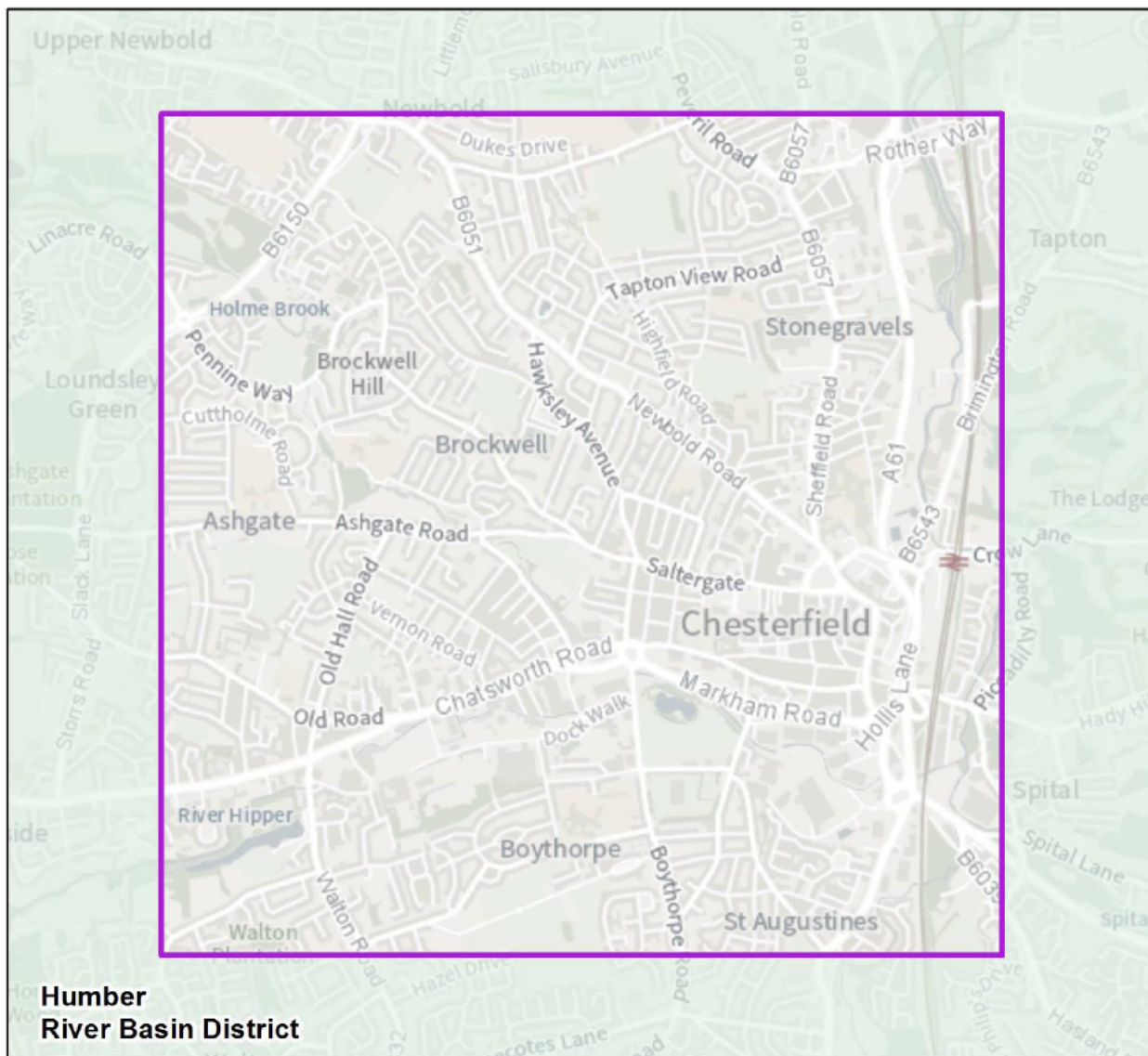
The next major capital intervention to the defences is currently anticipated to be needed in the 2050s, when the defences improved in 2006/07 will be coming to the end of their design life. Addressing the impact of climate change would be considered in any intervention to the defences at this time.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Burton upon Trent FRA

Measures have been developed that apply specifically to the Burton-upon-Trent FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Burton-upon-Trent FRA. You can find information about all the measures that apply to the Burton-upon-Trent FRA in the '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Chesterfield Surface Water Flood Risk Area



Flood Risk Area: Chesterfield, Humber

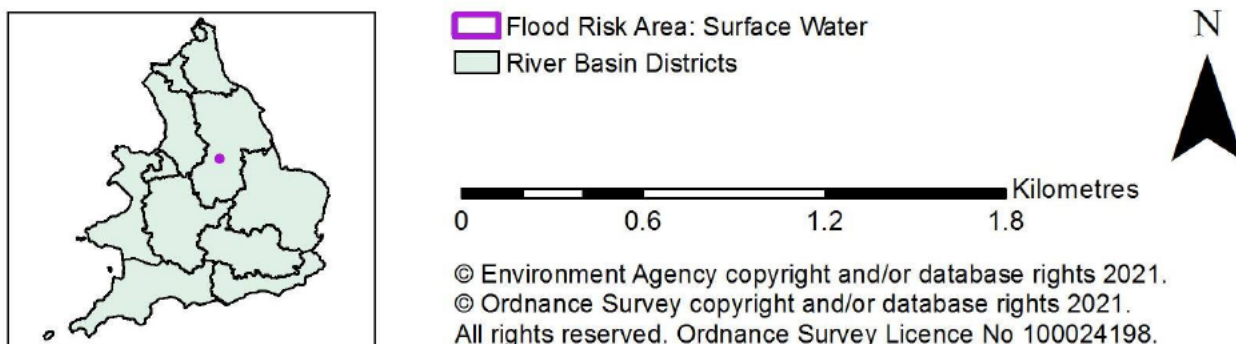


Figure 14: A map showing the boundary of Chesterfield Flood Risk Area

Introduction to the Chesterfield Flood Risk Area

The Chesterfield (Surface Water) 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).

As Lead Local Flood Authority (LLFA) Derbyshire County Council and is responsible for the development and delivery of the FRMP for this FRA. The Environment Agency's remit includes managing flood risk from main rivers in the FRA. Yorkshire Water is the sewerage undertaker for this area.

The FRA covers the town of Chesterfield, extending across the central urbanised area. It is noted that the FRA does not encompass the whole of the Chesterfield Borough, which extends beyond the boundary of the FRA. The area is characterised by urban and suburban communities, with the River Rother and Chesterfield Canal running Northwards through the FRA.

The geology is generally mudstone, siltstone and sandstone which are part of the Pennine lower coal measures. Soils are often loamy clay which impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Wildlife sites within the FRA boundary, which include Brockwell Reservoir, Holmebrook Valley Park, Chesterfield Canal and Oakfield Avenue Meadow.

Chesterfield was founded as a Roman fort close to the very edge of the Roman Empire. Over time, Chesterfield became a prosperous market town in the Middle Ages, serving north-eastern Derbyshire and beyond. With the Industrial Revolution the town's population grew as various industries, heavy engineering and mining developed in the town.

The reduction in industrial and mining activities in the 20th Century, led to an economic downturn for the area. This also meant brownfield sites became available for development. Chesterfield is currently undergoing changes with several key developments completed, and further developments planned such as Chesterfield Waterside, Markham Vale, Peak Resort and the Northern Gateway.

Historically, fluvial flooding is a prominent issue from both main river and ordinary watercourses through the area. These include flooding from the River Hipper, the River Rother. To a lesser extent, surface water flooding has also occurred historically in Chesterfield.

Much of the sewer network in Chesterfield dates to the Victorian era. Much of the sewer system has been modelled and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding.

Current flood risk

Chesterfield is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers.

There are numerous records of historic flooding in Chesterfield, most recently being the significant incident in November 2019 where several properties and critical infrastructure were flooded.

The [flood hazard and risk maps](#) show that in the Chesterfield (Surface Water) FRA approximately 4,925 people live in areas at risk of flooding from surface water. Of these, 13.2% are in areas of high-risk.

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

- 389 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 4.8 km of roads
- 1.3 km of railway lines
- 1.7 ha of agricultural land
- areas of scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

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, RMAs have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Derbyshire County Council lead on the management of surface water flood risk, in their role as the LLFA, in collaboration with other Risk Management Authorities (RMAs). Other stakeholders include Chesterfield Borough Council and Yorkshire Water. There are regular operational meetings organised by Derbyshire County Council for the RMAs to discuss work programmes and resolve any operational issues. At a strategic level, Derbyshire County Council is a stakeholder in the South Yorkshire Flood Risk Partnership and Yorkshire RFCC meetings.

The LLFA, Chesterfield Borough Council and Yorkshire Water maintain assets that perform a flood risk management function on the drainage network. For Derbyshire County Council this would be predominantly the assets which serve the public highway. The Environment Agency similarly maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. The Canal & River Trust manages and maintains its network to reduce risks of asset failure, while the Chesterfield Canal Trust is responsible for restoring the last nine miles of the Canal.

Although Derbyshire County Council does not have any specific flood warning arrangements in place for surface water flooding. With regard to incident response, plans and policies are in place to manage flooding incidents. The Derbyshire Resilience Forum Multi-Agency Flood Plan and the Flood Response Policy outlined the Local flood risk management strategy, which sets out how Derbyshire County Council will respond and manage these incidents both prior to, during and after a flooding event.

The Environment Agency monitor river and rainfall conditions at 5 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur.

These flood warning areas include the:

- Holmebrook at Ashgate
- River Hipper at Brampton
- River Hipper at Central Chesterfield
- River Rother at Central Chesterfield
- River Rother at North Chesterfield and Brimington
- River Rother at Tapton

The LLFA have not undertaken any specific surface water modelling and risk mapping for the FRA and are reliant on the Risk of surface water flood maps provided by the Environment Agency to identify areas at risk from surface water flooding within the FRA.

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 Derbyshire Local Flood Risk Management Strategy was implemented in 2015. Derbyshire County Council developed a strategy to:

- further develop an understanding of the flood risk to Derbyshire and the impacts of climate change working collaboratively with all other Risk Management Authorities and relevant groups/bodies to ensure a coordinated response to flood risk management for Derbyshire
- continue to work with all relevant bodies to ensure appropriate and sustainable development in Derbyshire
- continue to prioritise limited resources effectively to support communities most at risk in Derbyshire
- continue to help and support the local communities of Derbyshire to manage their own risk
- continue to help protect and enhance the natural and historic environment of Derbyshire

Recent improvement to flood risk has included three property level flood protection schemes at Hollis Lane, Brampton and Tapton Terrace, which have improved the flood risk to 93 properties within the flood risk area. In addition, works to the Avenue Flood Balancing Reservoir reduced flood risk to 115 properties.

Derbyshire County Council has no Flood Risk Management Schemes in the current 6-year Environment Agency Capital programme 2021/27.

The impact of climate change and future flood risk

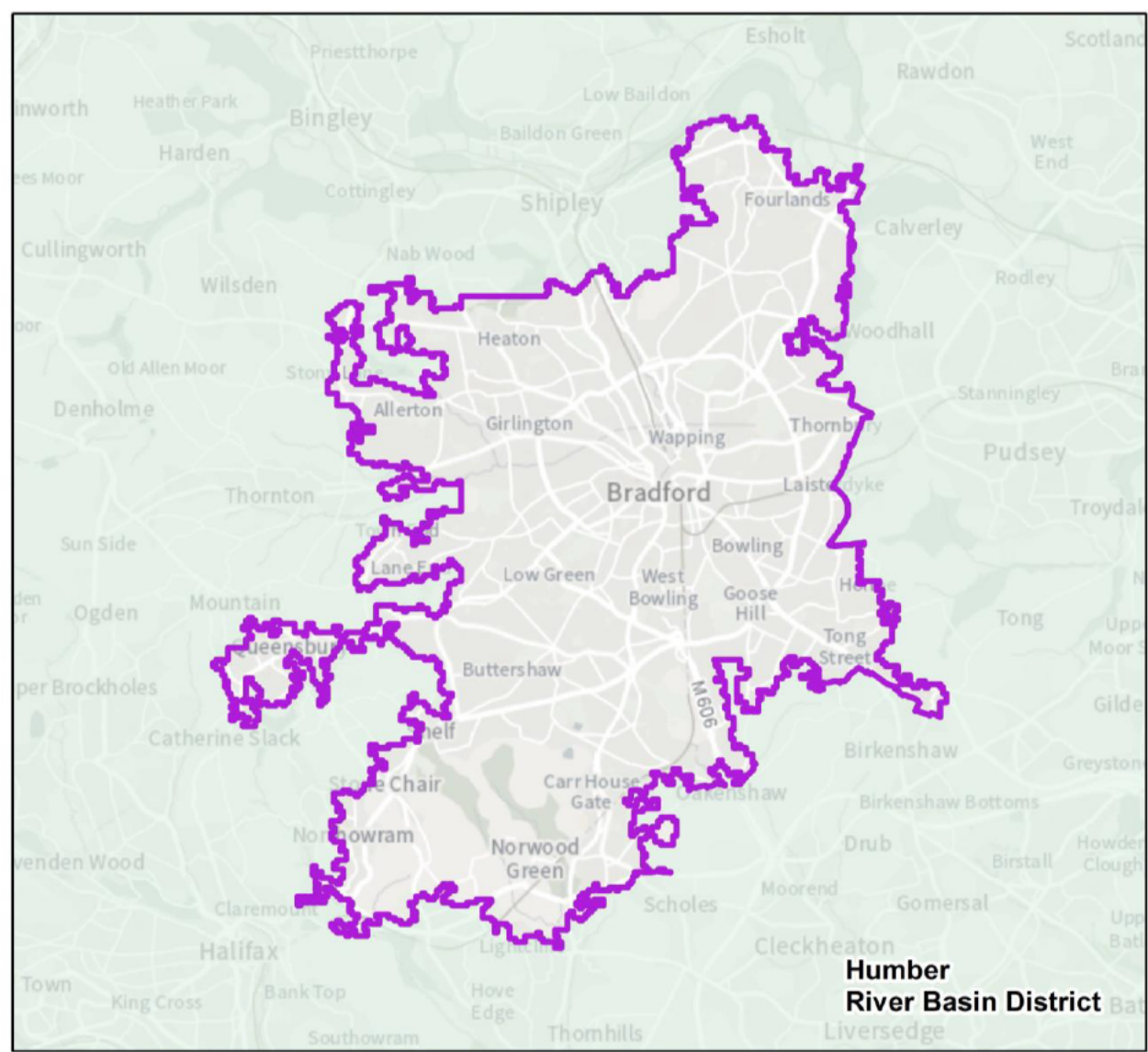
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please see the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Chesterfield FRA

Measures have been developed which apply specifically to the Chesterfield (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Chesterfield (Surface Water) FRA. You can find information about all the measures which apply to the Chesterfield (Surface Water) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The City of Bradford Surface Water Flood Risk Area



Flood Risk Area: City of Bradford, Humber



-  Flood Risk Area: Surface Water
-  River Basin Districts

0 2 4 6 Kilometres

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Figure 15: A map showing the boundary of the City of Bradford Flood Risk Area

Introduction to the City of Bradford Flood Risk Area

The City of Bradford 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).

The City of Bradford Metropolitan District Council take the lead on the development and delivery of the FRMP as it is the Lead Local Flood Authority (LLFA) responsible for managing flood risk from 'local' sources. These local sources of flooding are surface water, groundwater and ordinary watercourses.

The Environment Agency's remit covers flood risk from rivers and the sea.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The City of Bradford FRA covers many of the districts of Bradford which feature businesses and residential properties.

The Leeds and Liverpool Canal lies within the FRA and is owned and maintained by the Canal & River Trust.

The underlying bedrock throughout Bradford varies and in areas includes millstone grit, overlain by lower coal measures, superficial deposits of alluvium and till with a bedrock of sandstone, clay, sand and silts.

Ground conditions also vary and in areas it is described as slowly permeable, seasonally wet, acid, loamy and clayey soils, while other areas freely drain with acid loamy soils.

Within the City of Bradford FRA, there are multiple Registered Parks, Ancient Woodlands, Local Nature Reserves, Listed Buildings, Scheduled Monuments, conservation areas and a UNESCO World Heritage Site, as well a registered battlefield at Adwalton, Drighlington.

Under the Flood and Water Management Act 2010 the City of Bradford Metropolitan District Council (CBMDC) is the Lead Local Flood Authority (LLFA). The Council maintains council owned watercourses, clears grilles of debris at hotspots, advises on flood risk, designs drainage schemes, inspects and maintains council owned culverts, pumping stations and reservoir inspections. Through the planning process, Bradford provided consultation responses to mitigate flood risk to proposed and existing developments and works closely with partners during flood events.

Several watercourses within Bradford originate outside the Council's administrative boundary. Although it is likely that small land use changes within Bradford will only have localised impact on river flows, major land use changes in the upstream catchments of the River Aire and River Wharfe could have a significant impact on their flow regime and flood risk.

As LLFA the CBMDC have:

- prepared a strategic level Local Flood Risk Management Strategy (LFRMS) for Bradford District to reduce local flood risk from surface water, ordinary watercourses, groundwater and reservoirs
- worked closely with other key stakeholders to ensure delivery of effective joined up flood risk management
- completed a Preliminary Flood Risk Assessment (PFRA) and provide Annex updates
- prepared Surface Water Management Plans for areas at greatest risk when identified through the planning cycle
- investigated flooding incidents in order to understand their cause and ensure that appropriate agencies play their part in the effective management and resolution of flooding incidents

CBMDC oversees all ordinary watercourses (non-main river) and has the legal powers to enforce landowners to remove watercourse obstructions.

CBMDC aim to:

- consider opportunities to reduce flood risk to existing communities and developments through better management of surface water using Sustainable Drainage Systems (SuDS) and provision for conveyance and storage of floodwater
- Present a thorough and updated understanding of all flood risk based on up-to-date Environment Agency modelling. Use opportunities offered by new development to reduce the causes and impacts of flooding
- Identify the requirements for site-specific FRAs in particular locations, including those at risk from sources other than flooding from watercourses

Flood risk across the Bradford district is varied but caused mainly by overland flow following short, high intensity, or heavy prolonged rainfall events, and/or as a result of overtopping from rivers and watercourses. Throughout the district, Bradford suffers flood risk from fluvial sources, surface water, groundwater, sewers, and residual risk from canals and reservoirs. In some instances, sites may suffer from a combination of more than one source of flooding. Historically flooding has significantly affected parts of Bradford with several largescale damaging flood events having occurred. Due to the increasing effects of climate change, awareness of and preparedness for flooding, both at a local and national scale, is vital in reducing flood risk to local authority areas.

Main rivers in the Bradford District include River Aire, River Worth and the River Wharfe. There are several ordinary watercourses throughout the district that also cause flood risk throughout the district.

There are certain locations, generally within urban areas, where the probability and consequence of surface water and sewer flooding are more prominent due to the complex hydraulic interactions that exist in the urban environment. Connectivity, sewer capacity, and the location and condition of highway gullies all have a major role to play in surface water flood risk throughout Bradford.

The FRA is susceptible to flooding from surface water during times of increased rainfall.

Current flood risk

The [flood hazard and risk maps](#) show that in the City of Bradford FRA some 22,353 people live in areas at risk of flooding from surface water of which 5.8% are in areas of high risk.

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

- 3,039 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 17.15km of roads
- 7.94km of railway
- 70.87ha of agricultural land
- areas of environmental permitting regulations, parks and gardens, listed buildings, water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the City of Bradford FRA.

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

How the risk is currently managed

The management of surface water flood risk is led by City of Bradford Metropolitan District Council (CBMDC) in collaboration with other Risk Management Authorities (RMAs) and other stakeholders for example Environment Agency, Yorkshire Water and the IDB who manage some smaller watercourses that flow into the city. Bradford District Council owns and maintains several assets throughout the district which includes culverts, bridge structures, gullies, weirs and trash screens. Many of these assets are located along ordinary watercourses within smaller urban areas where watercourses may have been culverted or diverted, or within rural areas. All these assets can have beneficial flood risk management functions, but they can also increase flood risk if they become blocked or fail. In most cases responsibility lies with the riparian landowner. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

CBMDC (as the LLFA), under the provisions of the Flood and Water Management Act, has a duty to maintain a register of structures or features that have a significant effect on flood risk, including details of ownership and condition as a minimum. The Asset Register should include those features relevant to flood risk management function including feature type, description of principal materials, location, measurements (height, length, width, diameter) and condition grade. The Act places no duty on the LLFA to maintain any third-party features, other than those for which the authority has responsibility as land or asset owner.

Regular meetings are held between the Environment Agency and CBMDC regarding incident management, ongoing capital projects and future investment. CBMDC is also part of the West Yorkshire Flood Risk Partnership, enabling broader (catchment scale) tactical and strategic approaches to be agreed with neighbouring LLFAs and other partners.

The Environment Agency monitor river and rainfall conditions at a number of sites in and surrounding the FRA, including a hydrometric monitoring site at Cottingley Bridge, Saltaire, Ilkley, Addinham, Silsden, Riddlesden, Oxenhope and Oakworth. Rain gauges are installed at Graincliffe Reservoir and Keighley (Marley) sewage works. There are also continuous river flow gauges at Keighley Dalton Lane and Bingley.

There are 23 flood warnings in and around the City of Bradford FRA, with a proportion of these being issued frequently to a relatively small number of properties and others being reserved for more extreme flooding that would affect a larger number of homes and businesses. The flood response in Bradford is generally well-rehearsed, with the Environment Agency, CBMDC and other partners taking operational action at specific levels and residents responding to flood warnings to put property level resilience measures in place.

Water level and flow information is used to inform and calibrate mathematical modelling of the river network. The Bradford Aire Catchment FAS Model covers the river Aire from the edge of Bradford Council boundary upstream of the FRA to the boundary downstream where Bradford borders Leeds. The model was updated in 2019 to account for data collected in the floods of the winter of 2015-16 and to inform the Bradford Aire Catchment FAS as well as several proposed projects in the future. Smaller watercourses in Bradford have also been modelled, but some of these models are simpler in nature and may use older modelling methods. There are several surface water model updates which have also been created, which include Keighley and Stockbridge and Silsden.

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

Since 2015 the Environment Agency has been working closely with CBMDC to create an extensive programme of works to address the flood risk in and around the FRA. Working in partnership, the Environment Agency and CBMDC have proposed several projects in and around the surrounding FRA to address the challenges of climate change and to build new assets in places that are currently undefended. These projects are in their infancy but do suggest measures to tackle surface water issues including culvert remediation works and surface water drainage.

The impact of climate change and future flood risk

As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the City of Bradford FRA

Measures have been developed which apply specifically to the City of Bradford FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the City of Bradford FRA. You can find information about all the measures which apply to the City of Bradford FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The City of Sheffield Surface Water Flood Risk Area

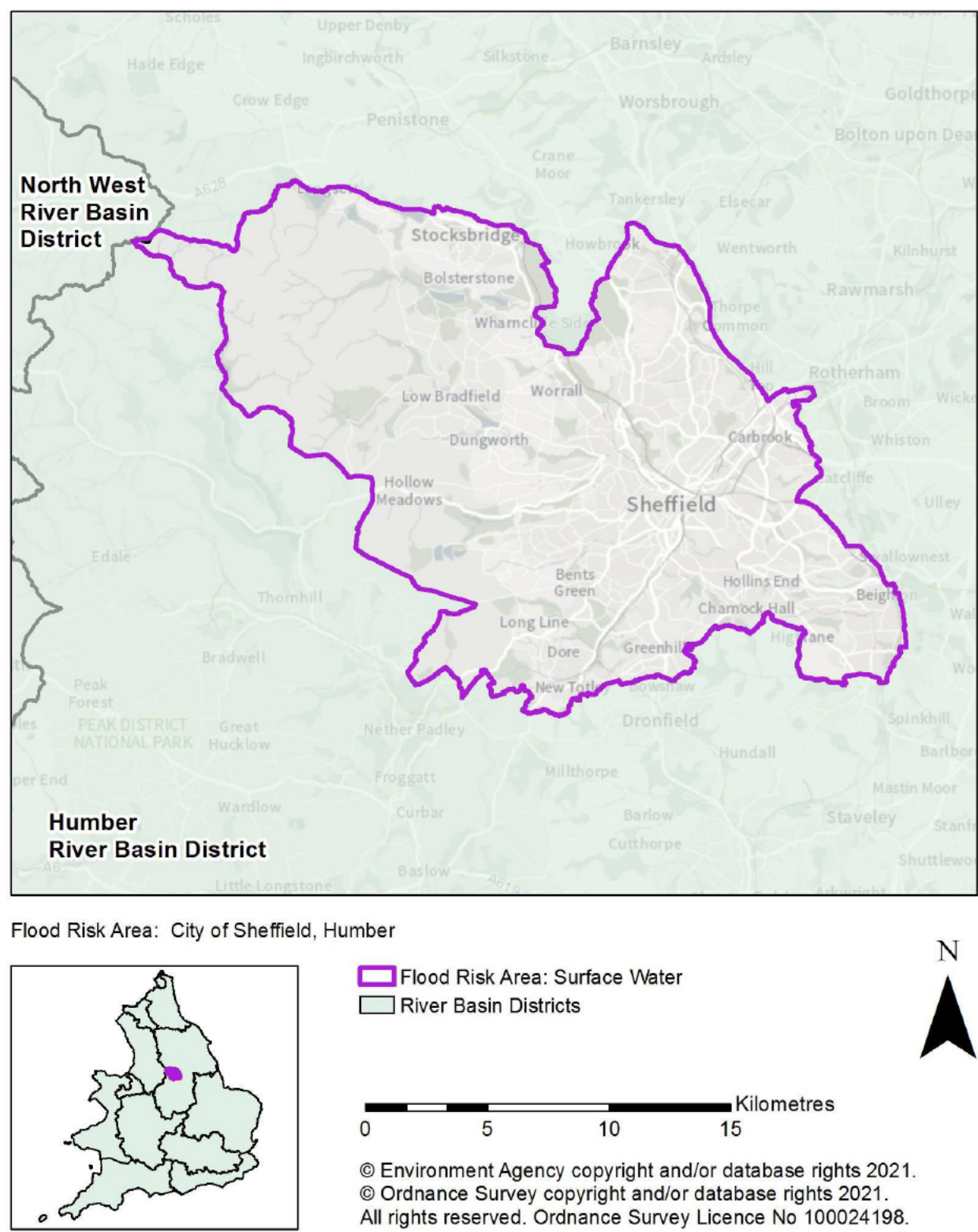


Figure 16: A map showing the boundary of the City of Sheffield Surface Water Flood Risk Area

Introduction to the City of Sheffield Surface Water Flood Risk Area

The Sheffield 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).

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA.

Sheffield City Council are the Lead Local Flood Authority whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Sheffield FRA covers several businesses and residential properties in the vicinity of the River Don, River Sheaf, Blackburn Brook and Porter Brook.

The Sheffield FRA lies on a bedrock of mudstone, siltstone and sandstone with Pennine coal measures formations and overlaid by alluvium.

The soils in Sheffield are seasonally wet deep stone less fine silty and clayey soils variably affected by groundwater, and slowly permeable seasonally waterlogged loamy over clayey and fine silty soils over soft rock. These soils can absorb large volumes of water when dry, reducing the volume of water entering the rivers however once saturated, surface run-off increases causing flashy river response. There are no reports of groundwater emergence causing significant flooding.

The solid geology of Sheffield is characterised by Namurian (Millstone Grit) to the west, and Lower Westphalian to the east. The soils are typically alluvium along the river corridors, with relatively large areas of peat within the uppermost reaches of the River Don catchment. The presence of peat is an important characteristic when considering the response of a catchment to rainfall. The soil is very absorbent, however once saturated will rapidly release a relatively high volume of water which could contribute to localised flash flooding.

The FRA is susceptible to flooding from the River Don, River Sheaf, Blackburn Brook and Porter Brook. Other smaller watercourses such as River Loxley and Kelham Goyt (tributaries of the river Don) also cause flood risk.

Sheffield's unique and complex hydrology and topography combined with the city's historical development and urbanisation influence the nature of flood risk within the area.

Floodplains in the city are not extensive and urbanisation, particularly industrial, has taken place right up the banks of the rivers. In many urban areas, including the city centre, rivers have been culverted to allow development and therefore the natural river system is significantly restricted, increasing the risk of flooding.

Urbanisation has caused increased flood risk in Sheffield, particularly from the Porter Brook. This river had been culverted beneath the city centre to make way for development however this constricts the river channel and increases flooding to overbank areas in times of intense rainfall.

The topography of Sheffield is dominated by the steep slopes of the Peak District to the west, falling towards the characteristically undulating nature of the River Don catchment to the east. To the west of Sheffield city centre, a relatively large proportion of the district is situated on steep sided valleys, and the river valleys are well contained. Watercourses have been (often partially) culverted. Relatively few properties are at risk of flooding from rivers in these upper reaches, however there is higher risk of flash flooding following intense rainfall as water runs rapidly off the valley sides.

With the City's relatively high levels of tree/vegetation (and in places discarded debris) there is material lying in and around watercourse channels. The steep grades also bring high velocities in spate conditions which then wash down accumulated material. Inlets, with or without screens, can become blocked quickly even when the inlet was 100% clear beforehand. Many of the culverts are old, laid to facilitate development perhaps 100 years ago or more, and some are known to be rubble culverts in unknown condition and with uncertain locations. With inspection and maintenance almost impossible there is potential for collapse or internal blockage. Fortunately, this has not to date been as big a problem as inlet blockages, but all culverts carry this blockage risk. To the east of the city centre, the district flattens, and the river valleys widen.

Runoff from the steep upper reaches arrives quickly, resulting in the overtopping of the rivers into flatter floodplain areas. Within these flatter areas, the drainage system relies heavily upon an ability to drain freely into the rivers. When river levels are high, the drainage systems are unable to discharge, resulting in surface water flooding that exacerbates problems within low lying areas.

Current flood risk

The [flood hazard and risk maps](#) show that in the City of Sheffield Surface Water FRA some 40,790 people live in areas at risk of flooding from surface water of which 7.1% are in areas of high risk.

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

- 3,246 non-residential properties
- 23.41km of roads
- 38.52km of railway
- 187.75ha of agricultural land
- areas of environmental designated sites, special areas of conservation, special protection areas, SSSIs, parks and gardens, scheduled monuments, listed buildings, water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the City of Sheffield Surface Water FRA.

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

How the risk is currently managed

The management of surface water flood risk is led by Sheffield City Council in collaboration with other Risk Management Authorities (RMAs) and other stakeholders for example Environment Agency and Yorkshire Water.

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 continuously measures the river levels at 19 measuring stations across the Sheffield FRA. These are continuous river flow gauging stations on the Bagley Dike, Blackburn Brook, Car Brook, Charlton Brook, Porter Brook, River Don and River Sheaf. The network of monitoring and gauging stations feed into the flood forecasting system for the city.

Rainfall data is available from the city's two Universities, The University of Sheffield and Sheffield Hallam University.

Flow measuring station information and live on the ground information is used to inform activities related to 7 flood alert and 49 flood warning areas that cover the FRA.

The Environment Agency's Flood Warnings Direct Service provides flood warnings direct to customers by telephone, mobile, fax or pager. Customers can also get practical advice on preparing for a flood and what to do if one happens. The areas that are within the flood warning zone include properties within the River Don corridor between Hillsborough and the M1, properties adjoining the River Sheaf between Bannerdale Road and the River Don, and properties adjoining the Porter Brook.

Detailed modelling of the potential impacts of climate change has been carried out for the River's Don, Sheaf, Porter and their tributaries.

The adopted flood zones underpinning Sheffield are largely based upon this and historical flood outline data.

In accordance with current best practice these have informed the Environment Agency's Flood Zone Maps and the basis for the assessment of flood alleviation schemes and management across the city.

The Environment Agency flood maps for surface water for the Sheffield area indicate a wide scatter across the city with no concentration of risk in any specific area.

Sheffield City Council holds a register of assets that contain details of all structures and features which have significant impact on flood risk. This includes assets which defend against flooding, such as flood defence walls and gates, as well as those which form a key part of a drainage system such as the local watercourse culvert network.

The Environment Agency maintain flood risk management assets for example river channels, flood defence walls and embankments throughout the FRA. Sheffield LLFA and Yorkshire Water similarly maintain assets that perform a flood risk management function.

Between 2015 and 2021 the Sheffield Flood Defence Programme has completed several Flood Alleviation Schemes (FAS) schemes, for example, Sheffield Lower Don FAS (completed in 2018, comprising flood defence walls from city centre to Meadowhall) and Sheffield Watercourses Culverts FAS (completed in 2020, lining and relaying sections of 9 strategic watercourse culverts across the city and upgrading non-compliant inlet screens). Further work is ongoing across the Sheffield FRA as part of this programme, details are described within the measures for the FRA. Measures include improving flood defence walls and surface water drainage, providing flood storage, environmental and recreational enhancements and improving culverted watercourses on the Don, Loxley, Sheaf, Porter, Kirkbridge Dike, Car Brook, Blackburn Brook, Clough Dike rivers. Aligned with this programme is the Upper Don Reservoir Storage FAS; the Environment Agency in collaboration with Sheffield City Council are investigating the potential reservoir storage options in the uplands of Sheffield.

The Natural Flood Management FAS is a project working with partner organisations such as Sheffield City Council, Environment Agency, Natural England, The Wildlife Trust, National Highways, Yorkshire Water and private landowners in finding shared opportunities for upland flow management.

- Sheffield City Council have completed some work on identifying potential NFM opportunity areas. Sheffield City Council are continuing to pursue these opportunities and mutual funding routes
- Resulting additional standard of protection by holding back water in the uplands is thought to provide some small-scale benefits, but none the less significant and worthwhile due to multiple wider environmental and recreational benefits

The impact of climate change and future flood risk

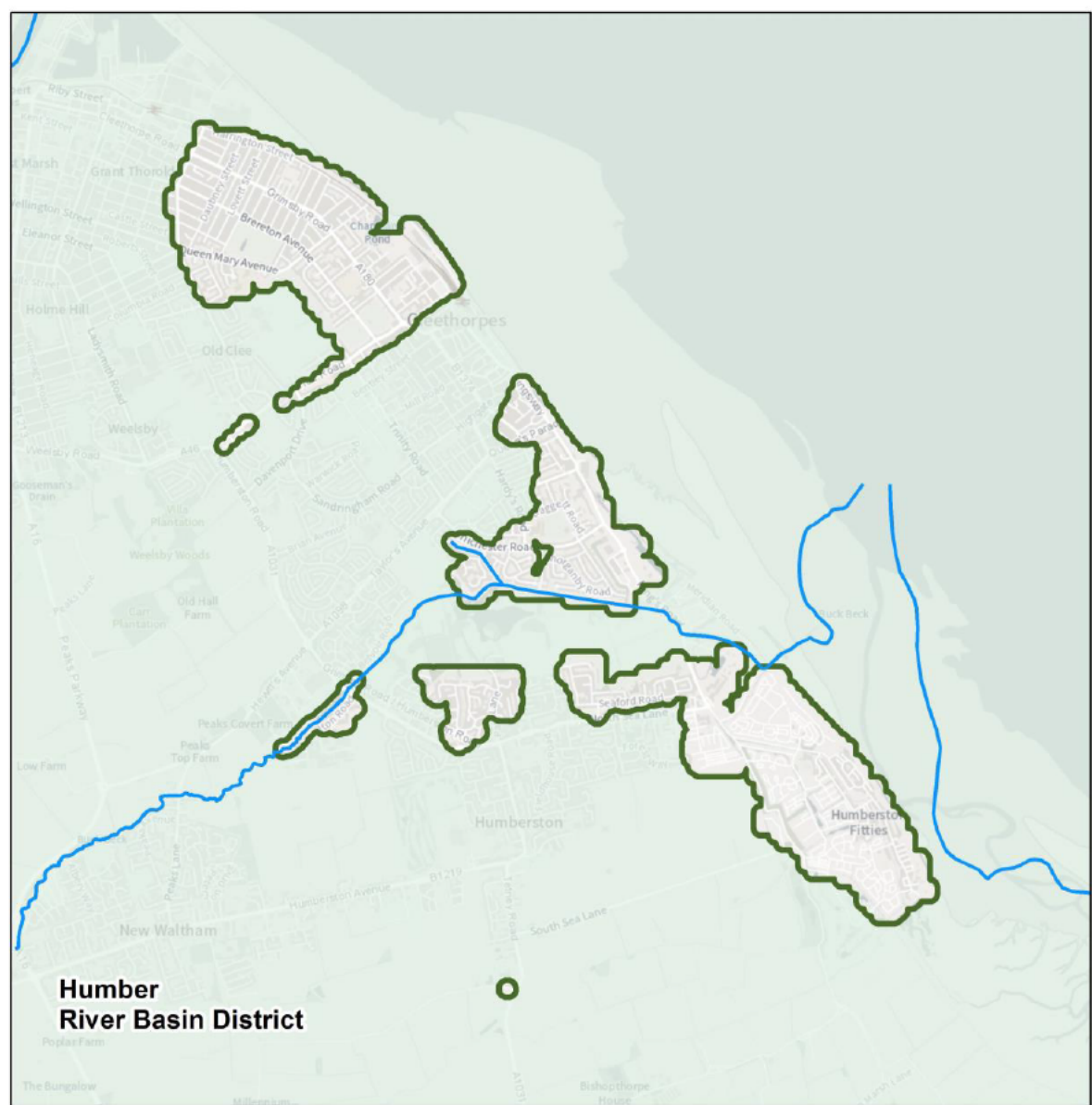
As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the City of Sheffield Surface Water FRA

Measures have been developed which apply specifically to the City of Sheffield Surface Water FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the City of Sheffield Surface Water FRA. You can find information about all the measures which apply to the City of Sheffield Surface Water FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Cleethorpes Rivers and the Sea Flood Risk Area



Flood Risk Area: Cleethorpes, Humber

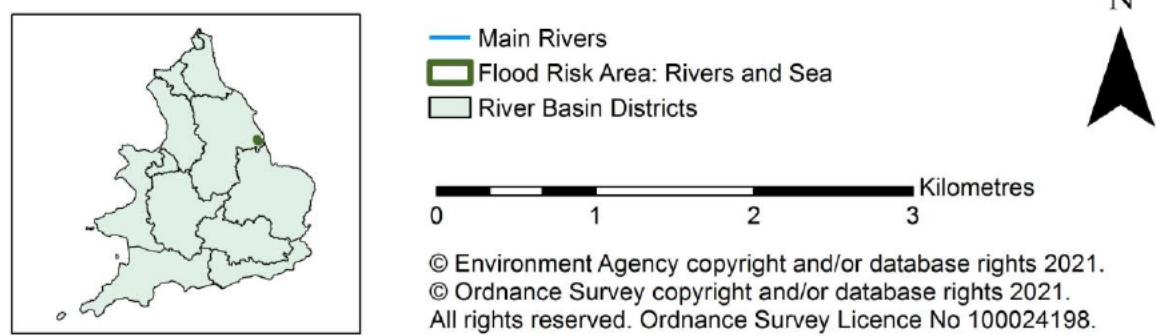


Figure 17: A map showing the boundary of the Cleethorpes Flood Risk Area

Introduction to the Cleethorpes Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA. North East Lincolnshire Council are the Lead Local Flood Authority (LLFA) responsible for managing flood risk from 'local' sources. These local sources of flooding include:

- surface water
- groundwater
- ordinary watercourses

North East Lincolnshire Council are the Coastal Protection Authority in this FRA.

The Environment Agency's remit covers flood risk from rivers and the sea.

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

The North East Lindsey and Lindsey Marsh Internal Drainage Board (IDB) are responsible for land drainage in the south west of the FRA.

The Cleethorpes FRA covers the separate northern and southern parts of Cleethorpes. It also extends southwards along the coast to include Humberston and The Fitties. The northern part of the FRA borders the Grimsby FRA and shares the same tidal flood cell.

Cleethorpes is mainly urban, with grade 3 agricultural land at the periphery. The predominant soil type is wet deep loam. The designated bathing waters within the FRA are designated at low risk.

The Humber Estuary is a Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar. The local nature reserve, Cleethorpes Country Park, also lies within the FRA.

Historically Cleethorpes developed as a fishing village. During the 1820's the first development as a health holiday resort was seen. Sea-bathing and the taking of medicinal water becoming fashionable. The resort expanded following railway links made with industrial towns in Yorkshire. Cleethorpes Pier opened in 1873 and the promenade in 1885. Through the 1920's the town boundary was extended to include part of Humberston and Weelsby.

While commonly referred to as a seaside resort, Cleethorpes actually sits on the Humber Estuary. The sea at Cleethorpes is the mouth of the Humber. At low tide bathers are separated from the sea by several hundred metres of sand.

The economy is reliant on seasonal tourism, and development is often in conflict with tidal flood risk. Cleethorpes is physically linked to the neighbouring town of Grimsby by built up residential estates and the villages of Old Clee and Weelsby.

The Northern Becks operational catchment is rural to the south and urban to the north. The north is dominated by industrial areas around Immingham and the important coastal towns of Grimsby and Cleethorpes. There are several protected areas in the catchment including:

- drinking water protected area safeguard zone
- important bathing waters
- urban wastewater directive sensitive sites

Buck Beck and Goosepaddle Drain are heavily modified main rivers which flow through the centre of the Cleethorpes FRA and out to sea.

The main risk within the FRA is from tidal sources.

Current flood risk

Cleethorpes last experienced flooding in:

- June 2007 - significant surface water flooding incident
- December 2013 - tidal flooding

The [flood hazard and risk maps](#) show that in the Cleethorpes Flood Risk area some 18,514 people live in areas at risk of flooding from rivers and the sea. Of these 6% are in areas of high risk:

- also shown to be in areas at risk of flooding from rivers and sea are: 484 non-residential properties - including community centres, hospitals, schools/colleges, retail parks and public utilities
- 2.17km of railway
- 52.24ha of agricultural land
- environmental designations
- listed buildings
- water abstraction points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Cleethorpes FRA.

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

How the risk is currently managed

The management of flood risk from rivers and sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs). These include:

- North East Lincolnshire Council
- North East Lindsey IDB

The Environment Agency have the strategic overview of flood risk across the FRA and provide the tactical management and operational delivery for the risk from rivers and the sea. This is undertaken in collaboration with the North East Lincolnshire Council as the LLFA and CPA, and North East Lindsey IDB. Further support is given to Anglian Water who manage the sewerage network. The flood risk management investment is coordinated through the RFCC and locally through the LLFA in combination with the Environment Agency.

The tidal defences along the Humber Estuary are managed and maintained by the Environment Agency. Buck Beck and Goosepaddle Drain have liner defence embankments and walls, together with a sea outfall structure.

North East Lincolnshire Council manage and maintain the coastal defences along the sea front at Cleethorpes and at Humberston Fitties under the Coastal Protection Act. North East Lindsey IDB pumping stations assist the management of water levels within the land drainage systems.

The Humber Local Resilience Forum (Humber LRF) is a multi-agency partnership made of representatives from local public services such as:

- emergency services
- local authorities
- NHS
- Environment Agency

The LRF Risk Assessment Working Group produces a Community Risk Register for the Humber Sub-region. This identifies the risks and likelihood of them occurring. It also considers the impact they would have on the community and economy should they happen. This assessment includes risks from flooding. The forum work in a multi-agency collaboration to manage flood incidents under the Civil Contingencies Act 2004.

The Environment Agency undertakes Hydrometric Monitoring at 1 location within the FRA.

This information is used to inform activities related to 7 flood warning areas that cover the FRA which enable people to receive a warning when flooding could occur. This data also informs the operational response during a flood incident.

Updated modelling and mapping of Buck Beck was undertaken in 2019. Improvements to the Humber Estuary flood risk modelling have been completed as part of the developing Humber 2100+ strategy.

Flood risk maps are published based on the outputs from 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 operates and maintains flood risk management assets along the Humber Estuary and on the main watercourses in the FRA. These include:

- flood defence embankment
- walls
- flood gates
- channels
- culverts
- debris screens
- sea outfalls

This work includes routine inspection and clearance activities as well as regular repair and replacement of assets.

Flood risk improvement works that benefit the Cleethorpes FRA completed recently by the Environment Agency include:

June 2016

Work was completed around the port of Grimsby on a £20 million project. This reduced the risk of overtopping and potential failure of three and a half kilometres of tidal flood defences to the town. The standard of protection has been improved to a 0.5% chance in any given year.

Sept 2018

Refurbishment of the tidal outfall structure to Buck Beck.

Flood risk improvement works completed recently by North East Lincolnshire Council include:

Oct 2017

Cleethorpes Terminal Groyne was replaced with a rock groyne structure. Together with other intermediate timber groynes repairs, this ensured that the beach protecting the North Promenade became stabilised. It is re-nourished as an amenity beach through natural coastal processes.

The Environment Agency has identified the need to better protect communities of Cleethorpes and Humberston, taking into consideration the increasing risk of tidal flooding due to the predicted effects of climate change. Over the next 6 years we will continue to work with North East Lincolnshire Council to develop a scheme to reduce the risk. The

more vulnerable coastal protection section in front of the Humberston Fitties is of particular importance. The business case will identify the scale of the government funding and the local contributions required.

Additional improvements have also been identified for completion along coastal defences in the FRA in future years.

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, considering predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Cleethorpes.

The impact of climate change and future flood risk

As sea levels rise, it means that coastal flooding will become more frequent as higher water levels and storms will be seen more often. Rainfall intensity is expected to increase in future which will cause river flows to increase.

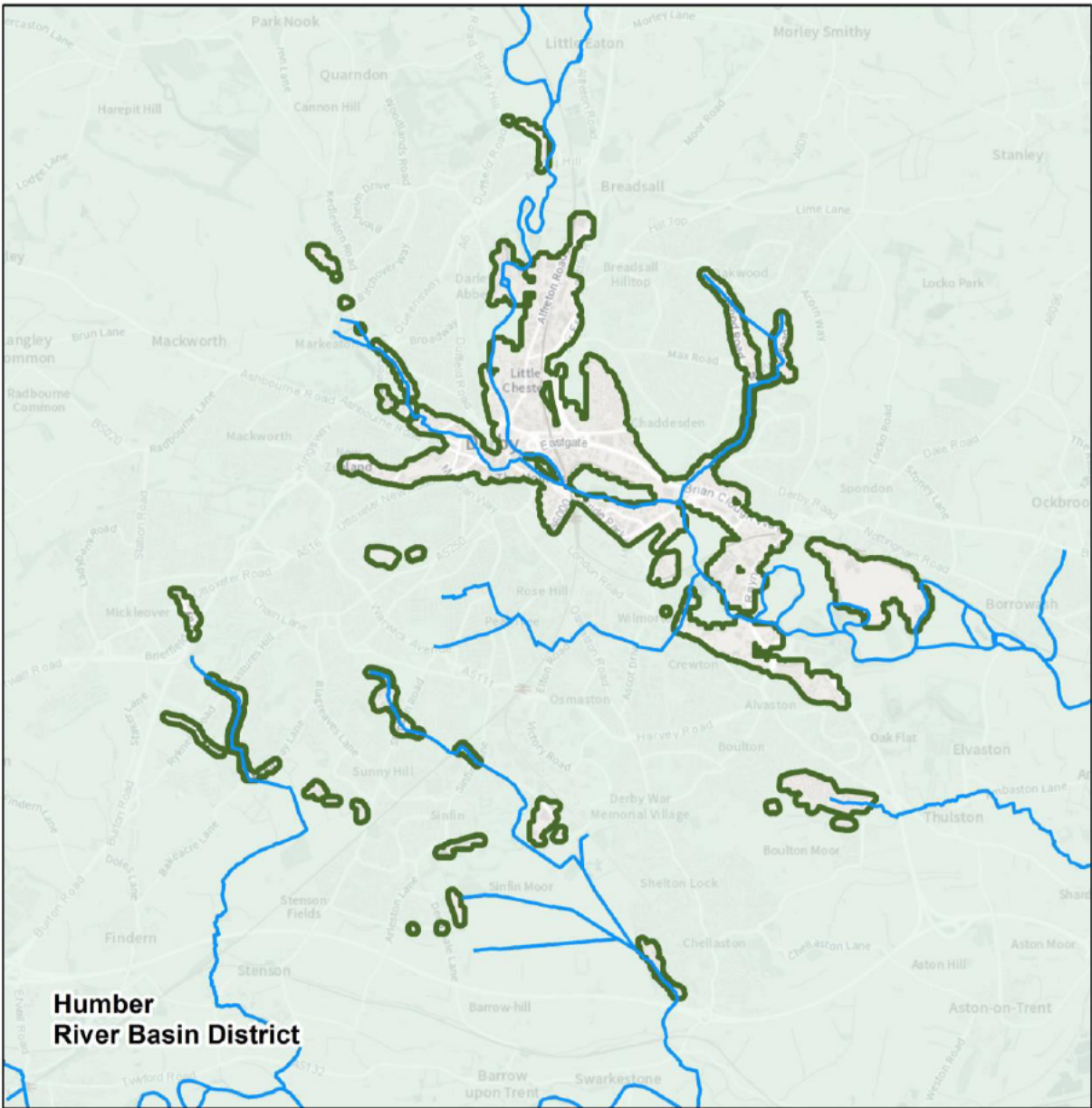
Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber RBD.

Objectives and measures for the Cleethorpes FRA

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

You can find information about all the measures which apply to the Cleethorpes FRA in '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Derby Rivers and Sea Flood Risk Area



Flood Risk Area: Derby, Humber

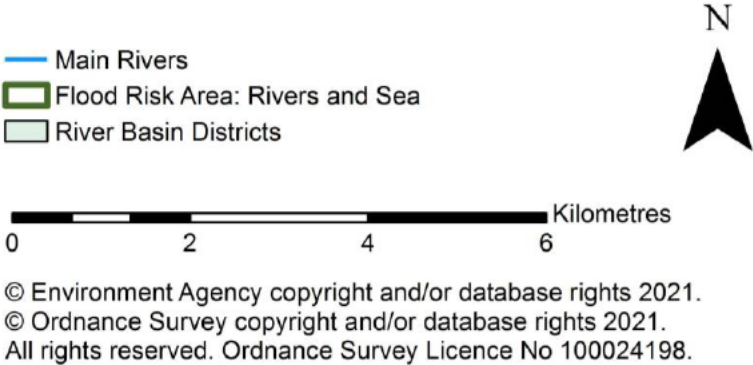


Figure 18: A map showing the boundary of Derby Rivers and the Sea Flood Risk Area

Introduction to the Derby Rivers and Sea Flood Risk Area

The Derby (Rivers and Sea) 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authority (LLFA) Derby City Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the city of Derby, extending across the central urbanised area. The area is characterised by urban and suburban communities. There are several main rivers in the FRA including the Markeaton Brook and the Chaddesden Brook, which are tributaries of the River Derwent. In addition, the Cuttle Brook, Meadow Drain and Hell Brook are tributaries of the River Trent. There are also several ordinary watercourses such as the Mackworth Brook, the Thulston Brook and the Bramble Brook.

The geology is generally mudstone, siltstone and sandstone from the Edwalton Member, Branscombe Mudstone Formation, Gunthorpe Member and Tarporley Siltstone Formation. Soils are often loamy clay which impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Nature Reserves sites within the FRA boundary, which include Darley and Nutwood Reserve and Sunnysdale Park. There is also the notable Derwent Valley Mills World Heritage Site which also intersects the FRA boundary, to the north of Derby City.

Derby was founded as a Roman fort named 'Derventio' in the area which is now the Little Chester district of the City. Overtime, Derby became a prosperous market town in the Middle Ages. With the Industrial Revolution the population grew with the development of silk and cotton mills. Derby also became a hub for engineering with the establishment of the Midland Railway headquarters, and later Rolls-Royce.

Derby is currently undergoing changes with several key regeneration projects planned such as the Derby City Centre Masterplan, Infinity Park, Connect Derby and Community and Place Regeneration.

Historically, fluvial flooding is a prominent issue from both Main River and Ordinary Watercourses through the area. To a lesser extent, surface water flooding has also occurred historically in Derby.

Derby is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Derby has grown. All the sewer system has been modelled by Severn Trent Water in a hydraulic model, including all foul, combined and surface water sewers and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external

flooding. Severn Trent Water have undertaken schemes to increase the capacity of the sewers in Derby to reduce the risk of sewer flooding.

Current flood risk

Derby is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers.

River levels on the River Derwent were significantly high during periods of 2019 and 2020. The newly completed 'Our City Our River' defences successfully protected close to one thousand residential and commercial properties from flooding in Derby City during these flood events.

The flood hazard and risk maps show that in the Derby (Rivers and Sea) FRA approximately 18,116 people live in areas at risk of flooding from rivers. Of these, 1% are in areas of high-risk.

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

- 3,075 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 6.6 km of roads
- 7.05 km of railway lines
- 72.7 ha of agricultural land
- areas of scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency leads on the management of flood risk from main rivers, in collaboration with other RMAs. Other stakeholders include Derby City Council and Severn Trent Water. There are regular operational meetings organised by Environment Agency for the RMAs to discuss work programmes and resolve any operational issues.

The Environment Agency maintains flood risk management assets, for example: river channels, flood defence walls or embankments, throughout the FRA. Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network.

The Derbyshire Local Resilience Forum (Derbyshire LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Derwent.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Derwent and Trent, along with their tributaries. Derby City Council and Severn Trent Water have hydraulic models of various culverted watercourses and sewer systems.

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

‘Our City Our River’ (OCOR), Derby’s flood alleviation project is currently in progress (2015 to 2027). OCOR is led by Derby City Council in partnership with the Environment Agency. The project was developed as a result of the Lower Derwent flood risk management strategy, which was adopted in 2011. The OCOR project has been developed to reduce flood risk and create a high-quality riverside, linking the city centre with the river. It includes plans for defences which would provide a greater level of protection up to a 1% chance of occurrence and provide an opportunity to release the economic potential of brownfield sites along the river.

Additional Capital projects are planned to be undertaken by Derby City Council as the LLFA. Further details on these can be found in the [Derby \(Surface Water\) FRA](#) information.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Derby FRA

Measures have been developed which apply specifically to the Derby (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Derby (Rivers and Sea) FRA. You can find information about all the measures which apply to the Derby (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Derby Surface Water Flood Risk Area

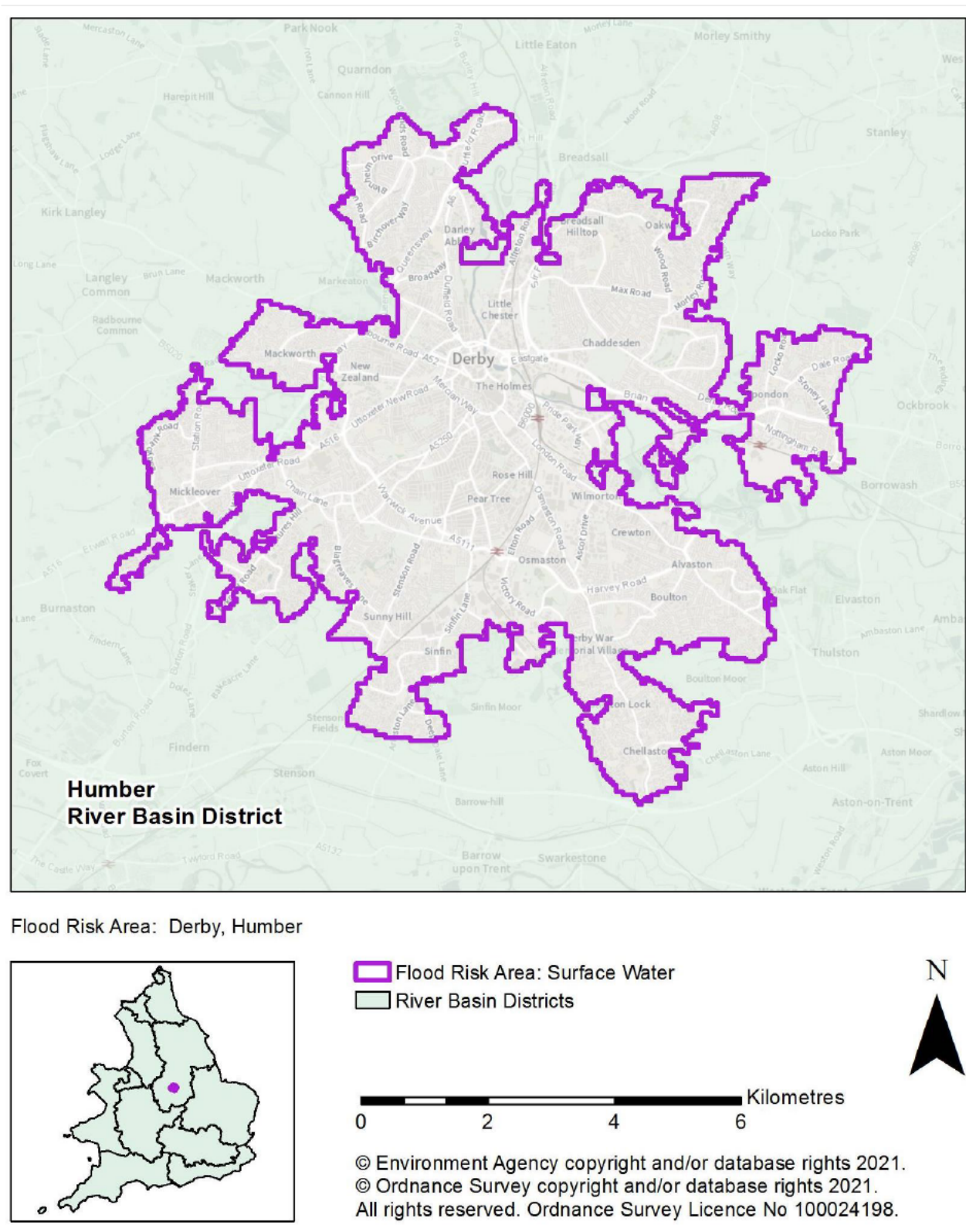


Figure 19: A map showing the boundary of the Derby Surface Water Flood Risk Area

Introduction to the Derby Surface Water Flood Risk Area

The Derby (Surface Water) 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).

As Lead Local Flood Authority (LLFA) Derby City Council is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Environment Agency's remit includes managing flood risk from main rivers in the FRA. Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the city of Derby, extending across the central urbanised area. The area is characterised by urban and suburban communities. There are several main rivers in the FRA including the Markeaton Brook, the Chaddesden Brook and the Cotton Brook, which are tributaries of the River Derwent. In addition, the Cuttle Brook and Hell Brook are tributaries of the River Trent. There are also several Ordinary Watercourses such as the Mackworth Brook, the Thulston Brook and the Bramble Brook.

The geology is generally mudstone, siltstone and sandstone from the Edwalton Member, Branscombe Mudstone Formation, Gunthorpe Member and Tarporley Siltstone Formation. Soils are often loamy clay which impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Nature Reserves sites within the FRA boundary, which include Sunnydale Park and Elm Wood, which is also designated Ancient Woodland.

Derby was founded as a Roman fort named 'Derventio' in the area which is now the Little Chester district of the city. Over time, Derby became a prosperous market town in the Middle Ages. With the Industrial Revolution the population grew with the development of silk and cotton mills. Derby also became a hub for engineering with the establishment of the Midland Railway headquarters, and later Rolls-Royce.

Derby currently has several key regeneration projects planned, such as the Derby City Centre Masterplan, Infinity Park, Connect Derby and the Community and Place Regeneration Programme.

Historically, fluvial flooding is a prominent issue from both Main River and ordinary watercourses through the area. Surface water flooding has also occurred historically in Derby.

Derby is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Derby has grown. All the sewer system has been modelled by Severn Trent Water in a hydraulic model, including all foul, combined and surface water sewers and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent have undertaken schemes to increase the capacity of the sewers in Derby to reduce the risk of sewer flooding.

Current flood risk

Derby is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers.

The [flood hazard and risk maps](#) show that in the Derby (Surface Water) FRA there are approximately 30,981 people living in areas at risk of flooding from surface water. Of these, 2,358 are in the high-risk category.

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

- 12,675 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 23.8 km of roads
- 19.4 km of railway lines
- 919.4 ha of agricultural land
- areas of scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

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 manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Derby City Council lead on the management of surface water flood risk, in their role as the LLFA, in collaboration with other RMAs. Other stakeholders include the Environment Agency and Severn Trent Water.

The Derbyshire Local Resilience Forum (Derbyshire LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

Derby City Council takes a proactive approach to managing surface water and fluvial flood risk. Council officers monitor, cleanse and service a wide array of flood risk management assets, including:

- flood defences
- trash and security screens
- culverts
- sluices
- pumping stations
- cyclic maintenance of highway drainage

The LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Environment Agency similarly maintains flood risk management assets for example river channels, flood defence walls or embankments, within the FRA.

The Environment Agency monitors river and rainfall conditions at 4 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Derwent.

Derby City Council has recently undertaken an Integrated Urban Drainage (IUD) model covering the City. This advanced model incorporates the combined risk from sewers, ordinary watercourses, culverts and surface water to produce an overall risk map for flood risk. Once published, the outputs of this will be available on the Environment Agency's national surface water flood maps.

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 Derby City Local Flood Risk Management Strategy was implemented in 2017. Derby City Council developed a strategy to:

- improve our knowledge of existing Flood Risk Management Assets
- develop economical, risk-based flood risk management schemes and infrastructure maintenance regimes that form a sustainable approach to reducing flood risk
- educate and engage with communities and elected Derby City Council members to raise awareness of flood risk
- minimise the risk of flooding from new developments, avoiding development that puts more people at risk of flooding
- promote flood risk management activities that consider climate change, enhance the natural environment, conserve and enhance the historic environment, improve water quality and provide amenity benefits
- work in partnership with Risk Management Authorities and other key stakeholders to share a common understanding of flood risk
- promote riparian responsibilities for the maintenance of watercourses

The Eggington Brook, Mickleover, Flood Risk Reduction Scheme led by Derby City Council was completed in 2015 involved the construction of a length of flood bund to prevent local surface water flooding. This reduced flood risk to 10 properties in the area.

The Cuttle Brook Flood Alleviation Scheme project led by Derby City Council is due to be completed in 2021. Increased flood storage, a flood defence bund and a variety of habitat improvements including wetlands and meadow planting will be provided in Sunnydale Park, Littleover. As well as ecological improvements, the scheme will reduce flood risk to 31 properties in the area.

Derby City Council is also currently leading on a project to upgrade and refurbish the Cotton Brook culvert through the Pear Tree area of the city. This aims to secure and improve the function of this very important watercourse culvert and the project is programmed for completion in 2025.

‘Our City Our River’ (OCOR), one of Derby's major flood alleviation projects, is led by Derby City Council in partnership with the Environment Agency. Additional information on this project can be found in the [Derby Rivers and Sea FRA](#) section.

On top of these major flood risk management schemes, the Council continues to undertake an ongoing programme of flood risk management and highways schemes related to surface water flood risk throughout the city.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Derby FRA

Measures have been developed which apply specifically to the Derby (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Derby (Surface Water) FRA. You can find information about all the measures which apply to the Derby (Surface Water) FRA in the interactive mapping tool - [‘Flood Plan Explorer’](#).

The Duncroft Rivers and Sea Flood Risk Area

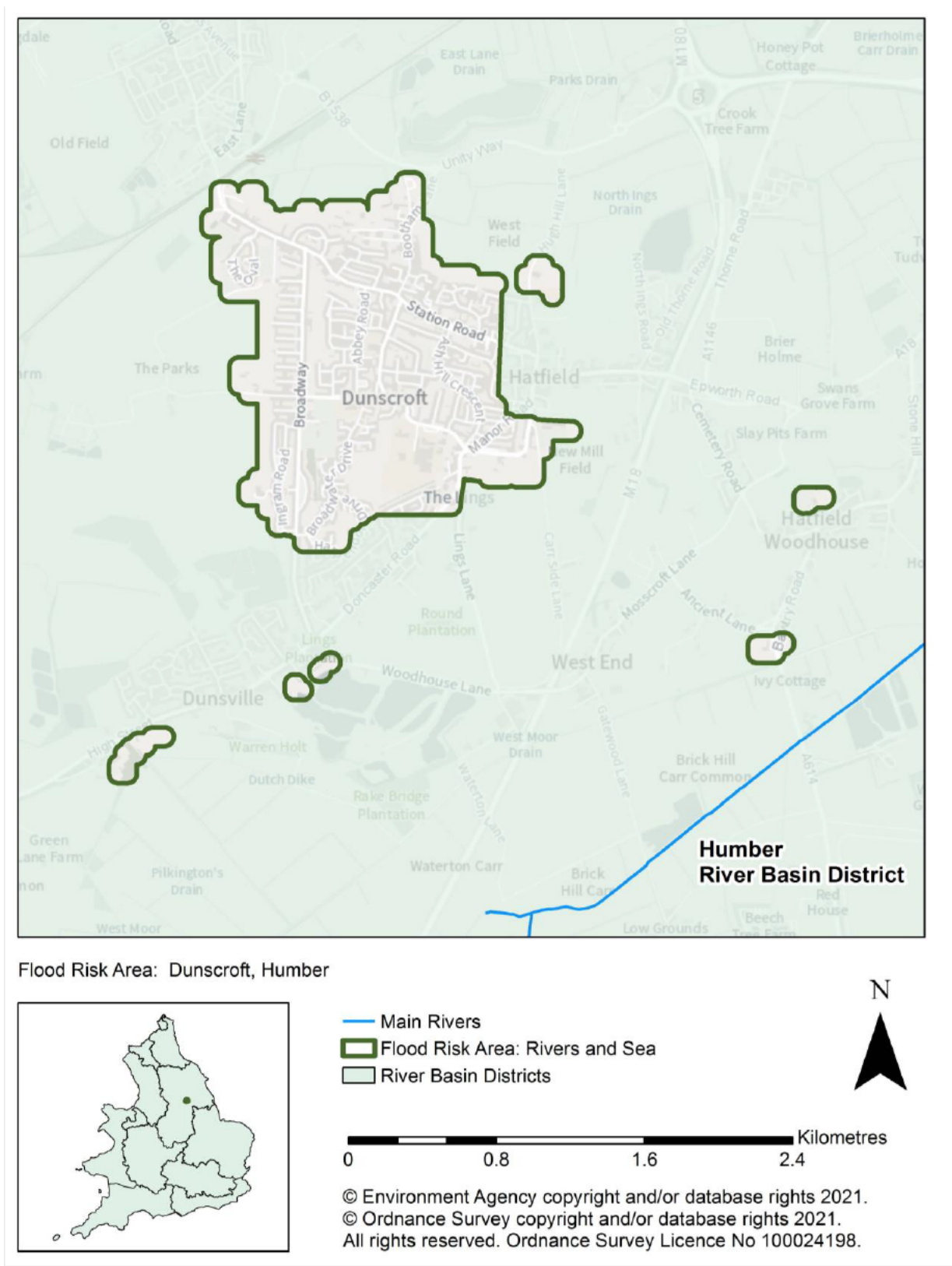


Figure 20: A map showing the boundary of the Duncroft Flood Risk Area

Introduction to the Dunscroft Flood Risk Area

The Dunscroft 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).

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

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Dunscroft FRA covers some businesses and residential properties that are within the immediate area of the River Don as well as some of the dykes and drains in the surrounding area of the town.

The FRA lies on sandstone, pebbly (gravelly) Chester formation overlaid in a few areas with alluvium and river terrace deposits. The soils are predominantly deep well drained sandy and coarse loamy and deep stoneless fine silty and clayey soils variably affected by groundwater.

There is one Local Wildlife site in Dunscroft, Wyndthorpe Hall. There are also a few listed buildings in Dunscroft, mainly around Manor Road, where there is also a heritage at risk area.

Since medieval times, land and drainage activities have been draining the marshy land to allow the land to be reclaimed predominantly for housing and agriculture. Over time flood defences have been created to provide flood risk protection to the reclaimed areas and pumping stations have been erected to create additional agricultural land in the area.

The majority of the flood risk is from the River Don, with additional fluvial flood risk caused by water backing up the dykes and drainage ditches during periods of heavy rainfall and resulting high river levels.

The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Don as well as some of the dykes and drains in the surrounding area of the town. The majority of Dunscroft FRA has been designated as Flood Zone 3 with the remainder of the FRA designated as Flood Zone 2. There is also a risk of surface water flooding in the FRA, particularly during periods of heavy rainfall.

Current flood risk

The [flood hazard and risk maps](#) show that in the Dunscroft (Rivers and Sea) FRA approximately 8,532 people live in areas at risk of flooding from rivers. Of these, none are in areas of high-risk.

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

- 135 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 0.03 km of railway lines
- 56.3 ha of agricultural land
- areas of listed buildings

Based on this information, RMAs have concluded that further steps should be taken to manage risk 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 Risk Management Authorities (RMAs) and other stakeholders for example Doncaster Council, Yorkshire Water and Doncaster East Internal Drainage Board.

The FRA is covered by the South Yorkshire Flood Risk Partnership group that was set up by the Environment Agency following the implementation of the Floods and Water Management Act 2010. Representatives from the Environment Agency, LLFAs and Yorkshire Water sit on the group to strategically manage flood risk across South Yorkshire.

The FRA is also covered by the Isle of Axholme Strategy. Located in a largely rural area of South Yorkshire, Lincolnshire and North Nottinghamshire in the UK, the Isle of Axholme is artificially drained by a complex network of drains and over 60 pumping stations. The objectives of the Isle of Axholme Strategy are to:

- provide the most cost-effective approach for land drainage and flood risk management
- demonstrate resilience in the face of extreme events and/or future change
- maximise the overall carbon efficiency and sustainability of the options considered
- improve the management of existing biodiversity and incorporate gains where possible
- ensure that the strategy is understood and supported by key partners and the wider community
- fulfil the requirements of the WFD, specifically the Humber RBMP

The Isle of Axholme strategy is in progress, but when complete it will see a reduction of flood risk to around 18,000 properties, critical infrastructure and agricultural land. The strategy includes investment in the refurbishment of the Keadby and West Stockwith pumping stations as part of a capital investment of £204 million into the ageing assets would be needed to continue suitable protection and ensure the long-term economic prosperity of the area.

There are no Environment Agency hydrometric monitoring sites within the FRA and there is 1 flood alert and flood warning that cover a small section of the Dunscroft FRA.

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

There are no Environment Agency or third-party flood risk asset management structures in the Dunscroft FRA.

Since the devastating 2019 flooding across South Yorkshire, organisations have been working together to respond to the flood risk and climate emergency in South Yorkshire on a regional scale.

The South Yorkshire Catchment Plan is a vital part of this work. The plan brings key partners and priorities together to build a climate resilient region, to strengthen our capacity to act together over the long term and to provide a compelling programme for investors.

The plan will provide a strong, regional level ambition that benefits the communities of South Yorkshire and will set out how we tackle the causes of flooding, not just the symptoms. The plan is a chance to do things differently and become a national example of innovation and excellence.

We are also reviewing options for large nature-based solutions in the lower catchment, as discussed above, to help build climate resilience and make more space for water. We have an official investment request on our medium-term plan of £40million for Source to Sea – nature-based solutions programme. This programme will still need external funding, but this signifies our ambition and our commitment to respond to the climate and nature emergency in South Yorkshire.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

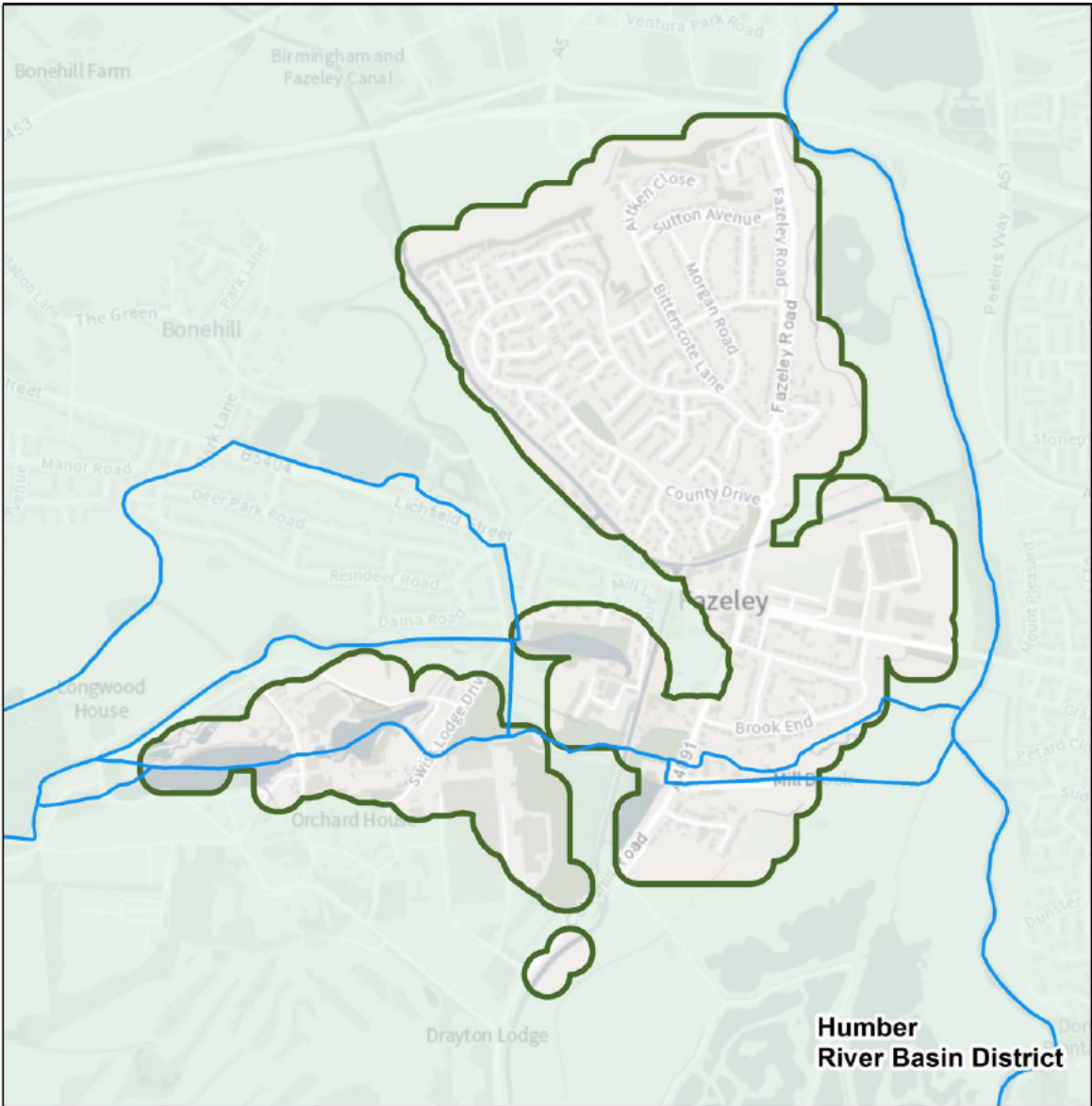
Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Dunscroft FRA

Measures have been developed which apply specifically to the Dunscroft FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Dunscroft FRA. You can find information about all of the measures which apply to the Dunscroft FRA in the interactive mapping tool - '[Flood Plan](#)

[Explorer](#). This includes information on which national objectives each measure helps to achieve.

The Fazeley Rivers and Sea Flood Risk Area



Flood Risk Area: Fazeley, Humber



- Main Rivers
- Flood Risk Area: Rivers and Sea
- River Basin Districts

0 0.4 0.8 1.2 Kilometres

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Figure 21: A map showing the boundary of Fazeley Flood Risk Area

Introduction to the Fazeley Flood Risk Area

The Fazeley 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 takes the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Staffordshire 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.

Fazeley is a town in the District of Lichfield, located on the outskirts of, and forming part of, the wider Tamworth built up area. It is a primarily urban residential area with some light industry. It is located at the confluence of the Bourne Brook with the River Tame. Since the early industrial period, it also sits on the junction of the Birmingham to Fazeley Canal and the Coventry Canal. Both the River Tame and the Bourne Brook are designated main rivers.

The FRA includes 5 Local Wildlife Sites. Parts of Fazeley are designated as a Conservation Area and there are a number of listed buildings within the FRA.

The FRA is at risk of fluvial flooding from the River Tame and the Bourne Brook.

The River Tame flows to the east of the FRA and is one of the principal tributaries of the River Trent. Approximately 42% of the Tame basin is urbanised, making it the most heavily urbanised river basin in the United Kingdom.

The Bourne Brook is some 14 km in length, with a 35 km² catchment. As it reaches Fazeley it flows through Drayton Manor Park and has been modified historically. The Bourne Brook splits into two channels through Fazeley, including a channel known as Mill Brook. Each channel flows into the River Tame to the east of the FRA.

The River Tame catchment is very responsive to rainfall due to the urbanised nature of the upper catchments, and the high percentage of impermeable surfaces. Flooding is more likely during summer months due to the intense rainfall events associated with this season.

Flood defences exist in the FRA that reduce flood risk from the Bourne Brook and the River Tame. These include defences improved or constructed by the Environment Agency in 2014 to reduce flooding from the Bourne Brook at its downstream end. This £3.5m Fazeley section of the Lower Tame flood scheme included:

- new flood banks at Mayfair Drive
- new flood walls - along New Mill Lane, Coton Green Football Club, Brook End and parts of Coleshill Road

- raising of an existing flood bank on Brook End
- the construction of a floodgate across New Mill Lane

The scheme was designed to provide protection against a flood event with a 0.5% chance of occurring in any given year. It has reduced the risk of flooding to 250 properties in the area. The works included environmental improvements to the Bourne Brook.

A further approximately 1.1km of flood banks exists within the FRA:

- along Fazeley Road
- around Willowbank and Meadow Bank
- along the Tamworth Road

These were constructed in the 1960s to provide protection against a River Tame flood that, at that time, was equal to a flood event with a 1% chance of occurring in any given year. These defences reduce the risk of flooding to the majority of properties in the FRA. Between 2021 and 2027, the Environment Agency intends to investigate the standard of protection of these defences. If necessary and viable, the Environment Agency will seek to replace a section of the flood bank along the Fazeley Road.

Flood risk remains further upstream on the Bourne Brook. This is due to the complex network of mill streams and feeder channels associated with Drayton Manor Park and an old mill.

There is risk of surface water and sewer flooding in the FRA. As part of the 2014 scheme, the Environment Agency worked with Staffordshire County Council to reduce surface water flooding on Brook End and Coleshill Road. Staffordshire County Council and the Environment Agency have also carried out [awareness campaigns](#) to explain risks of flooding from all sources to residents.

Parts of Fazeley FRA are also at risk from reservoir inundation.

Current flood risk

There is a history of flooding within the Lower Tame catchment. The most recent significant events occurred in summer 2007. Many houses in Fazeley flooded in summer 2007:

- due to overtopping of the flood banks at the Bourne Brook/Tame confluence
- as a result of floodwater overtopping into the Birmingham and Fazeley Canal at Kingsbury and flowing northwards along the canal before reaching the properties

The [flood hazard and risk maps](#) show that in the Fazeley FRA 3,363 people live in areas at risk of flooding from rivers. Of these, 10% are shown to live in areas of high risk.

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

- 105 non-residential properties - including education, healthcare and transport services

- roads including the A4091 and the B5404
- 0.11km of railway
- 115.39 ha of Grade 3 agricultural land*
- 2 listed buildings
- 4 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 majority of the properties shown as being in areas at risk are provided a high level of protection by the flood defences. These include most of those shown in the maps as being at high to medium risk.

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Fazeley 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 maintain the flood risk management scheme completed in 2014. The Environment Agency visits the scheme 3 times each year for routine maintenance and inspection as part of its long-term maintenance programme:

- the grass is cut on the flood embankments and woody vegetation removed
- mortar and joint seals on the flood wall are inspected and renewed as appropriate
- outfalls and their flaps are checked monthly to ensure their effective operation
- the New Mill Lane Floodgate and a trash screen in Lichfield Street are checked every other month to remove debris and ensure free operation of the gate to reduce build-up of water levels

There is also CCTV on site to enable remote monitoring of debris build up and water level rise to initiate gate closure operation and/or a debris clearance visit.

The Environment Agency also uses its permissive powers to carry out maintenance when required on:

- flood banks on Fazeley Road, around Willowbank and around Meadow Bank
- on the culverts and channels of the Bourne Brook downstream of the A4091 in the town

The responsibility lies with third parties for:

- River Tame river channel
- Bourne Brook channel upstream of the A4091
- the flood bank along Tamworth Road

Severn Trent Water has a maintenance programme in place for public sewers.

The Environment Agency has a hydraulic model for the River Tame (2009) that is being updated and improved to give a better understanding of flood risk in the area. 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 and water levels and provides a flood warning service for the area. If acted upon this can reduce the impact of flooding. The Fazeley FRA is covered by 2 Flood Alert Areas and 3 Flood Warning Areas.

The impact of climate change and future flood risk

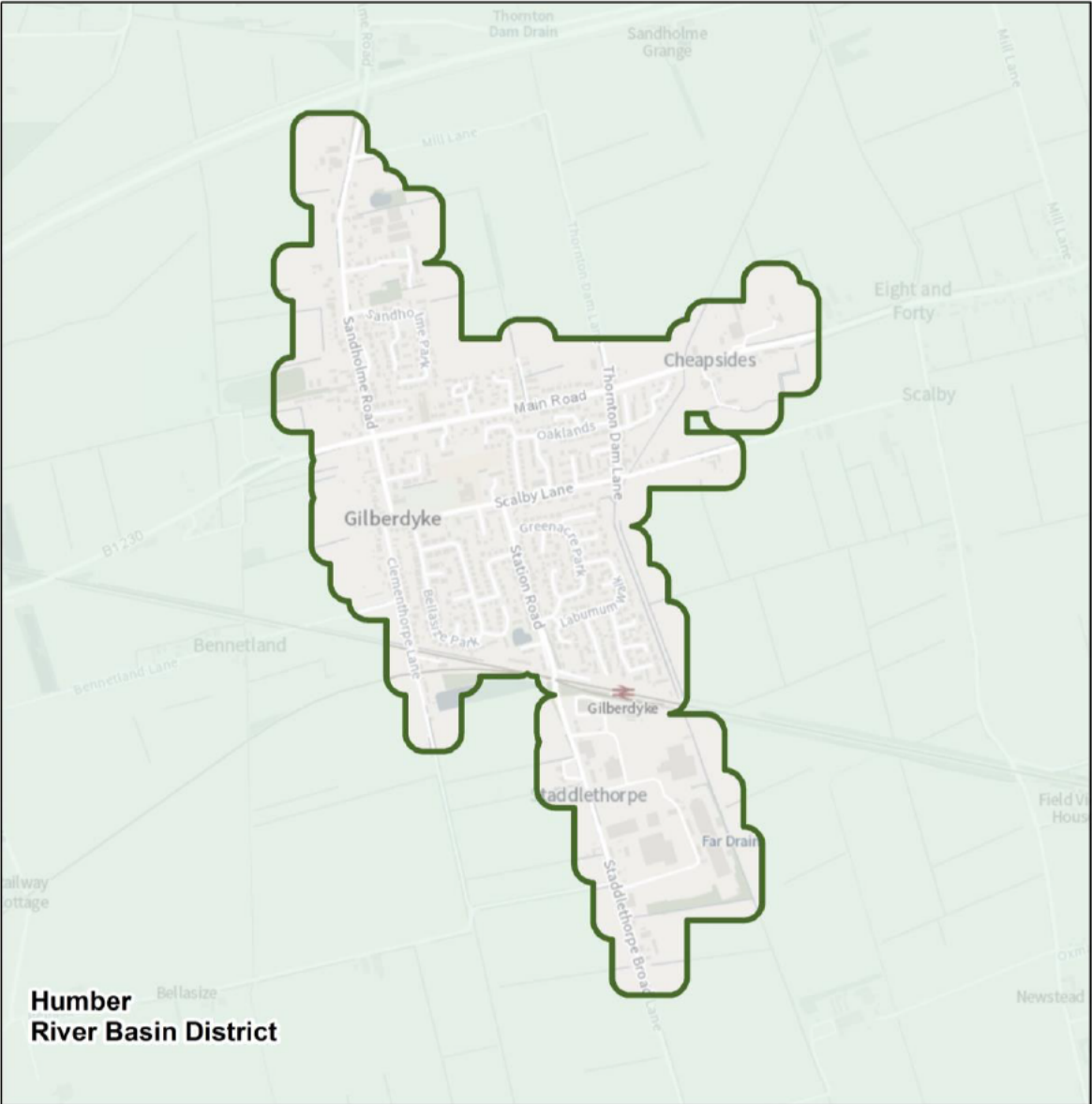
Rainfall intensity is expected to increase in future. This is likely to lead to increased fluvial flows in rivers and potentially increased frequency and intensity of summer rainfall events (which the River Tame is particularly sensitive to). Modelling has indicated that the standard of protection of the defences will be reduced by the impacts of climate change. The current intention is to undertake a managed adaptive approach to ensure the defences continue to provide adequate flood risk protection in the future.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Fazeley FRA

Measures have been developed that apply specifically to the Fazeley FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Fazeley FRA. You can find information about all of the measures that apply to the Fazeley FRA in the '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Gilberdyke Rivers and Sea Flood Risk Area



Flood Risk Area: Gilberdyke, Humber

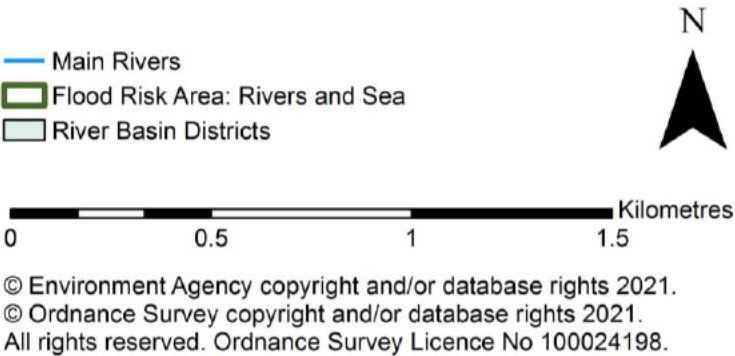


Figure 22: A map showing the boundary of Gilberdyke Flood Risk Area

Introduction to the Gilberdyke Flood Risk Area

The Gilberdyke 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 FRMP for this FRA.

East Riding of Yorkshire Council are the Lead Local Flood Authority whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

Ouse and Humber Internal Drainage Board (IDB) is responsible for most of the watercourses around Gilberdyke.

The Gilberdyke FRA covers several businesses and residential properties in the village. The surrounding area consists of Grade 3 agricultural land.

Gilberdyke sits within the Humberhead levels, national landscape character area 39 which is described as a flat, low-lying and large-scale agricultural landscape with large, regular and geometric arable fields divided by ditches and dykes.

Soils around the FRA are predominantly stoneless clayey and fine loamy top soils over clayey subsoil, with low permeability leading to seasonal waterlogging.

The most significant wildlife designation in the area is the Humber Estuary, which is designated as a Site of Special Scientific Interest (SSSI), Ramsar site, a Special Area of Conservation (SAC) and Special Protected Area (SPA) principally for its wildfowl populations. There are no other designated conservation sites within the FRA. The Cross Keys public house is the only listed building (Grade II) in the FRA.

Gilberdyke FRA falls within the Market Weighton catchment, which based on BGS maps the bedrock geology consists of a series of sandstones and mudstones. Towards the east characteristics tend to be made up of silty, sandy soils towards the Gilberdyke FRA.

Gilberdyke is considered a rural service centre and sits within low lying land at flood risk from the Humber Estuary to the south and Market Weighton Canal to the east. It sits wholly within Flood Zone 3, and is therefore considered to be at risk now and in the future. As such, development ambitions within the Local Plan are likely to be limited. However, the 2016 Local Plan identified a site (ref. NEW-A) for employment uses.

Bishopsoil Drain in Gilberdyke flows directly into the Humber through management structures. Gilberdyke has historically been affected by levels in watercourses in the area but also recently by more intense rainfall events as well.

The FRA is susceptible to tidal flooding from the River Ouse. Gilberdyke also has a significant risk of flooding from surface water across a number of different locations in the village.

The FRA is susceptible to flooding predominantly from the rivers and the sea, however there is some risk of surface water flooding in the FRA as well. According to Environment Agency flood maps, a major part of Gilberdyke is at medium risk of flooding from rivers and the sea (between 1% to 3.33% chance of flooding in any one year).

Far Drain flows along the eastern side of the settlement but is not deemed to be the main source of flooding.

Historical flooding around Gilberdyke has affected areas outside of the main riparian zones in the Market Weighton catchment. Whilst this local flooding may be attributed to fluvial flooding precipitation is the key input and driver of flooding in the FRA.

Flood risk from surface water occurs locally in different parts of the town. Some properties are at risk around Sandholme Close (NW of the town) as well as across the residential area to the north of Scalby Lane, particularly around Lindon Close. Another cluster of properties is at risk along Station Rd and Westbrook Rd in the centre of Gilberdyke where the 2007 flood event had its largest impact on properties.

Current flood risk

Current risk in Gilberdyke is primarily from the River Ouse that flows south of the village and the Market Weighton canal that flows to the east. There are a number of ordinary watercourses flowing through the village and surrounding area, Far Drain/Bishopsoil Drain to the east and Bellasize Drain to the west.

The entire village is shown to be within Flood Zone 3a for both tidal and fluvial risk. Risk from ordinary watercourses wasn't included in the flood zone and as such there may be a potential fluvial risk from these watercourses.

The [flood hazard and risk maps](#) show that in the Gilberdyke FRA some 3,202 people live in areas at risk of flooding from rivers of which none are considered to be in areas of high risk.

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

- 47 non-residential properties
- 1.49km of railway
- 160.16ha of agricultural land
- areas of listed buildings

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Gilberdyke FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example East Riding of Yorkshire Council and Yorkshire Water. Authorities in the area include:

- ERYC – Lead Local Flood Authority main responsibility flood risk from surface water and ordinary watercourses
- Environment Agency – Responsibility primarily main rivers in the FRA and major watercourses. Watercourses aren't maintained by the Environment Agency or IDB, responsibility falls to riparian owners
- Yorkshire Water – the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA
- Ouse and Humber IDB – Help in reducing risk to residents in Gilberdyke. Also responsible for operation and maintenance of key pumps in the catchment area as a whole
- Riparian Owners – Ownership of watercourses which aren't major and overlap on property/land owned. Maintenance and responsibility of any that do overlap into owned land lies with riparian ownership. Inspection work/cleaning could be carried out by the LLFA dependent on circumstances

Regular meetings are held between the Environment Agency and ERYC with regard to incident management, ongoing capital projects and future investment. ERYC is also part of the East Yorkshire Flood Risk Partnership, enabling broader tactical and strategic approaches to be agreed with neighbouring LLFAs and other partners.

The Environment Agency monitor river levels near to the FRA on Market Weighton Canal at Newport (North America) and at Weighton Lock, where the canal discharges in to the Humber Estuary. Estuary tidal levels are also monitored here. Levels in the River Ouse are monitored at Blacktoft, located to the South of the FRA.

The nearest Environment Agency rain gauge to the FRA is also located at Weighton Lock, which is approximately 5km south-east of the FRA.

Gilberdyke is within the Tidal River Ouse from Selby to Faxfleet and River Foulness and Market Weighton Catchment Flood Alert areas. There are currently no flood warning areas that cover the FRA.

Water level and flow information is used to inform and calibrate mathematical modelling of the Humber Estuary, Rivers Ouse and Market Weighton Canal.

The Environment Agency completed the Upper Humber Flood Mapping Study in 2016. This improved the understanding of the potential flood mechanisms in the area, including the FRA, and produce a complete set of defended and undefended flood mapping outputs for various flooding scenarios.

In addition, in 2021 the Humber 2100+ Project, which is undertaking a comprehensive review of the Humber Flood Risk Management Strategy (FRMS), modelled the first set of consistent extreme water levels around the estuary. This set of levels cover those sections of the Rivers Ouse and wider estuary that pose a flood risk to the FRA.

ERYC developed an Integrated Catchment Model (ICM) of the Market Weighton Canal catchment in 2017. This model has been developed for a strategic assessment of flood risk across the Market Weighton catchment area that includes the FRA.

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

Gilberdyke and the surrounding area is flat and low-lying, thus without tidal defences the area would be subject to flooding during most tidal cycles. As a result the FRA is heavily reliant on flood defences to prevent regular inundation. The left bank of the River Ouse as it flows past Blacktoft to the south of the FRA is lined by a series of flood walls and embankments. Weighton Lock is located where Market Weighton Canal discharges in to the Humber Estuary, which blocks high tidal levels propagating up the canal and flooding the surrounding area. These flood defences are operated and maintained by the Environment Agency.

Ouse and Humber IDB have a pumping station located on the downstream end of Blacktoft Drain, to the west of Blacktoft village. This station manages water levels in watercourses connected to the FRA, during periods of high flows and tide locking, thereby reducing flood risk.

There are no formal defences in the village, however the entire village is shown to be in an area benefitting from defences due to tidal defences. The Tidal River Ouse defences protect against tidal flooding, however ordinary watercourses still may pose a risk.

Drainage improvements have been completed at Gilberdyke village hall, which alongside a Flood Alleviation Scheme that was implemented in 2010 along Westbrook Rd, Station Rd and Scalby Lane mitigate surface water flood risk in Gilberdyke. All properties in this area at risk from surface water flooding are shown to be at low risk from Environment Agency flood mapping (between 1% and 0.1% chance of flooding in any one year).

ERYC has conducted numerous smaller scaled schemes in Gilberdyke during the previous funding cycle. These have been aimed to reduce the risk from multiple sources of

flooding and include improvements to Gilberts Dyke, along Greenacre Estate and Sandholme Road as well as general drainage improvements across the village.

Ouse and Humber IDB, recently completed the Howdenshire FAS schemes, which developed two new pumping stations in the area which aim to reduce the risk of flooding to residents in Gilberdyke and nearby locations of Laxton and Eastrington. Details can be found here: [Yorkshire and Humber drainage boards](#).

Following the significant flooding of 2007, the Ouse and Humber IDB developed and delivered the Gilberdyke and Blacktoft Flood Alleviation Scheme. The scheme included the enlargement of Blacktoft Drain and a number of connecting watercourses along with the construction of a pumping station to manage water levels and over pump in to the Humber Estuary during periods of tide locking.

The Environment Agency (EA) has future investment identified to deliver capital maintenance works to the tidal defences along the River Ouse and the Humber Estuary, which provide flood protection to the FRA. These works will be required to keep the defences in the required condition in order to ensure that the current level of flood protection is sustained to Gilberdyke and the surrounding area.

In order to understand this investment need more clearly, the Environment Agency is currently developing a strategic capital maintenance plan for all of the existing linear flood risk assets in the area, including those that protect the FRA.

The future management of flood risk around the Humber Estuary, including the FRA and surrounding area, is set out in the Humber FRMS. A comprehensive review of the existing Humber FRMS is currently underway.

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, taking into account predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Gilberdyke.

ERYC is developing a Gilberdyke SuDs retrofit project, which aims to look at residual surface water issues in the village.

The impact of climate change and future flood risk

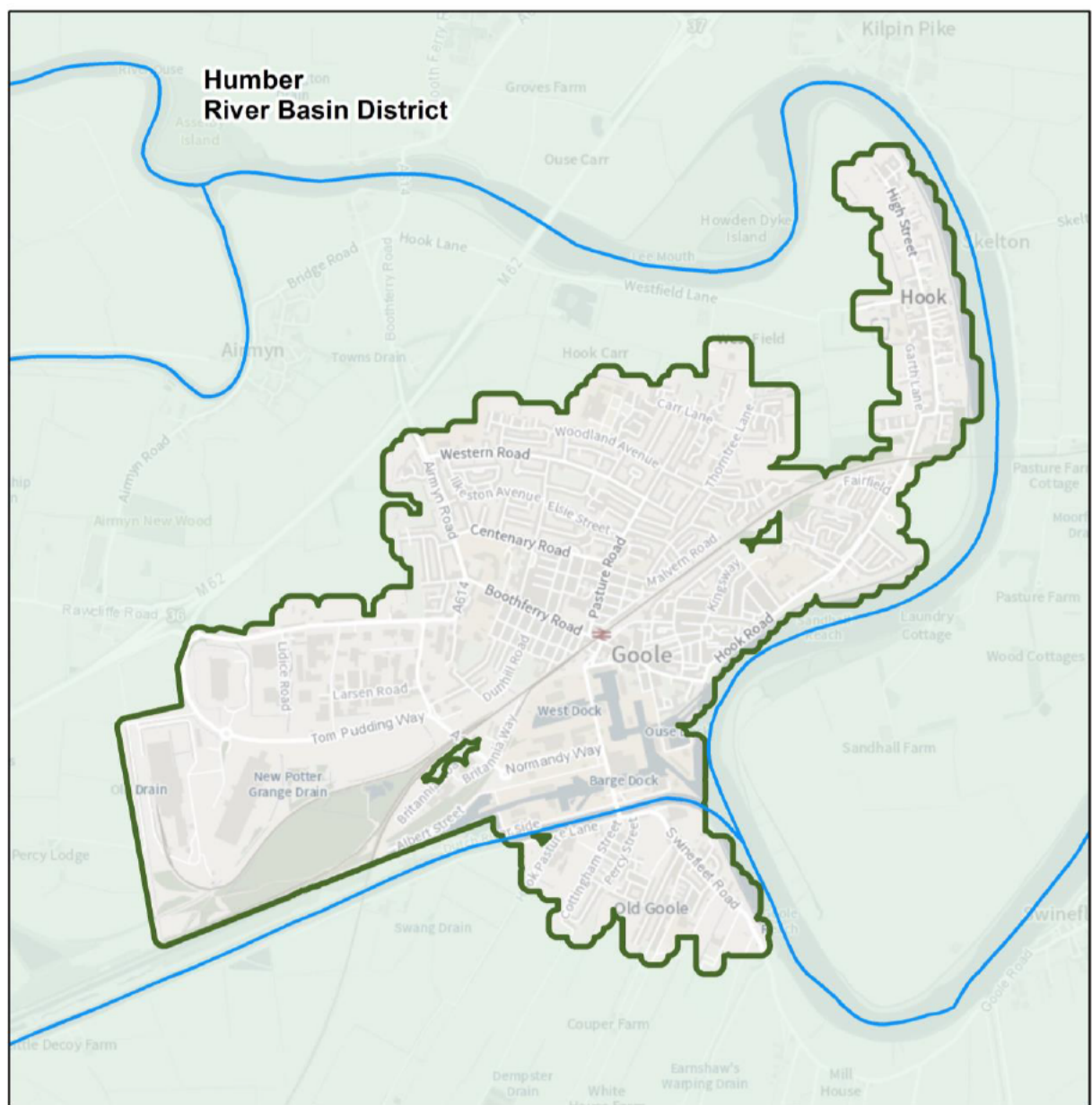
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

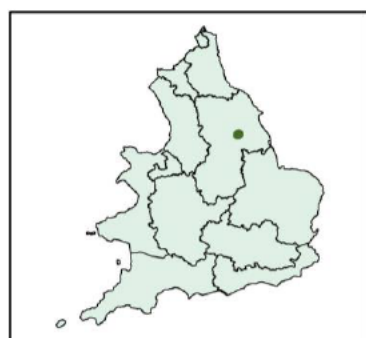
Objectives and measures for the Gilberdyke FRA

Measures have been developed which apply specifically to the Gilberdyke FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Gilberdyke FRA. You can find information about all of the measures which apply to the Gilberdyke FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Goole Rivers and Sea Flood Risk Area



Flood Risk Area: Goole, Humber



- Main Rivers
- Flood Risk Area: Rivers and Sea
- River Basin Districts

0 1 2 3 Kilometres

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Figure 23: A map showing the boundary of Goole Flood Risk Area

Introduction to the Goole Flood Risk Area

The Goole 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 FRMP for this FRA.

East Riding of Yorkshire Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Goole and Airmyn Internal Drainage Board (IDB) is responsible for a number of watercourses around Goole along with the operation of five pumping stations.

The Goole FRA covers several businesses and residential properties in the vicinity of the River Ouse, Dutch River, Aire and Calder Navigation (Knottingley & Goole Canal). The surrounding area consists of Grade 1 agricultural land to the north of the FRA and Grade 2 to the west.

The town of Goole sits within the Humberhead levels, national landscape character area 39 which is described as a flat, low-lying and large-scale agricultural landscape with large, regular and geometric arable fields divided by ditches and dykes.

Soils around Goole are predominantly calcareous heavy silty clay loam topsoils over similar subsoils, which drain well.

The most significant wildlife designation in the area is the Humber Estuary, which is designated as a Site of Special Scientific Interest (SSSI), Ramsar site, a Special Area of Conservation (SAC) and Special Protected Area (SPA) principally for its wildfowl populations. The Goole Conservation Area lies within the heart of the town, near to the docks. The Oak Hill Local Wildlife site lies within the south west portion of the FRA. Immediately adjacent to the FRA, between Goole and Hook, is the Mayfield & Broom Park Local Nature Reserve.

Goole is underlain by primarily sandstone and mudstone to the east of the area. Aquifer designations are present in the area with the sandstone designated as the principal and mudstone a secondary aquifer. These characteristics allow more storage of water in the ground due to higher levels of permeability which will impact groundwater flooding within the FRA.

Local topography of Goole and the surrounding area is close to sea level due to being a port town, situated at the confluence of the Rivers Ouse and Don, generally the ground level of 2 to 4m above ordnance datum (AoD). The land use in the area differentiates from

industrial sites to agricultural land. The Humber Estuary is the main Site of Specific Interest (SSSI) located within close proximity of the Goole FRA.

The Goole area is bounded by the River Ouse to the east, Aire to the north and Don to the south. The drainage system in the area originally consisted of a combined sewer system of foul and surface water which discharged into the River Ouse. More recently, parts of the sewerage system have been designed to drain surface water and sewage into separate systems, which both eventually draining into the historical system.

The FRA is susceptible to flooding from the River Ouse, Dutch River, Aire and Calder Navigation Knottingley & Goole Canal. Hook Drain is also a major riparian watercourse serving Goole, which links to several other drains in the town affecting river and tidal influences. The River Ouse system which discharges at Lock Hill when river levels are low, has an impact on tidal influences in the area.

The FRA is at risk from multiple sources of flooding the most notable being tidal and fluvial flooding, but the area has also been impacted by surface water flooding as well. From Rivers and the Sea The FRA's principle risks from rivers and the sea is from overtopping and from breaches.

Where defences are overtopped, it is important to acknowledge that damage may be considerable and recovery may be slow due to the reliance on pumps and difficulties in effecting repairs at some potential breach locations.

The FRA is most susceptible from both fluvial and tidal flooding from the Rivers Ouse, Don (Dutch River) and Aire.

Goole is surrounded to the East by the River Ouse, to the north by the River Aire and the River Don and the Knottingley & Goole Canal to the South. The land primarily lies between two and four metres AOD, which is significantly lower than the Mean High Water Springs (MHWS) level for the River Ouse.

The low-lying nature of Goole and the surrounding area means that it relies heavily upon artificial drainage and is prone to surface water flooding following intense rainfall.

Nearly all of Goole and the surrounding area is potentially at risk of flooding if the raised defences or dock gates were ever to fail, although the likelihood of a breach is relatively low. Resultant flood depths in the town would range from two to four metres with flood hazard assessment showing that the depths and velocity of flow following a breach of the defences would result in a danger to life across the FRA.

The majority of Goole, with the exception of the docks is at risk from inundation in the event of failure of the Kellington Ings Reservoir (also known as Hensall Ings), on the River Aire.

Despite Goole being principally designated at risk from rivers and the sea, the area is also prone to surface water flooding as demonstrated by the events in August 2011 and July 2012. The area heavily relies upon artificial drainage and during times of intense rainfall.

Groundwater flooding being harder to identify given current understanding is limited. Based on the Environment Agency's Area Susceptible to Groundwater Flooding Map (AStGWf) of which Goole falls within the greater than 75% of the susceptible to groundwater flooding.

Current flood risk

Recent flooding in Goole, including events in 2007, 2011 and 2012, has been as a result of intense summer storms leading to surface water flooding.

The [flood hazard and risk maps](#) show that in the Goole FRA 22,062 people live in areas at risk of flooding from rivers, of which less than 1% are in areas of high risk.

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

- 885 non-residential properties
- 5.32km of railway
- 334.58ha of agricultural land
- areas of environmental permitting regulations, special areas of conservation, special protection areas, RAMSAR, SSSIs, scheduled monuments, listed buildings and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Goole FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Goole Town Council, Yorkshire Water, Goole and Airmyn IDB (who are responsible for the maintenance of 24km of watercourses and operation of 5 surface water pumping stations within its boundary. There is also riparian responsibility with some watercourses in the area most specifically Hook Drain.

ERYC is the Lead Local Flood Authority (LLFA) main responsibility flood risk from surface water and ordinary watercourses.

Environment Agency responsibility is primarily main rivers in the FRA and major watercourses. Watercourses aren't maintained by the Environment Agency or IDB, responsibility falls to riparian owners.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

Goole and Airmyn IDB is the Internal Drainage Board (IDB) in the area who take responsibility in managing flood risk in the area. This could be through maintenance of watercourses, ditches and drains associated with drainage and water level management in rural areas.

Riparian owners have ownership of watercourses which aren't major and overlap on property/land owned. Maintenance and responsibility of any that do overlap into owned land lies with riparian ownership. Inspection work and cleaning could be carried out by the LLFA dependent on circumstances.

Other documents available regarding strategy in the Goole FRA include the Humber Flood Risk Management Plan (FRMP), which sets out measures across the Humber Estuary strategic area in which Goole falls. The measures include the maintenance of existing assets such as culverts, river banks and defences.

The Goole FRMP sets out risk management across the area of Goole with regard to management and maintenance of key flood risk assets in the area.

Also relevant to the Goole FRA, is the development of the Humber 2100+ Strategy, which sets out a long-term strategic approach to managing tidal risk on the Humber Estuary for the next 100 years.

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. These include East Riding of Yorkshire Council (ERYC), Goole and Airmyn IDB, Goole Town Council, Association of British Ports (ABP) and Yorkshire Water.

Regular meetings are held between the Environment Agency and ERYC with regard to incident management, ongoing capital projects and future investment. ERYC is also part of the East Yorkshire Flood Risk Partnership, enabling broader tactical and strategic approaches to be agreed with neighbouring LLFAs and other partners.

The Environment Agency monitor river levels on the River Ouse at Goole Docks, the River Aire at Airmyn and the Dutch River at Rawcliffe Bridge.

The nearest Environment Agency rain gauge to the FRA is located approximately 12km to the east of the FRA at Weighton Lock, where Market Weighton Canal meets the Humber Estuary.

There are two flood warning areas within the FRA, River Ouse at Goole Docks and River Ouse at Goole, and River Aire at Rawcliffe and Rawcliffe Bridge. Goole is within the Tidal River Ouse, Don and the Dutch River Catchment Flood Alert area. The flood response in Goole is generally well-rehearsed, with the EA, ERYC and other partners (including ABP who undertake incident response operations at Goole Docks) taking action at specific levels.

Water level and flow information is used to inform and calibrate mathematical modelling of the Rivers Ouse, Aire & Don (Dutch River). The Environment Agency completed the Upper

Humber Flood Mapping Study in 2016. This improved the understanding of the potential flood mechanisms in the area, including the FRA, and produce a complete set of defended and undefended flood mapping outputs for various flooding scenarios.

In addition, in 2021 the Humber 2100+ Project, which is undertaking a comprehensive review of the Humber Flood Risk Management Strategy (FRMS), modelled the first set of consistent extreme water levels around the estuary. This set of levels cover those sections of the Rivers Ouse, Aire and Don that surround the FRA.

The most recent SFRA of Goole produced in 2019 assessed the residual risk in the area through hydrologic modelling of overtopping and breach scenarios. The present day modelling showed the whole of Goole is protected from flooding for a 1% chance of flooding in any one year combined fluvial and tidal event as well as a 0.5% chance of flooding in any one year combined fluvial and tidal event.

The impact of climate change was considered with this modelling which showed an increased overtopping of defences along the River Ouse in the future. However, the majority of Goole was still shown to be protected by flooding with water from overtopping not reaching the town itself.

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

Goole and the surrounding area is heavily reliant on flood defences to prevent regular inundation. The right bank of the River Ouse as it passes Goole is lined by a series of flood walls and embankments. These defences have a standard of protection (SoP) of 0.5% chance of flooding in any one year against fluvial and tidal flooding. These defences are maintained by the Environment Agency.

The Dutch river is also lined by a series of flood walls and embankments along both banks, providing protection to the docks and Old Goole from both tidal and fluvial flooding. Pumping stations are also in operation in the area which discharge surface water directly into the River Ouse to prevent surcharging of the drainage system.

Goole and the surrounding area is heavily reliant on flood defences to prevent regular inundation. The right bank of the River Ouse as it flows past Goole is lined by a series of flood walls and embankments. The Dutch River and River Aire are both also lined by a series of flood walls and embankments along both banks, providing protection to the FRA and surrounding areas from tidal and fluvial flooding. Most of these defences are operated and maintained by the Environment Agency. Associate British Ports (ABP) operate propping equipment to support the outer lock gates on Victoria and Ocean Docks during significant tidal levels, so as to ensure that these levels do not enter the dock area and in to Goole.

In September 2017, the construction of a flood alleviation scheme by Yorkshire Water began to protect properties in the Atlee Drive of Goole. A feasibility study for Old Goole has been included in the pipeline programme 2021 onwards subject to funding, technical understanding and environmental considerations.

A number of improvements have been undertaken since 2015 including:

- maintenance of existing culverts and watercourse at West Park
- land drainage improvement scheme at Grange Road
- additional highway drainage and speed table to reduce runoff at Parklands

Maintenance work in the area is ongoing - specifically on the main rivers in the FRA. Dutch River, investigative works, assessment and appraisal is to be undertaken to develop a strategy and deliver identified works for the left bank of the river. Further work is planned on the River's Aire and Ouse with the main work being maintenance of current assets.

The Environment Agency (EA) has a number of future projects identified to deliver future capital maintenance works to the defences around the FRA, in order to keep them in the required condition. Current estimates indicate that in excess of £50m of investment will be required over the next 50 years, in order to ensure that the current level of flood protection is sustained by the defences around Goole.

In order to understand this investment need more clearly, the Environment Agency is currently developing a strategic capital maintenance plan for all of the existing linear flood risk assets along the stretches of the Rivers Aire, Don and Ouse that protect the FRA.

The future management of flood risk around the Humber Estuary, including the FRA and surrounding area, is set out in the Humber FRMS. A comprehensive review of the existing Humber FRMS is currently underway.

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, with a particular focus on the first 25 years, taking into account predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Goole.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Goole FRA

Measures have been developed which apply specifically to the Goole FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Goole FRA. You can find information about all of the measures which apply to the Goole FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Grimsby Rivers and the Sea Flood Risk Area

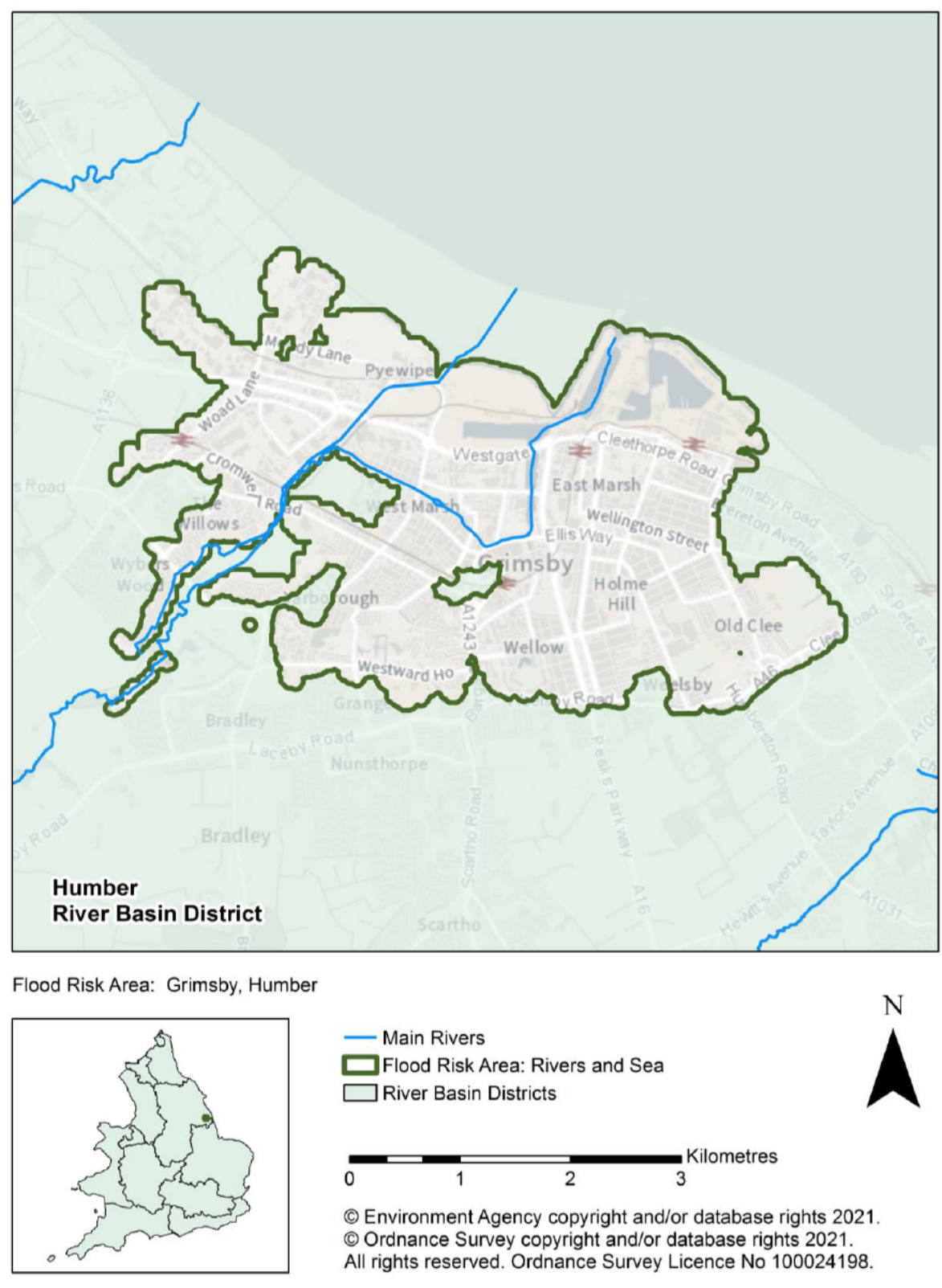


Figure 24: A map showing the boundary of Grimsby Flood Risk Area

Introduction to the Grimsby Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA. North East Lincolnshire Council are the Lead Local Flood Authority (LLFA) responsible for managing flood risk from 'local' sources.

These local sources of flooding are:

- surface water
- groundwater
- ordinary watercourses

North East Lincolnshire Council are also the Coastal Protection Authority in this FRA.

The Environment Agency's remit covers flood risk from rivers and the sea.

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

The North East Lindsey Drainage Board are responsible for draining land in the north-east of the FRA.

The Grimsby FRA is mainly urban and extends to the residential areas of:

- Great Coates
- Little Coates
- Weelsby
- Old Clee

It also includes the industrial areas of Pyewipe and the Royal Docks.

There is equal predominance of seasonally wet deep clay and wet deep loam in the FRA. Grade 3 agricultural land is at the periphery of the FRA. The Humber Estuary is a Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar. The local nature reserve, Weelsby Woods, also lies within the FRA.

Historically the town was settled on low-lying islands and raised areas of the Humber Marsh. It expanded into the surrounding marshes as they were drained. By the twelfth century Grimsby had developed into a fishing and trading port. It was well placed to exploit the rich fishing grounds in the North Sea. Over the next few hundred years the Haven began to silt up, preventing ships from docking.

It was only after dredging began in the 1800's that the town grew rapidly as the port was revived. Grimsby's port boomed and imports included:

- iron

- timber
- wheat
- hemp
- flax

New docks were needed to cope with the expansion. The demand for fish in Grimsby grew during the 1950s, and Grimsby laid claim to the title of being the largest fishing port in the world.

The main sectors of the Grimsby economy today are:

- ports and logistics
- food processing - specifically frozen foods and fish processing
- chemicals and process industries

Eastern Cleethorpes has a thriving tourist industry. To the west, along the Humber, is large-scale industrial activity. Established from the 1950s onwards this focused on chemicals. From the 1990s gas-powered electrical generation has also featured.

Grimsby has developed as a renewable energy centre. Its proximity to the biggest cluster of offshore wind farms in Europe has brought new jobs to the area.

The Northern Becks operational catchment is rural to the south, and urban to the north. The north is dominated by industrial areas around Immingham and the important coastal towns of Grimsby and Cleethorpes. There are a number of protected areas in the catchment including:

- drinking water protected area safeguard zone
- important bathing waters
- Urban Wastewater Directive sensitive sites

Flowing through the FRA and out to sea are:

- River Freshney
- Laceby Beck
- New Cut Drain

A flood storage area on the River Freshney was built in 2000 and upgraded in 2013. This helps to manage flows through the town.

The main risk within the FRA is from tidal sources.

18 sirens at locations around Grimsby and northern Cleethorpes were previously in place to warn residents of a severe tidal flood warning. These have been recently turned off and are in the process of being decommissioned. Sign up to the Environment Agency flood warning service is available to all temporary and permanent residents.

Current flood risk

Grimsby has experienced widespread surface water flooding incidents in:

- June 2016
- Aug 2017
- Aug 2019
- Nov 2019
- Aug 2020

The [flood hazard and risk maps](#) show that in the Grimsby Flood Risk area 51,623 people live in areas at risk of flooding from rivers and the sea. Of these less than 1% are in areas of high risk.

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

- 2,891 non-residential properties - including community centres, hospitals, schools and colleges, retail parks and public utilities
- 12.04km of railway
- 133.62ha of agricultural land
- permitted installations
- listed buildings
- water abstraction points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Grimsby FRA.

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

How the risk is currently managed

The management of flood risk from rivers and sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs). These include:

- North East Lincolnshire Council
- North East Lindsey IDB
- Associated British Ports (ABP)

The Environment Agency have the strategic overview of flood risk across the FRA, and provide the tactical management and operational delivery for the risk from rivers and the sea. This is undertaken in collaboration with the North East Lincolnshire Council as the LLFA and North East Lindsey IDB. Further support is given to Anglian Water who manage the sewerage network. The flood risk management investment is coordinated through the RFCC and locally through the LLFA in combination with the Environment Agency.

The tidal defences along the Humber Estuary are managed and maintained by the Environment Agency. This is in collaboration with ABP within the port of Grimsby. The River Freshney and New Cut Drain have liner defence embankments and a flood storage area downstream of Great Cotes Road.

North East Lindsey IDB pumping stations assist the management of water levels within the land drainage systems. There are several surface water pumping stations managed by North East Lincolnshire Council to manage the drainage from the highway underpasses.

The Humber Local Resilience Forum (Humber LRF) is a multi-agency partnership made of representatives from local public services, such as:

- emergency services
- local authorities
- NHS
- Environment Agency

The LRF Risk Assessment Working Group produces a Community Risk Register for the Humber Sub-region. This details a description of the risks and likelihood of it occurring. It also considers the impact it would have on the community and economy should it happen. This assessment includes risks from flooding. The forum work in a multi-agency collaboration to manage flood incidents under the Civil Contingencies Act 2004.

The Environment Agency undertakes hydrometric monitoring at 5 locations within the FRA. This information is used to inform activities related to 5 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur. This data also informs the operational response during a flood incident.

Updated modelling and mapping in the River Freshney was undertaken in 2016. Improvements to the Humber Estuary flood risk modelling have been completed as part of the developing Humber 2100+ strategy.

Flood risk maps are published based on the outputs from 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 operates and maintains flood risk management assets along the Humber Estuary and on the main watercourses in the FRA. These include:

- flood defence embankments and walls
- flood storage area
- flood gates
- channels
- culverts
- debris screens

This work includes routine inspection and clearance activities as well as regular repair and replacement of assets.

Associated British Ports (ABP) actively manage the water levels within the docks to reduce the impacts of tidal inundation.

Flood risk improvement works that benefit the Grimsby FRA completed recently by the Environment Agency include:

June 2016

Work was completed around the port of Grimsby on a £20 million project which reduced the risk of overtopping and potential failure of three and a half kilometres of tidal flood defences to the town. The standard of protection has been improved to a 1 in 200 (0.5%) chance in any given year.

The Environment Agency has embarked on developing a scheme to undertake structural improvements to the sea defences in:

- Middle Drain
- Stallingborough
- Pyewipe

This will reduce the risk of tidal flooding of:

- residential properties
- commercial properties
- large industrial plants
- key infrastructure

Construction is expected from 2022 to 2024.

North East Lincolnshire Council have undertaken a number of projects to reduce the risk of surface water within the FRA. These include:

- Peaksfield Avenue
- Willingham Street
- St Nicolas Drive

A scheme to better protect properties in Broadway is in development.

A strategic study is being undertaken by North East Lincolnshire Council in collaboration with Anglian Water. This will reduce the risk of surface water flooding to additional parts of the FRA. Improvements are expected to be delivered in phases between 2022 and 2025.

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, taking into account predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Grimsby.

The impact of climate change and future flood risk

As sea levels rise, it means that coastal flooding will become more frequent as higher water levels and storms will be seen more often. Rainfall intensity is expected to increase in future which will cause river flows to increase.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber RBD.

Objectives and measures for the Grimsby FRA

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

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

The Gunthorpe Rivers and Sea Flood Risk Area

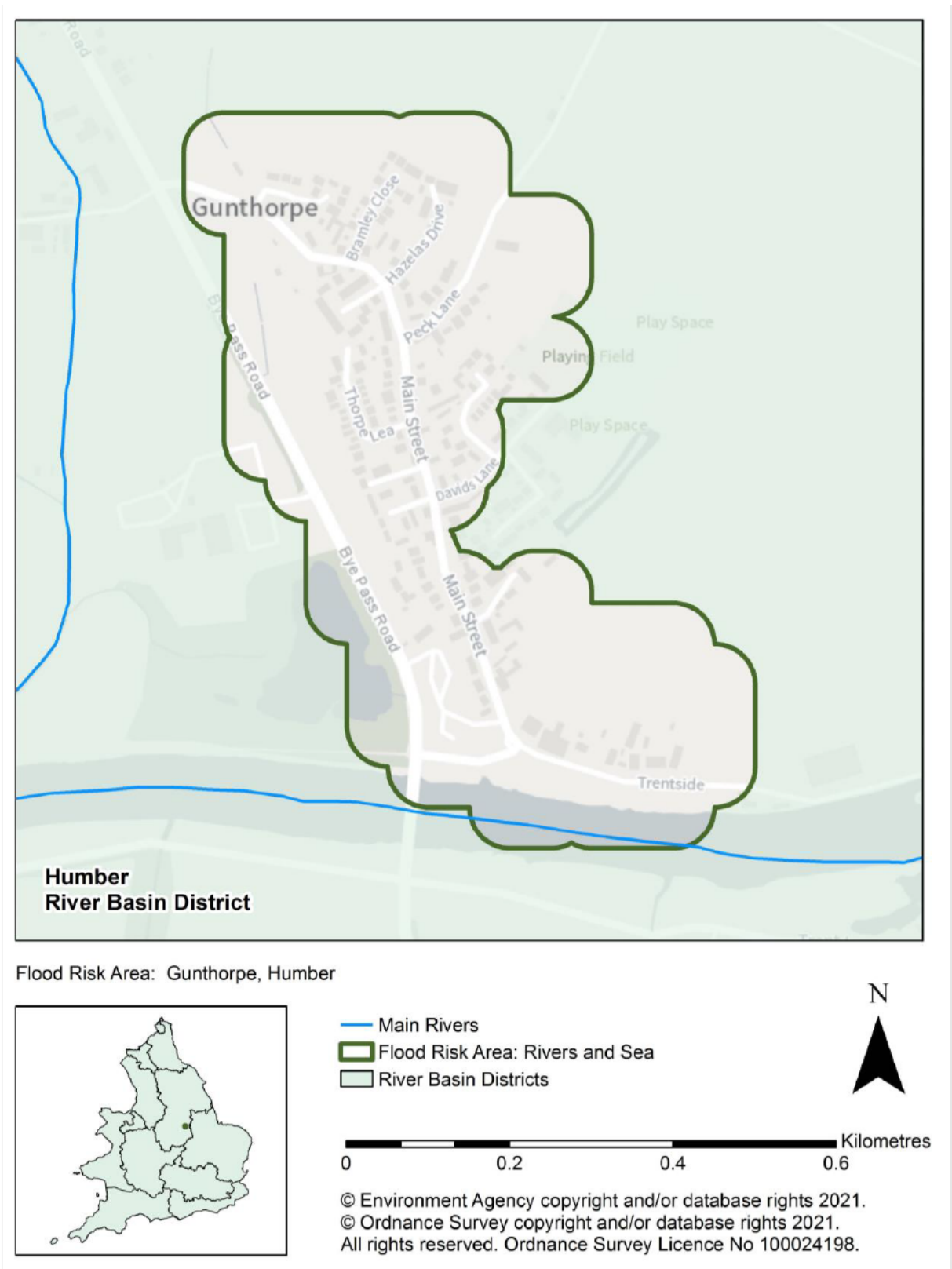


Figure 25: A map showing the boundary of Gunthorpe Flood Risk Area

Introduction to the Gunthorpe FRA

The Gunthorpe 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authority (LLFA) Nottinghamshire County Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The Gunthorpe FRA covers the village of Gunthorpe, and part of Gunthorpe Bridge, a strategically important crossing for the A6097 road over the River Trent. Gunthorpe is a village characterised by residential suburbs, business and amenity areas, parallel to the A6097, with the River Trent (main river) skirting the south of the FRA.

Gunthorpe is located in the River Trent valley, east of Nottingham. Much of the village is built on Triassic mudstone which are relatively permeable. The Trent valley also features floodplain alluvium and sands and gravels.

There has been significant sand and gravel extraction works throughout the Trent Valley, some of which are still active. Adjacent to the Gunthorpe FRA is the Gunthorpe Riverside Gravel Pit wildlife site. Within the FRA boundary there is also 1 listed building and a henge to the south of Lodge Farm, which is a scheduled ancient monument.

Gunthorpe is served by a foul / combined gravity sewer network, which includes 2 sewage pumping stations. There is also a limited network of surface water sewers. Severn Trent Water has a hydraulic model of the foul / combined sewers.

Current flood risk

The primary source of flood risk for Gunthorpe is flooding from the River Trent. There are records of historic flooding in Gunthorpe. In recent years, the River Trent has flooded in January 2021, February 2020 and November 2019. Each of these events saw flooding to properties and businesses, along with disruption to the A6097 crossing.

The [flood hazard and risk maps](#) show that in the Gunthorpe (Rivers and Sea) FRA approximately 384 people live in areas at risk of flooding from rivers. Of these, 25.3% are in areas of high-risk.

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

- 7 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 0.65 km of roads
- 31.1 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments and listed buildings

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments. Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network.

Internal Drainage Boards (IDBs) operate in the low-lying fen and valley areas, maintaining pumping stations and drainage channels to ensure that people are safe and the risk of flooding is greatly reduced. The Trent Valley Internal Drainage Board (TVIDB) covers an area of low-lying land from the west of Gainsborough, straddling the River Trent and its tributaries, down to the south of Nottingham, a total of 44,093ha. The board's team, maintains 778km of watercourse and operates 18 pumping stations across their area, which includes part of the Gunthorpe FRA.

The Nottinghamshire Local Resilience Forum (Nottinghamshire LRF) is a multi-agency partnership made of representatives from:

- local public services
- the emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions within the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Trent.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the River Trent and 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

The impact of climate change and future flood risk

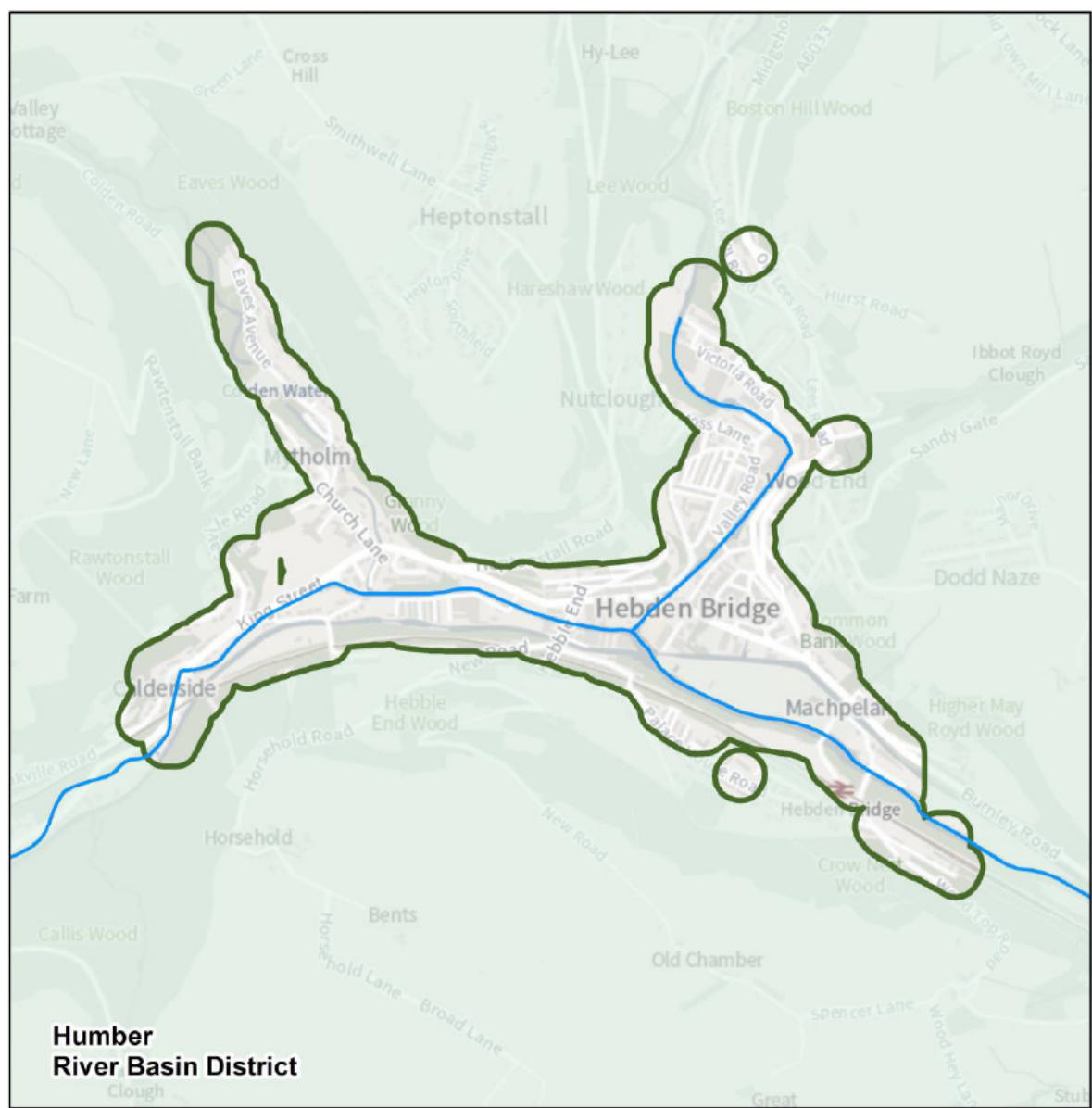
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Gunthorpe FRA

Measures have been developed which apply specifically to the FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Gunthorpe FRA. You can find information about all of the measures which apply to the Gunthorpe FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Hebden Bridge Rivers and Sea Flood Risk Area



Flood Risk Area: Hebden Bridge, Humber

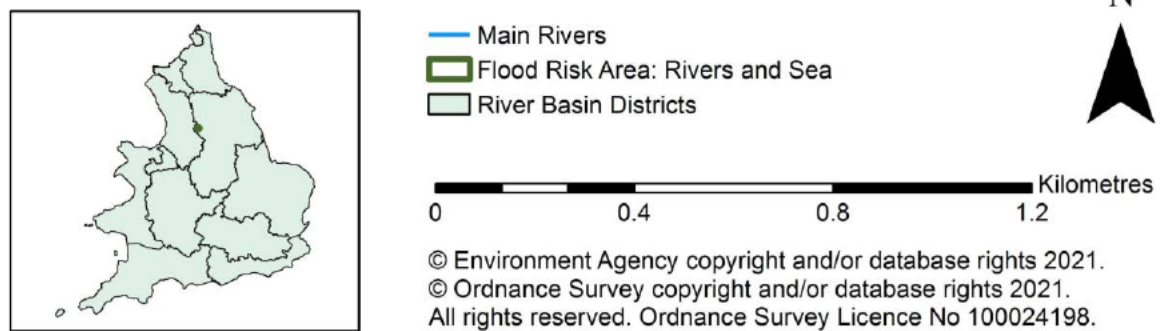


Figure 26: A map showing the boundary of Hebden Bridge Flood Risk Area

Introduction to the Hebden Bridge Flood Risk Area

The Hebden Bridge 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.

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

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Hebden Bridge FRA covers several businesses and residential properties in the vicinity of the River Calder, Hebden Beck.

The Hebden Bridge FRA lies on a bedrock of Kinderscoutian aged sandstone, sandstone todmorden grit and a mixture of mudstone and siltstone hebden formation overlaid with alluvium. The predominant soils in the Hebden Bridge FRA are well drained coarse loamy soils over rock and coarse loamy very acid upland soils over rock with a wet peaty surface horizon and thin ironpan.

Calder Valley Community Land Trust has been set up to create sustainable and affordable housing designed to meet the needs of the Hebden Bridge community. There are new housing developments planned for the area.

Due to the constraint of the valley size, the flood plain and historic and heritage features, development in Hebden Bridge tends to be small scale and is mostly brownfield land development and changes to existing property.

Hebden Bridge is at risk from fluvial, canal and surface water flooding. It is located in a steep-sided valley at the confluence of three rivers: River Calder, Hebden Water and Colden Clough. There is a risk of flooding from overtopping of the canal as a result of high inflows exceeding the canal capacity during storm events. The canal overtops in Hebden Bridge and floods properties between the canal and River Calder. The town and surrounding villages are also at risk of surface water flooding.

Current flood risk

Hebden Bridge has a long history of flooding with records of regular events dating back to 1837. More recently, flooding has occurred in 2000, 2006, three times in 2012, 2013 and three times during the winter of 2015-16. The flooding on Boxing Day 2015 was estimated to have been a 0.5% average exceedance probability (AEP) event which flooded 551 residential and non-residential properties. Flooding affected all major transport routes through Calderdale and other critical infrastructure.

The most recent flood event was experienced in February 2020 when torrential rain, from Storm Ciara, caused torrents of floodwater to sweep through the streets, cars submerged, businesses badly damaged, misery for residents.

The [flood hazard and risk maps](#) show that in the Hebden Bridge FRA some 1,706 people live in areas at risk of flooding from rivers of which 29% are considered to be in areas of high risk.

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

- 404 non-residential properties
- 1.15km of road
- 0.18km of railway
- areas of scheduled monuments, listed buildings and water abstractions and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Hebden Bridge FRA.

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

How the risk is currently managed

Following the devastating flooding experienced on Boxing Day 2015 the Calderdale Flood Recovery and Resilience Programme Board was set up. The board is led by Calderdale Council, but includes all key partners including the Environment Agency, Yorkshire Water, the Canal & River Trust, Network Rail, local councillors. The aim of the Board is to oversee the delivery of all the work contained in the Calderdale Flood Recovery and Resilience Programme, with its aim of reducing the risk of flooding within the borough of Calderdale, and building the resilience of local communities to withstand the effects of any future flood events. Feeding into the board are four operational groups which include Flood Reduction and Investment, Natural Flood Management, Community Resilience and Resilient Infrastructure.

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders for example Calderdale Council, Yorkshire Water, Northern Power Grid and the Canal & River Trust. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

There are two continuous river level gauge telemetry stations in Hebden Bridge; one on the River Calder and one on Hebden Water at Hebden Bridge Nutclough. There is one flood alert and 3 flood warnings covering the Hebden Bridge FRA.

The water level information is used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have up to date modelling and they are being revised as part of the ongoing development of the Hebden Bridge FAS.

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 have permissive powers on the main rivers in Hebden Bridge to clear blockages deemed to cause a flood risk and once the Hebden Bridge Scheme is completed there will be future assets to maintain. Calderdale LLFA and Yorkshire Water maintain assets that perform a flood risk management function on the drainage network.

The Hebden Bridge Flood Alleviation Scheme (FAS) is currently being developed, led by the Environment Agency, to improve protection for approximately 400 properties.

The scheme will consist of:

- raising and strengthening river walls
- using glass panels and raising barriers to minimise any intrusion on river views
- improving protection to riverside properties
- installing a canal overflow
- improving the drainage of surface water with a series of gully systems and pumping stations

Work commenced at the Vale Centre site, Stubbing Holme Road in April 2021 to repair the dilapidated wall and facilitate installation of the canal overflow. This will be followed by a phased approach to delivering the fluvial elements of the scheme. The project team are planning to hold a public information event to provide more information about the plans for the scheme later this year. This project will reduce the flood risk to 231 commercial properties and move 180 commercial properties to a lower flood risk band, directly safeguarding approximately 700 jobs. In addition, the scheme will better protect 183 residential properties and move 130 to a lower flood risk band and improve the resilience of the A646 road towards Mytholmroyd and the M62.

The Environment Agency regularly holds meetings with partners, local councillors and community representatives to provide them with updates on progress of the Hebden Bridge Flood Alleviation Scheme. The project team has also taken part in community forums such as the Hebden Bridge Business Forum and the Disability Access Forum to get feedback on proposals for the scheme.

The Environment Agency is also working with Yorkshire Water to investigate using reservoirs above Hebden Bridge to store water and help reduce flood risk. There are, however, significant challenges associated with the use of reservoirs designed for water

supply for managing flood risk, though all parties are fully committed to exploring any viable opportunities.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Hebden Bridge FRA

Measures have been developed which apply specifically to the Hebden Bridge FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Hebden Bridge FRA. You can find information about all of the measures which apply to the Hebden Bridge FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Hedon Rivers and Sea Flood Risk Area

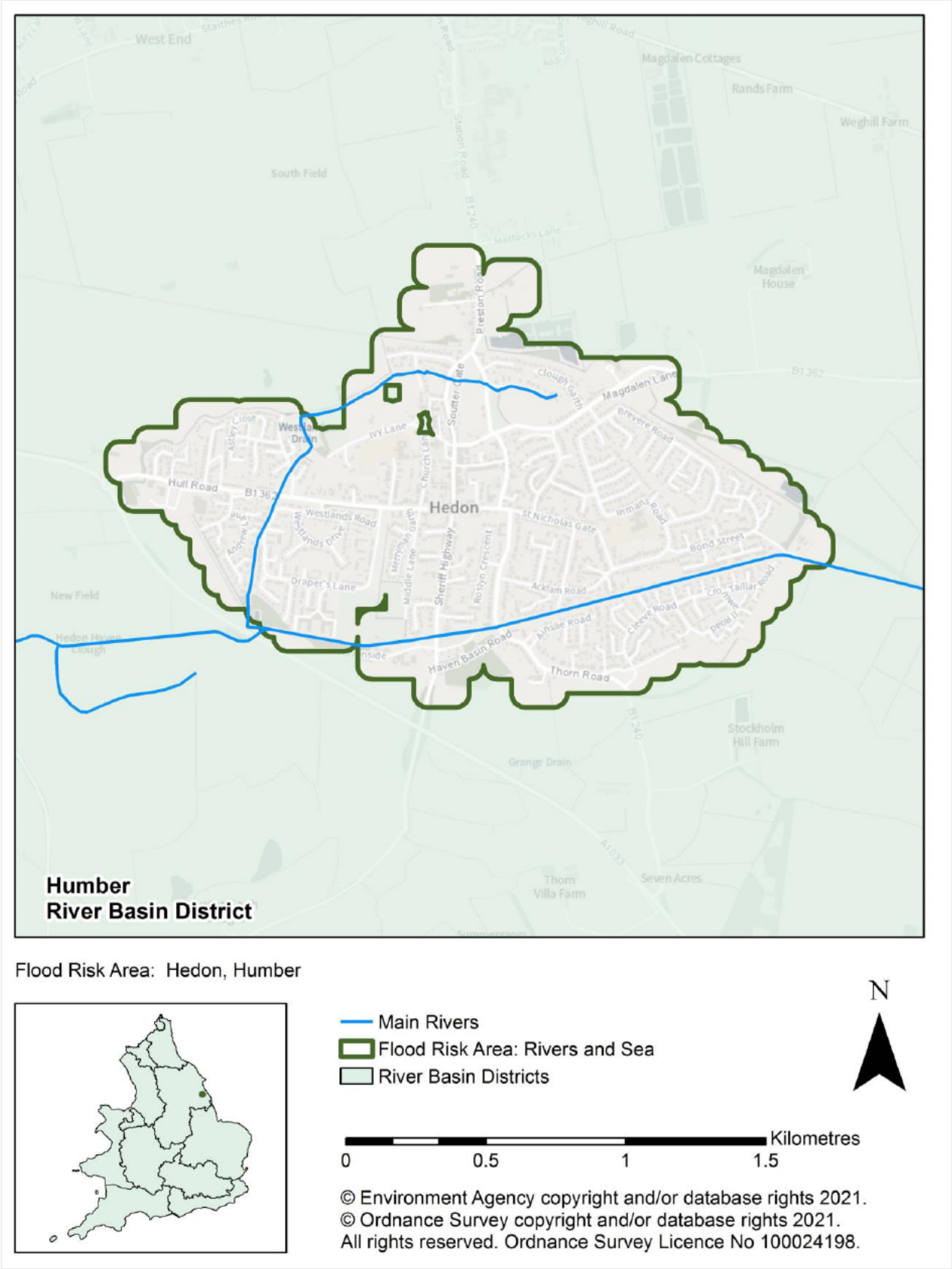


Figure 27: A map showing the boundary of Hedon Flood Risk Area

Introduction to the Hedon Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA.

East Riding of Yorkshire Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The South Holderness Internal Drainage Board (IDB) is responsible for a number of watercourses around Hedon.

The Hedon FRA covers several businesses and residential properties in the vicinity of the Burstwick Drain. Much of the surrounding area is Grade 3 agricultural land.

Soils around Hedon are dominated by clayey alluvial deposits that reflect the local low lying topography along the Humber Estuary and the rest of the course of Burstwick Drain. Permeability is low and soils are easily waterlogged meaning managed drainage is required to lower the water table.

Hedon, along with much of the surrounding area, is situated within a surface water Nitrate Vulnerable Zone. The most significant wildlife designation in the area is the Humber Estuary, which is designated as a Site of Special Scientific Interest (SSSI), Ramsar site, a Special Area of Conservation (SAC) and Special Protected Area (SPA) principally for its wildfowl populations. The old line of the Hedon to Winestead railway line lies just to the east of the FRA, which is designated as Local Wildlife site.

The land use in Hedon is predominantly rural agricultural land, particular in the upper parts of the FRA area. Specifically the area has been defined as 'Grade 3 Agricultural Land' being good to moderate quality, the topography of the land is relatively flat as well. The highest elevations reach approximately 27m AoD in the upper catchment. Compared to the south western part of the catchment, which includes Hedon, down to the confluence with the Humber Estuary, lies on very low ground of around 3m AoD.

For future development in the Hedon area it is key that residual risk is taken into account as the majority of Hedon lies in Flood Zone 3a and is protected by defences. Any development proposed would have to take into account these factors.

The FRA is susceptible to flooding from the Burstwick Drain. The drain flows east to west through the south area of the town with the drain discharging at low tide at Salt End into the Humber Estuary through a tidal gate called Burstwick New Clough. This tidal gate

controls water discharging from the Burstwick catchment into the Humber Estuary and prevents backing up of water from the Estuary.

Hedon FRA has been designated as a Flood Risk Area from Rivers and the Sea. Burstwick Drain contributes to both fluvial and tidal risk in the area as with times with higher tides this tidal gate will be raised to control the flow of water within the drain and vice versa when river levels are higher than usual.

Modelling of the area showed that a tidal defence breach of the Burstwick New Clough gate would result in potentially half of the Hedon area being at risk from flooding if the asset was to ever fail.

Residual risk is present in the FRA where alleviation measures have taken place. In the event of breach that causes flooding in the town it is important to acknowledge that recovery may be slow due to the reliance on pumped discharges and potential repairs to any breach locations.

Surface water flood risk is also present in the Hedon FRA. The risk mainly comes from where the drainage network discharges into the Burstwick Drain through flapped outfalls. When these outfalls lock due to high levels in the drain, backing up of the surface water system will occur and result in localised surface water flooding, this was seen in 2007.

Groundwater flooding is also a factor which could contribute to risk in Hedon with the East Yorkshire aquifer underlying the area which is primary characteristic is chalk. However, the drift geology of the area composed of clayey, loamy soils would impede water infiltration. As a result this would limit the interaction between surface water and groundwater and reduce the risk of groundwater flooding associated with the rise of the water table.

Current flood risk

Hedon suffers regularly from flooding, with more recent events occurring in 2000, 2007, 2014, 2017, 2018 and 2019. Mostly these events lead to highway flooding and flooding of gardens and public open space. However, in June 2007 more significant flooding in Hedon, including property flooding, was experienced.

Section 19 of the Flood and Water Management Act gave LLFA's the duty to report on flooding where it considers necessary or appropriate investigations, and these have been conducted in regard to flooding in Hedon since 2015. In August 2017, intense rainfall occurred across East Riding with Hedon being one area affected. The S19 investigation concluded that flooding occurred as a result of the drainage systems being overwhelmed by intense rainfall followed periods of rain throughout the day that had filled the systems.

In April 2018, many accounts of flooding were reported across East Riding with several including reports of garden and internal flooding in Hedon. Prolonged rainfall for several months occurred, leading to high groundwater levels and high levels in rivers and watercourses in the area. As a result, highway flooding occurred in Hedon from high water

levels in Burstwick Drain and as a result of the surface water system being unable to cope with the levels of water.

In November 2019, heavy rain led to surface water flooding across East Riding and Hedon, East Riding of Yorkshire Council (ERYC) initiated a S19 investigation for this event.

The [flood hazard and risk maps](#) show that in the Hedon FRA 8,788 people live in areas at risk of flooding from rivers of which none are considered to be in areas of high risk.

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

- 163 non-residential properties
- 94.61ha of agricultural land
- areas of scheduled monuments and listed buildings

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Hedon FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example. These include East Riding of Yorkshire Council, (ERYC), South Holderness IDB, Hedon Town Council and Yorkshire Water.

The integrated nature of the risk in Hedon means the LLFA, sewerage company and the Environment Agency work together on reducing risk from all sources.

Regular meetings are held between the Environment Agency and ERYC with regard to incident management, ongoing capital projects and future investment. ERYC is also part of the East Yorkshire Flood Risk Partnership, enabling broader tactical and strategic approaches to be agreed with neighbouring LLFAs and other partners.

The Environment Agency monitor river levels on both Burstwick Drain and Westlands Drain around Hedon. On Burstwick Drain monitoring sites are located at Salt End (Burstwick Clough) and Thorne Road Bridge. Monitoring on Westlands Drain is located at its confluence with Burstwick Drain, adjacent to the A1033.

The nearest rain gauge to the FRA is located at the Environment Agency's Great Culvert Pumping Station, on Holderness Drain.

There are three flood warning areas within the FRA, Westlands Drain at Hedon, Burstwick drain at Hedon West and Burstwick Drain at Hedon East. Hedon is within the Burstwick

and Keyingham Drains Flood Alert area. The flood response in Hedon is generally well-rehearsed, with the Environment Agency, ERYC and other partners taking action at specific levels to enact pumping and other operational arrangements.

Water level and flow information is used to inform and calibrate mathematical modelling of the drainage network. The Environment Agency completed the Burstwick Drain Modelling Study in 2015, which provided a greater understanding of flood risk across the catchment (including the FRA) at the time. In addition ERYC have developed an Integrated Catchment Model (ICM) that includes the Burstwick Drain, Old Fleet Drain and part of the Keyingham Drain catchments. The ICM covers the FRA and was used for the development of the Burstwick Catchment Flood Risk Management Plan (FRMP) published in June 2018.

The South Holderness Internal Drainage Board (IDB) is responsible for a number of watercourses within the area around and including in Hedon. Part of Old Fleet Drain, Preston New Drain, Reedmere sewer, part of Burstwick Drain, part of Thorngumbald Drain and part of Skeffling Drain. The IDB doesn't have any pumping stations in the area, through the operation and maintenance of outfalls and the channel system in the area. The IDB seek to maintain a general standard capable of providing flood protection to agricultural land from a 5% chance of flooding in any one year event and to developed areas from a 1% chance of flooding in any one year event.

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA.

East Riding of Yorkshire Council (ERYC) are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Humber FRMP also set out measures across the Hull and East Riding management catchment and the Humber Estuary Strategic area, both of which the Hedon FRA forms part of. Also relevant to the Hedon FRA, is the development of the Humber 2100+ Strategy, which sets out a long-term strategic approach to managing tidal risk on the Humber Estuary for the next 100 years.

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

Following the 2007 events, the Environment Agency and ERYC have undertaken a number of improvements to drainage systems and riverbanks to tackle fluvial flood risk within the Hedon FRA. This includes:

- raising of fluvial defences at Hedon and Burstwick to a 0.5% chance of flooding in any one-year standard of protection to prevent overtopping of banks during high flows
- installation of two over-pumping stations by the EA. One is a mobile facility at Burstwick New Clough which drawdown high water levels in the drain whilst it is tide-locked. The other is installed at the outfall of the Westland's Drain cannot discharge into the Burstwick Drain by gravity

Westland's Drain is protected by high ground as it flows through Hedon and a tidal gate at Burstwick New Clough controls water discharging from the Burstwick Drain into the Humber Estuary. Failure of the tidal gate during periods of high tide would lead to significant volumes of water from the Humber Estuary entering the Burstwick Drain and would have a significant effect on flood risk in Hedon.

Hedon and the surrounding area generally have a ground level of less than 5m above ordnance datum (AOD), which is lower than the Mean High Water Spring level. As such, Hedon and the surrounding area is reliant on a number of flood risk assets to prevent regular tidal inundation. The largest single asset is Burstwick Clough, which comprises a set of tidal doors and associated penstocks, to stop the ingress of tidal water in to Burstwick Drain. There is a similar structure at the downstream end of Westlands Drain, at its confluence with Burstwick Drain to stop high levels in Burstwick Drain propagating upstream on Westlands Drain.

Following flooding in 2007, the Environment Agency has undertaken a number of improvements to drainage systems and riverbanks around the FRA to tackle fluvial flood risk. These include:

- raising of fluvial defences at Hedon to a 0.5% chance of flooding in any one-year standard of protection to prevent overtopping of banks during high flows
- installation of two pumping facilities. One is a mobile facility at Burstwick New Clough to drawdown high water levels in the drain whilst it is tide-locked. The other is installed at the outfall of the Westlands Drain and is operated at times when water from the Westlands Drain cannot discharge into the Burstwick Drain by gravity

In 2011, demountable pump apparatus, including permanent pipework, valve gear and hardstanding, was installed to improve the operational response and reduce flood risk on the Inmans Estate in Hedon. This equipment was jointly funded by Yorkshire Water and East Riding of Yorkshire Council.

Phase 2 of the Hull and Holderness Flood Alleviation Scheme (HHFAS) is within the pipeline programme going forward in the councils FCERM programme. This includes two schemes which are located in the town of Hedon. These schemes appear as Preston and Hedon North FAS and Hedon FAS in the national programme. These schemes are subject to funding, technical feasibility and environmental considerations.

East Riding of Yorkshire Council are currently developing two flood alleviation schemes (FAS) covering the FRA:

- Hedon FAS – The proposed outline scheme includes improvements to the existing drainage systems, installation of new infrastructure to prevent high waters from surcharging the existing network and flow routing measures to prevent water reaching properties at risk. An additional low hard defence to the east of Inmans Estate to prevent overland flooding from agricultural land to the east
- Preston & North Hedon FAS – The outline scheme currently proposed for the northern areas of Hedon includes the construction of a flood storage area to provide a reduction in flood risk and also control the diverted flows from additional measures proposed in Preston

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Hedon FRA

Measures have been developed which apply specifically to the Hedon FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Hedon FRA. You can find information about all of the measures which apply to the Hedon FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Hesse Rivers and Sea Flood Risk Area

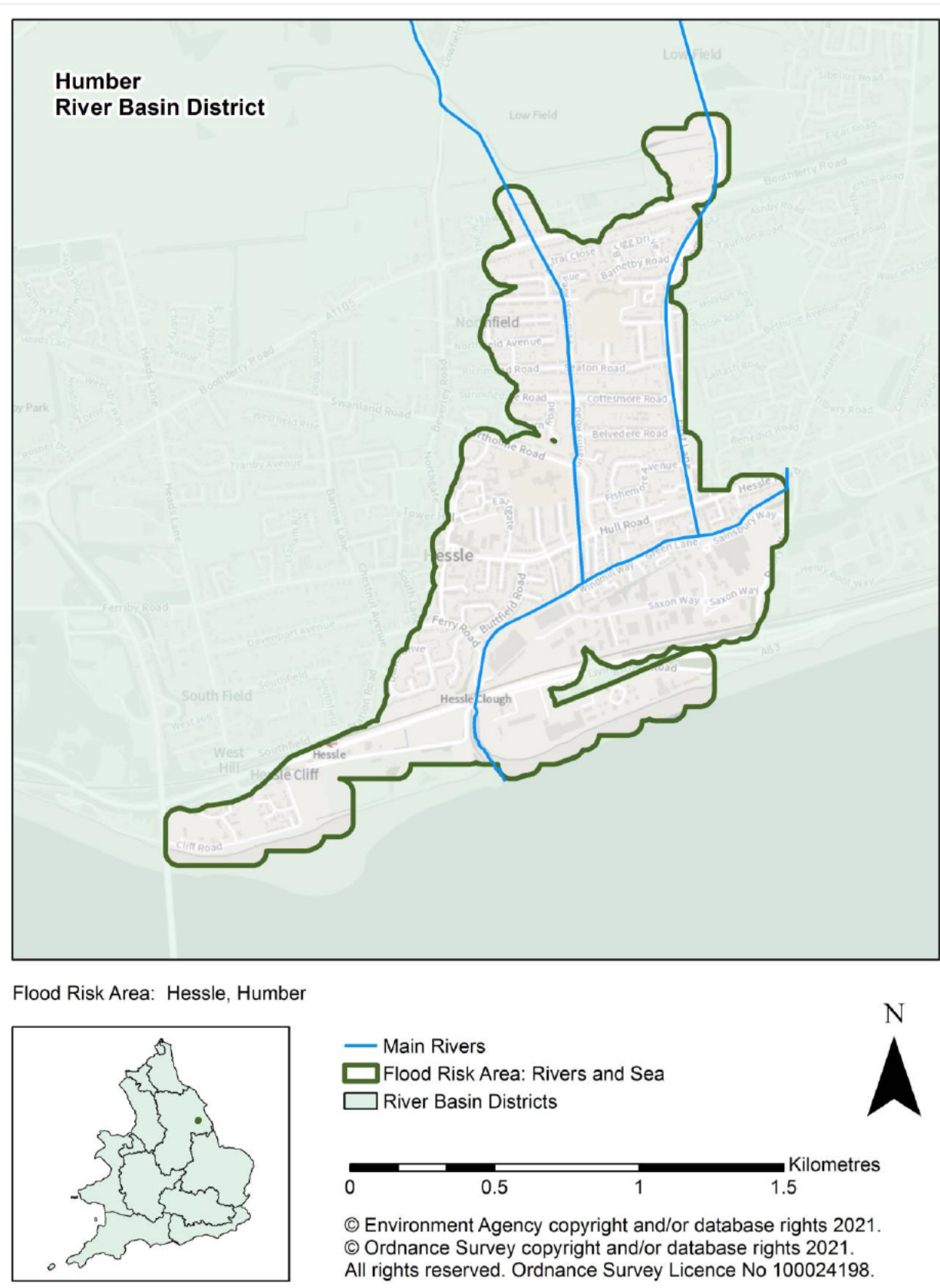


Figure 28: A map showing the boundary of Hessle Flood Risk Area

Introduction to the Hessle Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA.

East Riding of Yorkshire Council are the Lead Local Flood Authority (LLFA) for the majority of the FRA, whose remit includes flood risk from surface water and ordinary watercourses. Hull City Council is the Lead Local Flood Authority for the easternmost section of the FRA.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Hessle FRA covers some businesses and residential properties that are within the immediate area of the Humber.

Hessle lies on a bedrock of chalk that is overlaid by tidal flats and glacial Devensian Till. There are two predominant soil types within the Hessle FRA:

1. Deep fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging.
2. Seasonally wet deep stoneless non-calcareous and calcareous clayey soils.

The Humber Estuary has been designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area and Ramsar site (SPA). There are no other conservation or heritage designations within Hessle FRA, however there is a Local Nature Reserve located immediately to the west of the FRA at the Humber Bridge Country Park, and sites of Nature Conservation Importance including mudflats and a plantation nearby to the east. There are also a number of listed buildings along the western edge of the FRA located within the central area of Hessle town.

The Humber Bridge crosses the Humber estuary between Hessle and Barton upon Humber, North Lincolnshire.

The FRA is most susceptible to fluvial flooding from Western Drain, Acre head Drain and Fleet Drain, during times of increased rainfall. The FRA is at risk from tidal flooding, resulting from elevated water levels in the Humber estuary and is also susceptible to surface water flooding.

Current flood risk

The FRA and surrounding area was significantly affected by surface water flooding during the June 2007 event. Other recent events occurred in 2010, 2012, 2014 and 2019.

The low-lying southern extent of the FRA at Hessle Foreshore, which runs alongside the banks of the Humber, suffered significant flooding from the North Sea tidal surge of December 2013.

The [flood hazard and risk maps](#) show that in the Hessle FRA 6,257 people live in areas at risk of flooding from rivers of which 5% are considered to be in areas of high risk.

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

- 277 non-residential properties
- 0.50km of roads
- 0.62km of railway
- 1.82ha of agricultural land
- areas of special protection, special areas of conservations, RAMSAR sites and SSSIs

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Hessle FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders including East Riding of Yorkshire Council, Hull City Council and Yorkshire Water.

The Humber LFR meets quarterly and has a number of working sub-groups who have created local plans to address flood risk such as the Multi-Agency Flood Plan and an East Coast Tidal Inundation Flood Plan.

The Environment Agency monitors fluvial and tidal levels at the Hessle gauging station situated within the Hessle FRA.

There are two flood alert areas in FRA, one for fluvial flood risk and one for tidal flood risk. There are also 7 flood warning areas that cover the FRA, 5 for tidal flooding and 2 for fluvial flooding.

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

Western Drain and Acre Head Drain emanate from the West Ella Valley and North Ella areas of the East Riding, before flowing through the urban areas of Kirk Ella and Anlaby.

Both watercourses are culverted for significant parts of their downstream extent, through the FRA, before they outfall at their confluences with Fleet Drain, in Hessle. Various routine maintenance activities are undertaken by the Environment Agency on all three of these main-river watercourses, to reduce blockage risk and manage conveyance.

In 2010, following the devastating effects of the June 2007 flooding, the Environment Agency constructed the Western Drain Flood Alleviation scheme. The scheme consisted of a flood storage reservoir to attenuate flood flows in Western Drain and addressed specific capacity issues within the culverted section that runs through the FRA and the Northfield area of Hessle. The scheme continued to be owned, operated and maintained by the Environment Agency until 2018.

More recently, East Riding of Yorkshire Council have constructed the Anlaby and East Ella Flood Alleviation Scheme. The project was complete in early 2020 at a cost of £22m and reduces surface water flood risk over and above that addressed through the original Western Drain scheme. The scheme comprises of a larger flood storage reservoir, which incorporates the previous Western Drain reservoir, along with other connecting watercourses and infrastructure designed to link the north eastern Tranby catchment into the storage area. This includes a large storm-water culvert 1.5km long, 1.8m in diameter, and up to 14m deep, and an energy dissipation unit at the outfall of the tunnel, which allows floods flows to bypass large parts of the urban area.

To reduce the risk of tidal flooding to the FRA, East Riding of Yorkshire Council are currently in the final parts of constructing the Hessle Foreshore Tidal Defence (HFTD) scheme. This project reduces tidal flood risk to over 4000 residential and commercial properties in Hessle, at a cost of £11m, through a combination of defences that cover three discrete elements:

Hessle Clough Sluice Structure involved the raising of the existing wall around Hessle Clough Sluice by approximately 1m to prevent overtopping during a tidal surge event.

A63 Barrier, National Highways have constructed a defence in the form of a concrete flood wall alongside the A63, which doubles as a vehicle restraint barrier for the dual carriageway.

Cliff Road Glass Wall involves raising of the road locally under the Humber Bridge and the construction of a glass and concrete wall along the northern bank of the Humber estuary.

In order to manage the residual risk of flooding within the FRA, East Riding of Yorkshire Council are developing the Hessle Fleet Drain Fluvial/Pluvial Scheme. Work to assess available options to reduce risk are currently underway, with a view to potentially delivering future capital works.

The future management of flood risk around the Humber Estuary, including the FRA and surrounding area, is set out in the Humber FRMS. A comprehensive review of the existing Humber FRMS is currently underway.

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, with a particular focus on the first 25 years, taking into account predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Hessle.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Hessle FRA

Measures have been developed which apply specifically to the Hessle FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Hessle FRA. You can find information about all of the measures which apply to the Hessle FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Hinckley & Burbage Surface Water Flood Risk Area

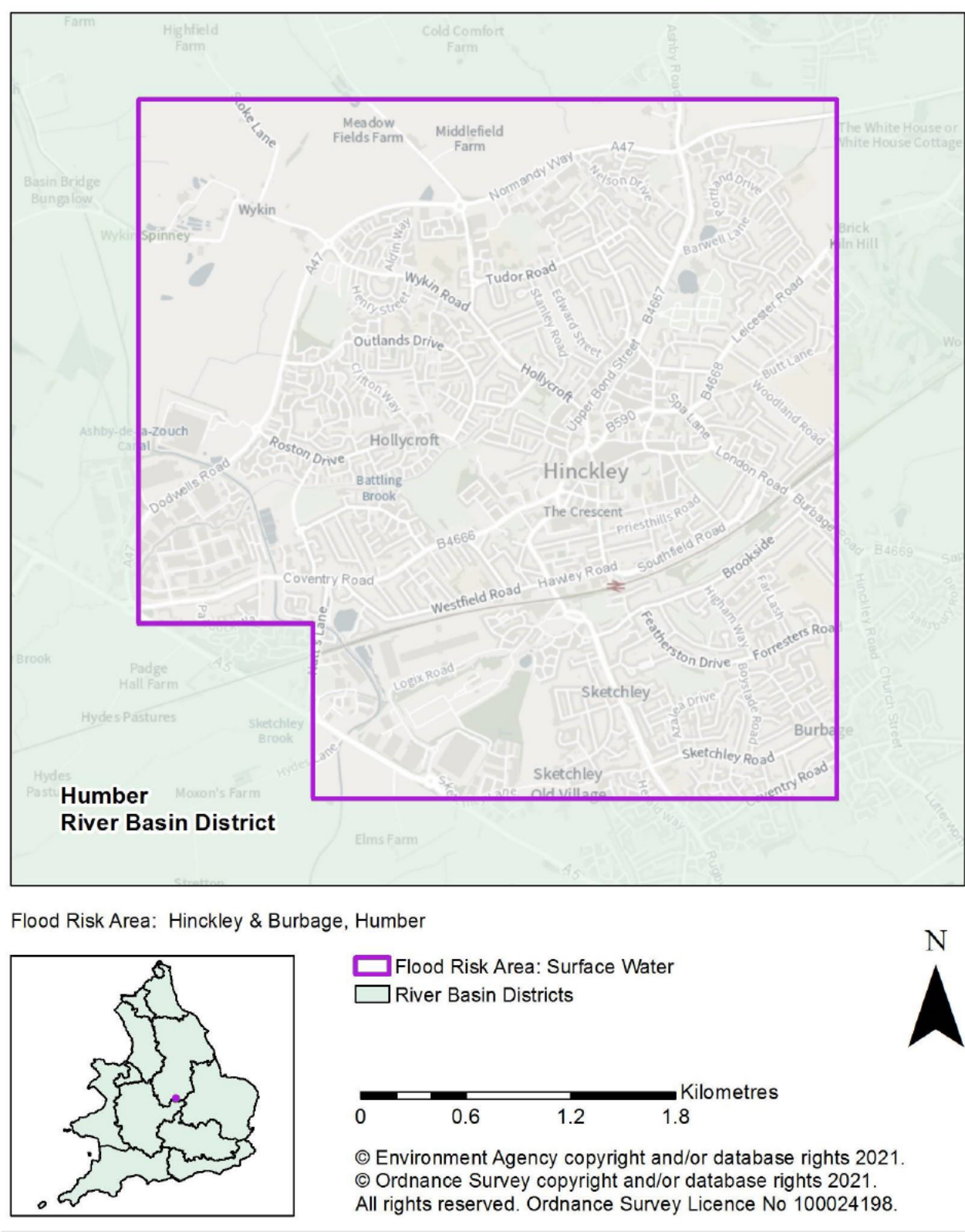


Figure 29: A map showing the boundary of Hinckley & Burbage Flood Risk Area

Introduction to the Hinckley & Burbage Flood Risk Area

The Hinckley & Burbage (Surface Water) 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).

As Lead Local Flood Authority (LLFA), Leicestershire County Council is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Severn Trent Water is the sewerage undertaker for this area. The Environment Agency's remit includes managing flood risk from main rivers in the FRA.

The FRA covers the town of Hinckley, extending across the central urbanised area into the Burbage area. The area is characterised by urban and suburban communities, as well as rural fringe. There are several watercourses in the FRA. These include:

- Harrow Brook (main river)
- Sketchley Brook (main river and ordinary watercourse)
- Battling Brook (ordinary watercourse)

These watercourses flow westwards through the FRA as tributaries of the River Anker.

The Ashby Canal also crosses the FRA in a north westerly direction.

The geology is generally mudstone which are part of the Mercia Mudstone Group. Soils are often clay that have a naturally high ground water table and impede drainage. This results in significant amounts of rainfall becoming surface water run-off.

There are several Local Wildlife sites within the FRA boundary including:

- Brodick Road Flood Retention Area
- Clarendon Park Arboretum
- Courting Stiles
- Burbage Flood Retention Area

The remains of the motte and bailey castle at Hinckley, a Scheduled Ancient Monument, is also located in the FRA.

Hinckley was founded as a large Saxon Village and is recorded in the Domesday Book. Overtime Hinckley became a prosperous medieval market town. With the Industrial Revolution the town population grew as various industries, such as hosiery and weaving, developed in the town. The urban district boundary extended to include Burbage in 1936.

Hinckley and Burbage are currently undergoing changes with several key developments planned, such as the Hinckley Square, and further housing developments planned as part of the Burbage Neighbourhood Development Plan.

Surface water flooding is a prominent issue with multiple historic flood events in the Hinckley & Burbage FRA. In addition, there have been incidents in the FRA of:

- fluvial flooding from both main river and ordinary watercourses - including from the Sketchley Brook and watercourses that connect to it
- sewer flooding from foul and combined sewers
- overtopping of the Ashby Canal in Hinckley (one recorded incident)

Hinckley and Burbage is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded over many years as the area has grown.

In addition to sewers, the drainage network in the FRA comprises:

- highway drains and gullies
- culverted and open watercourses – such as tributaries to the Sketchley Brook, the Harrow Brook culvert, and northern tributary culvert under the A5 Watling Street
- privately owned drainage
- pumping stations – such as the Severn Trent Water pumping station at Dodwells Road

Surface water run-off can overwhelm the drainage network and result in surface water and sewer flooding.

Severn Trent Water has a hydraulic model of the sewer system, including all public foul, combined and surface water gravity sewers and pumping stations.

Severn Trent Water has carried out schemes that address both sewer flooding and surface water flood risk in:

- Coventry Road, Hinckley (2012)
- Island Close, Hinckley (2017)

A flood storage area is located on the Harrow Brook, to the east of the Ashby Canal and the west of Brodick Road.

Current flood risk

Hinckley & Burbage is at risk of flooding from a variety of sources. The primary sources include flooding from surface water and rivers.

There are records of historic flooding in Hinckley & Burbage, including in 2012, 2013, 2016 and 2018. Recent incidents also include December 2017 where 4 properties experienced flooding at Watling Street as a result of surface water and foul sewer flooding sources. A Formal Flood Investigation has been published for this event.

Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding.

The [flood hazard and risk maps](#) show that in the FRA 3,482 people live in areas at risk of flooding from surface water. Of these, 5% live in areas of high risk.

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

- 240 non-residential properties (including schools and healthcare services)
- 0.1km of major road network
- 1.28 km of railway
- 66 ha of agricultural land
- 0.14 ha scheduled ancient monument and 1 listed building
- 2 Environmental Permitting Regulatory sites

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 manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Leicestershire County Council lead on the management of surface water flood risk, in their role as the LLFA, in collaboration with other RMAs. Other key stakeholders include Hinckley and Bosworth Borough Council, the Environment Agency and Severn Trent Water.

The Leicestershire Local Resilience Forum (Leicestershire LRF) is a multi-agency partnership made of representatives from:

- local public services
- the emergency services
- local authorities
- the NHS
- the Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The LLFA works with the Leicestershire LRF to better coordinate community resilience and recovery after a flood event. The LLFA joins other partnership members in the training of volunteer flood wardens. These are members of the local community who can organise community response, as well as providing critical information as part of partner response/recovery.

Leicestershire County Council and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Environment Agency uses its permissive powers to maintain the flood bank in the Brodick Storage Area, and main river channels. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Environment Agency monitors rainfall conditions at one site in the FRA. This information is used to inform activities related to the flood alert area that covers the FRA, which enables people to receive a warning when flooding could occur. This flood alert area includes the Harrow Brook and Sketchley Brook as tributaries of the River Anker.

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 Leicestershire Local Flood Risk Management Strategy (LFRMS) was implemented in 2015. The LFRMS was developed to:

- adopt a collaborative approach to managing local flood risk by working with local partners and stakeholders to identify, secure and optimise resources, expertise and opportunities for reducing flood risk and increasing resilience to flooding
- develop a greater understanding of local flood risk by improving local knowledge and the understanding of local flood risk
- adopt a sustainable approach to reducing local flood risk, using tools that are economically viable, deliver wider environmental benefits and promote the wellbeing of local people
- reduce the harmful consequences of local flooding to communities through proactive actions that enhance preparedness and resilience to local flood risk and contribute to minimising community disruption
- aim to mitigate and manage flood risk relating to development through the promotion of sustainable drainage systems and supporting the development of local policies and guidance
- ensure the financial viability of flood related schemes through the development of appropriate policies and assessment tools to ensure that flood risk management measures provide value for money whilst minimising the long term revenue costs. Seeking to use natural processes where possible or source the costs of any maintenance from the financial beneficiaries of the development
- encourage flood management activities by private owners of ordinary watercourses and flood defence structures as well as limit the development of constrictions on ordinary watercourses

In 2017, Leicestershire County Council obtained Local Levy funding to support Severn Trent Water in the creation of the Hinckley and Burbage Integrated Catchment Model. This model study has produced a comprehensive hydraulic model of a critical section of Hinckley and Burbage's drainage network. This model is currently being used by Severn Trent Water to test and develop proposals to reduce local flood risk to key areas in Burbage. This project is currently ongoing and is being led by Severn Trent Water. Additional partners are due to be brought to the table to further optioneering/discussions.

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 Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Hinckley & Burbage FRA

Measures have been developed that apply specifically to the Hinckley & Burbage (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Hinckley & Burbage (Surface Water) FRA. You can find information about all the measures which apply to the Hinckley & Burbage (Surface Water) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Huddersfield Rivers and Sea Flood Risk Area

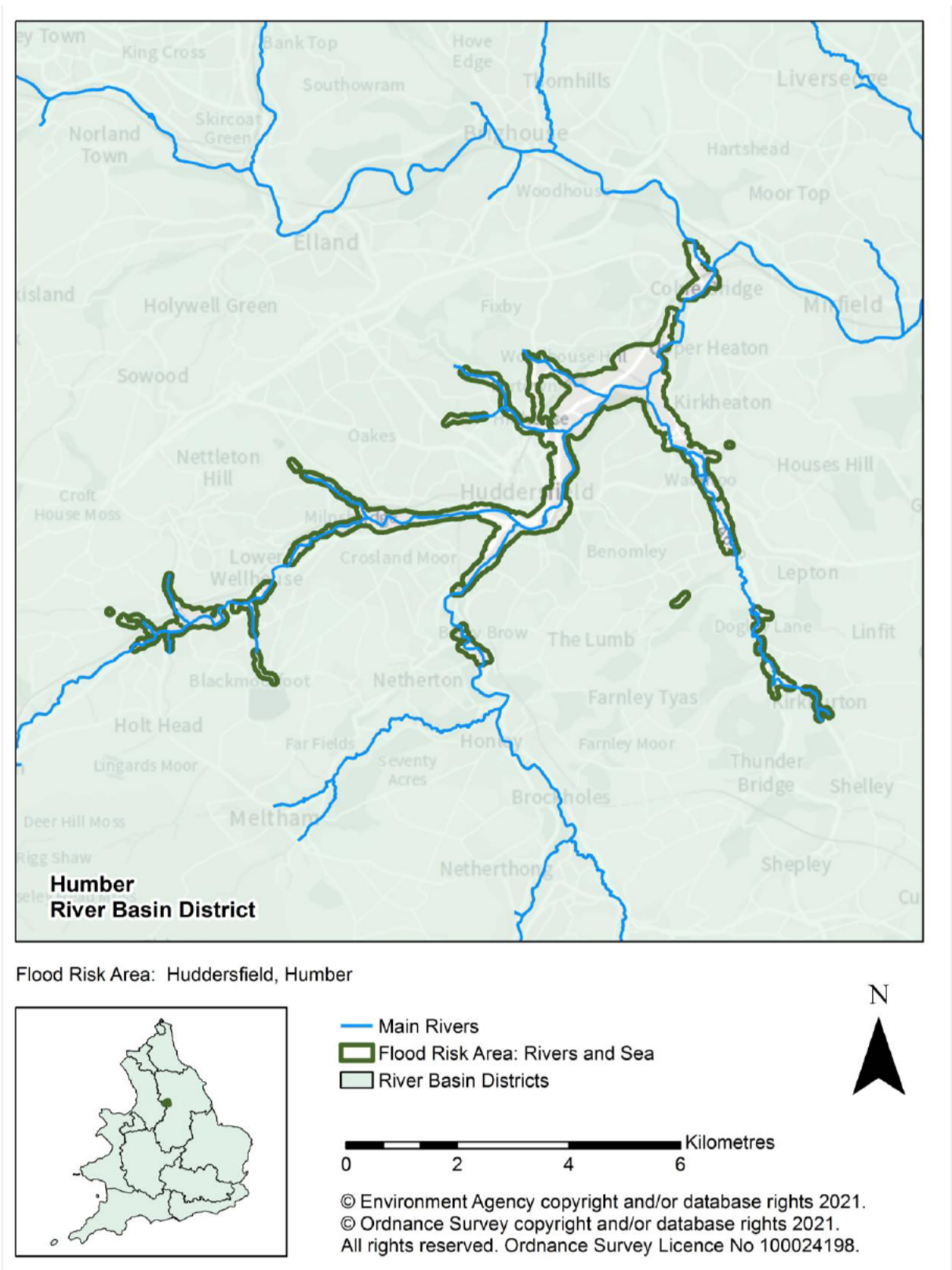


Figure 30: A map showing the boundary of Huddersfield Flood Risk Area

Introduction to the Huddersfield Flood Risk Area

The Huddersfield 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 FRMP for this FRA.

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

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Huddersfield FRA covers some businesses and residential properties that are within the immediate area of:

- River Colne
- River Holme
- Fenay Beck

The predominant soil type in Huddersfield is loam over sandstone. This would make it a relatively well drained area, however due to the large amount of urbanisation and therefore increased impermeable surfaces, this characteristic may have been altered.

There are two weirs in the centre of Huddersfield, one of which appears to have been constructed in the 18th century to aid navigation of the Huddersfield Narrow Canal. The other was installed to control water for use in local industries in the early 20th century. It was also in the late 18th century that Huddersfield began to develop as a centre of wool trade with the completion of the Broad Canal and the Huddersfield Narrow canal.

The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Colne, River Holme as well as Fenay Beck.

The FRA is split between two Hydrological catchments, The Colne and Fenay Beck catchment and the Holme catchment. These two catchments have a combined area of 23,863 hectares.

This FRA includes the largest town in the UK in Huddersfield with a population of around 160,000 people. This means there is a large amount of urban infrastructure, impermeable surfaces and drainage. This could have an impact on the speed at which rainwater enters the river, decreasing the lag time and increasing the risk of flash flooding.

Current flood risk

There are not very many significant historical flood events within this FRA. There are a few historic cases around the mid-1940s and localised flooding from fluvial and pluvial sources

throughout the area although much is suspected to have gone unreported. There has however been some more recent flooding to a small number commercial and residential properties from the River Colne downstream of Huddersfield, for example as a result of Storm Ciara in February 2020.

The [flood hazard and risk maps](#) show that in the Huddersfield FRA some 10,257 people live in areas at risk of flooding from rivers of which 21% are in areas of high risk.

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

- 1,003 non-residential properties
- 0.79km of roads
- 0.41km of railway
- 34.76ha of agricultural land
- areas of environmental, permitting regulations, listed buildings and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Huddersfield FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Kirklees Council and Yorkshire Water.

Regular meetings take place between the Environment Agency and Kirklees council to discuss the programme of works and any other issues in the Kirklees area related to flood risk. Periodically these meetings are attended by others stakeholders, including Yorkshire Water. The West Yorkshire Flood Risk Partnership meeting enables broader (catchment scale) tactical and strategic approaches to be agreed with neighbouring LLFAs for example, Calderdale Council and Wakefield Council.

The Environment Agency monitor river and rainfall conditions at 10 sites in and immediately adjacent to the FRA. These collect data on river levels (6 sites), river flows (3 sites) and rainfall (1 sites).

This information is used to inform activities related to 27 flood warning areas that cover the FRA which enable people to receive a warning when flooding could occur.

The water level and flow information is also used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have hydraulic models with the Colne and Holme the most used and updated in the FRA. It has been updated in 2020

with a combination of 1D and 2D outputs. The other models in the FRA are mostly dated within the last 10 years.

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 maintains a small number of assets within this FRA such as walls, outfalls and weirs. In central Huddersfield there are two weirs, then a small range of other assets spread over the other main watercourses in the FRA.

There are currently early investigations taking place to better understand the levels of flood risk in several locations throughout the FRA.

The impact of climate change and future flood risk

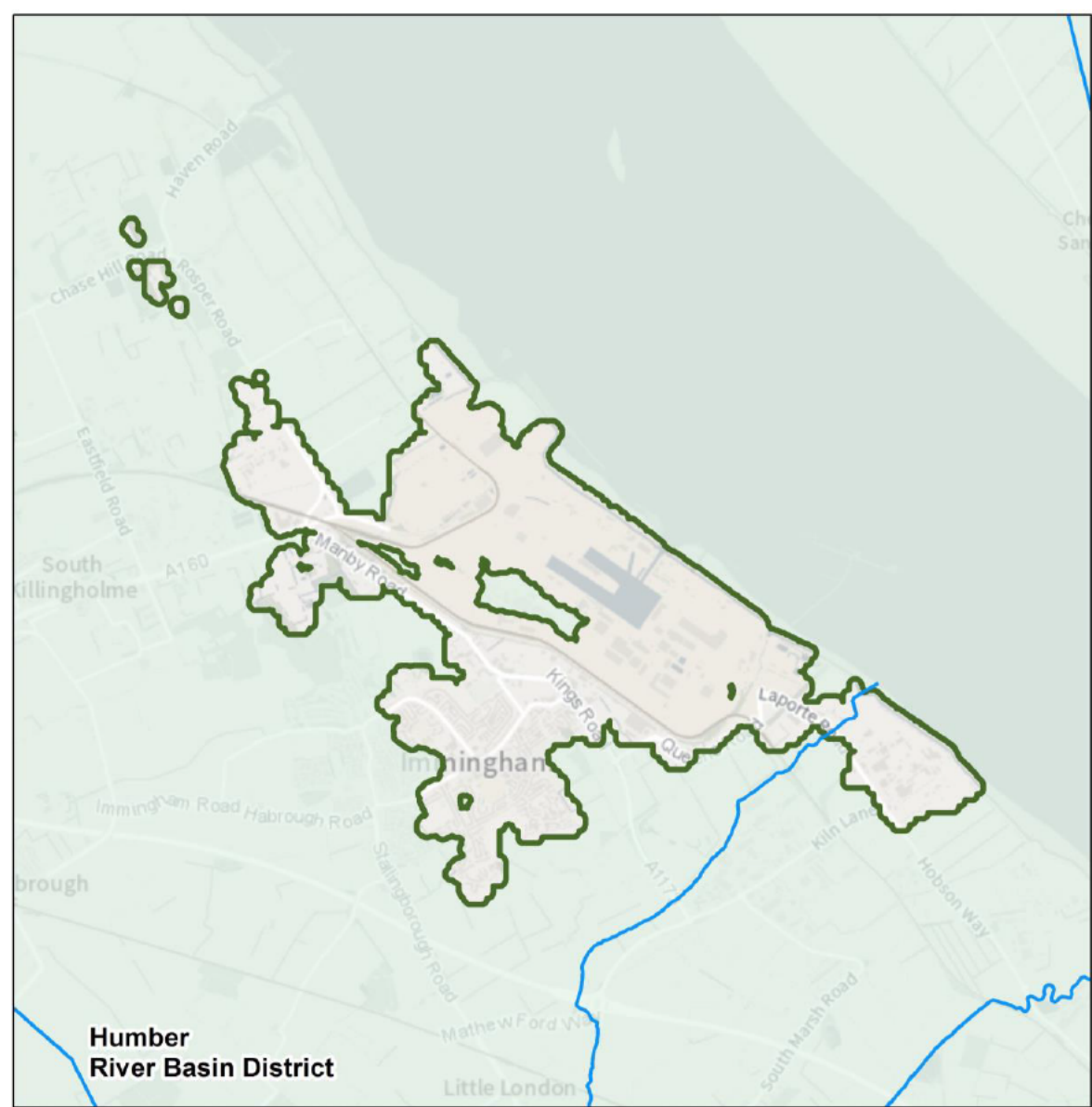
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Huddersfield FRA

Measures have been developed which apply specifically to the Huddersfield FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Huddersfield FRA. You can find information about all the measures which apply to the Huddersfield FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Immingham Rivers and the Sea Flood Risk Area



Flood Risk Area: Immingham, Humber

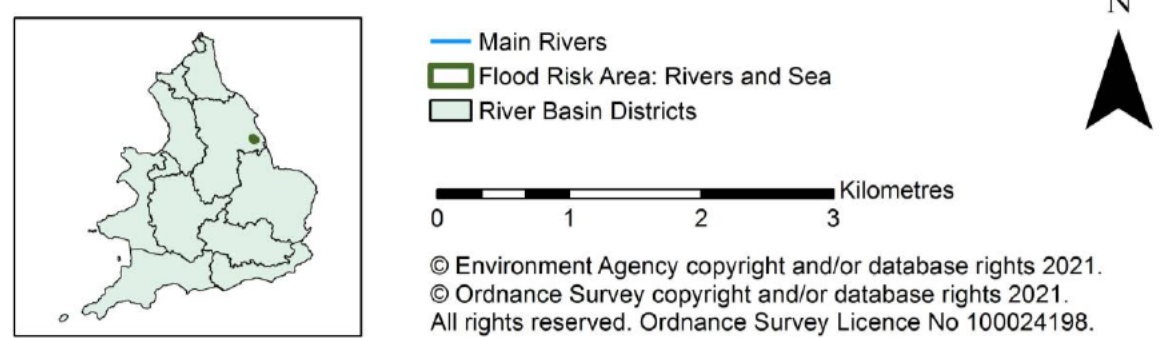


Figure 31: A map showing the boundary of Immingham Flood Risk Area

Introduction to the Immingham Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA. The FRA spans the boundary of two Lead Local Flood Authorities (LLFAs). North East Lincolnshire Council to the south, and North Lincolnshire Council to the northern extent. The LLFAs are responsible for managing flood risk from 'local' sources. These local sources of flooding are:

- surface water
- groundwater
- ordinary watercourses

The Environment Agency's remit covers flood risk from rivers and the sea.

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

North East Lindsey IDB is responsible for the land drainage in this area.

The Immingham FRA is mainly urban, with grade 3 agricultural land at the periphery. The predominant soil type is seasonally wet deep clay.

The Humber Estuary is a Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar.

The Northern Becks operational catchment is rural to the south and urban to the north. The north is dominated by the industrial areas of:

- Immingham
- North Killingholme
- Stallingborough

There are several protected areas in the catchment including:

- drinking water protected area safeguard zone
- important bathing waters
- Urban Wastewater Directive sensitive sites

Stallingborough North Beck Main River flows out to sea through the south of the FRA.

Immingham sits on the south-west bank of the Humber. The land is low-lying. It extends from 5m above sea level around the port to a peak of 21m in the south-west corner. Away from the urban areas the land is below mean high-water level and is drained by a series of gravity and pumped drainage systems.

The area was relatively unpopulated and undeveloped until the early 1900's when the Great Central Railway began developing Immingham Dock.

Industrial development grew in the post-war era. This developed Immingham from a minor place into a significant town in the 20th century. Expansion from the 1950's onwards saw new housing developments along Pilgrim Avenue and Pelham Road. Development peaked in the 1980's, with only minor expansion since.

Immingham FRA sits on the Humber Estuary and remains an important Port for import and export of freight. The port contains several sites of critical national infrastructure. There are two major oil refineries and several power stations adjacent to the FRA.

The main flood risk within the Immingham FRA is from tidal sources.

Current flood risk

Immingham experienced recent surface water flooding in August 2017 following a summer storm.

The [flood hazard and risk maps](#) show that in the Immingham Flood Risk area 5,934 people live in areas at risk of flooding from rivers and sea. Of these less than 1% are in areas of high risk.

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

- 464 non-residential properties - including community centres, schools, retail parks and public utilities.
- industrial developments - including Oil refineries, power stations, and chemical processing plants
- 5.7km of railway
- 322.31ha of agricultural land
- permitted installations
- listed buildings
- water abstraction points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Immingham FRA.

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

How the risk is currently managed

The management of flood risk from rivers and sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs). These include:

- North East Lincolnshire Council

- North East Lindsey Drainage Board
- Associated British Ports (ABP)

The Environment Agency have the strategic overview of flood risk across the FRA, and provide the tactical management and operational delivery for the risk from rivers and the sea. This is undertaken in collaboration with the North East Lincolnshire Council as the LLFA and North East Lindsey IDB. Further support is given to Anglian Water who manage the sewerage network.

The flood risk management investment is coordinated through the Regional Flood and Coastal Committee. Local investment is through the LLFA in combination with the Environment Agency.

The tidal defences along the Humber Estuary are managed and maintained by the Environment Agency except in the port. These are maintained by ABP.

The Stallingborough North Beck has linear defence embankments. Pumping stations assist the management of water levels within the land drainage system.

The Humber Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services such as:

- emergency services
- local authorities
- NHS
- Environment Agency

The LRF Risk Assessment Working Group produces a Community Risk Register for the Humber Sub-region. This includes detailed descriptions of the risks and likelihood of it occurring. It also considers the impact it would have on the community and economy should it happen. This assessment includes risks from flooding. The forum work in a multi-agency collaboration to manage flood incidents under the Civil Contingencies Act 2004.

The Environment Agency undertakes Hydrometric Monitoring at 4 locations within the FRA. Monitoring includes:

- surface water
- groundwater
- fluvial levels

This information is used to inform activities related to 5 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur. This data also informs the operational response during a flood incident.

Modelling and mapping of the Stallingborough and Oldfleet Drain was undertaken in 2009 and updated in 2018. Improvements to the Humber Estuary flood risk modelling have been completed as part of the developing Humber 2100+ strategy.

Flood risk maps are published based on the outputs from 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 operates and maintains flood risk management assets along the Humber Estuary and on the main watercourses in the FRA. These include:

- flood defence embankments and walls
- flood gates
- channels
- culverts
- debris screens

This work includes routine inspection and clearance activities as well as regular repair and replacement of assets.

Flood risk improvement works that benefit the Immingham FRA completed recently by the Environment Agency include:

- 2017 – Tidal defence improvements at the port main lock, completed by Associated British Ports and North East Lincolnshire Council

A further phase of improvements is planned from 2022.

The Environment Agency has embarked on developing a scheme to undertake structural improvements to the sea defences between:

- Middle Drain
- Stallingborough
- Pyewipe

This will reduce the risk of tidal flooding to:

- residential properties
- commercial properties
- large industrial plants
- key infrastructure

Construction is expected from 2022 to 2024.

A project is being developed to better protect the town of Immingham. This is being led by North East Lincolnshire Council in collaboration with:

- Environment Agency
- North East Lindsey Drainage Board
- Anglian Water

This is expected to be delivered in phases between 2021 and 2027. The tidal outfall at Habrough Marsh Drain will be improved first. Further improvements expected to follow include:

- surface water
- land drainage
- sewerage network

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, considering predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Immingham.

The impact of climate change and future flood risk

As sea levels rise, it means that coastal flooding will become more frequent as higher water levels and storms will be seen more often. Rainfall intensity is expected to increase in future which will cause river flows to increase.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber RBD.

Objectives and measures for the Immingham FRA

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

You can find information about all the measures which apply to the Immingham FRA in '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Kingston upon Hull Rivers and Sea Flood Risk Area



Flood Risk Area: Kingston upon Hull, Humber

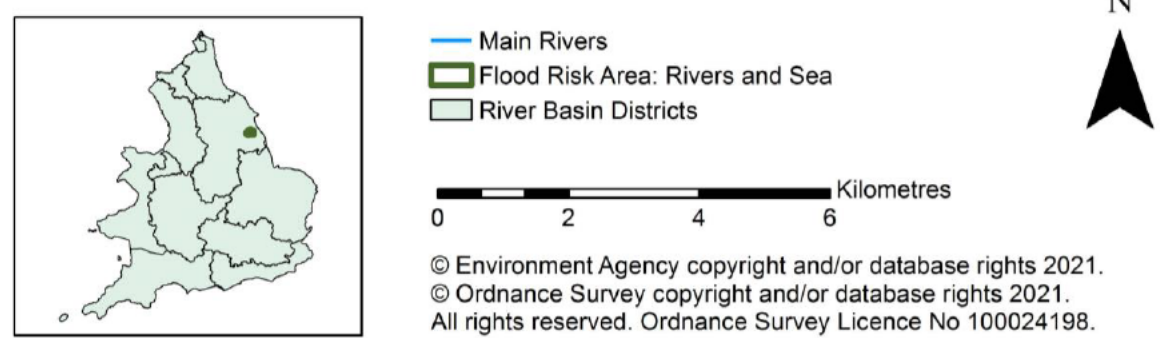


Figure 32: A map showing the boundary of the Kingston upon Hull Flood Risk Area

Introduction to the Kingston upon Hull Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA.

Hull City Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Kingston upon Hull FRA has an area of coverage which extends most of the Hull administrative area. This therefore includes several businesses and residential properties in the city.

Hull sits on a chalk bedrock, overlaid with tidal flat deposits and soils are predominantly wet deep stoneless non-calcareous and calcareous clayey soils. There is also a high-water table in the city due to the proximity of the aquifers within the chalk. Much of this urban area is very low lying and much of the city it built on reclaimed marshland. The nature of the topography and geology has led to a complex relationship between the groundwater, drains, surface water and rivers.

The Humber Estuary has been designated as a Special Area of Conservation (SAC) and a Ramsar site, a wetland of international importance. Within the FRA there are protected habitat areas of coastal and floodplain grazing marsh and deciduous woodland as well as several small Local Wildlife sites and Rockford Fields, a small Local Nature Reserve.

There are several listed buildings within Hull, mainly situated around the city centre, such as the grade 2 listed Guildhall and Town Hall Chambers. There are also a few scheduled ancient monuments and Beverley Road has been designed as a 'heritage at risk' conservation area. Pearson Park and East Park are registered parks.

Kingston upon Hull, originally developed as a port, suffered widespread damage in the World War II bombing raids, due to its heavy industry and its proximity to mainland Europe. In the early 2000, the city undertook a large regeneration programme, which was centred around the coast and estuary and in 2017 it was awarded the UK's Capital of Culture.

The flood risk in the Hull FRA is mainly tidal, during times of storm surges and high tides in the Humber Estuary. The tidal Humber levels also significantly affect the levels of River Hull through the city centre rather than being influenced by fluvial flooding.

The risk of surface water flooding is further explained in the [Kingston upon Hull and Haltemprice Surface Water FRA](#).

Current flood risk

Kingston upon Hull has long a history of flooding due to its topography and proximity to the estuary. There were several significant flood events since 2000 with June 2007 causing some of Hull's worst ever flooding after a period of heavy and sustained rainfall and in 2013 Hull suffered damage from the largest storm surge for at least 60 years.

The [flood hazard and risk maps](#) show that in the Kingston upon Hull FRA 281,885 people live in areas at risk of flooding from rivers of which 1% are considered to be in areas of high risk.

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

- 9,754 non-residential properties
- 32.38km of roads
- 24.27km of railway
- 453.74ha of agricultural land
- areas of environmental permitting regulations, special protection, special areas of conservations, RAMSAR sites, SSSIs, parks and gardens, scheduled monuments, listed buildings and water abstractions and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Kingston upon Hull and Haltemprice Rivers and Sea FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Hull City Council and Yorkshire Water.

The Living with Water Partnership is a partnership between the four organisations responsible for water management in our region; The Environment Agency, Hull City Council, The East Riding of Yorkshire Council and Yorkshire Water and the University of Hull – all of which play a role in managing water in the area. Living With Water aims to help build understanding across Hull and the East Riding about the threats and opportunities water brings to our region. The partnership are working together to build flood resilience, develop innovative water management systems, and highlight our region as a great place to live, work and visit.

Building Resilience - Raising awareness of flood risks within communities and deliver practical advice and information to help local people protect their homes and businesses, and to make them feel safe. Our aim is to achieve a year-on-year reduction in flood risk.

Driving sustainable solutions - Exploring innovative water management systems and collaborating with local communities and global experts to develop long-term urban water resilience in Hull and the East Riding.

Be Flood Aware - helping residents and businesses in Hull and the East Riding become more resilient to flooding. Raising awareness of flood risks in our area and delivering practical advice and information to help local people protect their homes and businesses.

There are three flood alerts that cover the FRA; one tidal and two fluvial. There are also 29 flood warning target areas that cover the FRA.

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 Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, taking into account predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Hull.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Kingston upon Hull FRA

Measures have been developed which apply specifically to the Kingston upon Hull FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Kingston upon Hull FRA. You can find information about all the measures which apply to the Kingston upon Hull FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Kingston upon Hull and Haltemprice Surface Water Flood Risk Area

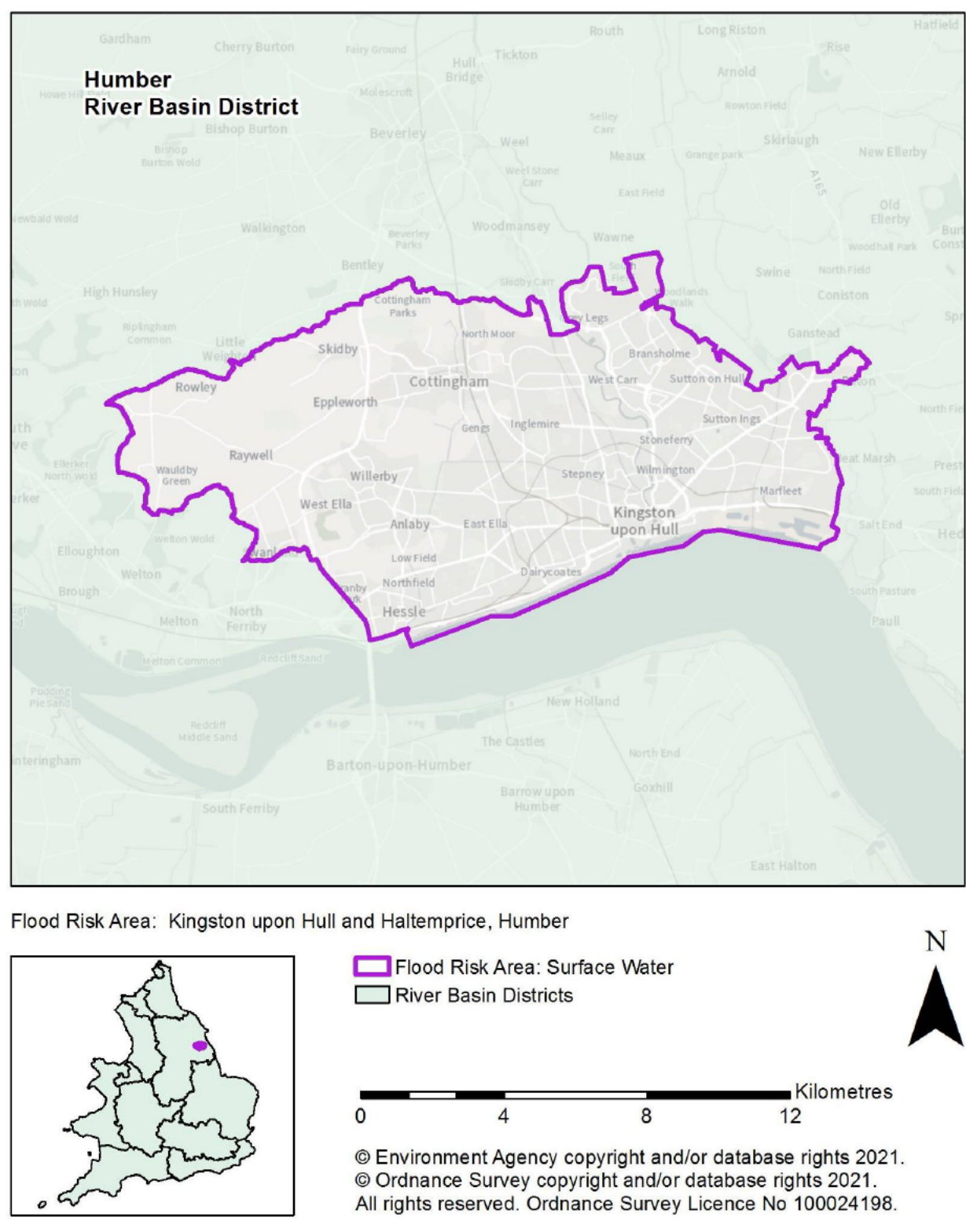


Figure 33: A map showing the boundary of the Kingston upon Hull and Haltemprice Flood Risk Area

Introduction to the Kingston upon Hull and Haltemprice Flood Risk Area

The Kingston upon Hull and Haltemprice Surface Water 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) because it is high – some context would be good here for the average reader.

The Kingston upon Hull and Haltemprice Surface Water FRA for the Humber RBD, aligns with the Kingston upon Hull and Haltemprice Flood Risk Management Plan (FRMP) developed by East Riding of Yorkshire Council and also the Hull City Council FRMP which is captured in the Hull City Council Local Flood Risk Management Strategy (LFRMS). The details below provide a summary of the flood risk information for this area. The East Riding of Yorkshire Council Kingston upon Hull and Haltemprice FRMP and Hull City Council LFRMS should be reviewed to obtain further detailed information on the area and plans for flood risk management.

East Riding of Yorkshire Council and Hull City Council as the Lead Local Authorities (LLFAs) in the area have the responsibility to manage the risk of surface water and ordinary watercourses in the administrative areas shown above. Although the area is designated at risk from surface water flooding, the FRA is at risk from multiple sources of flooding, which makes management of risk complex and interlinked.

The Environment Agency's remit covers flood risk from rivers and the sea.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Kingston upon Hull and Haltemprice FRA covers the city of Kingston upon Hull, and areas of East Yorkshire; including the villages of Cottingham, Anlaby, Willerby, Kirk Ella and Hessle, part of the village of Swanland and the village of Skidby. This area is referred to as Haltemprice. The FRA also includes an area on the eastern side of Hull, which includes the western part of the village of Bilton. The topography of the FRA is characterised by low-lying and relatively flat land within Kingston upon Hull, with the exception of Sutton.

Surface water that enters the FRA from rainfall and surface water runoff from surrounding land must flow through Hull's drainage system before it can be discharged into the Humber via Hull's wastewater treatment works in east Hull.

The geology of the area is founded on chalk, which is overlain with glacial till except for the eastern part of Cottingham, which is overlain with river terrace deposits. This transition between till and alluvial deposits roughly coincides with the administrative boundary of Kingston Upon Hull and East Riding of Yorkshire. Large aquifers, which are used for public drinking water supply, are present in the chalk. In order to protect these from contamination, a large proportion of the FRA lies within the Groundwater Source Protection Zones.

The environmental landscape of the FRA is a combination of rural, urban and suburban. Rural land uses provide the overall setting for the Haltemprice settlements, which are predominantly arable. Hedgerows are found widespread within the same settlements within the surrounding landscape. Recreational facilities such as golf courses, sports pitches, playing fields, hospitals are scattered throughout the Haltemprice settlements also contribute to the landscape of the FRA.

All types of flood risk are present within the FRA, with some areas at risk from multiple sources of flooding. There is an increasing risk to people and property within the Hull and Haltemprice area and this risk is expected to increase in the future due to climate change. There is a strong dependence on flood defences and drainage infrastructure in place to mitigate this risk. In addition, flood forecasting and warning plays a critical role in protecting lives and property, yet the current uptake to the Environment Agency's Flood Warning Service among residents and businesses is relatively low.

The western, southern and eastern edges of the FRA sit within tidal flood risk zones. areas This includes several villages within East Yorkshire and a large area of Kingston upon Hull, farmland and other open spaces.

Fluvial flooding can occur in some parts of the FRA mainly due to overtopping of main rivers after heavy rainfall over the area. Several of the main rivers that discharge into the Humber are tidally locked twice a day and so river levels can rise when water it not able to discharge. The River Hull takes flows from as far upstream as Driffield in East Yorkshire so rainfall north of the FRA has an impact on flows in the FRA.

Previous flooding events in the FRA have come from a range of sources, the most notable events were the 2007 floods, which caused widespread surface water flooding, and the 2013 Tidal Surge the largest ever recorded on the North Sea.

Groundwater flood risk is present in the FRA. Works to manage this are undertaken by Yorkshire Water. The water table is high in the west of the FRA.

Current flood risk

The FRA is hydrologically very interconnected. The complex nature of the drainage system in the FRA mean that there is a heavy reliance on the infrastructure in place to pump and discharge water. Distinguishing between sources of flood risk is not always possible as the interaction between surface water, watercourses and the sewers is complex. Combined with high groundwater levels in the FRA and the impact of tidal cycles, flooding tends to be the result of multiple sources.

The [flood hazard and risk maps](#) show that in the Kingston upon Hull and Haltemprice Surface Water FRA some 29,461 people live in areas at risk of flooding from surface water. Of these, 1% are considered to be in areas of high risk.

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

- 1,141 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 8.65km of roads
- 1.73km of railway
- 293.19ha of agricultural land
- areas of environmental designated sites, special areas of conservation, special protection areas, RAMSAR sites, SSSIs, parks and gardens, scheduled monuments, listed buildings, water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Kingston upon Hull and Haltemprice Surface Water FRA.

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

How the risk is currently managed

There are various organisations and stakeholders with responsibilities for flood risk management as described in the National FCRM Strategy. The Risk Management (RMAs) that operate within the FRA and their key functions are as follows:

East Riding of Yorkshire Council owns and operates numerous schemes in conjunction with other RMAs to reduce the flood risk in the FRA. These schemes include Anlaby and East Ella Flood Alleviation Scheme (AEEFAS) which was completed in 2020. The FAS is an interception system that captures floodwater from the Westella Valley and Tranby Hill watershed areas and divert flows to a large floodwater attenuation area. The risk reduction to properties is 4,495 residential and 74 commercial properties.

Willerby and Derringham Flood Alleviation Scheme (WADFAS), which was complete as of November 2020. It was designed to intercept surface water runoff from the west of the FRA specifically Great Gutter Valley, estimates to reduce the risk of flooding to 8,000 residential properties and 120 commercial properties.

Cottingham and Orchard Park Flood Alleviation Scheme, (COPFAS) has been designed with the intention to intercept surface water runoff from west of the FRA (Raywell Valley and Cottingham Park watersheds). Stored into a number of lagoons so can be discharged in a controlled manner into the downstream urban drainage system which reduces the flood risk to 5,741 residential and 333 commercial properties in the area. The council also owns and operates a number of culverts on the line of main rivers and major watercourses throughout the Haltemprice area.

Hull City Council is the Lead Local Flood Authority (LLFA) for Kingston upon Hull and so is responsible for managing the risk of flooding caused by groundwater, ordinary watercourses and surface water. Hull City Council is also a major landowner with the boundary of Kingston upon Hull and so is the riparian owner for many watercourses. Kingston upon Hull is a heavily urbanised area so there isn't the space for large surface

water storage schemes. Instead, smaller surface water schemes have been built across the city on existing open green spaces. This includes Hull's Aquagreens, which temporarily store localised surface water to reduce the flood risk to local homes, business and infrastructure, and also serve to improve the natural environment by reducing pollution in runoff and improving water quality and providing new habitat for wildlife.

All new major developments within the city must have sustainable drainage systems (SuDS) built in to manage on site drainage. SuDS are also being retrofitted onto existing buildings and schools to intercept rainwater from roofs before it enters the sewer system to reduce the pressures on aging infrastructure during heavy rainfall events.

Collaboration of RMAs has led to the formation of the Living with Water partnership to raise flood risk awareness across the FRA. The aim of this project is to increase flood risk resilience across Hull and East Riding of Yorkshire to make residents more aware to the impact of flooding and to enable people to be more prepared to reduce the impacts of flooding and aid a faster recovery.

The Environment Agency maintains the main rivers in the area as well as being the main authority regarding tidal flooding in the FRA. Main rivers include, the River Hull, Wanless Beck/Mill Beck, Creyke Beck, Broadlane Beck, Cottingham Drain, Setting Dyke, Sand Dyke, Acres Head Drain, Western Drain and Hessle Fleet Drain.

The Environment Agency owns separate pumps at East Hull pumping station to pump flows from Holderness Drain into the Humber Estuary during high tides.

A new pumping station is currently being built at the end of Holderness Drain to replace the existing pumping station. The Environment Agency also operates demountable pumps at Hessle Haven to over pump the Hessle Fleet Drain during combinations of high tides and high river levels.

The Environment Agency completed refurbishment and maintains the Hull Tidal Surge Barrier, which protects approximately 17,000 properties from tidal flooding.

The Environment Agency operates a flood warning service to throughout the catchment. The Flood Warning Service also provided by the EA, ensure numbers/signed up to this service is at a growing level due to the risk likely to increase due to climate change. There has been an improvement in the service but the uptake is still poor.

Yorkshire Water owns and operates the public sewer network and key pumping stations including 'East Hull' and West Hull pumping stations. Yorkshire Water also own and operate Keldgate reservoir and several large potable water distribution mains that may cause flooding due to failure.

Since 2007, Yorkshire Water has invested over 40 million in improving the capacity of these pumping stations and making them more robust, including £16 million on the new Bransholme pumping station which has the largest screw pumps in Europe. Works have included replacing and overhauling pumping apparatus and updating and improving the

reliability of high voltage electrical supply including building in reliability through redundancy.

The western part of the village of Bilton lies within the operating area of Beverley and North Holderness Internal Drainage Board (IDB). Whose responsibility is to maintain ordinary watercourses in their located area and aim to reduce all sources of flood risk.

National Highways are responsible for providing adequate drainage for the A63 trunk road.

The impact of climate change and future flood risk

As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

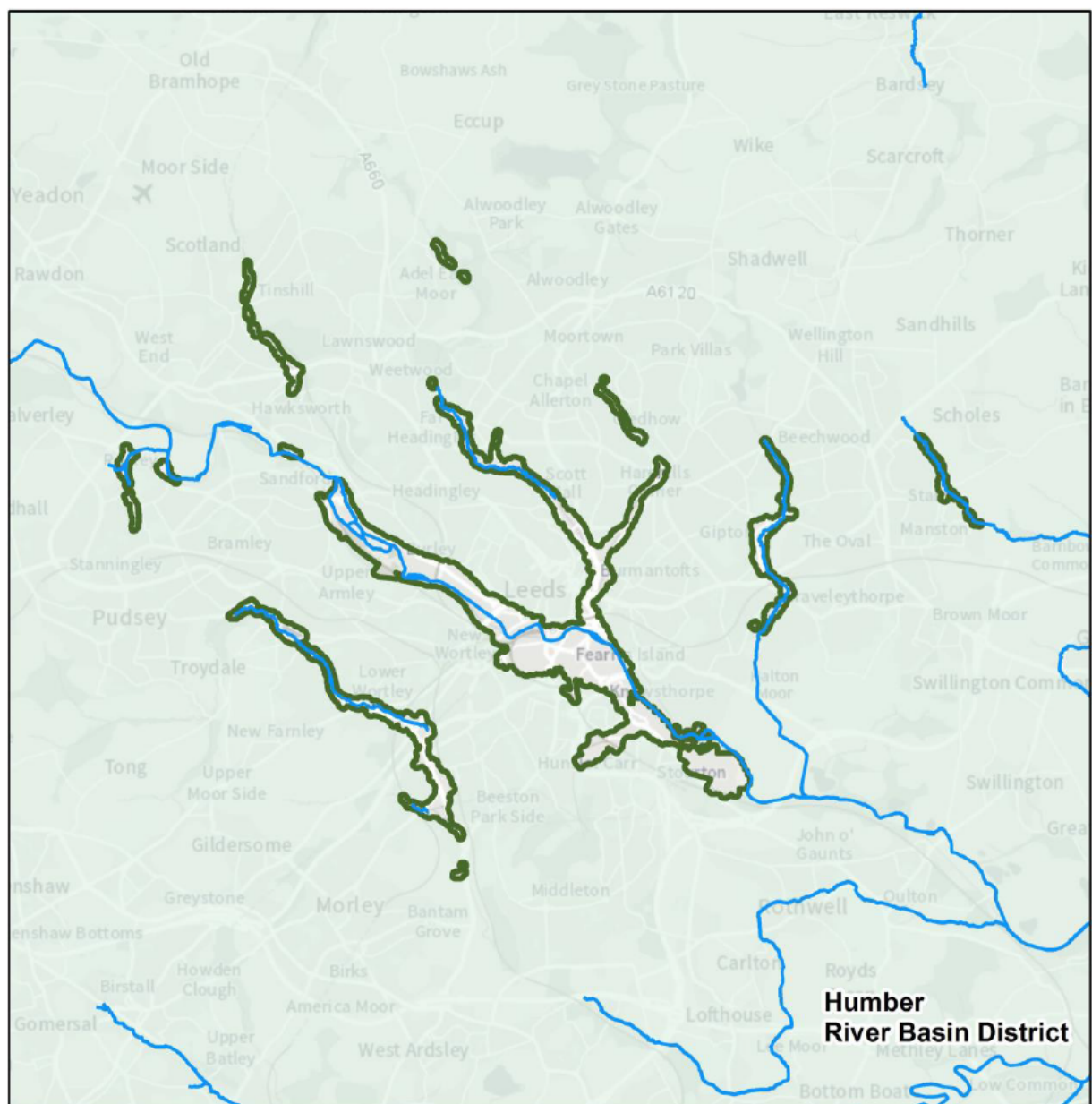
Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Kingston upon Hull and Haltemprice Surface Water FRA

Measures have been developed which apply to the Kingston upon Hull and Haltemprice Surface Water FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Kingston upon Hull and Haltemprice Surface Water FRA. These measures are also incorporated into the corresponding Kingston upon Hull and Haltemprice FRA developed by East Riding of Yorkshire Council and in the Hull City Council Local Flood Risk Management Strategy.

You can find information about all of the measures which apply to the Kingston upon Hull and Haltemprice Surface Water FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Leeds Rivers and Sea Flood Risk Area



Flood Risk Area: Leeds, Humber



- Main Rivers
- ▭ Flood Risk Area: Rivers and Sea
- ▭ River Basin Districts

0 3 6 9 Kilometres

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Figure 34: A map showing the boundary of the Leeds Rivers and Sea Flood Risk Area

Introduction to the Leeds Rivers and Sea Flood Risk Area

The Leeds Rivers and Sea 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 FRMP for this FRA.

Leeds City Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the water and sewerage company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Leeds Rivers and Sea FRA covers many of the districts of Leeds which feature businesses and residential properties that are within the immediate area of the River Aire within the city centre as well as those within the surrounding areas of:

- Wyke Beck
- Wortley Beck
- Meanwood Beck
- Gledhow Beck
- Cock Beck
- Moseley Beck
- Fagley Beck

The Leeds and Liverpool canal lies within the FRA and is owned and maintained by the Canal & River Trust.

The Leeds to Liverpool Canal Site of Special Scientific Interest (SSSI) is located within the Leeds Rivers and Sea FRA. In addition to this, there are multiple Registered Parks, Ancient Woodlands, Listed Buildings and Scheduled Monuments within this area of coverage.

Leeds Metropolitan District (slightly bigger than the FRA area) covers 562 square kilometres and includes approximately 360 square kilometres of countryside designated as Green Belt. The general topography is undulating in characteristic and varies in level from 10m above Ordnance Datum (OD) at Fairburn on the River Aire and Thorp Arch on the River Wharfe to more than 340m at Hawksworth Moor. The FRA is traversed from the Northwest to Southeast by the River Aire. The northern boundary includes parts of the River Wharfe catchment, which flows from West to East. The River Calder forms part of the southern boundary flowing from the southwest to join the River Aire at Castleford.

The rocks underlying the area date from the Upper Carboniferous period: the sandstones and grits of the older, Millstone Grit, series are to the north of the city; the alternating shales, mudstones, coal seams and sandstones of the Lower Coal Measures are to the

south. The soils are mainly clayey or loamy and are relatively impermeable. However, sands and gravels predominate adjacent to the River Aire.

Leeds was a major mill town during the industrial revolution with wool being the dominant industry. The Leeds Liverpool Canal was completed in 1816 and connects with the river Aire in various places through a series of locks, sluices, weirs and gates.

Leeds Dock, on the Aire & Calder Navigation, was once a vast complex of store yards and warehouses busy offloading coal and goods from the barges that plied this wide canal. It was a nerve centre providing a vital cross-Pennine link from Liverpool along the Leeds and Liverpool Canal (which connects through a lock onto the Aire and Calder Navigation in Leeds) to the North Sea.

There are a variety of other historical developments related to flood risk of note within the FRA including the Farnley Balancing Pond on Wortley Beck (owned by Yorkshire Water), Waterloo Lake in Roundhay Park which discharges into Wyke Beck, and various other historical structures such as Kirkstall Goit on the River Aire which in the past diverted water to power Burley Mills. The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Aire and the numerous Becks throughout the city.

Much of the FRA relates to the River Aire catchment (other than a small section of Cock Beck which is a tributary of the river Wharfe). The Aire catchment area covers approximately 1,114 kilometre squared and includes four sub-catchments:

- Upper Aire
- Mid Aire (which is where this FRA sits)
- Lower Aire
- Worth

The River Aire flows for 148 kilometres from its source in the Yorkshire Dales near Malham to its confluence with the River Ouse near Goole.

The headwaters of the Aire catchment area are characterised by swift-flowing upland streams, which flow through former mill towns nestling in narrow valley bottoms. Below Leeds, the River Aire follows an increasingly gentle meandering course through a broad floodplain where it joins the River Ouse.

Within the FRA there are several tributaries that contribute to flood risk in addition to the River Aire. These include Wortley Beck, Farnley Wood Beck, Meanwood Beck and Wyke Beck.

This FRA is predominantly related to flood risk from rivers, however, there is interaction with other sources of flooding in various places, particularly surface water and sewer flooding. These other sources of flood are covered in more detail by the Leeds Surface Water FRA.

Current flood risk

At the end of 2015 Yorkshire experienced months of rainfall leading to one of the wettest winters on record. Further rainfall on Christmas and Boxing Day resulted in the highest river levels ever seen in many places along the River Aire. The flow in the River Aire in Armley on the 27 December was the highest ever recorded, resulting in flood levels in some locations that were approximately 1.2m higher than those experienced during the previous record set in autumn 2000. Flooding affected homes and businesses, as well as critical and local infrastructure. Property flooding in Leeds district totalled 3,368.

There have been no significant flood events since 2015 in the FRA, although there have been several near misses, most notably Storm Ciara in February 2020.

The [flood hazard and risk maps](#) show that in the Leeds Rivers and Sea FRA 18,429 people live in areas at risk of flooding from rivers of which 28% are in areas of high risk.

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

- 3,340 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 7.88km of roads
- 2.72km of railway
- 26.84ha of agricultural land
- areas of environmental designated sites, listed buildings, water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Leeds Rivers and Sea FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Leeds City Council, Yorkshire Water, the West Yorkshire Combined Authority, National Highways and Network Rail. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

Regular meetings take place between the Environment Agency and Leeds City Council through various groups and boards to discuss the programme of works and any other issues in the Leeds area related to flood risk. Periodically these meetings are attended by others stakeholders, including Yorkshire Water. The West Yorkshire Flood Risk Partnership meeting enables broader (catchment scale) tactical and strategic approaches to be agreed with neighbouring LLFAs e.g. Bradford Council and Wakefield Council.

The Environment Agency also sits on the Leeds Flood Resilience Programme Board, a Leeds City Council board which is responsible for providing a strategic overview of flood resilience in Leeds, and where necessary, approvals and decision making that may affect programme process and delivery. In addition, they make links to and create opportunities for catchment wide collaboration, working and develop ambitious integrated schemes. The board includes the Environment Agency, Yorkshire Water as well as LCC team representatives covering:

- flood risk
- development
- highways and transport
- planning
- asset management and regeneration
- communities
- strategy and policy
- resources and housing
- regeneration
- civil engineering
- communications
- parks and countryside

The Environment Agency monitor river and rainfall conditions at 17 sites in and immediately adjacent to the FRA. These collect data on river levels (13 sites), river flows (1 sites) and rainfall (3 sites).

This information is used to inform activities related to 26 flood warning areas that cover the FRA which enable people to receive a warning when flooding could occur.

The water level and flow information is also used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have hydraulic models. The hydraulic model of the River Aire through the FRA is of a very good standard as it was developed in detail alongside the Leeds Flood Alleviation Scheme (model was approved in 2020). All the other tributaries have models from 2015 or later.

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 do not maintain any significant flood risk management assets within the FRA. This is in part because Leeds City Council have taken the decision to lead on building and maintaining many of the flood defence assets within the city. These include several improvements recently completed by LCC:

- Leeds Flood Alleviation Scheme Phase 1 completed in 2017, better protecting 3,000 properties

- Ramsden Street Kippax flood embankment completed in 2017, better protecting 32 properties
- Killingbeck Meadows Flood Storage area, Wyke Beck completed in 2020, better protecting better protecting more than 30 properties
- Mickletown Pit Lane embankment completed in 2021, better protecting 5 properties
- Leeds Flood Alleviation Scheme Phase 2 in construction at time of writing (2021)

The impact of climate change and future flood risk

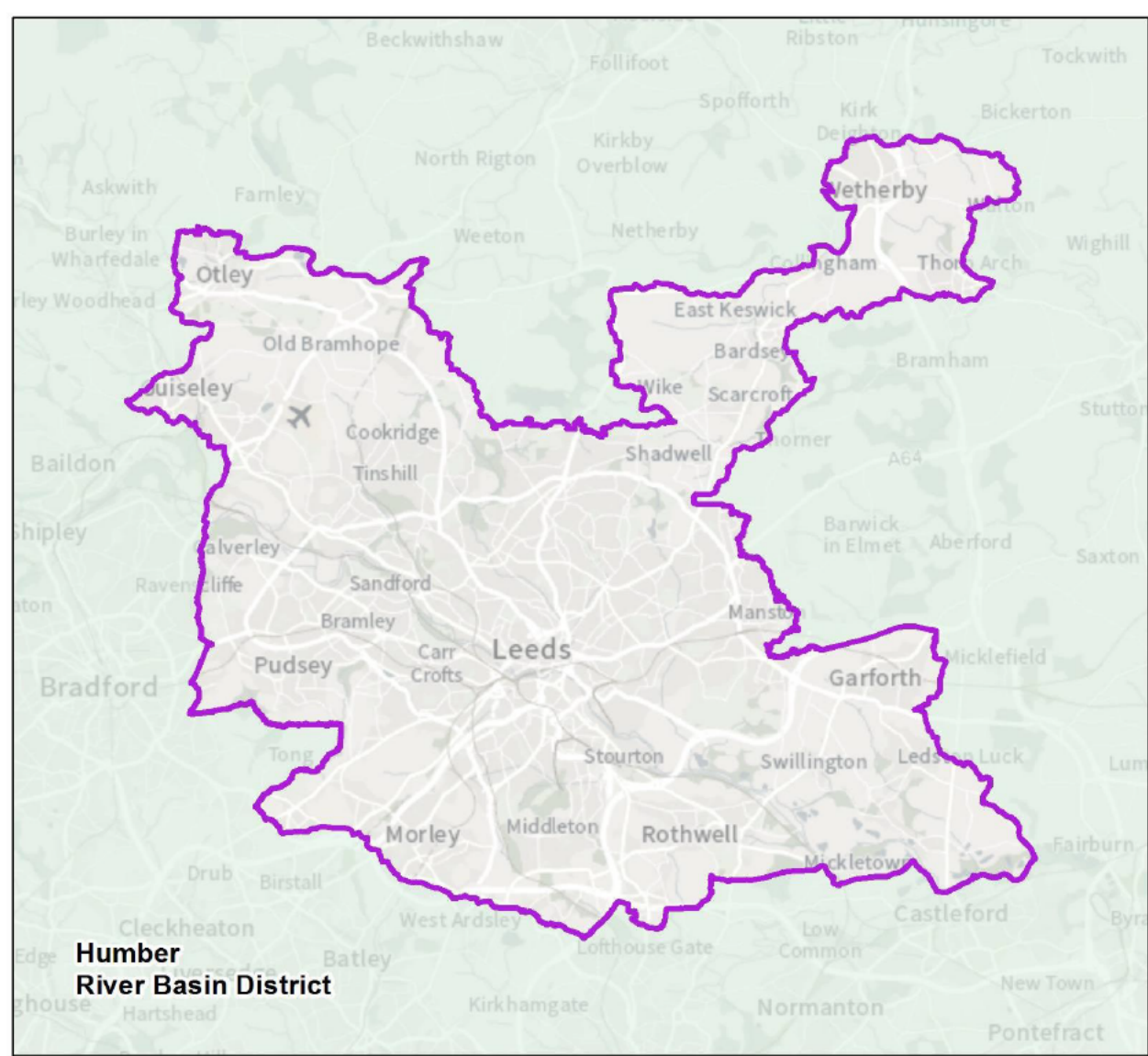
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Leeds Rivers and Sea FRA

Measures have been developed which apply specifically to the Leeds Rivers and Sea FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Leeds Rivers and Sea FRA. You can find information about all the measures which apply to the Leeds Rivers and Sea FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Leeds Surface Water Flood Risk Area



Flood Risk Area: Leeds, Humber

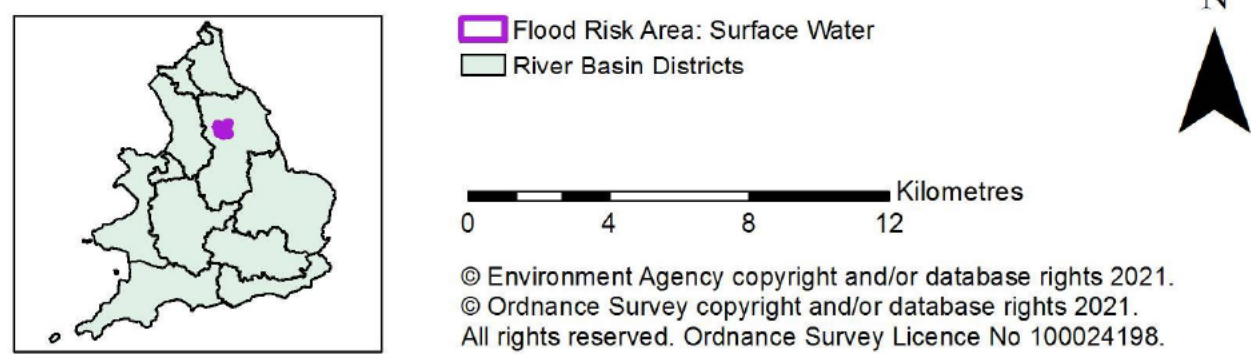


Figure 35: A map showing the boundary of the Leeds Surface Water Flood Risk Area

Introduction to the Leeds Surface Water Flood Risk Area

The Leeds Surface Water 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).

Leeds City Council take the lead on the development and delivery of the FRMP as it is the Lead Local Flood Authority (LLFA) responsible for managing flood risk from 'local' sources. These local sources of flooding are surface water, groundwater and ordinary watercourses.

The Environment Agency's remit covers flood risk from rivers and the sea.

Yorkshire Water is the water and sewerage company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Leeds Surface Water FRA covers many of the districts of Leeds which feature businesses and residential properties.

The Leeds and Liverpool canal lies within the FRA and is owned and maintained by the Canal & River Trust.

There are several Sites of Special Scientific Interest (SSSI) located within the Leeds Surface Water FRA. These include:

- Breary Marsh
- Fairburn and Newton Ings
- Leeds to Liverpool Canal
- Eccup Reservoir
- Mickletown Ings
- Hetchell Wood
- Linton Common
- Great Dib Wood
- Townclose Hills
- Roach Lime and Yeadon Brickworks and Railway Cutting

In addition to this, there are multiple Registered Parks, Ancient Woodlands, Local Nature Reserves, Listed Buildings and Scheduled Monuments within the area.

Leeds Metropolitan District (slightly bigger than the FRA area) covers 562 square kilometres and includes approximately 360 square kilometres of countryside designated as Green Belt. The general topography is undulating in characteristic and varies in level from 10m above Ordnance Datum at Fairburn on the River Aire and Thorp Arch on the River Wharfe to more than 340m at Hawksworth Moor.

The FRA is traversed from the Northwest to Southeast by the River Aire. The northern boundary includes parts of the River Wharfe catchment, which flows from West to East.

The River Calder forms part of the southern boundary flowing from the southwest to join the River Aire at Castleford.

The rocks underlying the area date from the Upper Carboniferous period: the sandstones and grits of the older, Millstone Grit series are to the north of the city; the alternating shales, mudstones, coal seams and sandstones of the Lower Coal Measures are to the south. The soils are mainly clayey or loamy and are relatively impermeable. However, sands and gravels predominate adjacent to the River Aire.

Although Leeds was initially served by combined sewers (foul and surface water), it has been the policy since the 1950's to ensure that new development and redevelopment would be serviced on a separate sewerage system basis. Therefore, a significant part of the city now has separate or partially separate sewers, with the surface water sewers connected in many cases directly to watercourses.

The original trunk interceptor sewer for Leeds was built c.1850 and drained to the sewage treatment works at Knostrop. This trunk sewer, since extended, renewed and partially duplicated, roughly follows the line of the River Aire from Bridge Road, Kirkstall to Knowsthorpe. In the 1920s further treatment facilities were built on higher ground at Knostrop and a new interceptor sewer - to the north of the original trunk sewer - was laid between Morris Lane, Kirkstall, and the new facilities. This new sewer drains most of the northern part of the city and is known as the High-Level Sewer. The original interceptor sewer has become known as the Low-Level Sewer. These sewers drain to the High-Level and Low-Level treatment works respectively.

Leeds district is susceptible to flooding from a variety of sources and every year this FRA area experiences flooding incidents that affect residential and business properties and city-wide infrastructure. These result from severe weather and from issues with the design and maintenance of the built environment.

The FRA is susceptible to flooding from surface water during times of increased rainfall.

There is also interaction with other sources of flooding across the FRA as follows:

- river flooding (main river and ordinary watercourse occurs when a watercourse cannot cope with the water draining into it from surrounding land. There is a separate FRA covering many of these rivers called the Leeds River and Sea FRA
- sewer flooding can occur when they are overwhelmed by heavy rainfall, or they become blocked. The chance of flooding depends on the capacity of the local sewer system and amount of rain that falls
- groundwater flooding occurs when levels of water in the ground rise above the surface. It is most likely to happen in areas where the ground contains permeable rocks that water can soak into or pass through easily

Current flood risk

Between 13 to 16 November 2015, high intensity, long duration rainfall resulted in fluvial flooding that was focused on Otley, but also affected areas such as Leeds city centre. An estimated 78mm of rain fell during this period. 73 residential properties were flooded, of which 62 were in Otley (note this was predominantly from the river Wharfe).

Then, between 25 to 29 December 2015, further rainfall led to the highest recorded levels on the River Aire, Calder and Wharfe. Flooding from these rivers, as well as other sources, affected homes and businesses, as well as critical and local infrastructure. Property flooding in Leeds district totalled 3368.

There have been no significant surface water (or river) flood events since 2015 in the FRA, although there have been several near misses and numerous incidents of highway flooding.

The [flood hazard and risk maps](#) show that in the Leeds Surface Water FRA 62,021 people live in areas at risk of flooding from surface water of which 7% are in areas of high risk.

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

- 5,559 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 62.11km of roads
- 33.16km of railways
- 1509.97ha of agricultural land
- areas of environmental designated sites, parks and gardens, listed buildings, water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Leeds Surface Water FRA.

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

How the risk is currently managed

The management of surface water flood risk is led by Leeds City Council in collaboration with other Risk Management Authorities (RMAs) and other stakeholders for example Environment Agency and Yorkshire Water.

Leeds City Council has a large Flood Risk Management team. The Leeds Flood Risk Management Strategy (updated in 2018) is the guiding strategy document and sets out measures to reduce flooding across the district. Leeds City Council monitor their performance of meeting the objectives of managing flood risk through several forums and planning processes, which include:

- monthly Flood Risk Management Performance Monitoring (MTP) report that tracks progress against annually set performance indicators. It also tracks an assessment of corporate risks
- annual and monthly progress reviews against the Environment Agency's MTP
- annual and monthly reporting of corporate performance using numbers of commercial and residential receptors better protected from flooding
- annual review of progress undertaken by the Council's Scrutiny Board (sustainable economy and culture)

Additionally, the Council's progress toward flood risk management objectives is monitored quarterly through several board meetings with partners, such as the Leeds Flood Resilience (LFR) Programme Board.

The LFR Programme Board is responsible for providing a strategic overview of flood resilience in Leeds, and where necessary, approvals and decision making that may affect Programme process and delivery. In addition, they will link to and create opportunities for catchment wide collaboration and working and develop ambitious integrated schemes. The board includes the Environment Agency, Yorkshire Water as well as LCC team representatives covering:

- flood risk
- development
- highways and transport
- planning
- asset management and regeneration
- communities
- strategy and policy
- resources and housing
- regeneration
- civil engineering
- communications
- parks and countryside

The Environment Agency monitor river and rainfall conditions across the FRA. These collect data on river levels, river flows and rainfall. There are 5 rainfall sites across the FRA.

This information is used to inform activities related to 51 flood warning areas (across Leeds District) which enable people to receive a warning when flooding could occur. Note that these flood warning areas are predominantly related to main river flooding and not surface water.

The water level and flow information is also used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have hydraulic models. Leeds City Council have also commissioned surface water modelling of numerous locations across the FRA to support capital schemes including in Garforth, Kippax and Potternewton.

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

Leeds City Council operate and maintain assets that perform a flood risk management function (both surface water and river flooding) in several locations across the FRA. Some examples of surface water assets that Leeds City Council operate and maintain include Glebelands and Barley Hill surface water flood storage areas in Garforth, Hawthorne Terrace in Garforth and Westfields, Allerton Bywater.

The Environment Agency similarly operates and maintains flood risk management assets on the main watercourses in the FRA. These include:

- flood defence walls
- flood gates
- channels
- culverts
- debris screens

This work includes routine inspection and clearance activities as well as periodic repair and replacement of assets.

The Canal & River Trust maintains the Leeds and Liverpool Canal as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

Since 2015 Leeds City Council have completed the following improvements to surface water flood risk:

- Hawthorne Terrace FAS phase 1 (2016) and phase 2 (2020) West Garforth 10 properties
- Glebelands Recreation Ground (2017) 10 properties
- Barley Hill Recreation Ground phase 2 (2017) 24 properties
- Westfields, Allerton Bywater (2018) 40 properties

The impact of climate change and future flood risk

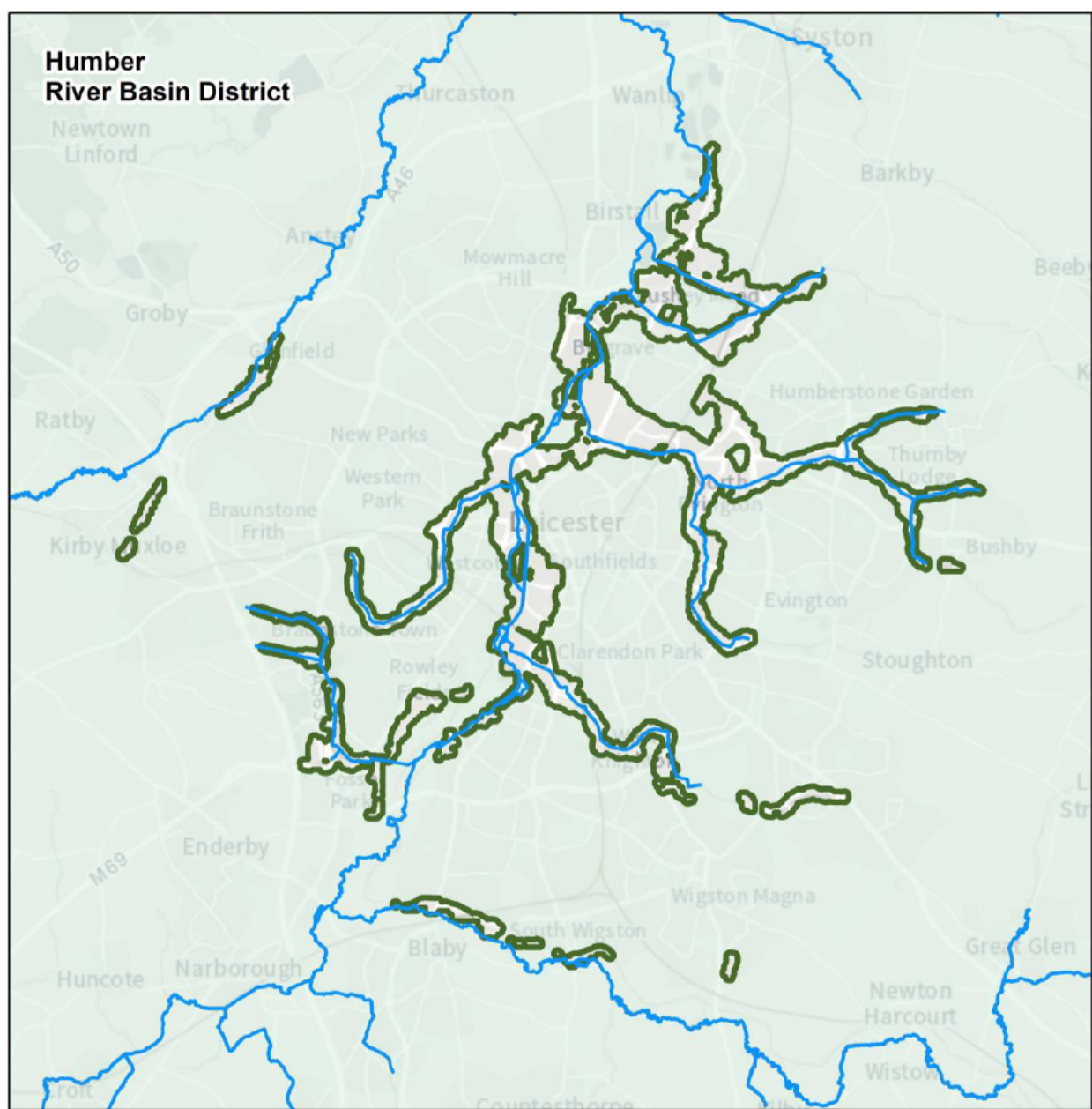
As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

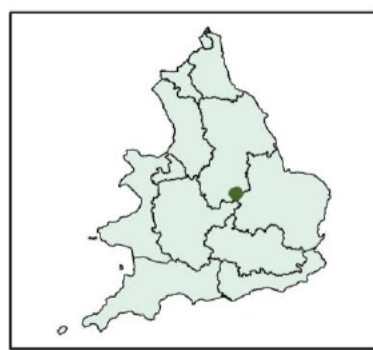
Objectives and measures for the Leeds Surface Water FRA

Measures have been developed which apply specifically to the Leeds Surface Water FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Leeds Surface Water FRA. You can find information about all the measures which apply to the Leeds Surface Water FRA in the interactive mapping tool - ['Flood Plan Explorer'](#). This includes information on which national objectives each measure helps to achieve.

The Leicester Rivers and Sea Flood Risk Area



Flood Risk Area: Leicester, Humber



Main Rivers

Flood Risk Area: Rivers and Sea

River Basin Districts

Kilometres

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Figure 36: A map showing the boundary of the Leicester Rivers and Sea Flood Risk Area

Introduction to the Leicester Rivers and Sea Flood Risk Area

The Leicester Rivers and Sea 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 is responsible for the development and delivery of the Flood Risk Management Plan for this FRA. The Lead Local Flood Authorities (LLFA), Leicester City Council and Leicestershire County Council are responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the city of Leicester and extends to surrounding towns including:

- Oadby
- Wigston
- Braunstone
- Glenfield
- Birstall

The area is characterised by dense urban concentrations with the River Soar (main river) running northwards through the city.

Leicester dates to pre-Roman times, occupying a strategic location on the River Soar. The historic city was founded on land adjacent to the River Soar but has since expanded to include areas which were previously villages on the periphery of the city such as:

- Aylestone
- Belgrave
- Humberstone
- Evington

The ground rises steeply to the east and west with several watercourses connecting to the River Soar through heavily populated areas. This topography makes Leicester particularly susceptible to surface water flooding following heavy downpours or prolonged periods of rain.

Main river tributaries of the River Soar include:

- River Sence
- Melton Brook
- Braunstone Brook
- Saffron Brook
- Willow Brook

Leicester City Council and Leicestershire County Council are responsible for several ordinary watercourses (OW). Some of the more significant of these include:

- Hol Brook
- Wash Brook

- Ethel Brook
- Portwey Brook
- Gilroes Brook

The Grand Union Canal also passes through the city and connects to the River Soar for several reaches. There are a few locations where the canal is embanked or artificially raised above surrounding ground levels. The canal passes through the Leicester Central Development Area before joining a navigable stretch of the River Soar as it passes north of the city.

The FRA is predominantly urban with some sections of open space and meadows along the River Soar and Grand Union Canal corridor. Floodplain conveyance projects have been carried out along the River Soar corridor that also provide ecological enhancements and access improvements (examples are Aylestone Meadows and Cardinals Meadows).

The geology is generally Keuper Marl combined with beds of Triassic Sandstone. Soils are often loamy clay which impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Nature Reserves within the FRA area. These include Aylestone Meadows, Humberstone Park, Watermead County Park and Birstall Reserve. There are also several Scheduled Ancient Monuments and listed buildings within the FRA, such as Jewry Wall and the remains of Leicester Castle.

Flooding from rivers can occur as a result of the channel capacity being exceeded, a blockage occurring, or as a result of surcharge from culverted sections. There are limited formal flood defences on the River Soar. Flood risk has been exacerbated by several constrictions to the flow on the River Soar, including redundant railway bridges, deposition within the channel and historic land raising in the flood plain.

Leicester is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Leicester has grown. Severn Trent Water has a hydraulic model of the sewer system, including all public foul, combined and surface water gravity sewers and pumping stations and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water have undertaken schemes to increase the capacity of the sewers in Leicester to reduce the risk of sewer flooding. There are several flood storage reservoirs in Leicester, including Dakyn Road basin on Bushby Brook, the Knighton Park Basins on Wash Brook, Saffron Brook and the Braunstone Park basins on Braunstone Brook.

Groundwater flood incidents are thought to have occurred in the FRA but it is unclear whether flooding was as a result of high groundwater levels or other local factors.

Current flood risk

Leicester is at risk of flooding from a variety of sources. The primary sources include flooding from main rivers, surface water, ordinary watercourses (OW) and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source.

There are records of historic flooding in Leicester.

In June 2012 surface water from a particularly intense rainfall event caused both Hol Brook and Gilroes Brook to flood onto the surrounding roads and backup into multiple residential properties and gardens, particularly on Fosse Road South and Carisbrooke Road.

A flood event in November 2012 was estimated to be between a 5% and 10% Annual Exceedance Probability (AEP) Event. The Soar came close to flooding in excess of 1,000 residential and commercial properties in the Belgrave and Abbey Meadows areas of the city.

In summer 2016 intense summer storms caused localised flooding along Evington Brook (main river) and Hol Brook (OW). Surface water flooding was also recorded in Evington, Eyres Monsell and New Parks.

Several OWs (Portwey Brook, Ethel Brook, Gilroes Brook, Hol Brook and Wash Brook) have caused flooding in the past, and some records exist for these incidents. The main consequences appear to be flooding to roads and gardens, but properties have also been affected.

The [flood hazard and risk maps](#) show that in the Leicester (Rivers and Sea) FRA approximately 32,896 people live in areas at risk of flooding from rivers. Of these, 13% are in areas of high-risk.

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

- 2,122 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 2.3 km of roads
- 0.25 km of railway lines
- 46.6 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency leads on the management of flood risk from main rivers, in collaboration with other RMAs. Other stakeholders include Leicestershire City Council Leicestershire County Council and Severn Trent Water.

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Canal & River Trust maintains the Grand Union Canal as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Leicestershire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions at 7 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Soar.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers such as the Soar, along with their 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

Leicester Conveyance Project was led by the Environment Agency in partnership with Leicester City Council. One part of the scheme converted a former school playing field into a wetland and wildflower park complete with cycleway and boardwalk and reconnected the

River Soar with its floodplain. Consisting of grass and decommissioned allotments, the public rarely used the site before this project; and ecologically it contributed very little. Funded in 2013 and completed in 2016, the 7.4 hectares restored at Ellis Meadows formed the second phase of a larger natural flood management project for the city. Taking a blue-green infrastructure approach to managing flood risk through a combination of land lowering and reshaping, wetland creation, and vegetation management has reduced the flood risk for over 2000 homes and businesses in Leicester.

Works were also carried out at Loughborough Road next to the River Soar to create a flood relief culvert and land lowering either side of the bridge to create additional floodplain capacity. The culvert was designed to prevent flood water building up on the upstream side of the bridge and causing a potential flood risk to existing properties in the Belgrave area. The culvert constructed also provides better public access along the river, as it forms part of the cycle route to the north of the city. Wetland habitats have been enhanced through the creation of ponds and wetlands either side of the bridge.

The Environment Agency, in partnership with Leicester City Council, is looking to further reduce the risk of flooding in Leicester as recommended by the Leicester Integrated Flood Risk Management Strategy. The Leicester Integrated Flood Risk Management Strategy was developed in 2017. The Environment agency, Leicester City Council and other RMAs worked together to develop a strategy to:

- further reduce the risk of flooding
- provide environmental and social benefits for local residents and businesses
- continue to support and encourage wildlife
- ensure rivers and streams are an integral part of the urban environment

Appraisal work on the Braunstone Brook and Willow Brook which are tributaries of the River Soar concluded that capital works could not be justified at this time. Capital options are being considered on the River Soar as part of the River Soar Flood Risk Management Scheme. The current preferred option involves storage of flood water upstream of the City. There is likely to be a partnership funding deficit associated with delivery of the project, so the timescales are to be confirmed.

Additional Capital projects are planned to be undertaken by Leicester City Council as the LLFA. Further details on these can be found in the Leicester Surface Water FRA information.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Leicester Rivers and Sea FRA

Measures have been developed which apply specifically to the Leicester Rivers and Sea FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Leicester Rivers and Sea FRA. You can find information about all the measures which apply to the Leicester Rivers and Sea FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Leicester Surface Water Flood Risk Area

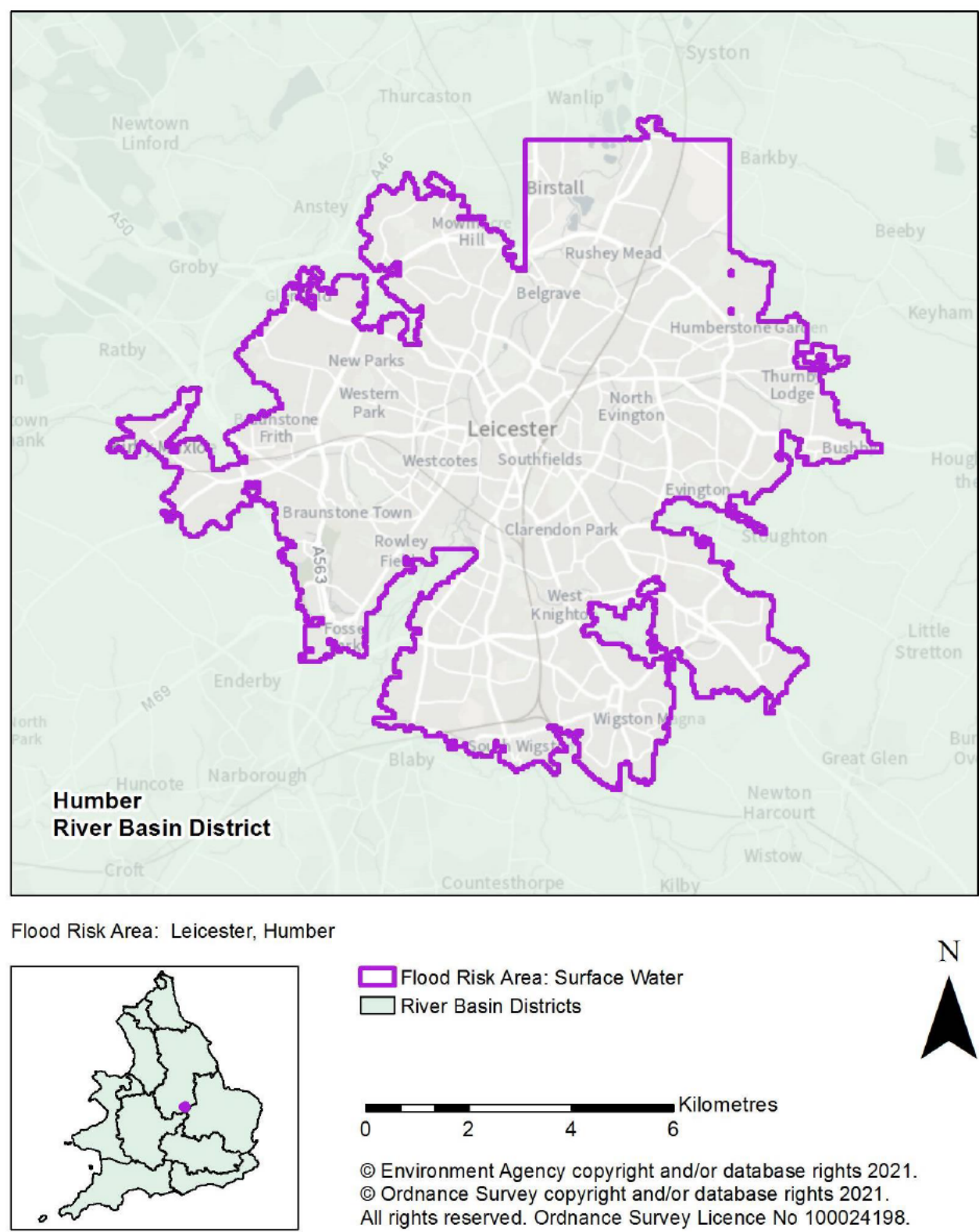


Figure 37: A map showing the boundary of the Leicester Surface Water Flood Risk Area

Introduction to the Leicester Surface Water Flood Risk Area

The Leicester (Surface Water) 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).

As Lead Local Flood Authorities (LLFA), Leicester City Council and Leicestershire County Council are responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Environment Agency's remit includes managing flood risk from main rivers in the FRA. Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the city of Leicester and extends to surrounding towns including Oadby, Wigston, Braunstone, Glenfield and Birstall. The area is characterised by dense urban concentrations with the River Soar (main river) running northwards through the city.

Leicester dates to pre-Roman times, occupying a strategic location on the River Soar. The historic city was founded on land adjacent to the River Soar but has since expanded to include areas which were previously villages on the periphery of the city such as:

- Aylestone
- Belgrave
- Humberstone
- Evington

The ground rises steeply to the east and west with several watercourses connecting to the River Soar through heavily populated areas. This topography makes Leicester particularly susceptible to surface water flooding following heavy downpours or prolonged periods of rain.

Main river tributaries of the River Soar include:

- River Sence
- Melton Brook Braunstone Brook Saffron Brook Willow Brook

Leicester City Council and Leicestershire County Council are responsible for several ordinary watercourses (OW). Some of the more significant of these include:

- Hol Brook
- Wash Brook
- Ethel Brook
- Portwey Brook
- Gilroes Brook

The Grand Union Canal also passes through the city and connects to the River Soar for several reaches.

The Leicester (Surface Water) FRA is predominantly urban with some sections of open space and meadows along the River Soar and Grand Union Canal corridor. Floodplain conveyance projects have been carried out along the River Soar corridor that also provide

ecological enhancements and access improvements (examples are Aylestone Meadows and Cardinals Meadows).

Surface water flooding has historically, and continues to be, a significant issue in Leicester. The flashy nature and short duration of such events has made them difficult to predict and protect against.

Leicester is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Leicester has grown. Severn Trent Water has a hydraulic model of the sewer system, including all public foul, combined and surface water gravity sewers and pumping stations and information is available for the capacity and condition of the network.

Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken schemes to increase the capacity of the sewers in Leicester to reduce the risk of sewer flooding. Flood risk has been exacerbated by several constrictions to the flow on the River Soar which includes redundant railway bridges, deposition within the channel and historic land raising in the flood plain.

There are limited formal flood defences on the River Soar, however there are several flood storage reservoirs in Leicester. These include the Dakyn Road basin on the Bushby Brook, the Knighton Park Basins on the Saffron Brook/Wash Brook and the Braunstone Park basins on the Braunstone Brook.

The Grand Union Canal runs through Leicester and merges with the River Soar at several locations. There are a few locations where the canal is embanked or artificially raised above surrounding ground levels. The canal passes through the Leicester Central Development Area before joining a navigable stretch of the River Soar as it passes north of the city. Records from the Canal & River Trust (formerly British Waterways) have recorded one incident of a canal structure breach. In 1986 a failure of the Freemans Meadow Weir, lock and sluice system was recorded. There is no information that confirms if flooding occurred, or whether there were any consequences.

Groundwater flood incidents are thought to have occurred in the FRA but it is unclear whether flooding was as a result of high groundwater levels or other local factors.

Current flood risk

Leicester is at risk of flooding from a variety of sources. The primary sources include flooding from main rivers, surface water, ordinary watercourses (OW) and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source.

There are records of historic flooding in Leicester.

In June 2012 surface water from a particularly intense rainfall event caused both Hol Brook and Gilroes Brook to flood onto the surrounding roads and backup into multiple residential properties and gardens, particularly on Fosse Road South and Carisbrooke Road.

A flood event in November 2012 was estimated to be between a 5% and 10% Annual Exceedance Probability (AEP) Event. The Soar came close to flooding in excess of 1,000 residential and commercial properties in the Belgrave and Abbey Meadows areas of the city.

In summer 2016 intense summer storms caused localised flooding along Evington Brook (main river) and Hol Brook (OW). Surface water flooding was also recorded in Evington, Eyres Monsell and New Parks.

Several OWs (Portwey Brook, Ethel Brook, Gilroes Brook, Hol Brook and Wash Brook) have caused flooding in the past, and some records exist for these incidents. The main consequences appear to be flooding to roads and gardens, but properties have also been affected.

The [flood hazard and risk maps](#) show that in the Leicester (Surface Water) FRA approximately 57,996 people live in areas at risk of flooding from surface water. Of these, 9% are in areas of high-risk.

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

- 3,111 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 14.9 km of roads
- 11.6 km of railway lines
- 195 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

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 manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Leicester City Council lead on the management of surface water flood risk in collaboration with other RMAs. Other stakeholders include the Environment Agency, the Canal & River Trust, Leicestershire County Council, and Severn Trent Water. The LLR Prepared (the Local Resilience Forum covering Leicester, Leicestershire and Rutland) also operates within the FRA and is a multi-agency partnership coordinating emergency planning and responding in the event of emergencies. Flooding is one of the risks addressed by the LRF

through community flood preparation. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

Leicester City Council currently have river depth gauges installed at 5 sites within the city to provide surface water flood risk data collection and monitoring. Rainfall data is also collected using rain gauges installed at 5 sites across the city. The Environment Agency monitors river and rainfall conditions at 7 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Soar.

A Surface Water Management Plan (SWMP) was completed in 2012 to provide a more detailed understanding of surface water flood risk in the city. Modelling of surface water flood risk and some ordinary watercourses was completed, which identified 'hotspots' for further investigation. Updated modelling on selected ordinary watercourses has been carried out as part of the most recent Strategic Flood Risk Assessment (SFRA) in 2020. The outputs of this modelling have been incorporated into planning constraints mapping, to aid responses to planning applications.

The Leicester Integrated Flood Risk Management Strategy was implemented in 2018. The Environment agency, Leicester City Council and other RMAs worked together to develop a strategy to:

- further reduce the risk of flooding
- provide environmental and social benefits for residents and businesses
- continue to support and encourage wildlife
- ensure rivers and streams are an integral part of the urban environment

Leicester City Council is working with Severn Trent Water to investigate flood risk from the Hol Brook and inform delivery of a potential flood risk alleviation scheme in the catchment. There are also three schemes at the feasibility stage: Leicester Royal Infirmary surface water flood resilience, Western Park strategic SuDS, and Evington Brook flood alleviation. These schemes are included in the Leicester City Council Climate Emergency Action Plan (published in October 2020).

The impact of climate change and future flood risk

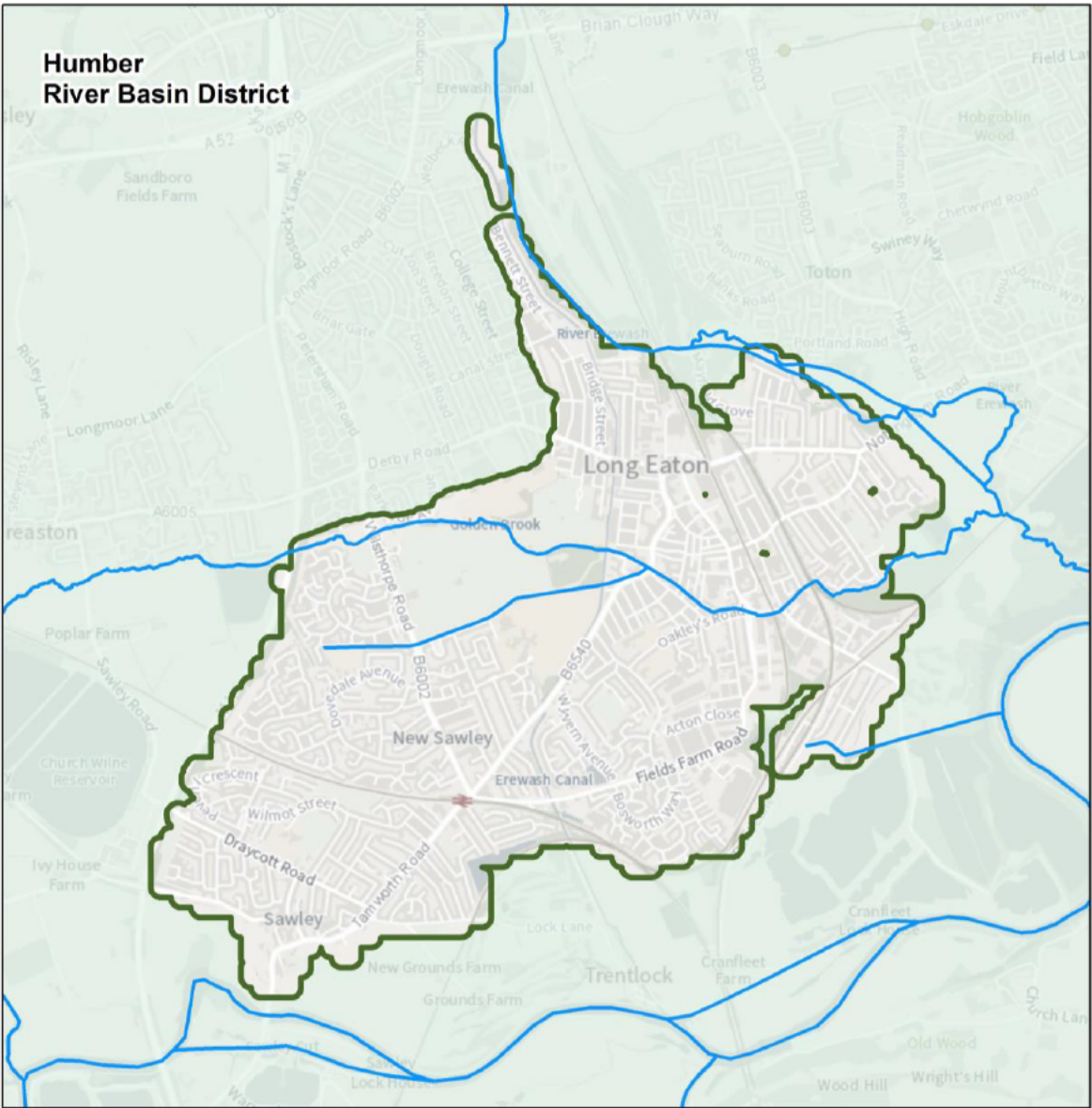
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

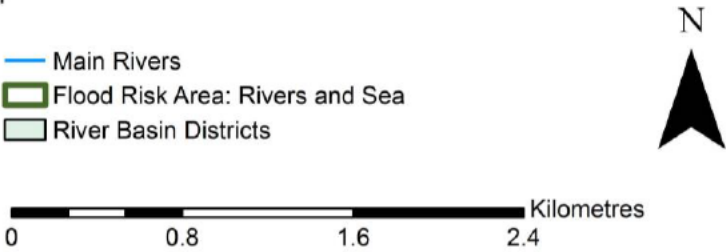
Objectives and measures for the Leicester (Surface Water) FRA

Measures have been developed which apply specifically to the Leicester (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Leicester (Surface Water) FRA. You can find information about all of the measures which apply to the Leicester (Surface Water) FRA in the interactive mapping tool - [‘Flood Plan Explorer’](#).

The Long Eaton Rivers and Sea Flood Risk Area



Flood Risk Area: Long Eaton, Humber



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Figure 38: A map showing the boundary of the Long Eaton Flood Risk Area

Introduction to the Long Eaton Flood Risk Area

The Long Eaton (Rivers and Sea) 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authority (LLFA) Derbyshire County Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The Long Eaton (Rivers and Sea) FRA covers the Long Eaton area and extends into areas including Sawley. The area is characterised by a compact town centre surrounded by residential suburbs, business and amenity areas with the River Trent (main river) skirting the southern edge of the FRA.

Long Eaton is located on an area of low hills in the lower River Trent valley. The Golden Brook and Harrington Drain flow eastwards through the FRA, and join the River Erewash, a tributary of the River Trent to the south of the FRA.

Much of the town is built on Triassic sandstones and mudstones which are relatively permeable. The Trent valley is floodplain alluvium, and gravel extraction activities in the FRA is common.

There are various Local Wildlife Reserves and sites such as Fox Covert, Forbes Hole, Manor Farm and the Erewash Canal. In Sawley there is a Scheduled Ancient Monument which is the remains of a roman fort. There are also several listed buildings across the FRA.

Flooding from rivers can occur as a result of the channel capacity being exceeded, a blockage occurring, or as a result of surcharge from culverted sections. There are extensive flood protection assets maintained by the Environment Agency in the FRA, which include raised defences and outfalls.

The Erewash Canal is owned and maintained by the Canal & River Trust. The Erewash Canal starts at the Langley Mill basin, runs southwards adjacent to the River Erewash and joins the River Trent at Trent Lock.

Long Eaton is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as the urban area as grown. Severn Trent Water has a hydraulic model of the public sewer system. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken work to increase the capacity of the sewers to reduce the risk of sewer flooding.

There is a risk of flooding from reservoirs and canals. Groundwater flood incidents are thought to have occurred in the FRA but it is unclear whether flooding was as a result of high groundwater levels or other local factors.

Current flood risk

Long Eaton is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source. The Environment Agency's reservoir flood data has identified that Long Eaton is located within an area at risk of reservoir flooding.

The [flood hazard and risk maps](#) show that in the Long Eaton (Rivers and Sea) FRA approximately 30,450 people live in areas at risk of flooding from rivers. Of these, 0.4% are in areas of high-risk.

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

- 1,346 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 0.1 km of roads
- 9.2 km of railway lines
- 107 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Nottingham Left Bank flood risk management scheme was completed in 2012. The £45 million scheme reduces the risk of flooding to 16,000 homes and businesses along a 27 kilometre stretch of the River Trent, from Sawley to Colwick, which includes the Long Eaton FRA. It also provides additional protection to key infrastructure at the heart of the communities along the Trent. The new scheme reduces the risk of flooding to 1% chance of flooding in any one year.

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. There are several significant assets in the FRA including:

- the West Park Flood Storage Reservoir

- the Breaston Storage Lagoon
- extensive raised defences protecting the FRA from flooding from the River Trent and the River Erewash and Golden Brook
- pumping station on Golden Brook
- pumping station on New Sawley Brook
- outfalls to the River Trent

Flood risk in Long Eaton is carefully managed by a suite of assets that were constructed by Erewash Borough Council as part of the Long Eaton & Breaston Flood Alleviation Scheme following the 1977 flood event. This includes 2 flood storage reservoirs, 2 pumping stations and flood doors.

To the west of the FRA area, Breaston Lagoon is an Environment Agency operated and maintained reservoir registered under the Reservoirs Act 1975 which is located to the west of Long Eaton. Breaston Lagoon was constructed in February 1991 by Erewash Borough Council as part of the Long Eaton & Breaston Flood Alleviation Scheme. The reservoir performs a strategic link in a chain of flood defences that protect over 7,500 properties from flooding.

Breaston Lagoon comprises a flood storage area with capacity for 302,000m³ when full which is retained by a concrete wall and earth embankment. Flows into the reservoir take place via an overspill weir and are controlled by a penstock in Golden Brook which is operated automatically through telemetry and monitoring systems. The reservoir drains down via a large diameter flapped valve.

West Park Flood Storage Reservoir at the centre of the FRA is an Environment Agency operated and maintained on-line reservoir on the Golden Brook and Harrington Drain located in the centre of Long Eaton. The reservoir impounding features were constructed in the 1980s as part of the Long Eaton & Breaston Flood Alleviation Scheme. The reservoir is split into a northern cell and smaller southern cell, both of which are designed to overtop into the Erewash Canal via a controlled spillway. West Park has a maximum flood storage capacity of 305,000m³ and works alongside Breaston Lagoon to store floodwater and protect Long Eaton.

Both reservoirs are classed as a Strategically Important Asset (SIA) due to the number of properties they protect and the consequences of the asset failing to operate as designed.

Other key defences include Grange Park pumping station and New Sawley Brook pumping station as well as Sheet Stores flood doors on the Erewash Canal – all of which are classed as SIAs.

Grange Park pumping station is located upstream of the confluence of Golden Brook and the River Erewash. As the River Erewash level rises, the Golden Brook's outfall is restricted, reducing conveyance and increasing water levels upstream. When the River Erewash's levels have risen sufficiently, telemetry readings at the station will automatically trigger and close a penstock. The pumps will then over-pump excess water from the Golden Brook downstream of the defences and into the River Erewash. Grange Park

pumping station directly benefits about 120 properties as well as contributing to the overall management of water levels in Long Eaton.

The LLFA and Severn Trent Water also maintain assets that perform a flood risk management function on the drainage network. The Canal & River Trust maintains the Erewash Canal, which goes through the town of Long Eaton as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Derbyshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Trent and the River Erewash.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Trent, River Erewash and the Golden Brook, along with their 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

The West Park Penstock Improvement Works was led by the Environment Agency. The scheme included improvements to the penstocks attached to the West Park Flood Storage Reservoir. The works were completed in 2015 and reduced flood risk to 660 properties.

The impact of climate change and future flood risk

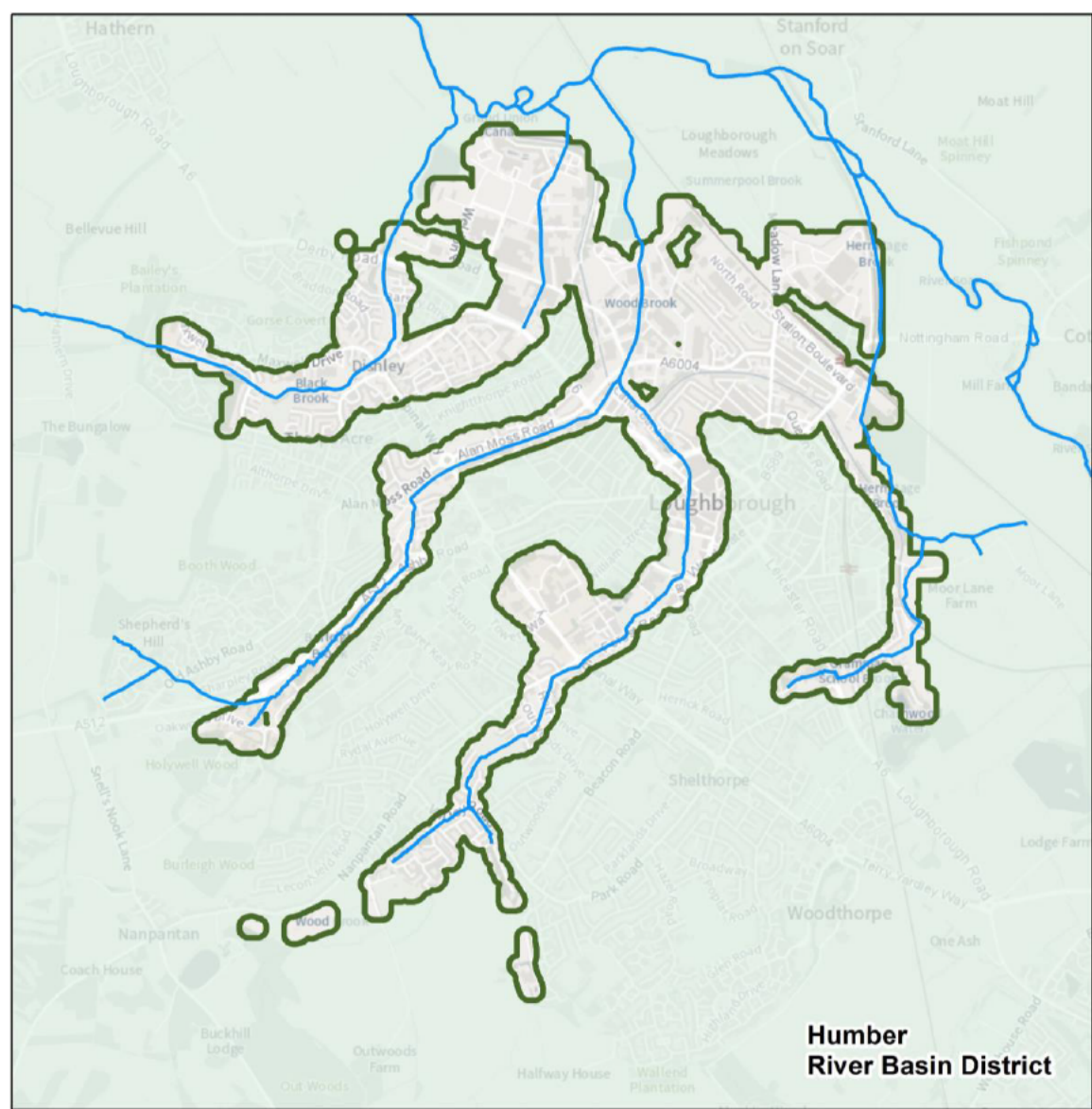
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Long Eaton Rivers and Sea FRA

Measures have been developed which apply specifically to the Long Eaton (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Long Eaton (Rivers and Sea) FRA. You can find information about all the measures which apply to the Long Eaton (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Loughborough Rivers and Sea Flood Risk Area



Flood Risk Area: Loughborough, Humber

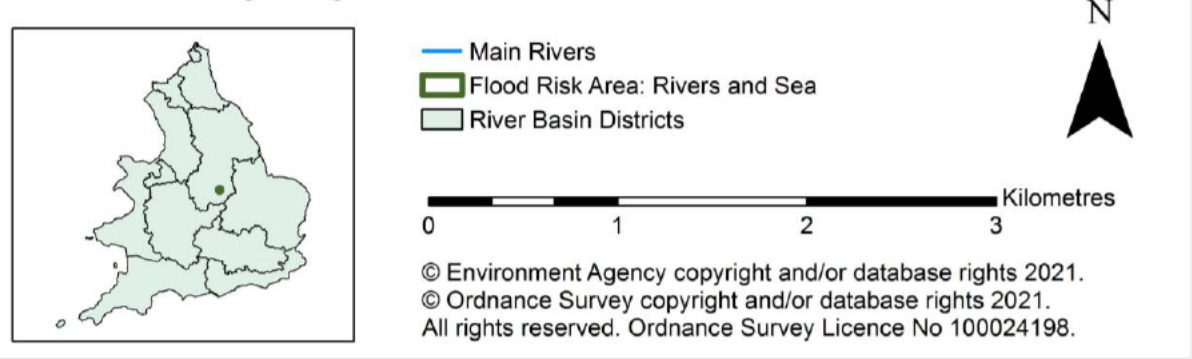


Figure 39: A map showing the boundary of the Loughborough Rivers and Sea Flood Risk Area

Introduction to the Loughborough Flood Risk Area

The Loughborough (Rivers and Sea) 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authority (LLFA) Leicestershire County Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the town of Loughborough, extending across the central urbanised area. The area is characterised by urban and suburban communities, as well as rural fringe. The main rivers are Wood Brook, Burleigh Brook, Black Brook and Hermitage Brook which flow northwards through the FRA, as tributaries of the River Soar. The Grand Union Canal also flows in a northerly direction through the FRA area.

The geology is generally siltstone, mudstones and sandstone which are part of the Gunthorpe member, Edwalton member or the Taporley Siltstone formation. Soils are often loamy clay which have a naturally high ground water table and impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Wildlife sites and Reserves within the FRA boundary, which include:

- Booth Wood
- Stonebow Washlands
- Pignut Spinney Marsh
- Dishley Pool
- Bishop Meadow
- Charnwood Water
- Paget Pastures

In addition, Holywell Wood which is a Local Wildlife site is also designated as Ancient Woodland, along with Outwood to the south of the FRA. Outwoods is also part of the Beacon Hill, Hangingstone and Outwoods Site of Special Scientific Interest (SSSI).

Loughborough was founded as a large Saxon village and is recorded in the Domesday Book. Overtime Loughborough became a prosperous medieval market town. During the Industrial Revolution the town population grew as various industries, such as framework knitting, lacemaking and pharmaceuticals developed in the town. The Loughborough University was founded in 1966.

Loughborough is currently undergoing changes with several key developments completed and further housing developments planned as part of the Charnwood Local Plan. The Loughborough Town Deal is also seeking for development funding for the town, focussing on urban regeneration, infrastructure, the arts, skills and enterprise.

Historically, fluvial flooding is a prominent issue from both main river and ordinary watercourses through the area. These include flooding from the River Soar and its tributaries, Wood Brook, Black Brook and Hermitage Brook. In addition, surface water flooding also is also a prominent issue for the FRA, with multiple historic flood events in Loughborough.

Loughborough is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Loughborough has grown. Severn Trent Water has a hydraulic model of the public sewer system in Loughborough and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken schemes to increase the capacity of the sewers in Loughborough to reduce the risk of sewer flooding.

Current flood risk

Loughborough is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers.

There are records of historic flooding in Loughborough, including several flooding events since 2015. Recent Incidents include October 2019 with 40 properties experiencing flooding as a result of main river, ordinary watercourse and surface water flooding sources.

The [flood hazard and risk maps](#) show that in the Loughborough (Rivers and Sea) FRA approximately 10,184 people live in areas at risk of flooding from rivers. Of these, 31% are in areas of high-risk.

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

- 782 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 1.1 km of roads
- 1.13 km of railway lines
- 68 ha of agricultural land
- areas of scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency leads on the management of flood risk from main rivers, in collaboration with other RMAs. Other stakeholders include Leicestershire County Council, Charnwood Borough Council and Severn Trent Water. There are regular operational meeting organised by Environment Agency for the RMAs to discuss work programmes and resolve any operational issues.

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Canal & River Trust maintains the Grand Union Canal as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Leicestershire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions at 3 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur. These flood warning areas include Wood Brook, Black Brook and the River Soar.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Soar, along with their 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

The Wood Brook and Tributaries Flood Risk Management Scheme is at the appraisal stage. A new hydraulic model of Wood Brook and Tributaries has been developed which provides inputs to the project. The hydraulic model outputs will also be incorporated into

an update of the Flood Map for the area. The progression of the project relies on the outcome of the Town Deal funding bid, which will help fund the scheme.

Additional Capital projects are planned to be undertaken by Leicestershire County Council as the LLFA. Further details on these can be found in the Loughborough (Surface Water) FRA information.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Loughborough FRA

Measures have been developed which apply specifically to the Loughborough (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Loughborough (Rivers and Sea) FRA. You can find information about all the measures which apply to the Loughborough (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Loughborough Surface Water Flood Risk Area

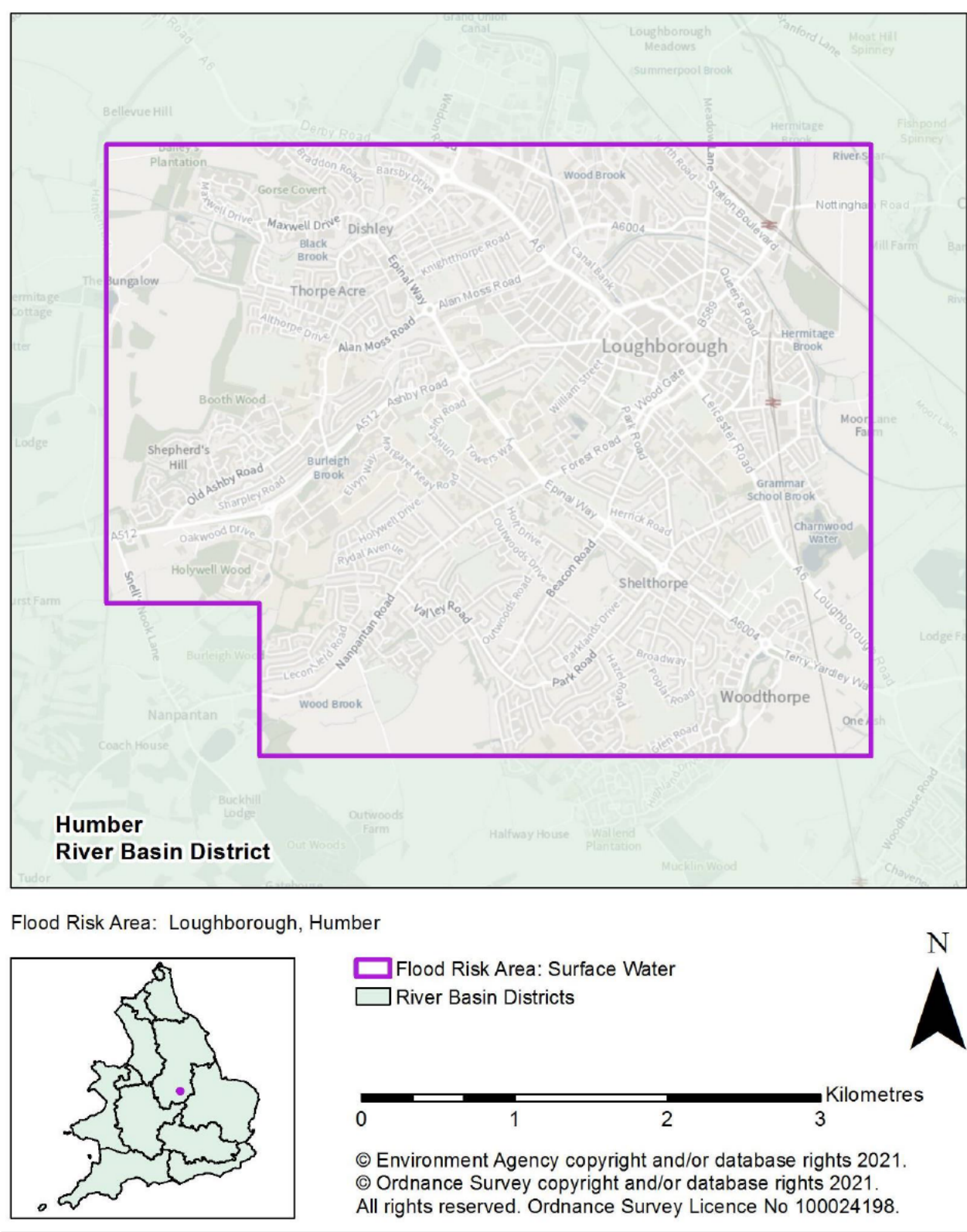


Figure 40: A map showing the boundary of the Loughborough Flood Risk Area

Introduction to the Loughborough Surface Water Flood Risk Area

The Loughborough (Surface Water) 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).

As Lead Local Flood Authority (LLFA) Leicestershire County Council is responsible for the development and delivery of the Flood Risk Management Plan for this FRA. The Environment Agency's remit includes managing flood risk from main rivers in the FRA. Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the town of Loughborough, extending across the central urbanised area. The area is characterised by urban and suburban communities, as well as rural fringe. The main rivers are Wood Brook, Black Brook and Hermitage Brook which flow northwards through the FRA, as tributaries of the River Soar. The Grand Union Canal also flows in a northerly direction through the FRA area.

The geology is generally siltstone, mudstones and sandstone which are part of the Gunthorpe member, Edwalton member or the Taporley Siltstone formation. Soils are often loamy clay which have a naturally high ground water table and impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Wildlife sites within the FRA boundary, which include:

- Booth Wood
- Gorse Covert
- Stonebow Washlands
- Pignut Spinney Marsh
- Charnwood Water
- Paget Pastures

In addition, Holywell Wood which is a Local Wildlife site is also designated as Ancient Woodland, along with Outwood to the south of the FRA. Outwood is also part of the Beacon Hill, Hangingstone and Outwood Site of Special Scientific Interest (SSSI).

Loughborough was founded as a large Saxon Village and is recorded in the Domesday Book. Over time Loughborough became a prosperous medieval market town. During the Industrial Revolution the town population grew as various industries, such as framework knitting, lacemaking and pharmaceuticals developed in the town. The Loughborough University was founded in 1966.

Loughborough is currently undergoing changes with several key developments completed and further housing developments planned as part of the Charnwood Local Plan. The Loughborough Town Deal is also seeking for development funding for the town, focussing on urban regeneration, infrastructure, the arts, skills and enterprise.

Historically, fluvial flooding is a prominent issue from both main river and ordinary watercourses through the area. These include flooding from the River Soar and its tributaries, Wood Brook, Moat Brook, Black Brook and Hermitage Brook. In addition, Surface water flooding also is also a prominent issue for the FRA, with multiple historic flood events in Loughborough.

Loughborough is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Loughborough has grown. Severn Trent Water has a hydraulic model of the public sewer system in Loughborough and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken schemes to increase the capacity of the sewers in Loughborough to reduce the risk of sewer flooding.

Current flood risk

Loughborough is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers.

Leicestershire County Council hold records of historic flooding in Loughborough. Recent incidents include June 2020 (predominately surface water and highway flooding) and October 2019 where around 40 properties experienced some degree of internal property flooding as a result of main river, ordinary watercourse and surface water flooding sources.

The [flood hazard and risk maps](#) show that in the Loughborough (Surface Water) FRA approximately 10,203 people live in areas at risk of flooding from surface water. Of these, 9% are in areas of high-risk.

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

- 622 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 1.66 km of roads
- 2.9 km of railway lines
- 81 ha of agricultural land
- areas of scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

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 manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Leicestershire County Council lead on the management of surface water flood risk, in their role as the LLFA, in collaboration with other RMAs. Other key stakeholders relevant to Loughborough include Charnwood Borough Council, the Environment Agency and Severn Trent Water. There are regular operational meetings organised by Leicestershire County Council for the RMAs to discuss work programmes and resolve any operational or drainage issues around Loughborough.

Leicestershire County Council is also a partner in the Loughborough Wood Brook Tributary Project. Led by the Environment Agency, this project is part of the greater Loughborough Town Deal, and aims to utilise flood risk management strategies in the upper catchment of the Wood Brook and its major tributaries to reduce the long-term flood risk to Loughborough.

The Leicestershire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The LLFA works with the Leicestershire LRF, to better coordinate community resilience and recovery after a flood event. The LLFA joins other partnership members in the training of volunteer flood wardens who are members of the local community who can organise community response, as well as providing critical information as part of partner response and recovery. Leicestershire County Council also continues to work with other RMAs to identify and review areas of Loughborough considered to be at very significant risk from surface water flooding. identify viable schemes to reduce this long-term risk.

Leicestershire County Council and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Environment Agency similarly maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. The Canal & River Trust maintains the Grand Union Canal as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Environment Agency monitors river and rainfall conditions at 3 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur. These flood warning areas include Wood Brook, Black Brook and the River Soar.

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

Current surface water modelling is restricted to the Environment Agency's Long-Term Flood Risk maps. However, as part of the Loughborough Wood Brook Tributary Project, more accurate long-term modelling has been undertaken by the Environment Agency which will be added to the Long-Term Flood Risk map database in due course.

The [Leicestershire Local Flood Risk Management Strategy](#) (LFRMS) adopts a collaborative approach to managing local flood risk by working with local partners and stakeholders to identify, secure and optimise resources, expertise and opportunities for reducing flood risk and increasing resilience to flooding.

- The LFRMS assists in developing a greater understanding of local flood risk by improving local knowledge and the understanding of local flood risk.
- It also adopts a sustainable approach to reducing local flood risk, using tools that are economically viable, deliver wider environmental benefits and promote the wellbeing of local people.
- The LFRMS helps to reduce the harmful consequences of local flooding to communities through proactive actions; that enhance preparedness and resilience to local flood risk and contribute to minimising community disruption.
- It also aims to mitigate and manage flood risk relating to development through the promotion of sustainable drainage systems and supporting the development of local policies and guidance.
- Through the LFRMS the financial viability of flood related schemes is secured, through the development of appropriate policies and assessment tools to by establishing flood risk management measures that provide value for money whilst minimising the long-term revenue costs. Seeking to use natural processes where possible or source the costs of any maintenance from the financial beneficiaries of the development further improves the viability of the activities.
- The LFRMS also encourages flood management activities by private owners of ordinary watercourses and flood defence structures, as well as limiting the development of constrictions on ordinary watercourses.

In addition to the LFRMS, the [Loughborough Surface Water Management Plan](#) (SWMP) was developed by Leicestershire County Council in 2013. The main requirements of the SWMP are:

- to provide a strategic overview of surface water flood risk across Loughborough with detailed assessment of surface water risk at high-risk locations, including identification and assessment of options and selection of preferred options for implementation
- map current and potential surface water flood risk areas, irrespective of source, and engage the community and all stakeholders to share this knowledge

- determine the consequences of surface water flooding, now and in the future, so that LCC can establish priorities and understand and compare the merits of different
- mitigation strategies
- identify effective, affordable, achievable and cost-beneficial measures to mitigate surface water flood risk which achieve multiple benefits where possible
- develop a strategy to inform the strategic planning of drainage provision in large new developments
- develop an implementation plan showing how partners and stakeholders will work together to finance and implement the preferred strategy

The outcomes of the SWMP are being reviewed with a view to developing interventions, which may include Natural Flood Management options in the Loughborough area.

Other flood risk improvement works that benefit the Loughborough FRA include the renewal of Environment Agency flood management assets along the River Soar.

The impact of climate change and future flood risk

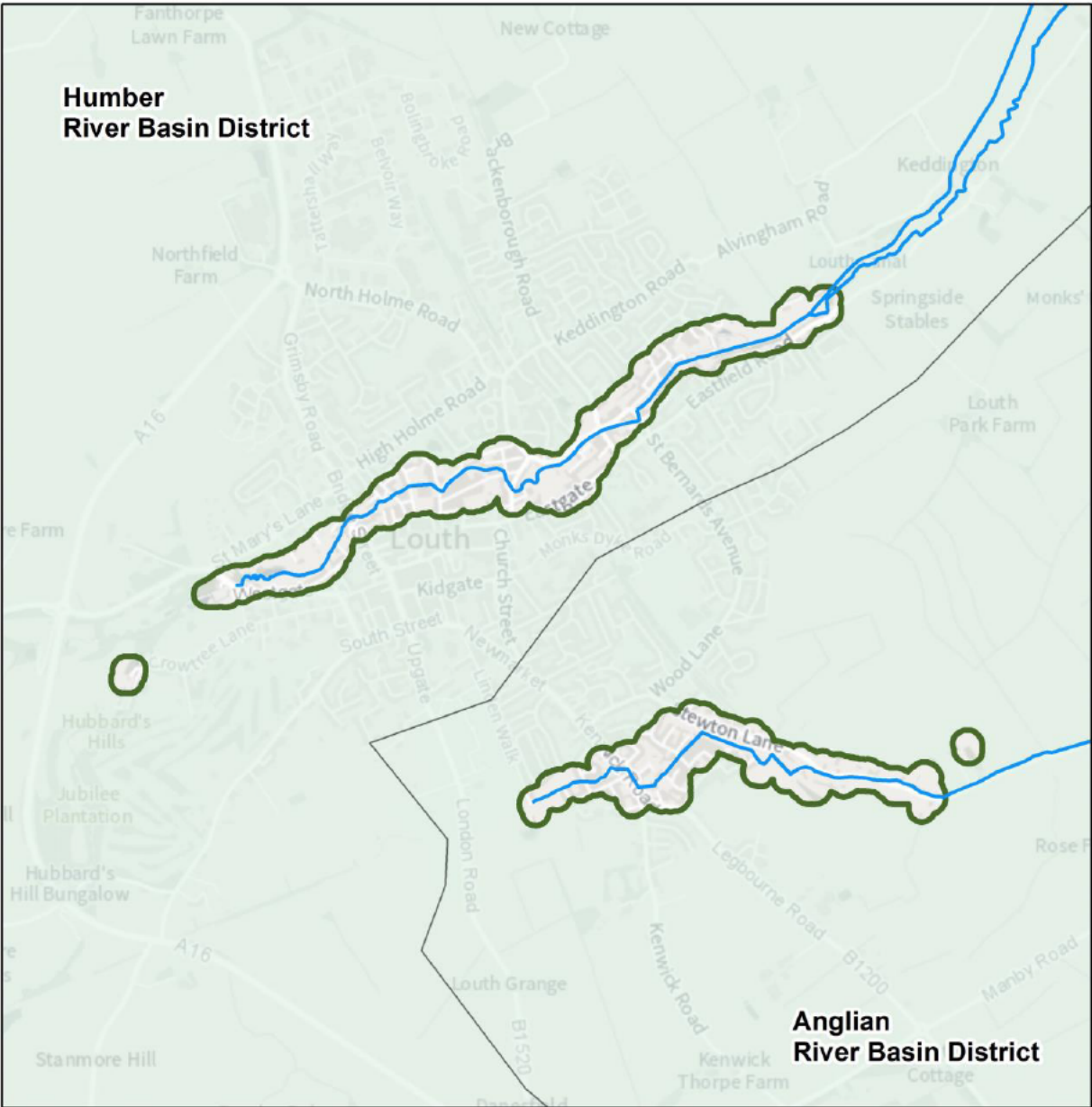
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District (RBD).

Objectives and measures for the Loughborough FRA

Measures have been developed which apply specifically to the Loughborough (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Loughborough (Surface Water) FRA. You can find information about all the measures which apply to the Loughborough (Surface Water) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Louth Rivers and the Sea Flood Risk Area



Flood Risk Area: Louth, Humber



- Main Rivers
- █ Flood Risk Area: Rivers and Sea
- ▒ River Basin Districts

0 0.6 1.2 1.8 Kilometres

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Figure 41: A map showing the boundary of the Louth Flood Risk Area

Introduction to the Louth Flood Risk Area

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

The Environment Agency take the lead on the development and delivery of the FRMP for this FRA. Lincolnshire County Council are the Lead Local Flood Authority (LLFA) responsible for managing flood risk from local sources. These local sources include:

- surface water
- groundwater
- ordinary watercourses

The Environment Agency's remit covers flood risk from rivers and the sea.

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

The Lindsey Marsh Internal Drainage Board (IDB) is responsible for land drainage in the east of Louth FRA.

The Louth FRA is divided into two distinct areas. The first surrounds the River Lud which flows through the centre of the town and lies within the Humber River basin District (RBD). The second surrounds Stewton Beck to the south of the town and lies within the Anglian RBD. The Louth FRA will be discussed entirely within the Humber RBD plan.

The FRA is mainly urban, with grade 3 agricultural land on the outskirts. The predominant soil type is seasonally wet deep loam.

Louth is at the foot of the Lincolnshire Wolds where they meet the Lincolnshire Marsh. It developed where the ancient trackway along the Wolds crossed the River Lud.

The town is east of a gorge carved into the Wolds that forms the Hubbard's Hills. This area was formed from a glacial overspill channel in the last glacial period. The River Lud meanders through the gorge before entering the town.

Historically Louth has always been a market town and there was once a thriving wool industry in Louth. This industry relied on water mills hence its developments grew up around the river. This later developed into a carpet making industry.

The town received a further boost when a canal was opened in 1770 making it easier to transport goods to and from Louth. When the railway reached Louth in 1848 it took trade away from the canal which later closed in 1924.

The south of the Northern Becks catchment is mainly rural and includes the market town of Louth. Louth nestles in the Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB).

Several nationally important chalk streams flow from the Lincolnshire Chalk. The River Lud flows from the Lincolnshire Wolds and through Louth FRA. Sections were canalised in the 1700s from Riverhead in Louth to the sea at Tetney Haven.

Louth Canal was once important to the economy of the town allowing import and export of goods. Many of the locks are now in a state of disrepair and the upper section is no-longer navigable.

Stewton Beck lies to the south of Louth and flows through the FRA and on to the village of Stewton, which is a small rural settlement.

Louth retains the only trading cattle market in Lincolnshire. It continues to be a popular market town and destination for visiting tourists and is expanding to the south between Louth and Stewton.

The main risk within the FRA is from fluvial sources.

Current flood risk

In May 1920 Louth suffered a terrible flood in which 23 people died. More recently, the town has experienced flooding in:

- June 2007 - 107 residential and commercial properties were flooded from the River Lud and from surface water
- July 2007 - 16 properties were flooded from the River Lud and from surface water

On both occasions, more than a months' worth of rain fell within 24 hours onto already saturated ground. This meant that the rivers and drains were overwhelmed.

The [flood hazard and risk maps](#) show that in the Louth Flood Risk area 1,223 people live in areas at risk of flooding from rivers and the sea. Of these, 28% are in areas of high risk.

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

- 43 non-residential properties
- 9.83ha of agricultural land
- listed buildings

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Louth FRA.

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

How the risk is currently managed

The management of flood risk from rivers and sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs). These include:

- East Lindsey District Council
- Lincolnshire County Council
- Lindsey Marsh Drainage Board
- Anglian Water

A partnership framework has been set up across Lincolnshire involving all RMAs to coordinate the management of flood risk and water management. Strategic direction is delivered by the Lincolnshire Flood Risk and Water Management Strategy Group. This is chaired by the Environment Agency.

The Management Group chaired by Lincolnshire County Council delivers the responsibilities of the LLFA. There are 4 Local Flood Risk and Drainage Management Groups chaired by Lincolnshire County Council Highways. These deliver flood risk and water management solutions to meet local circumstances.

The Louth Flood Risk Area is covered by the East Lindsey Flood Risk and Drainage Management Group.

The Lincolnshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services such as:

- emergency services
- local authorities
- NHS
- Environment Agency

To help prepare for and respond to emergencies the LRF publish a community risk register. This provides information on the key risks that have the potential to cause disruption to the county. These include east coast and inland flooding.

The Environment Agency undertakes Hydrometric Monitoring at 5 locations within the FRA. This information is used to inform activities related to 4 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur. This data also informs the operational response during a flood incident.

Modelling and mapping of the River Lud was last undertaken in 2009 as part of the Louth Canal model. The river upstream of the Riverhead tilting gate is due to be updated in 2021. Stewton Beck was last modelled in 2017 as part of the Saltfleet and Great Eau model update.

Flood risk maps are published based on the outputs from 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 operates and maintains flood risk management assets on the main watercourses in the FRA. These include:

- flood storage areas
- flood defence walls
- flood gates
- channels
- culverts
- debris screens

This work includes routine inspection and clearance activities as well as regular repair and replacement of assets.

Flood risk improvement works that benefit the Louth FRA completed recently by the Environment Agency include: 2018 completion of two flood storage reservoirs on the River Lud upstream of Louth.

These will regulate flood flows and reduce the chance of flooding to communities downstream.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future which will cause river flows to increase. Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber RBD.

Objectives and measures for the Louth FRA

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

You can find information about all the measures which apply to the Louth FRA in '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Mansfield Surface Water Flood Risk Area

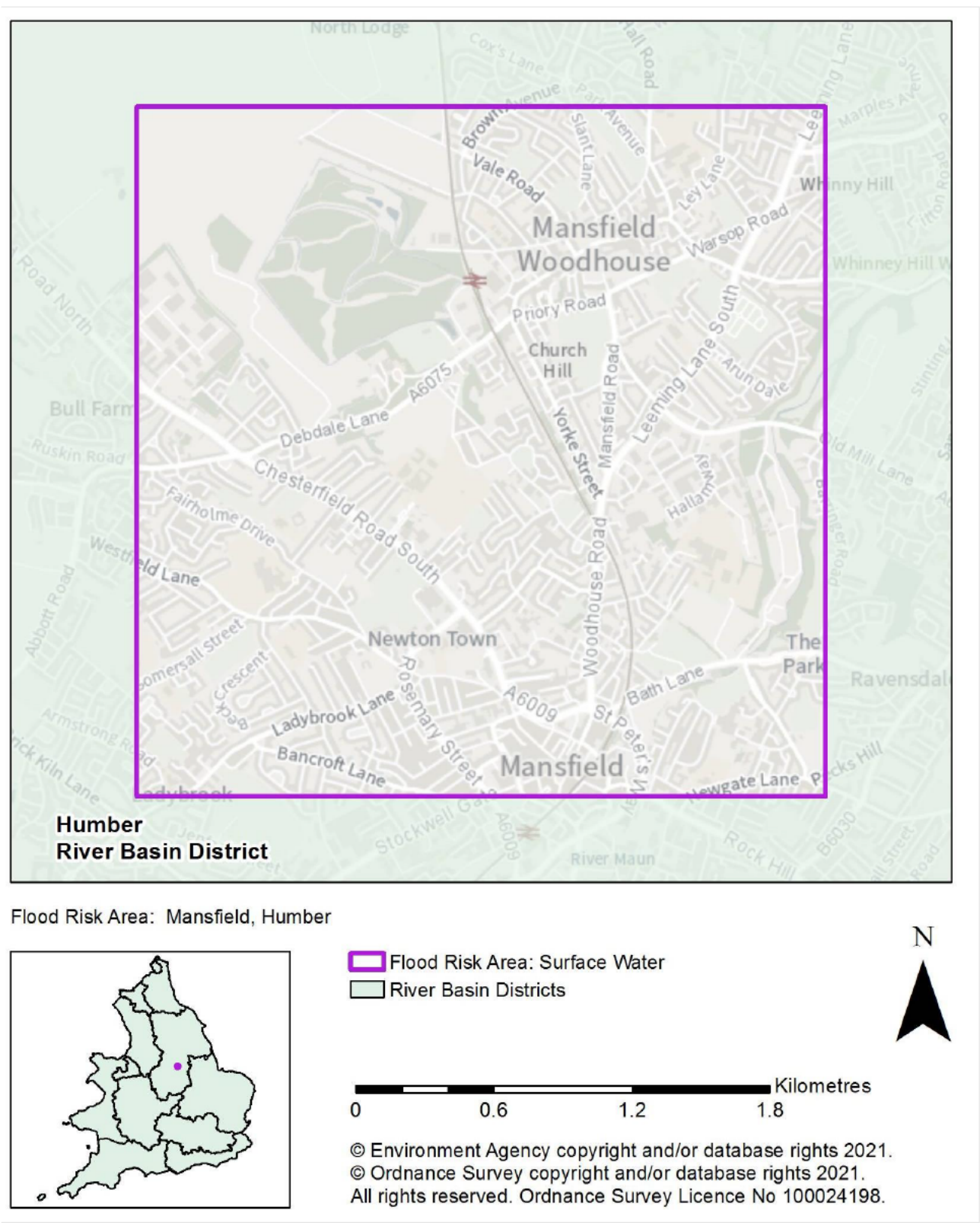


Figure 42: A map showing the boundary of the Mansfield Flood Risk Area

Introduction to the Mansfield Flood Risk Area

The Mansfield Surface Water 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).

Nottinghamshire County Council is the Lead Local Flood Authority (LLFA) covering Mansfield and is responsible for the development and delivery of the Flood Risk Management Plan for this FRA. The Environment Agency's remit includes managing flood risk from main rivers in the FRA. Severn Trent Water is the sewerage undertaker for this area.

The FRA covers the northern portion of the town of Mansfield, extending across the central urbanised area to Mansfield Woodhouse. The area is characterised by urban and suburban communities, as well as rural fringe. The River Maun flows in a north easterly direction through the FRA area.

The geology is generally dolostone, mudstones and sandstone which are part of the Cadeby formation, Edlington formation and Lenton Sandstone formation. Soils are often loamy clay which have a naturally high ground water table and impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several Local Wildlife sites within the FRA boundary, which include Debdale Lane Grassland and Maun Woodlands. In addition, Maun Valley Park is a designated Local Nature Reserve, to the East of the FRA area.

Mansfield was founded during Roman times and is recorded in the Domesday Book. Over time the area became a prosperous medieval market town. During the Industrial Revolution the town population grew as various industries, such as brewing, and coal mining developed in the town. The reduction in industrial and mining activities in the 20th Century, led to an economic downturn for the area, leaving vacant brownfield sites available for development. Mansfield's mix of heavily urbanised and rural topographies makes it an attractive area for development with several key developments completed and further housing developments planned.

Historically, fluvial flooding has been the prominent issue from both main river and ordinary watercourses through the area. The River Maun flows across the district through Mansfield town centre and later joins the River Idle. Tributaries to the River Maun include Caudwell Brook, Vicar Water, Rainworth Water and Foul Evil Brook. Alongside the threat from fluvial sources the current mix of topography does now contribute to the increasing risk from flash surface water run-off flooding and sewer flooding. The condensed nature of the urbanised area and in particular the number of critical services and businesses in that area increases the impact of any flood event.

Severn Trent Water is responsible for the public sewerage system in Mansfield which includes foul, combined and surface water sewers. Severn Trent is responsible for

managing flood risk from sewers. Nottinghamshire County Council as Highway Authority are responsible for the management of highway drainage.

Current flood risk

Mansfield is at risk of flooding from a variety of sources, including rivers, ordinary watercourses, surface water run-off and sewers.

There are records of historic flooding in isolated areas of Mansfield. The most recent incident of significance was in June 2016 where 17 properties experienced internal flooding from ordinary watercourse, surface water and sewer sources. This incident was investigated by Nottinghamshire County Council as Lead Local Flood Authority (LLFA) and a Section 19 report published as directed by the Flood and Water Management Act 2010.

The [flood hazard and risk maps](#) show that in the Mansfield (Surface Water) FRA approximately 3,005 people live in areas at risk of flooding from surface water. Of these, 11% are in areas of high-risk.

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

- 499 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 4.2 km of roads
- 0.48 km of railway lines
- 12.8 ha of agricultural land
- areas of scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

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 manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Nottinghamshire County Council in their role as LLFA lead on the management of surface water flood risk in Nottinghamshire. They work in collaboration with other RMAs and stakeholders. In Mansfield they include Mansfield District Council, Severn Trent Water, Parish Councils and Community Groups.

The Local Flood Risk Management Board was set up in 2011. This has representatives from Nottinghamshire County Council, Nottingham City Council, Water Companies represented by Severn Trent Water, the Environment Agency, Internal Drainage Boards (IDB) represented by the Lindsey Marsh Group of Internal Drainage Boards and all District and Borough Councils. The steering group is concerned with the implementation and

development of the Local Flood Risk Management Strategy, communications, working together, prioritising investment in flood schemes, looking for funding, sharing information and best practice. The group complements the Local Resilience Forum, carrying out flood planning, and warning and communicating with the public groups (for emergency planning), and contributing to the Policy planning and development management meetings for development planning and management.

The Nottinghamshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

In the event of a major flood incident the emergency services may instigate multi agency coordination meetings called a Strategic Coordinating Group (SCG) or Tactical Coordinating Group (TCG) to coordinate an effective response. Representatives from the Nottinghamshire LRF are invited to attend.

Nottinghamshire County Council as Highway Authority are responsible for the management of highway drainage. East Midlands Ltd carry out the function on the authority's behalf and have inspection, routine maintenance and reporting procedures in place to do so. Nottinghamshire County Council as LLFA maintain a register of assets deemed critical to flood risk, the register informs a cyclical inspection and action routine. Where necessary some assets are monitored by telemetry equipment to ensure closer monitoring and alerts. Severn Trent Water maintain the sewer network and other assets that perform a flood risk management function. The Environment Agency similarly maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA.

The Environment Agency monitors river and rainfall conditions at 2 sites in the FRA. This information is used to inform activities related to the River Maun Flood Warning Areas within the FRA which enable people to receive a warning when flooding could occur.

- 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

Nottinghamshire County Council as LLFA have commissioned a model of the entire Mansfield catchment including the FRA area. This work has been commissioned to try and understand in more detail the fluvial and pluvial flood risk. It will also identify any areas of

significant risk that may indicate potential schemes. This work is due to be completed by summer 2021.

The [Nottinghamshire Local Flood Risk Management Strategy](#) (LFRMS) was implemented in 2016. The LFRMS was developed to:

- pursue new solutions, partnerships and alleviation schemes to manage future flood risks and adapt to climate change
- increase awareness and cooperation within local organisations and communities and resilience to flooding and understanding of their land drainage responsibilities
- improve delivery of flood risk management by working in partnership across functions and organisations, taking a catchment-based approach
- integrate local flood risk management into the planning process and support sustainable growth
- consider the environmental impact of proposed flood risk management measures, maximise contribution to the sustainable management of cultural heritage and landscape and deliver environmental benefits

Funding of £76 million has been secured by Severn Trent Water from OFWAT to deliver a flood resilience programme in Mansfield.

Starting in 2021, the Green Recovery Project is a pilot project that will include many interventions, using a nature-based approach to reduce the risk of flooding whilst creating a green environment which will significantly benefit the town of Mansfield.

The interventions are likely to include the creation of new green spaces and rain gardens, tree planting, installing planters in urban areas and improving the absorption of pavement surfaces. Nottinghamshire County Council are partners on this project which will increase the resilience of the sewer network in the face of climate change as well as helping to manage flood risk from surface water flooding. The measures will also attenuate and reduce runoff and discharges to watercourses.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Mansfield FRA

Measures have been developed which apply specifically to the Mansfield (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Mansfield (Surface Water) FRA. You can find

information about all the measures which apply to the Mansfield (Surface Water) FRA in the interactive mapping tool - [‘Flood Plan Explorer’](#).

The Mirfield Rivers and Sea Flood Risk Area

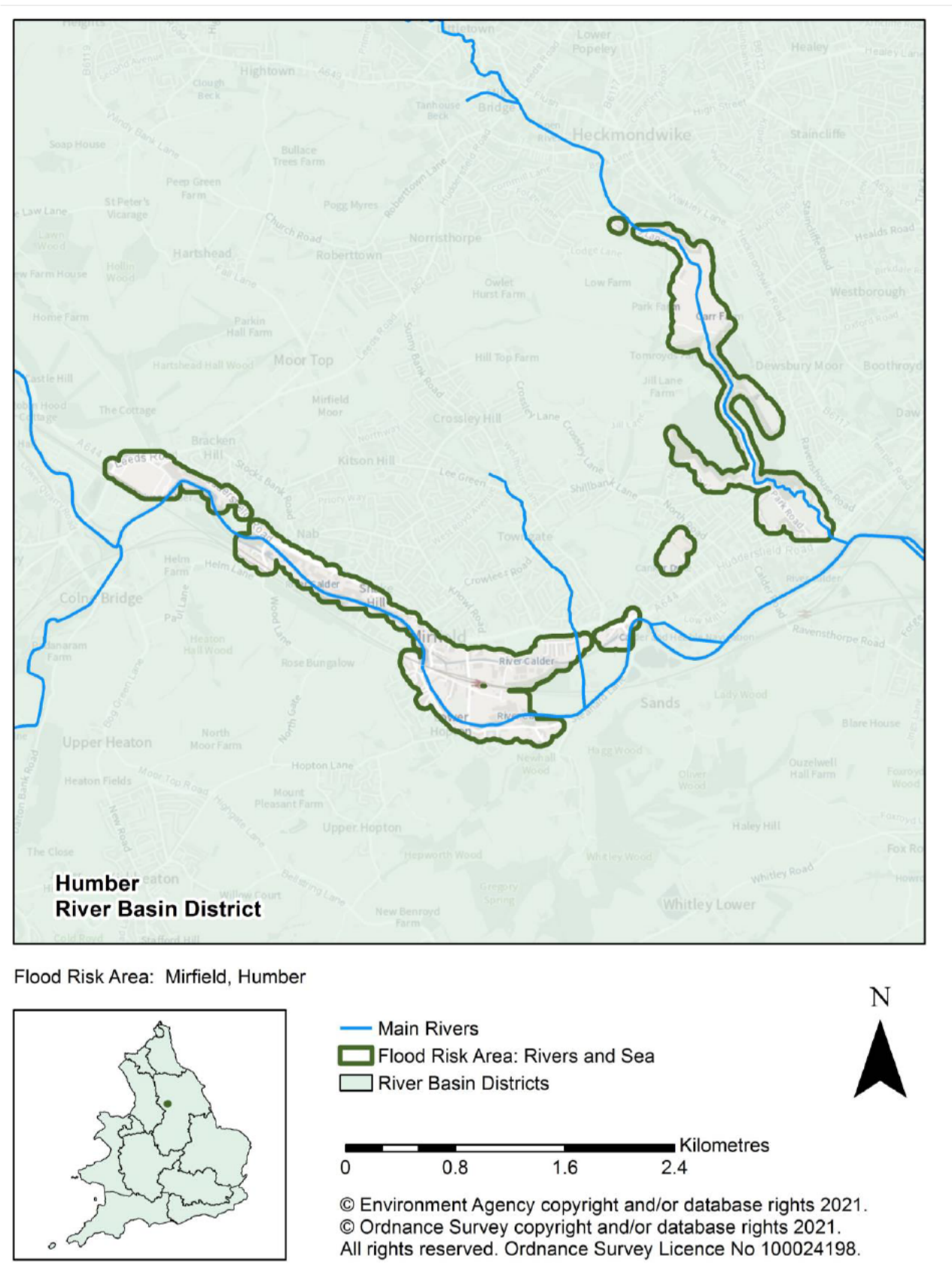


Figure 43: A map showing the boundary of the Mirfield Flood Risk Area

Introduction to the Mirfield Flood Risk Area

The Mirfield 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 FRMP for this FRA.

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

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Mirfield FRA covers some businesses and residential properties that are within the immediate area of the River Calder and River Spen.

Soils in Mirfield and over the Spen Valley are predominantly clay, shale and loam, varying in permeability but with some potential for being seasonally waterlogged. This alongside the predominantly hilly topography means this area can be in danger of flooding as this waterlogging will greatly decrease the lag time and the speed at which the water reaches the river channel.

The only development relevant to flood risk in Mirfield would likely be the two weirs installed for the purpose of navigation via the canal. The upstream of the two was damaged during the 2015 flood and repaired with the debris. These were constructed during the 18th century along with a canal through the town, part of the Calder and Hebble Navigation. Its construction resulted in many industries in Mirfield, such as textiles and boat yards. There are lock gates at the upstream and downstream ends of the canal. The River Spen Flood Alleviation Scheme was constructed in the 1990s and is comprised of a combination of walls, embankments and flood gates. The interaction between the River Calder, the weirs and the canal in Mirfield is complex and not fully understood. Further work is therefore required to understand the impact on flood risk (that will be undertaken as part of the Mirfield and Ravensthorpe Improvements project).

The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Calder and River Spen. The River Calder catchment, including the River Spen, covers just under 950 square kilometres. The River Calder flows for approximately 72 kilometres from its source, 400 metres above sea level at Heald Moor, near Todmorden to its confluence with the River Aire near Castleford.

Nearly 770,000 people live within the catchment area. The headwaters of the catchment are characterised by swift-flowing upland streams which then flow through a series of former mill towns nestling in narrow valley bottoms. The Calder catchment is generally urbanised with the major concentrations of population within the city of Huddersfield and the towns of Dewsbury, Halifax, Todmorden and Wakefield.

Current flood risk

Mirfield experienced significant flooding impacts in both the Boxing day floods in 2015 and in February 2020 floods. In both events many commercial properties were impacted including around 70 commercial and residential properties recorded in 2015.

In February 2020, its records indicate that 37 businesses flooded in Mirfield and 11 homes, with many more cut off because of flooded roads (particularly from flooding to Calder View and Steanard Lane). A further 15 businesses were flooded internally just downstream in Ravensthorpe (Low Mill Industrial Estate), with another 15 cut off because of flooded access roads.

Mirfield is reported to have been quite regularly affected by both fluvial and pluvial flooding intermittently since 2000 and, though few records exist, it is likely to have occurred earlier than this. In February 2020 several properties were also flooded in the Spen catchment following Storm Ciara, including businesses downstream of Rawfolds Bridge, houses around Knowlers Hill/ Radulf Gardens and houses on Ings Crescent and Valley Court. In some areas this is likely to be a combination of fluvial, surface water and sewer flooding. There are also numerous records of flooding in the Spen catchment before this date, most notably in 2007.

The [flood hazard and risk maps](#) show that in the Mirfield FRA 1,242 people live in areas at risk of flooding from rivers of which 50% are in areas of high risk.

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

- 145 non-residential properties
- 0.56km of roads
- 0.29km of railway
- 40.42ha of agricultural land
- areas of environmental, permitting regulations, listed buildings and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Mirfield FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Kirklees Council and Yorkshire Water.

Monthly meetings take place between the Environment Agency and Kirklees council to discuss the programme of works and any other issues in the Kirklees area related to flood

risk. Periodically these meetings are attended by other stakeholders, including Yorkshire Water. The West Yorkshire Flood Risk Partnership meeting enables broader (catchment scale) tactical and strategic approaches to be agreed with neighbouring LLFAs for example, Calderdale Council and Wakefield Council.

The Environment Agency monitor river and rainfall conditions at 6 sites in and immediately adjacent to the FRA. These collect data on river levels (2 sites), river flows (3 sites) and rainfall (1 site).

This information is used to inform activities related to 6 flood warning areas that cover the FRA, enabling people to receive flood warnings.

Modelling of the River Calder in Mirfield was conducted in 2015 and is of good quality although due to localised intervention some may be outdated in terms of current day risk levels. In March 2009, a hydrodynamically linked hydraulic model of the River Spen was built. This model is due to be updated in 2021/22 financial year by the Environment Agency for flood mapping and modelling purposes.

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

In Mirfield and Ravensthorpe there are no Environment Agency maintained assets to detail.

On the river Spen there are a number of Environment Agency maintained outfalls, walls and embankments located within the FRA. These assets are located throughout the catchment including at St Pegs Lane, Thornton Street, Valley Road, just upstream of the confluence with the River Calder and the other alongside Smithies Lane.

There are early investigations taking place for both Mirfield and on the River Spen to assess the viability of options to reduce flood risk. If viable solutions can be found projects will be progressed through the national Flood and Coastal Erosion Risk Management Investment Programme.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Mirfield FRA

Measures have been developed which apply specifically to the Mirfield FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Mirfield FRA. You can find information about all the measures which apply to the Mirfield FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Mytholmroyd Rivers and Sea Flood Risk Area

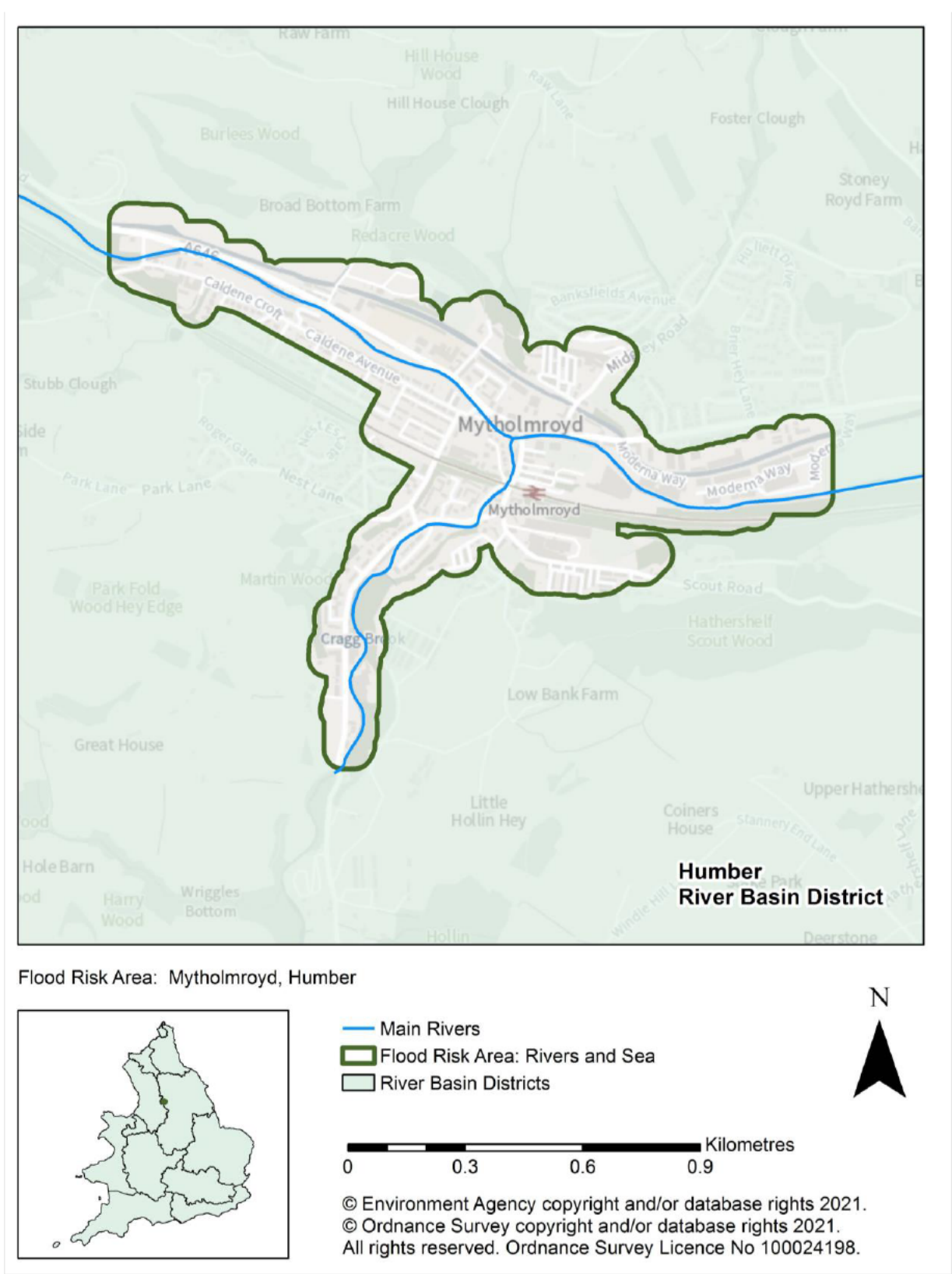


Figure 44: A map showing the boundary of the Mytholmroyd Flood Risk Area

Introduction to the Mytholmroyd Flood Risk Area

The Mytholmroyd 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 FRMP for this FRA.

Calderdale Metropolitan Borough Council (CMBC) are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the water and sewerage company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Mytholmroyd FRA covers several businesses and residential properties in the vicinity of the River Calder, Rochdale Canal and Cragg/Elphin Brook.

The FRA sits on a bedrock of mudstone, siltstone and sandstone with some sandstone lower kinderscout grit overlain with alluvium. The predominant soil type is well drained coarse loamy soils over rock.

There are two Local Wildlife Sites in Mytholmroyd; the Rochdale Canal and Redacre Wood which has also been designated as an Ancient Woodland. There are a few listed buildings within the FRA and the centre of the town has been designated as heritage of risk.

The FRA is susceptible to fluvial flooding from the River Calder and minor watercourses (Cragg/Elphin Brook and White Lee Clough). Associated with this is the residual risk of flooding from the Rochdale Canal when high inflows exceed the canal capacity during storm events. In addition the area is at risk from surface water, groundwater and overland flooding. The main arterial road (A646, Burnley Road) connecting the upper and lower Calder Valley also floods causing road closures. Mytholmroyd is situated in the valley bottom and has steep hillsides surrounding it meaning that flooding is a frequent occurrence, with a rapid onset and has a significant threat to life.

Current flood risk

Mytholmroyd has a long-recorded history of flooding, with events dating back as far as 1837. More recently flooding occurred in 2000, 2006, three times in 2012 and on Boxing Day 2015. Those of 2015 exceeded the largest gauged floods, which had occurred in 2012.

However, on Boxing Day 2015 the village also suffered a major landslip - of the former waste site, on Scout Road. This not only affected adjacent properties and blocked the road but also led to closure of the local school.

Mytholmroyd was also one of the worst hit communities in February 2020, when Storm Ciara caused widespread flooding to West Yorkshire. It was the second highest recorded flood event, second only to Boxing Day 2015.

The [flood hazard and risk maps](#) show that in the Mytholmroyd FRA 1,778 people live in areas at risk of flooding from rivers of which 39% are in areas of high risk.

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

- 185 non-residential properties
- 1.36km of road
- 0.23km of railway
- areas of listed buildings

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Mytholmroyd FRA.

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

How the risk is currently managed

Following the devastating flooding experienced on Boxing Day 2015 the Calderdale Flood Recovery and Resilience Programme Board was set up which is led by Calderdale Council but includes all key partners including:

- Environment Agency
- Yorkshire Water
- The Canal & River Trust
- Network Rail
- local councillors

The aim of the Board is to oversee the delivery of all the work contained in the Calderdale Flood Recovery and Resilience Programme, with its aim of reducing the risk of flooding within the borough of Calderdale and building the resilience of local communities to withstand the effects of any future flood events. Feeding into the board are four operational groups which include Flood Reduction and Investment, Natural Flood Management, Community Resilience and Resilient Infrastructure.

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders for example Calderdale Council and Yorkshire Water. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Hebden Royd Flood Action Group has developed a Community Flood Plan based on the main areas of Hebden Bridge and Mytholmroyd that have flooded in the past. The plan includes four flood stores supported by local people who act as key holders and distribute

the equipment they hold for reducing flooding and cleaning up afterwards. The group works closely with CMBC and the Environment Agency to identify ways of preventing flooding or reducing the damage it does.

There are three monitoring sites within the Mytholmroyd; a continuous river flow site, a temporary continuous surface water level site and a monitoring site for the Redacre sewage treatment works.

There is one flood alert for the Upper River Calder and two flood warnings that cover the FRA.

The water level and flow information is also used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have up to date hydraulic models due to the recently completed Mytholmroyd FAS. 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 a number of flood risk management assets for example river channels, flood defence walls or flood gates, throughout the FRA. Calderdale LLFA and Yorkshire Water similarly maintain assets that perform a flood risk management function on the drainage network.

The Mytholmroyd Flood Alleviation Scheme has been developed by the Environment Agency in partnership with Calderdale Council, the local community, and partners. VBA, a joint venture comprising VolkerStevin, Boskalis Westminster and SNC-Lavalin's Atkins business, is the Environment Agency's delivery partner responsible for its design and construction.

The completed flood defence scheme provides better protection to 400 properties in Mytholmroyd and cost over £41m providing a step change in flood risk reduction from a 20% chance of occurring in any one year to a 2% chance of flooding in any one year. The scheme was completed in Spring 2021.

Vital works completed as part of the scheme include:

- new, raised and improved walls
- relocation of Caldene Bridge
- widening of the river channel at key locations
- strengthening and water proofing of structures adjacent to the channel

Other flood risk improvement works that will benefit the Mytholmroyd FRA include:

- the 'Scout Road, Mytholmroyd Phase 3 Drainage Works', which is due for completion in 2021 at a cost of £0.66 million, protecting 30 properties

- The Mytholmroyd FAS Phase 2 which will increase the standard of protection in Mytholmroyd from 1 in 50yr to 1 in 75yr. This project is on the capital programme but is a number of years into the future

The impact of climate change and future flood risk

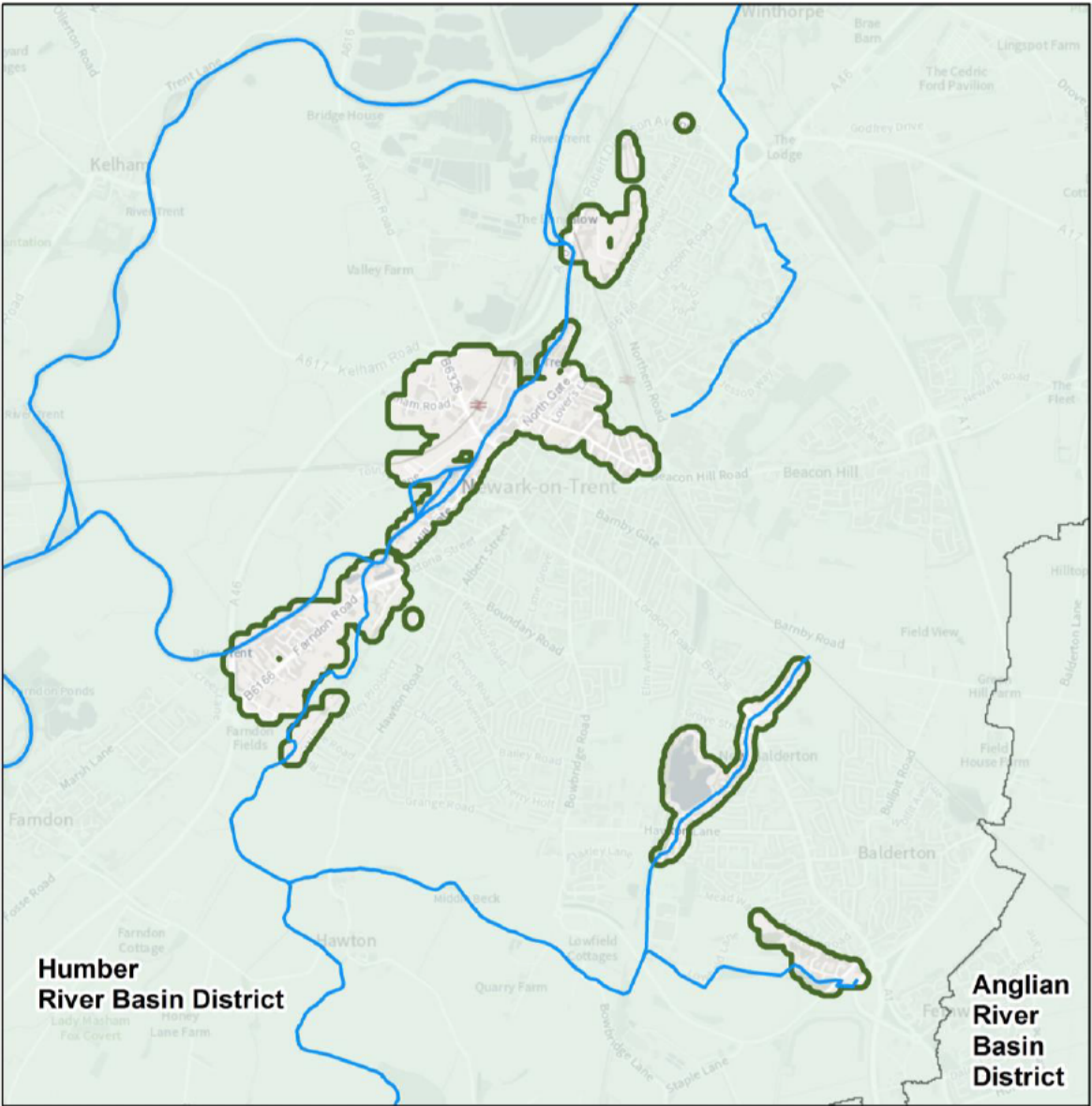
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

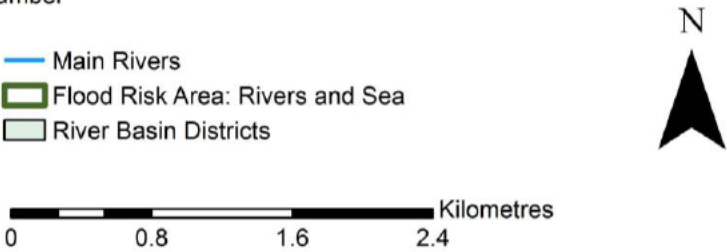
Objectives and measures for the Mytholmroyd FRA

Measures have been developed which apply specifically to the Mytholmroyd FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Mytholmroyd FRA. You can find information about all the measures which apply to the Mytholmroyd FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Newark-on-Trent Rivers and Sea Flood Risk Area



Flood Risk Area: Newark-on-Trent, Humber



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Figure 45: A map showing the boundary of the Newark-on-Trent Flood Risk Area

Introduction to the Newark-on-Trent Flood Risk Area

The Newark-on-Trent (Rivers and Sea) 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authority (LLFA) Nottinghamshire County Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The Newark-on-Trent (Rivers and Sea) FRA covers the centre of Newark-on-Trent and includes outlying areas such as Balderton and New Balderton. The area is characterised by a compact town centre surrounded by residential suburbs, business and amenity areas with the River Trent (main river) flowing in a north easterly direction through the FRA. In addition, Middle Beck and Lowfield Drain are included in the FRA boundary, which are tributaries of the River Devon, which joins the River Trent to the south of Newark-on-Trent.

Much of the town is built on Triassic mudstone which are relatively permeable. The Trent valley also features floodplain alluvium and sands and gravels. However, the area covered by the Newark-on-Trent FRA includes clay and loamy soils which impedes drainage and results in significant amounts of rainfall becoming surface water run-off.

There are several wildlife sites and local nature reserves within the FRA, including Devon Park Pastures, Balderton Gravel Pit and the Trent Wharves. There are also 87 listed buildings in the area, as well as several Scheduled Ancient Monuments. Notably this includes Newark Castle along the banks of the River Trent, the Queen's Sconce and Civil War town defences within the Friary Garden. The area has been classified as 'Heritage at Risk' by Historic England.

Flooding from rivers can occur as a result of the channel capacity being exceeded, a blockage occurring, or as a result of surcharge from culverted sections. There are extensive flood protection assets maintained by the Environment Agency in the FRA, which include raised defences, outfalls and culverts.

Newark-on-Trent is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Newark-on-Trent has grown. Severn Trent Water has developed and maintains a hydraulic model of the public sewerage system in Newark-on-Trent and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding.

Severn Trent Water has undertaken schemes to increase the capacity of the sewers in Newark-on-Trent to reduce the risk of sewer flooding.

Current flood risk

Newark-on-Trent is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source.

The [flood hazard and risk maps](#) show that in the Newark (Rivers and Sea) FRA approximately 3,000 people live in areas at risk of flooding from rivers. Of these, 22% are in areas of high-risk.

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

- 205 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 1.29 km of roads
- 1.36 km of railway lines
- 115 ha of agricultural land
- Areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. There are several assets in the FRA including extensive raised defences and outfalls to the River Trent. In addition, the Middle Beck has a culvert maintained by the Environment agency, and there is a raised embankment to the north of Lowfield Drain.

Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network.

Internal Drainage Boards (IDBs) operate in the low-lying fen and valley areas, maintaining pumping stations and drainage channels to ensure that people are safe, and the risk of flooding is greatly reduced. The Trent Valley Internal Drainage Board (TVIDB) covers an area of low-lying land from the west of Gainsborough, straddling the River Trent and its tributaries, down to the south of Nottingham, a total of 44,093ha. The Board's team maintains 778km of watercourse and operates 18 pumping stations across their area, which includes part of the Newark-on-Trent FRA.

The Nottinghamshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions within the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Trent.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Trent along with its 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

The Lowfield Pumping Station Refurbishment was led by the Trent Valley Internal Drainage Board. In addition to these works, the Environment Agency improved an existing flood defence embankment within the same flood cell. These works were completed in 2019 and reduced flood risk to 136 properties in the Balderton area.

Recently works have been undertaken to improve flood defences at Brewers Wharf, in the centre of Newark. As a result of this investment, 30 properties were better protected from flooding from the River Trent.

Severn Trent Water have made a £60m investment in Newark-on-Trent upgrading the sewers and water supply network throughout the town. The Newark Waste and Water Improvement Project completed in 2020 and provided relief to some 400 homes and businesses from sewer flooding.

The impact of climate change and future flood risk

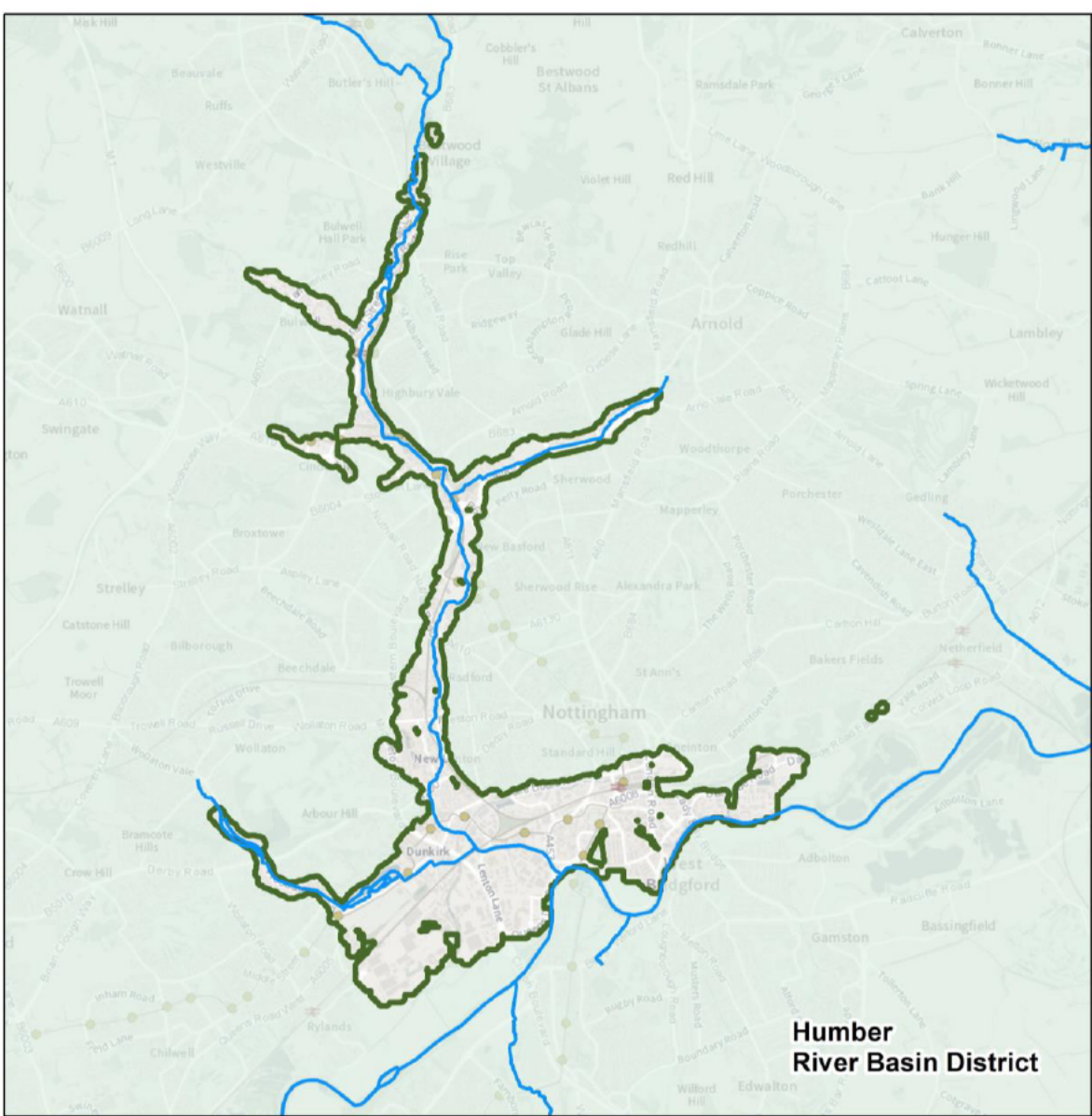
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Newark-on-Trent (Rivers and Sea) FRA

Measures have been developed which apply specifically to the Newark-on-Trent (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Newark-on-Trent (Rivers and Sea) FRA. You can find information about all the measures which apply to the Newark-on-Trent (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Nottingham Rivers and Sea Flood Risk Area



Flood Risk Area: Nottingham, Humber

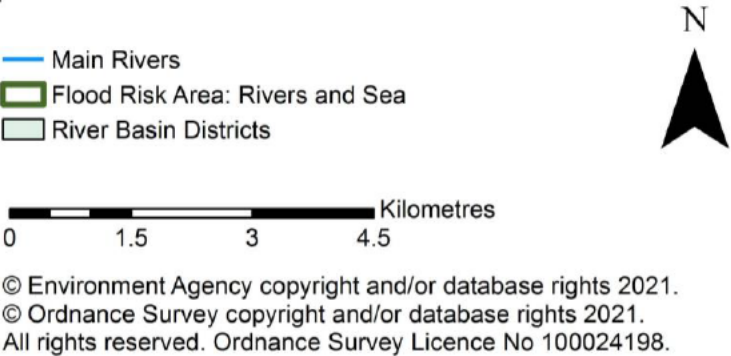
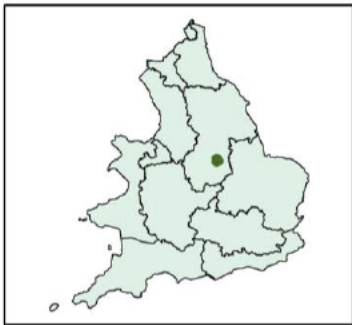


Figure 46: A map showing the boundary of the Nottingham Flood Risk Area

Introduction to the Nottingham Rivers and Sea Flood Risk Area

The Nottingham (Rivers and Sea) 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authority (LLFA) Nottingham City Council is responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The Nottingham (Rivers and Sea) FRA covers the Nottingham City administrative area and extends into areas including Bestwood Village, Daybrook and Wollaton. Areas of known flood risk include:

- The Meadows
- Lenton
- Dunkirk
- Basford
- Bobber's Mill
- Bulwell

The area is characterised by a compact city centre surrounded by residential suburbs, business and amenity areas with the River Trent (main river) skirting the southern edge of the city centre.

Nottingham is located on an area of low hills in the lower River Trent valley. Day Brook and Tottle Brook are main river tributaries of the River Leen which joins the River Trent in the city.

Much of the city is built on Triassic sandstones and mudstones which are relatively permeable. The Trent valley is floodplain alluvium. The steep nature of the Day Brook, Tottle Brook and River Leen upper catchments, and extensive urban development, can result in a rapid response to rainfall events.

Part of Colwick Cutting Site of Special Scientific Interest (SSSI), is located within Nottingham (Surface Water) FRA. There are more than 280 hectares of parks and gardens, as well as several Scheduled Ancient Monuments and listed buildings.

Flooding from rivers can occur as a result of the channel capacity being exceeded, a blockage occurring, or as a result of surcharge from culverted sections. There are extensive flood protection assets maintained by the Environment Agency in the FRA, which include raised defences, outfalls and syphons.

The Nottingham and Beeston Canal is owned and maintained by the Canal & River Trust. The Nottingham and Beeston Canal runs through Nottingham and joins the River Trent at Meadow Lane lock.

Nottingham is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Nottingham has grown. Severn Trent Water has developed and maintains a hydraulic model of the public sewerage system in Nottingham and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken schemes to increase the capacity of the sewers in Nottingham to reduce the risk of sewer flooding.

Current flood risk

Nottingham is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source.

There are records of historic flooding in Nottingham, which includes flooding incidents along Tottle Brook and Day Brook between 2015 and 2021. The Queen's Drive Park & Ride also experienced flooding in 2021 as a result of flooding from the River Trent.

The [flood hazard and risk maps](#) show that in the Nottingham (Rivers and Sea) FRA approximately 26,809 people live in areas at risk of flooding from rivers. Of these, 2.3% are in areas of high-risk.

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

- 1,979 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 6.3 km of roads
- 21.99 km of railway lines
- 16 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. There are several significant assets in the FRA including:

- raised defences which form the Nottingham Left Bank flood risk management scheme
- outfalls to the River Trent from Tottle Brook, Leen, Tinker's Leen and The Nottingham and Beeston Canal
- The River Leen syphon
- debris screens on Day Brook

The River Leen is a very urbanised catchment and has numerous other FCRM assets that the Environment Agency maintains, including walls, embankments and the sheet piles that characterise much of the channel are deemed an asset.

Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Canal & River Trust maintains the Beeston and Nottingham Canal as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Nottinghamshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions at 4 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Leen, Day Brook and the River Trent.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Trent, the Leen and Daybook, along with their 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

Nottingham Left Bank flood risk management scheme was completed in 2012. The £45 million scheme reduces the risk of flooding to 16,200 homes and businesses along a 27

kilometre stretch of the River Trent, from Sawley to Colwick. It also provides additional protection to key infrastructure at the heart of the communities along the Trent.

The West Bridgford Right Bank flood risk management Scheme was completed 2009 protecting 5,600 homes and businesses.

Day Brook Blue-Green Infrastructure project was led by Nottingham City Council. The scheme comprised of increasing upstream storage at Jubilee ponds and de-culverting the watercourse through Valley Road Park and Jason Spencer Sports Ground. It was completed in 2020 and reduced flood risk to 160 properties.

The Environment Agency is working in partnership with Nottingham City Council to review flood risk within the River Leen. With the challenge of changing climate impacting all flood risk sources, targeted replacement or upgrade of flood assets is being considered.

The River Leen catchment poses challenges given the tight constriction of the channel, through a densely urbanised area. Flood risk management needs to be considered holistically for all flood sources, to develop solutions which do not pass the risk of flooding onto others.

The Environment Agency is working with Nottingham City Council to explore a strategic approach to the River Leen to improve flood risk, biodiversity and open public access. The aim is to link with the increasing value and demand placed upon green space in our cities following the Covid-19 pandemic.

Additional capital projects are planned to be undertaken by Nottingham City Council as the LLFA. Further details on these can be found in the Nottingham (Surface Water) FRA information.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Nottingham (Rivers and Sea) FRA

Measures have been developed which apply specifically to the Nottingham (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Nottingham (Rivers and Sea) FRA. You can find information about all the measures which apply to the Nottingham (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Nottingham Surface Water Flood Risk Area

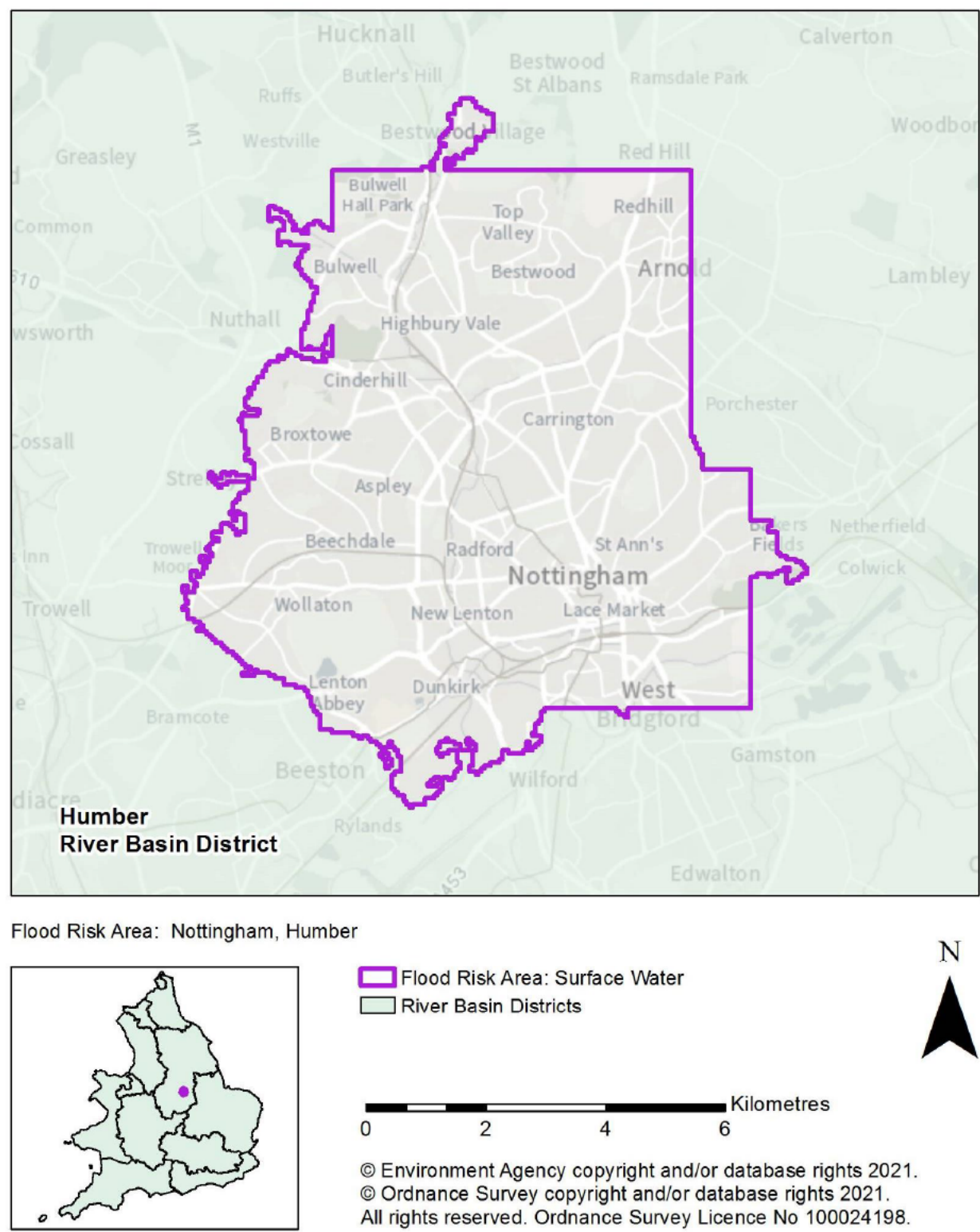


Figure 47: A map showing the boundary of the Nottingham Surface Water Flood Risk Area

Introduction to the Nottingham Surface Water Flood Risk Area

The Nottingham (Surface Water) 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).

Nottingham City Council and Nottinghamshire County Council lead the development and delivery of the Flood Risk Management Plan (FRMP) for the Nottingham (Surface Water) FRA. As Lead Local Flood Authorities (LLFAs) they are responsible for managing flood risk from surface water, groundwater and ordinary watercourses.

The Environment Agency's remit covers flood risk from main rivers and the sea. Severn Trent Water is the water company that owns, operates and maintains the sewerage network in the FRA.

The Nottingham (Surface Water) FRA covers the Nottingham City administrative area and extends into areas including Bestwood Village, Arnold and Ladybay. The area is characterised by a compact city centre surrounded by residential suburbs, business and amenity areas with the River Trent (main river) skirting the southern edge of the city centre.

Nottingham is located on an area of low hills in the lower River Trent valley. Day Brook and Tottle Brook are main river tributaries of the River Leen which joins the River Trent in the city. The Nottingham and Beeston Canal is owned and maintained by the Canal & River Trust.

Much of the city is built on Triassic sandstones and mudstones which are relatively permeable. The Trent valley is floodplain alluvium. The steep and urbanised nature of the Day Brook, Tottle Brook and River Leen catchments can result in a rapid response to rainfall events.

Part of Colwick Cutting Site of Special Scientific Interest (SSSI), is located within Nottingham (Surface Water) FRA. There are more than 280 hectares of parks and gardens, as well as several Scheduled Ancient Monuments, including Nottingham Castle, and listed buildings across the FRA.

Nottingham FRA is susceptible to surface water flooding due to the heavily urbanised nature of the river catchments and the increasing area of impermeable surfaces due to urban creep. The flashy nature and short duration of such flooding events makes them difficult to predict and protect against.

Nottingham is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as Nottingham has grown. Severn Trent Water has developed and maintains a hydraulic model of the public sewerage system in Nottingham and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn

Trent Water has undertaken schemes to increase the capacity of the sewers in Nottingham to reduce the risk of sewer flooding.

There is a risk of flooding from reservoirs and canals. Wollaton Park Lake is the only Reservoir in the Nottingham FRA. The Nottingham and Beeston canal runs through Nottingham and feeds into the River Trent. Nottingham is at risk of flooding from the canal when the river levels are high. Groundwater flood incidents are thought to have occurred in the FRA but it is unclear whether flooding was as a result of high groundwater levels or other local factors.

Current flood risk

Nottingham is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source.

There are records of historic flooding in Nottingham.

The most significant events in recent years affecting the Nottingham FRA have been as a result of summer storms. This includes the flooding of the Day Brook in June 2019, which impacted properties internally.

Nottingham was also affected by a significant summer event in June 2020, causing the Tottle Brook to overtop and widespread surface water flooding, affecting an excess of 60 properties across the Wollaton and Clifton area.

The [flood hazard and risk maps](#) show that in the Nottingham (Surface Water) FRA there are approximately 31,189 people living in areas at risk of flooding from surface water. Of these, 2,180 are in the high-risk category.

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

- 2,419 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 11.9 km of roads
- 16.6km of railway lines
- 49.7 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

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 manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

Nottingham City Council lead on the management of surface water flood risk in collaboration with other RMAs. Other stakeholders include Nottinghamshire County Council and Severn Trent Water.

The LLFAs and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Environment Agency similarly maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. The Canal & River Trust maintains the Nottingham and Beeston Canal as a navigable waterway. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Nottinghamshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation.

The Environment Agency monitors river and rainfall conditions at 4 sites in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Leen, the Day Brook and the River Trent.

The LLFA also monitors rainfall conditions at 4 sites in the FRA using rain gauges. The information is used to inform activities relating to flood risk investigations. A further 6 locations across the FRA have level sensors to monitor flood risk to enable a timely response should blockages or flooding occur.

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 Nottingham Integrated Flood Risk Management Strategy was implemented in 2018. The Environment Agency, Nottingham City Council and other RMAs worked together to develop a strategy to:

- further reduce the risk of flooding
- provide environmental and social benefits for local residents and businesses

- continue to support and encourage wildlife
- ensure rivers and streams are an integral part of the urban environment

The Day Brook Blue-Green Infrastructure project was led by Nottingham City Council. The scheme comprised of increasing upstream storage at Jubilee ponds and de-culverting the watercourse through Valley Road Park and Jason Spencer Sports Ground. It was completed in 2020 and reduced flood risk to 160 properties.

The Daron Gardens / Edern Gardens (Top Valley) Flood Risk Management Scheme was led by Nottingham City Council. The scheme comprised of fitting property level protection to properties at risk. It was completed in 2019 and reduced flood risk to 16 properties.

The Woolsington Close Flood Risk Management Scheme was led by Nottingham City Council. The scheme comprised of fitting property level protection and the construction of bund to direct water away from properties at risk. It was completed in 2019 and reduced flood risk to 14 properties.

The City-Wide Property Level Protection Scheme (Phase 2) was led by Nottingham City Council, the scheme was completed in 2019 and reduced flood risk to 70 properties through the implementation of Property Level Protection measures.

Nottingham City Council has a pipeline of multiple surface water projects for the next FRMP Cycle. This includes areas of Beechdale, Mapperley Park and Stockhill. Nottingham City Council is working with the Environment Agency to strategically manage flood risk across the River Leen catchment.

The impact of climate change and future flood risk

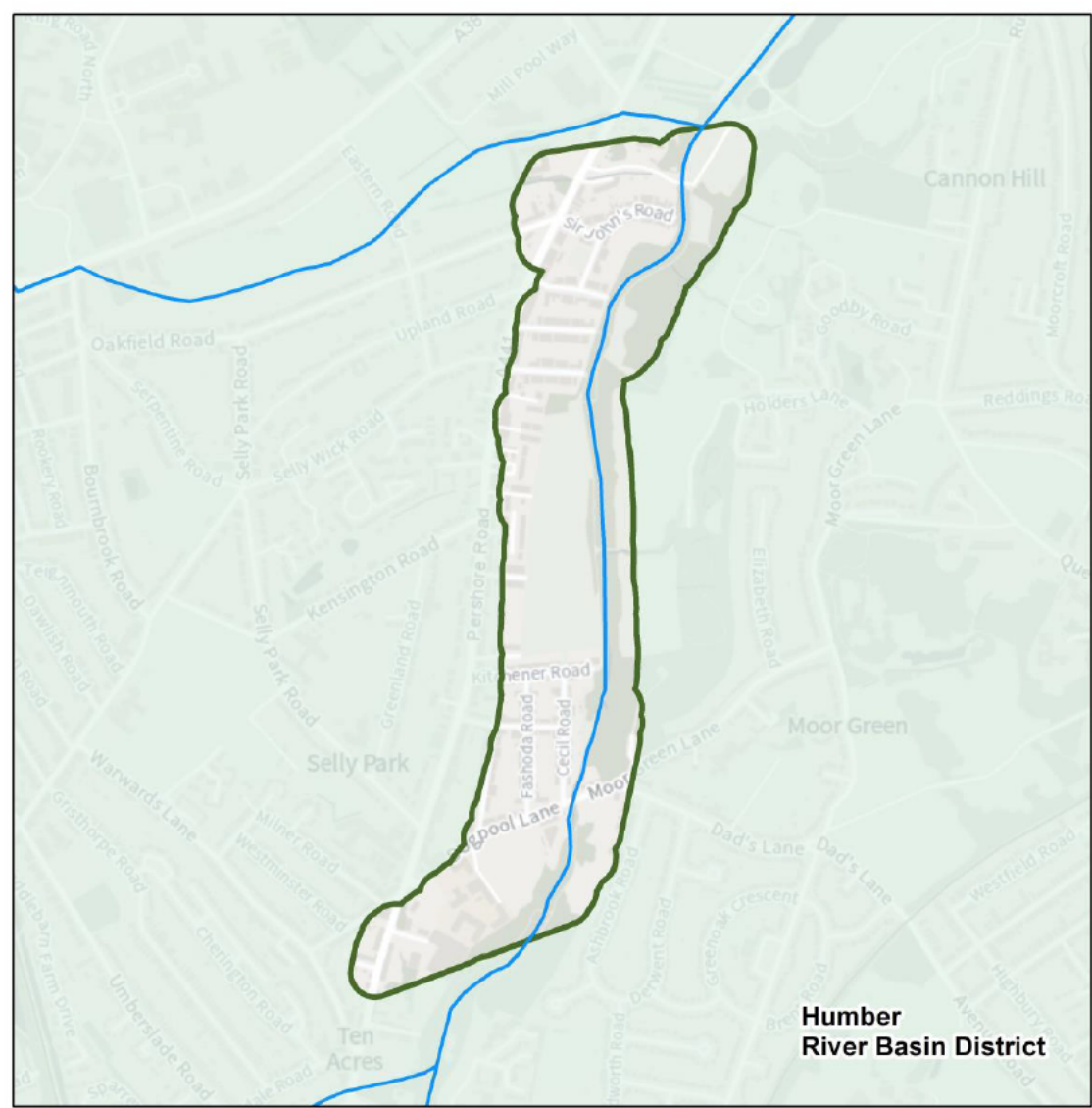
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Nottingham (Surface Water) FRA

Measures have been developed which apply specifically to the Nottingham (Surface Water) FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Nottingham (Surface Water) FRA. You can find information about all the measures which apply to the Nottingham (Surface Water) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

The Selly Park Rivers and Sea Flood Risk Area



Flood Risk Area: Selly Park, Humber



- Main Rivers
- Flood Risk Area: Rivers and Sea
- River Basin Districts

0 0.3 0.6 0.9 Kilometres

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Figure 48: A map showing the boundary of the Selly Park Flood Risk Area

Introduction to the Selly Park Flood Risk Area

The Selly Park Flood Risk Area (FRA) has been identified as a 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.

Birmingham City 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.

Selly Park is a primarily urban residential area. The FRA includes the River Rea and Rea Valley Local Wildlife Sites and Highbury Hall Grade II listed park. Edgbaston Pool, a Site of Special Scientific Interest (SSSI), lies to the north of the FRA.

The primary source of flood risk in the FRA is fluvial from two main rivers, the Bourn Brook and the River Rea. The River Rea rises in the Waseley Hills Worcestershire. It flows in a northerly direction through this Birmingham suburb before it joins the River Tame near Spaghetti Junction. The Bourn Brook is one of three main tributaries of the River Rea. It rises west of Woodgate Valley Country Park and joins the River Rea in Cannon Hill Park. Both rivers have been heavily modified over time.

Flood risk in Selly Park has been identified within 3 areas:

- Selly Park North, around the Bourn Brook to River Rea confluence in Cannon Hill Park
- Selly Park South, between the southern end of Cannon Hill Park and Dogpool Lane upstream and to the north
- in an area between Selly Park North and Selly Park South

In Selly Park North the risk is primarily from the Bourn Brook when water in the brook exceeds the capacity of the Pershore Road Bridge. Key flood risk areas have been identified as Sir John's Road and Third and Fourth Avenues to the south of Pershore Road. The Pershore Road, one of the main trunk roads into Birmingham, is also at risk of flooding.

In Selly Park South the risk is from the River Rea overtopping its left bank upstream of Dogpool Lane Bridge, and at higher flows its left bank downstream of the bridge. Key flood risk areas have been identified as:

- downstream of Dogpool Lane Bridge
- Fashoda Road
- Cecil Road
- Hobson Road

- Kitchener Road

A further 33 properties are at risk in the area between Selly Park North and Selly Park South:

- First Avenue
- Second Avenue
- Pershore Avenue

Flooding to properties on Pershore Avenue occurs when water exceeds the channel capacity in high flow events and overtops the left bank of the River Rea. Additionally, water floods properties on First Avenue and Second Avenue by flowing through the back gardens of properties at the northern end of Pebble Mill Playing fields.

Selly Park is also at risk from surface water and sewer flooding. Surface water flooding is mostly associated with the arterial road passing through the FRA. Surface water flows from the west of Pershore Road throughout the FRA. It collects on Pershore Road then, after following road contours, drains along western side streets towards the River Rea. These impacts are present in all three at risk areas.

Current flood risk

This FRA has suffered flooding from the Bourn Brook and the River Rea on several occasions. This includes severe flooding in 2008, and in June 2016 and May 2018. Over 70 properties flooded in September 2008 and over 30 properties flooded internally in 2018.

The [flood hazard and risk maps](#) show that in the Selly Park FRA 1,318 people live in areas at risk of flooding from rivers. Of these, 6% live in areas of high risk.

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

- 24 non-residential properties - including a healthcare facility
- 0.37km of the major road network - including the A441

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Selly Park 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 is led by the Environment Agency in collaboration with other RMAs. The Rea Catchment Partnership has been formed by risk management authorities and other organisations. This is focused on reducing flood risk across the River Rea catchment from all sources. The area covered by the Partnership includes Selly Park.

In addition, the local residents association has established a flood action group. This is supported by the Rea Catchment Partnership.

The Environment Agency has a hydraulic model for the River Rea that was updated in 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
- the assessment and design of flood risk management works

The Environment Agency monitors rainfall and water levels and provides a free flood warning service for the area. If acted upon this can reduce the impact of flooding. The Selly Park FRA is covered by 1 Flood Alert Area and 1 Flood Warning Area.

Recent flood risk management schemes have reduced fluvial flood risk in the Selly Park North and Selly Park South areas.

The £7.5m Selly Park North scheme became operational in 2019. This provides a standard of protection against a flood event with a 1% chance of occurring in any given year plus an allowance for climate change. This comprised works on the Bourn Brook and at its confluence with the River Rea. The Environment Agency worked alongside Calthorpe Estates and Birmingham City Council to:

- double the size of an existing flood storage area
- create a 2.4m dia. 227m by-pass culvert under Pershore Road to discharge water into the River Rea
- create an overland flow route on the former BBC Sports and Social Club site at Pebble Mill to direct flows into the new bypass culvert

The two areas of land that were raised on the former Pebble Mill site to facilitate the creation of the overflow channel will enable development of student accommodation and food and drink outlets. The scheme included habitat and recreational improvements to Harborne Lane and the Upper Bourn Brook area. This scheme has reduced flood risk to 160 properties and reduced the risk of fluvial flood water getting onto the highway.

The £3.6m Selly Park South flood risk management scheme became operational in 2018. This provides a standard of protection against a flood event with a 1% chance of occurring in any given year. The Environment Agency worked alongside St Andrew's Healthcare and Birmingham City Council to:

- construct an embankment and flood wall to prevent water overtopping the left bank upstream of Dogpool Lane Bridge
- create an embanked area to store water during storm events in the green open space on the right bank upstream of Dogpool Lane Bridge
- increase the wall height on the left and right bank downstream of Dogpool Lane Bridge

- improve existing access routes - including the cycle path and Ashbrook Road access drive

This has reduced flood risk to over 200 homes and key transport routes and services.

The properties that lie between the Selly Park North and Selly Park South flood risk management schemes are not protected by either scheme as they have a different flooding mechanism. The capital programme 2021-2027 includes funding to investigate a flood risk management scheme to better protect these properties from flood risk associated with the River Rea (First Avenue flood risk management scheme).

The Environment Agency inspects flood risk management assets throughout the FRA. These include:

- river channels
- flood defence walls and embankments

Assets that perform a flood risk management function on the drainage network are maintained by:

- Birmingham City Council
- Severn Trent Water
- Calthorpe Estates
- St Andrews Healthcare
- other owners of assets

Birmingham City Council, Severn Trent Water and the Environment Agency are continuing to investigate the residual risk of surface water and sewer flooding.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future. This will cause river flows to increase.

The Selly Park North and Selly Park South flood risk management schemes include some allowance for climate change.

The First Avenue flood risk management scheme will seek to protect the existing 33 properties at risk from flooding with a 1% chance of occurring in any given year. It will also seek to protect the further 36 which modelling indicates will be affected by climate change.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Selly Park FRA

Measures have been developed that apply specifically to the Selly Park FRA. These measures have been developed in addition to measures covering a wider geographic area

but which also apply to the Selly Park FRA. You can find information about all of the measures that apply to the Selly Park FRA in the '[Flood Plan Explorer](#)' - an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Sheffield Rivers and Sea Flood Risk Area



Flood Risk Area: Sheffield, Humber

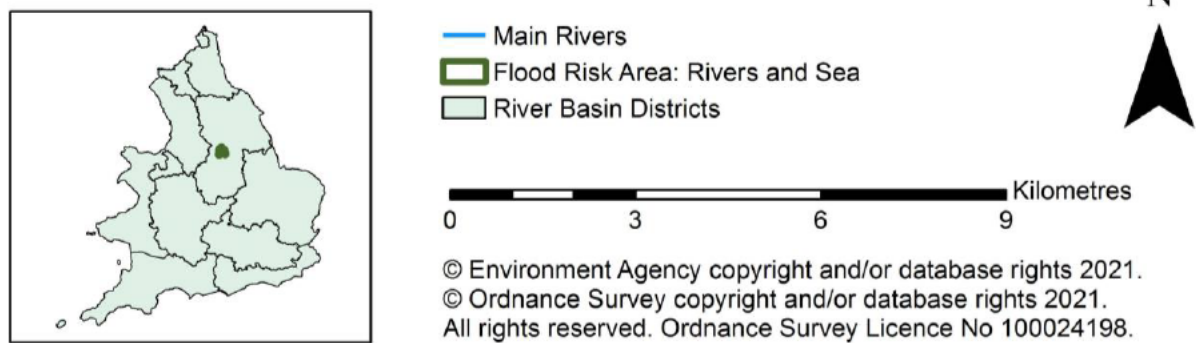


Figure 49: A map showing the boundary of the Sheffield Flood Risk Area

Introduction to the Sheffield Flood Risk Area

The Sheffield 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 FRMP for this FRA.

Sheffield City Council are the Lead Local Flood Authority whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Sheffield FRA covers several businesses and residential properties in the vicinity of the River Don, River Sheaf, Blackburn Brook and Porter Brook.

The Sheffield FRA lies on a bedrock of mudstone, siltstone and sandstone with Pennine coal measures formations and overlaid by alluvium.

The soils in Sheffield are seasonally wet deep stone less fine silty and clayey soils variably affected by groundwater, and slowly permeable seasonally waterlogged loamy over clayey and fine silty soils over soft rock. These soils can absorb large volumes of water when dry, reducing the volume of water entering the rivers however once saturated, surface run-off increases causing flashy river response. There are no reports of groundwater emergence causing significant flooding.

The solid geology of Sheffield is characterised by Namurian (Millstone Grit) to the west, and Lower Westphalian to the east. The soils are typically alluvium along the river corridors, with relatively large areas of peat within the uppermost reaches of the River Don catchment. The presence of peat is an important characteristic when considering the response of a catchment to rainfall. The soil is very absorbent, however once saturated will rapidly release a relatively high volume of water which could contribute to localised flash flooding.

The FRA is susceptible to flooding from the River Don, River Sheaf, Blackburn Brook and Porter Brook. Other smaller watercourses such as River Loxley and Kelham Goyt (tributaries of the river Don) also cause flood risk.

Sheffield's unique and complex hydrology and topography combined with the city's historical development and urbanisation influence the nature of flood risk within the area.

Floodplains in the city are not extensive and urbanisation, particularly industrial, has taken place right up the banks of the rivers. In many urban areas, including the city centre, rivers have been culverted to allow development and therefore the natural river system is significantly restricted, increasing the risk of flooding.

Urbanisation has caused increased flood risk in Sheffield, particularly from the Porter Brook. This river had been culverted beneath the city centre to make way for development however this constricts the river channel and increases flooding to overbank areas in times of intense rainfall.

The topography of Sheffield is dominated by the steep slopes of the Peak District to the west, falling towards the characteristically undulating nature of the River Don catchment to the east. To the west of Sheffield city centre, a relatively large proportion of the district is situated on steep sided valleys, and the river valleys are well contained. Watercourses in many locations have been partially culverted. Relatively few properties are at risk of flooding from rivers in these upper reaches, however there is higher risk of flash flooding following intense rainfall as water runs rapidly off the valley sides.

With the City's relatively high levels of tree/vegetation (and in places discarded debris) there is material lying in and around watercourse channels. The steep grades also bring high velocities in spate conditions which then wash down accumulated material. Inlets, with or without screens, can become blocked quickly even when the inlet was 100% clear beforehand. Many of the culverts are old, laid to facilitate development perhaps 100 years ago or more, and some are known to be rubble culverts in unknown condition and with uncertain locations. With inspection and maintenance almost impossible there is potential for collapse or internal blockage. Fortunately, this has not to date been as big a problem as inlet blockages, but all culverts carry this blockage risk. To the east of the city centre, the district flattens, and the river valleys widen.

Runoff from the steep upper reaches arrives quickly, resulting in the overtopping of the rivers into flatter floodplain areas. Within these flatter areas, the drainage system relies heavily upon an ability to drain freely into the rivers. When river levels are high, the drainage systems are unable to discharge, resulting in surface water flooding that exacerbates problems within low lying areas.

Current flood risk

Sheffield has a history of flooding with the 2007 flood causing extensive damage to the city when the River Don overtopped its banks causing widespread flooding. Thirteen people died in the flood, Meadowhall Shopping Centre was closed due to the flooding of some of its shops and Hillsborough Football Stadium was under nearly 2m of water.

Since 2015, there have been 2 significant floods; 2018 and 2019. In September 2019 Sheffield suffered its worst flooding since 2007 where heavy rainfall from Storm Bronagh caused flash flooding across the city. In November 2019, South Yorkshire suffered widespread flooding after a period of heavy rainfall. The River Don overtopped its banks in several locations in Sheffield and caused shoppers to be stranded in the Meadowhall Shopping Centre.

The [flood hazard and risk maps](#) show that in the Sheffield FRA some 15,057 people live in areas at risk of flooding from rivers, of which 8% are in areas of high risk.

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

- 3,646 non-residential properties
- 13.17km of road
- 16.46km of railway
- 18.61ha of agricultural land
- areas of environmental permitting regulations, SSSIs, parks and gardens, scheduled monuments, listed buildings and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Sheffield FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders, for example, Sheffield City Council, Rotherham, Doncaster, Barnsley and Derbyshire County Councils and Yorkshire Water.

The Sheffield Flood Risk Management Partnership was formed to manage and coordinate activities across the city and share information and data between the Environment Agency, Sheffield City Council and Yorkshire Water.

The Environment Agency continuously measures the river levels at 19 measuring stations across the Sheffield FRA. These are continuous river flow gauging stations on the Bagley Dike, Blackburn Brook, Car Brook, Charlton Brook, Porter Brook, River Don and River Sheaf. The network of monitoring and gauging stations feed into the flood forecasting system for the city. There are also a few continuous river flow gauging stations, an effluent site at Blackburn Meadows and a continuous water quality monitoring site at Hadfield's Weir.

Rainfall data is available from the city's two Universities, The University of Sheffield and Sheffield Hallam University.

Flow measuring station information and live on the ground information is used to inform activities related to 7 flood alert and 49 flood warning areas that cover the FRA.

The Environment Agency's Flood Warnings Direct Service provides flood warnings to customers by telephone, mobile, fax or pager. Customers can also get practical advice on preparing for a flood and what to do if one happens. The areas that are within the flood warning zone include properties within the River Don corridor between Hillsborough and the M1, properties adjoining the River Sheaf between Bannerdale Road and the River Don, and properties adjoining the Porter Brook.

Detailed modelling of the potential impacts of climate change has been carried out for the River's Don, Sheaf, Porter and their tributaries.

The adopted flood zones underpinning Sheffield are largely based upon this and historical flood outline data.

In accordance with current best practice these have informed the Environment Agency's Flood Zone maps and the basis for the assessment of flood alleviation schemes and management across the city.

The Environment Agency flood maps for surface water for the Sheffield area indicate a wide scatter across the city with no concentration of risk in any specific area.

Sheffield City Council holds a register of assets that contain details of all known structures and features which have significant impact on flood risk. This includes assets which defend against flooding, such as flood defence walls and gates, as well as those which form a key part of a drainage system such as the local watercourse culvert network.

The Environment Agency maintain flood risk management assets for example river channels, flood defence walls and embankments throughout the FRA. Sheffield LLFA and Yorkshire Water similarly maintain assets that perform a flood risk management function.

Between 2015 and 2021 the Sheffield Flood Defence Programme has completed several Flood Alleviation Schemes (FAS) schemes, for example, Sheffield Lower Don FAS (completed in 2018, comprising flood defence walls from city centre to Meadowhall) and Sheffield Watercourses Culverts FAS (completed in 2020, lining and relaying sections of 9 strategic watercourse culverts across the city and upgrading non-compliant inlet screens).

Further work is ongoing across the Sheffield FRA as part of this programme, details are described within the measures for the FRA. Measures include improving flood defence walls and surface water drainage, providing flood storage, environmental and recreational enhancements and improving culverted watercourses on the Don, Loxley, Sheaf, Porter, Kirkbridge Dike, Car Brook, Blackburn Brook, Clough Dike rivers.

Aligned with this programme is the Upper Don Reservoir Storage FAS; the Environment Agency in collaboration with Sheffield City Council are investigating the potential reservoir storage options in the uplands of Sheffield.

The Natural Flood Management FAS is a project working with partner organisations such as Sheffield City Council, Environment Agency, Natural England, The Wildlife Trust, National Highways, Yorkshire Water and private landowners in finding shared opportunities for upland flow management.

Sheffield City Council have completed some work on identifying potential NFM opportunity areas. Sheffield City Council are continuing to pursue these opportunities and mutual funding routes.

Resulting additional standard of protection by holding back water in the uplands is thought to provide some small-scale benefits, but none the less significant and worthwhile due to multiple wider environmental and recreational benefits.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Sheffield FRA

Measures have been developed which apply specifically to the Sheffield FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Sheffield FRA. You can find information about all of the measures which apply to the Sheffield FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Sparkhill Rivers and Sea Flood Risk Area

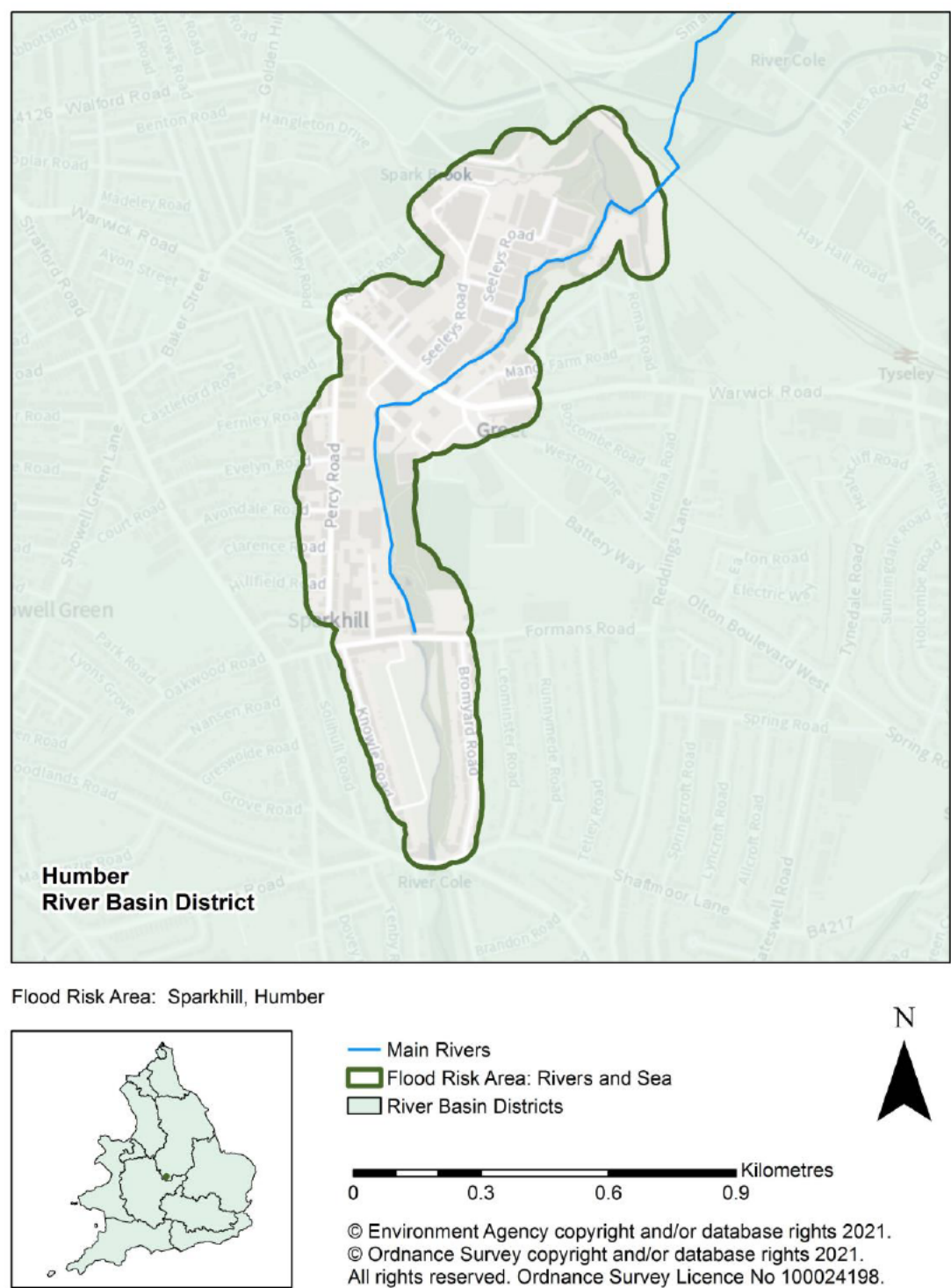


Figure 50: A map showing the boundary of the Sparkhill Flood Risk Area

Introduction to the Sparkhill Flood Risk Area

The Sparkhill Flood Risk Area (FRA) has been identified as a 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.

Birmingham City 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 waste water treatment infrastructure in the FRA.

Sparkhill is a primarily urban area of residential and commercial properties. The FRA includes The Ackers and The Shire, Cole Valley Local Wildlife Sites.

Fluvial flood risk in the Sparkhill FRA is from the River Cole.

The 40 km long River Cole rises on the lower slopes of Forhill, on the edge of the Birmingham Plateau at Red Hill. It flows south before flowing largely north-east across the plateau to enter the River Blythe below Coleshill. This is shortly before the Blythe joins the Tame. With a natural catchment of drift covered Keuper marl clay and historic urbanisation, the catchment run-off is fast. Heavy rain produces sudden floods that subside as quickly as they rise.

The River Cole in Sparkhill is a designated main river from Formans Road Bridge and is ordinary watercourse upstream of the bridge. Fluvial flooding in the Flood Risk Area occurs from water overflowing both the river channel upstream and downstream of the bridge.

The areas at risk of flooding in the Sparkhill FRA are:

- Formans Road (residential properties)
- Pentos Drive (1.7 ha of industrial units)
- Percy Road (residential properties)
- Greet Bridge (commercial properties)
- Tyseley Industrial Estate

Roads that have been affected include:

- the A41 Warwick Road
- Percy Road
- Seeleys Road
- Manor Farm Road

The FRA is also impacted by surface water flooding. This occurs from:

- run-off from impermeable areas
- the surface water drainage capacity being exceeded by the volume of storm water
- by the surface water sewers being unable to discharge when the River Cole water level is elevated

Surface water sewers discharging into the River Cole downstream of the Formans Road Bridge also contribute to elevated river levels in that location.

The FRA is also at risk of sewer flooding.

There are no engineered defences along the River Cole. Private defences have been constructed in some areas at risk, the design standards of which are unknown.

Surface water impacts are currently partially alleviated by a surface water pumping station on Percy Road that is owned by Severn Trent Water. The purpose of this pumping station is to pump surface water to the River Cole during times of high river levels when surface water outfalls cannot drain to the river by gravity.

Current flood risk

This FRA has suffered from flooding in 1999, twice in 2007, and in 2018.

The [flood hazard and risk maps](#) show that in the Sparkhill FRA 386 people live in areas at risk of flooding from rivers. None of these are in areas of high risk.

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

- 66 non-residential properties - including a primary school
- 0.48km of the A41 Warwick Road

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Sparkhill FRA.

Based on this information, Risk Management Authorities 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

Maintenance of the River Cole channel upstream of Formans Road Bridge is carried out by Birmingham City Council. Birmingham City Council also carry out maintenance on the designated main river downstream of the bridge, under the Environment Agency's 'Main River Maintenance Contract'. This includes:

- debris clearance
- grass cutting
- tree and bush work

Culvert and trash screen blockage removal are routine tasks carried out by Birmingham City Council, and other larger riparian owners. This is often done in liaison with the Environment Agency, particularly post flood works where the channel has suffered unusually heavy siltation.

Severn Trent Water maintains the surface water pumping station and has a maintenance programme in place for public sewers.

Since the 2018 flooding:

- Birmingham City Council has carried out works to restore the off-line storage capacity at Formans Road
- Birmingham City Council has also carried out works in conjunction with the Environment Agency to maintain flood channel and culvert capacity by:
 - clearing of natural and man-made debris
 - cutting back vegetation
 - removing a major blockage
- Severn Trent Water has carried out some improvement works to the pumping station

The Environment Agency has a hydraulic model for the River Cole (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 and river water levels upstream of the Flood Risk Area and provides a free flood warning service for the area. If acted upon this can reduce the impact of flooding. The Sparkhill FRA is covered by 1 Flood Alert Area and 1 Flood Warning Area.

As part of the 2021-2027 programme of works, the Environment Agency is assessing the viability of a scheme to better protect properties in the FRA from flood risk associated with the River Cole.

In addition, the Environment Agency is also working with local community leaders to establish a resilience network. This aims to support residents and business owners, providing them with the tools and contacts to ensure they are prepared for potential future flood events.

The Environment Agency, Birmingham City Council, Severn Trent Water and neighbouring LLFAs will continue to work together in the River Cole catchment to seek flood risk and environmental benefits for communities at risk of flooding. This includes in the Sparkhill FRA.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future. This will cause river flows to increase.

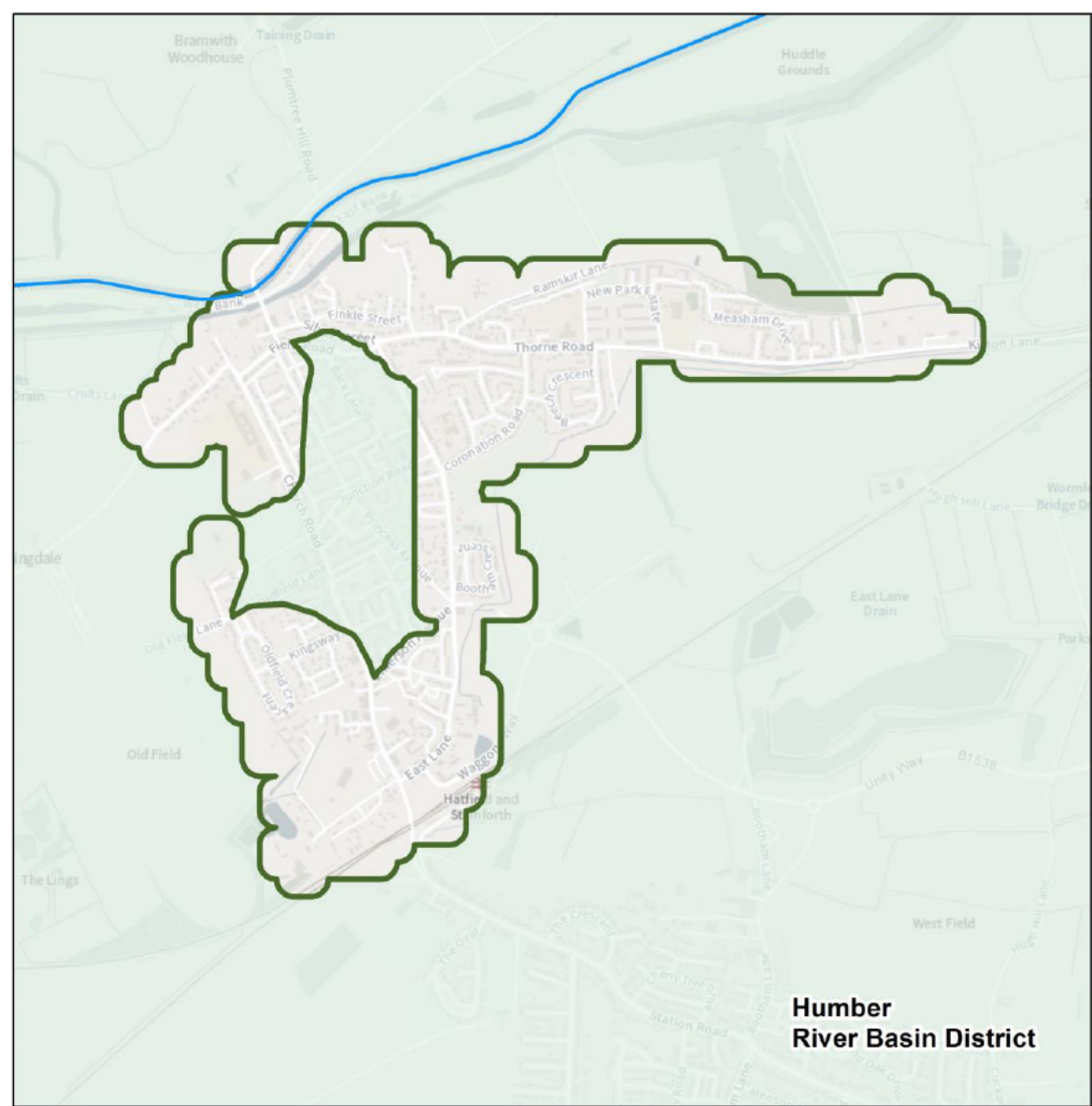
The options considered in the assessment of a flood risk management scheme for Sparkhill will take into consideration allowances for the impact of climate change.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

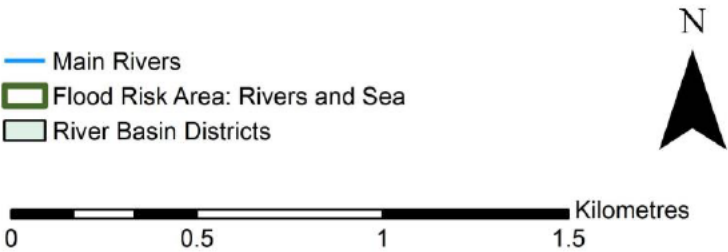
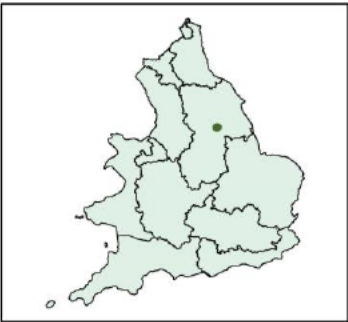
Objectives and measures for the Sparkhill FRA

Measures have been developed which apply specifically to the Sparkhill FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Sparkhill FRA. You can find information about all of the measures which apply to the Sparkhill FRA in the '[Flood Plan Explorer](#)' – an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The Stainforth Rivers and Sea Flood Risk Area



Flood Risk Area: Stainforth, Humber



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Figure 51: A map showing the boundary of the Stainforth Flood Risk Area

Introduction to the Stainforth Flood Risk Area

The Stainforth 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).

Doncaster Metropolitan District Council (DMDC) is the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Stainforth FRA covers some businesses and residential properties that are within the immediate area of the River Don as well as some of the dykes and drains in the surrounding area of the town.

The Stainforth FRA lies on a bedrock of sandstone, pebbly gravelly Chester formation that is overlaid by alluvium, Hemingborough glaciolacustrine formation or undifferentiated river terrace deposits. The predominant soil types in the FRA are deep well drained sandy and coarse loamy soils and deep stoneless fine silty and clayey soils variably affected by groundwater.

There is one Local Wildlife Site in the Stainforth FRA, Poltontoft part of Thorne Ashfields, one grade 2 listed bridge and 3 listed buildings.

Since medieval times, land and drainage activities have been draining the marshy land to allow the land to be reclaimed predominantly for housing and agriculture. Over time flood defences have been created to provide flood risk protection to the reclaimed areas and pumping stations have been erected to create additional agricultural land in the area.

The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the River Don as well as some of the dykes and drains in the surrounding area of the town. There is also a low risk of surface water flooding within the FRA.

Current flood risk

The [flood hazard and risk maps](#) show that in the Stainforth (Rivers and Sea) FRA, approximately 4,003 people live in areas at risk of flooding from rivers. Of these, 10% are in areas of high-risk.

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

- 93 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 1.61 km of railway lines
- 38.1 ha of agricultural land
- areas of listed buildings, and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Stainforth FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Doncaster Metropolitan District Council, Yorkshire Water, Doncaster East Internal Drainage Board (IDB) and Danvm Drainage Commissioners.

The FRA is covered by the South Yorkshire Flood Risk Partnership group that was set up by the Environment Agency following the implementation of the Floods and Water Management Act 2010. Representatives from the EA, LLFAs and Yorkshire Water sit on the group to strategically manage flood risk across South Yorkshire.

The FRA is also covered by the Isle of Axholme Strategy. Located in a largely rural area of South Yorkshire, Lincolnshire and North Nottinghamshire in the UK, the Isle of Axholme is artificially drained by a complex network of drains and over 60 pumping stations. The objectives of the Isle of Axholme Strategy are:

- to provide the most cost-effective approach for land drainage and flood risk management
- to demonstrate resilience in the face of extreme events or future change
- to maximise the overall carbon efficiency and sustainability of the options considered
- to improve the management of existing biodiversity and incorporate gains where possible
- to ensure that the strategy is understood and supported by key partners and the wider community to fulfil the requirements of the Water Framework Directive (WFD), specifically the Humber River Basin Management Plan (RBMP)

The Isle of Axholme is in progress, but when complete it will see a reduction of flood risk to around 18,000 properties, critical infrastructure and agricultural land. The strategy includes investment in the refurbishment of the Keadby and West Stockwith pumping stations as part of a capital investment of £204 million into the ageing assets would be needed to continue suitable protection and ensure the long-term economic prosperity of the area.

There are no hydrometric monitoring sites within the Stainforth FRA apart from a private treated effluent monitoring site at Innovation Centre Sewage Treatment Plant, Kirton Lane. The Stainforth FRA is covered by the Lower River Don catchment flood alert and 2 flood warnings. The flood warning for the River Don at Stainforth covers the majority of the FRA with a small area covered by the flood warning for the River Don at Braithwaite.

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 own and maintain flood walls and embankments along the River Don within the Stainforth FRA.

Since the devastating 2019 flooding across South Yorkshire, organisations have been working together to respond to the flood risk and climate emergency in South Yorkshire on a regional scale.

The South Yorkshire Catchment Plan is a vital part of this work. The plan brings key partners and priorities together to build a climate resilient region, to strengthen our capacity to act together over the long term and to provide a compelling programme for investors.

The plan will provide a strong, regional level ambition that benefits the communities of South Yorkshire and will set out how we tackle the causes of flooding, not just the symptoms. The plan is a chance to do things differently and become a national example of innovation and excellence.

We are also reviewing options for large nature-based solutions in the lower catchment, as discussed above, to help build climate resilience and make more space for water. We have an official investment request on our medium-term plan of £40million pounds for Source to Sea – nature-based solutions programme. This programme will still need external funding, but this signifies our ambition and our commitment to respond to the climate and nature emergency in South Yorkshire.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

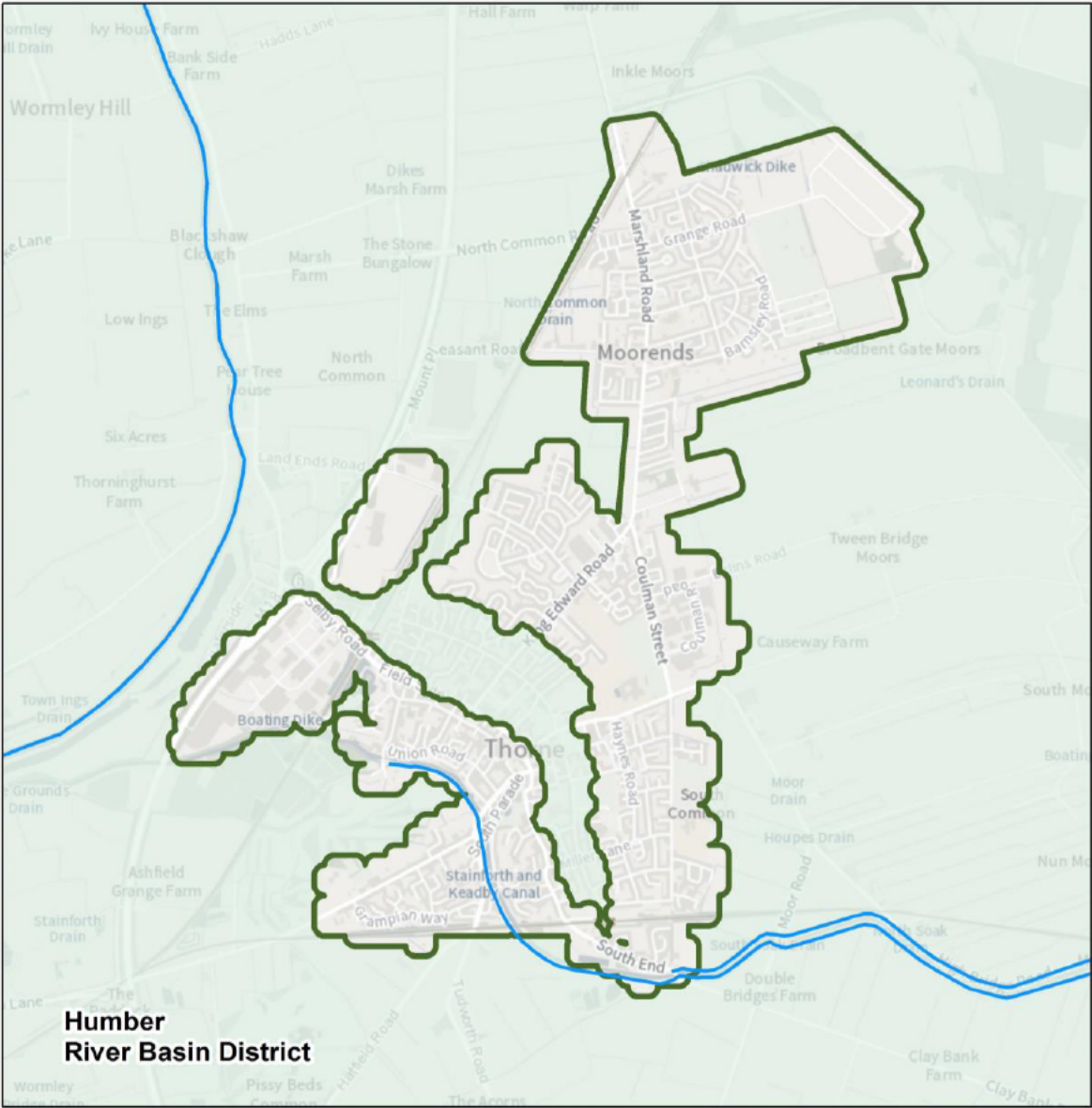
Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Stainforth FRA

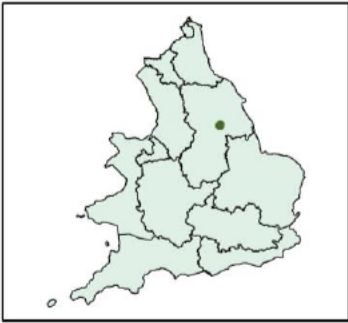
Measures have been developed which apply specifically to the Stainforth FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Stainforth FRA. You can find information about all the measures which apply to the Stainforth FRA in the interactive mapping tool - [‘Flood Plan](#)

[Explorer](#). This includes information on which national objectives each measure helps to achieve.

The Thorne and Moorends Rivers and Sea Flood Risk Area



Flood Risk Area: Thorne and Moorends, Humber



- Main Rivers
- ▭ Flood Risk Area: Rivers and Sea
- ▭ River Basin Districts

0 0.8 1.6 2.4 Kilometres

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Figure 52: A map showing the boundary of the Thorne and Moorends Flood Risk Area

Introduction to the Thorne and Moorends Flood Risk Area

The Thorne and Moorends 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).

Doncaster Metropolitan District Council (DMDC) are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Thorne and Moorends FRA covers some businesses and residential properties that are within the immediate area of the Stainforth and Keadby Canal.

Much of the Thorne and Moorends FRA lies on a bed of Sherwood sandstone overlaid by alluvium, Devensian glaciofluvial deposits and Hemingbrough Glaciolacustrine formation. Soils in Thorne and Moorends FRA are predominantly deep stoneless fine silty and clayey soils variably affected by groundwater; slowly permeable seasonally waterlogged stoneless clayey and fine loamy over clayey soils and seep well drained sandy and coarse loamy soils.

The FRA contains the Thorne, Crowle and Goole Moors Site of Special Scientific Interest (SSSI) and Local Wildlife Sites such as Oak Moor and Chadwick Dike Area, Thorne Railway Delves and Thorne Colliery. East of the FRA, there is the Thorne Moor Special Area of Conservation (SAC) and also the Thorne and Hatfield Special Protection Area (SPA). Within the FRA there is also the Humberhead Peatlands National Nature Reserve (NNR). There are several listed buildings in Thorne, many just west of St. Nicholas's Church.

Since medieval times, land and drainage activities have been draining the marshy land to allow the land to be reclaimed predominantly for housing and agriculture. Over time flood defences have been created to provide flood risk protection to the reclaimed areas and pumping stations have been erected to create additional agricultural land in the area.

The FRA is susceptible to flooding from the rivers during times of increased rainfall and elevated water levels in the Stainforth and Keadby Canal as well as from water backing up the dykes in south Thorne. Much of the FRA has been designated as Flood Zone 3 however benefits from flood defences.

Current flood risk

There are no recent significant flood events in the Thorne and Moorends FRA.

The [flood hazard and risk maps](#) show that in the Thorne and Moorends (Rivers and Sea) FRA approximately 13,402 people live in areas at risk of flooding from rivers. Of these, 0.02% are in areas of high-risk.

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

- 267 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 0.15 km of roads
- 2.71 km of railway lines
- 321.17 ha of agricultural land
- areas of listed buildings, and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Thorne and Moorends FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Doncaster Metropolitan District Council, Yorkshire Water and Doncaster East Internal Drainage Board (IDB).

The FRA is covered by the South Yorkshire Flood Risk Partnership group that was set up by the Environment Agency following the implementation of the Floods and Water Management Act 2010. Representatives from the Environment Agency, LLFAs and Yorkshire Water sit on the group to strategically manage flood risk across South Yorkshire.

The FRA is also covered by the Isle of Axholme Strategy. Located in a largely rural area of South Yorkshire, Lincolnshire and North Nottinghamshire in the UK, the Isle of Axholme is artificially drained by a complex network of drains and over 60 pumping stations. The objectives of the Isle of Axholme Strategy are to:

- provide the most cost-effective approach for land drainage and flood risk management
- demonstrate resilience in the face of extreme events and/or future change
- maximise the overall carbon efficiency and sustainability of the options considered
- improve the management of existing biodiversity and incorporate gains where possible
- ensure that the strategy is understood and supported by key partners and the wider community
- fulfil the requirements of the WFD, specifically the Humber River Basin Management Plan (RBMP)

The Isle of Axholme strategy is in progress, but when complete it will see a reduction of flood risk to around 18,000 properties, critical infrastructure and agricultural land. The strategy includes investment in the refurbishment of the Keadby and West Stockwith

pumping stations as part of a capital investment of £204 million into the ageing assets would be needed to continue suitable protection and ensure the long-term economic prosperity of the area.

There are no hydrometric monitoring sites, however just west of the FRA at Thorninghurst Farm there is a manual ground water level monitoring site and a surface water level monitoring site at Fishlake.

There are three flood warning areas covering the FRA:

- River Don at Moorends
- River Don at Thorne (Yorkshire tidal warnings)
- River Trent at Crowle (East Midlands warning)

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

There are a range of embankments to the South and West of Thorne along the River Don and the Stainforth and Keadby Canal which help to protect Thorne and Moorends from flooding.

Since the devastating 2019 flooding across South Yorkshire, organisations have been working together to respond to the flood risk and climate emergency in South Yorkshire on a regional scale.

The South Yorkshire Catchment Plan is a vital part of this work. The plan brings key partners and priorities together to build a climate resilient region, to strengthen our capacity to act together over the long term and to provide a compelling programme for investors.

The plan will provide a strong, regional level ambition that benefits the communities of South Yorkshire and will set out how we tackle the causes of flooding, not just the symptoms. The plan is a chance to do things differently and become a national example of innovation and excellence.

We are also reviewing options for large nature-based solutions in the lower catchment, as discussed above, to help build climate resilience and make more space for water. We have an official investment request on our medium-term plan of £40million for Source to Sea nature-based solutions programme. This programme will still need external funding, but this signifies our ambition and our commitment to respond to the climate and nature emergency in South Yorkshire.

The impact of climate change and future flood risk

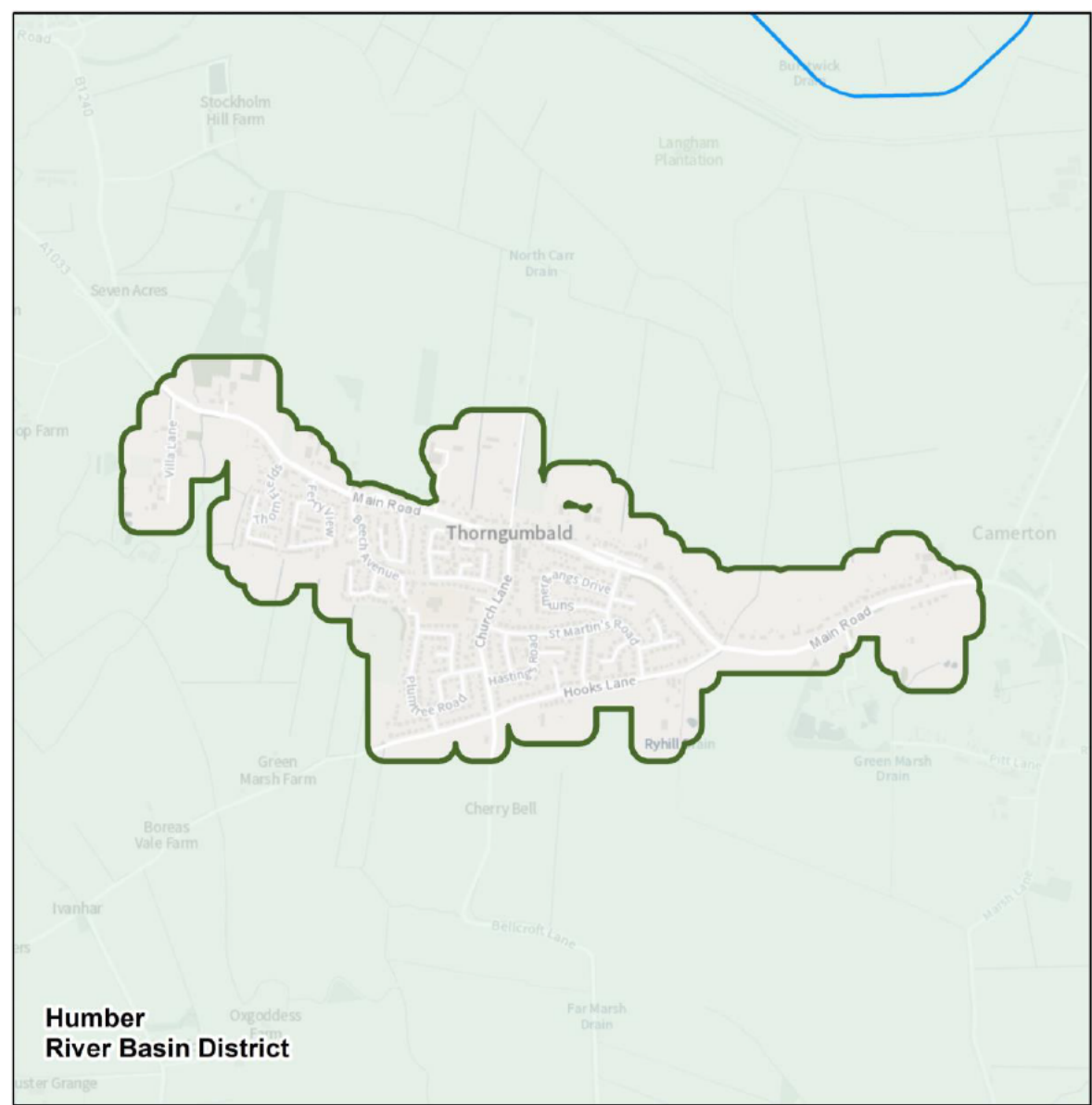
Rainfall intensity is expected to increase in future causing higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Thorne and Moorends FRA

Measures have been developed which apply specifically to the Thorne and Moorends FRA. These measures have been developed in addition to measures covering a wider geography, but which also apply to the Thorne and Moorends FRA. You can find information about all the measures which apply to the Thorne and Moorends FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Thorngumbald Rivers and Sea Flood Risk Area



Flood Risk Area: Thorngumbald, Humber

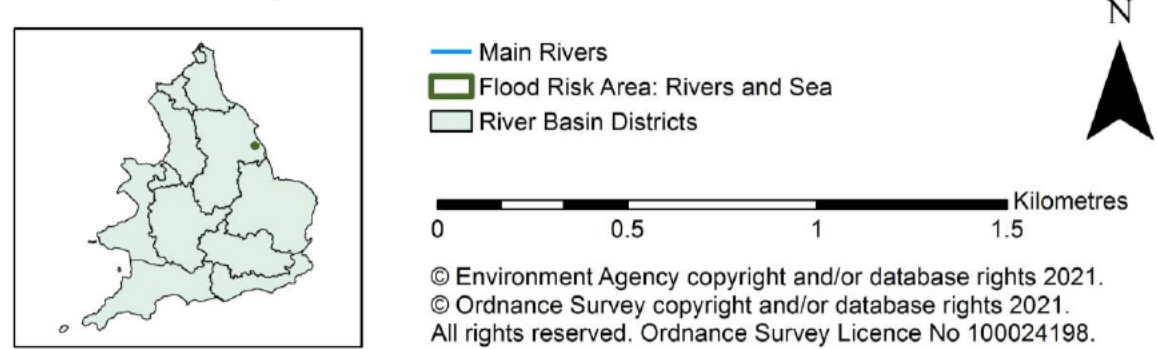


Figure 53: a map showing the boundary of the Thorngumbald Flood Risk Area

Introduction to the Thorngumbald Flood Risk Area

The Thorngumbald 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 FRMP for this FRA.

East Riding of Yorkshire Council are the Lead Local Flood Authority whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The South Holderness Internal Drainage Board (IDB) is responsible for a number of watercourses around Thorngumbald, with their drainage district covering a proportion of the FRA itself.

The Thorngumbald FRA covers several businesses and residential properties in the vicinity of the town centre.

Soils around Hedon are dominated by clayey alluvial deposits that reflect the local low-lying topography along the Humber Estuary. Permeability is low and soils are easily waterlogged meaning managed drainage is required to lower the water table.

Thorngumbald, along with much of the surrounding area, is situated within a surface water Nitrate Vulnerable Zone. The most significant wildlife designation in the area is the Humber Estuary, which is designated as a Site of Special Scientific Interest (SSSI), Ramsar site, a Special Area of Conservation (SAC) and Special Protected Area (SPA) principally for its wildfowl populations. The old line of the Hedon to Winestead railway line lies just to the north and east of the FRA, which is designated as Local Wildlife site.

The area surrounding Thorngumbald is generally flat and low lying near the Humber Estuary. It is dominated by agricultural landscape. The drift geology is dominated by alluvial deposits with a band of clayey soils which covers the low land around Thorngumbald.

Thorngumbald was once a Viking settlement, the name first being recorded in the Domesday Book as 'Torn', an Old English word meaning 'thorn bush'. A Baron Gumbaude settled in the area during the first half of 13th century, adding his name to the original and giving the village its present name.

Thorngumbald is now a primary village and sits on low lying land at flood risk dominated by the Humber Estuary, although there is also an extensive land drainage network in the vicinity. As the settlement sits within Flood Zone 3, and therefore at flood risk now and in the future, development ambitions within the Local Plan are likely to be limited, as a result the 2016 Local Plan made no specific allocations. The area is characterised with field

drains across the South Holderness area in general, many of which are maintained by South Holderness Internal Drainage Board. The main drains in Thorngumbald is Ryhill and Thorngumbald Drain.

The FRA is susceptible to flooding from surface water, as well as tidal flooding directly from the Humber Estuary.

Ryhill Drain and Thorngumbald Drain can overtop their banks at high flows causing flooding in the area. Ryhill Drain runs to the east of Thorngumbald and receives flow from Skeckling Drain, which drains the village of Burstwick. Thorngumbald drain runs to the north of Thorngumbald and then to the west to a pumped outfall. This drain isn't connected to Ryhill Drain but does have its source within 20m of Ryhill Drain.

The area of Thorngumbald is affected by the combination of pluvial and fluvial flooding along and around Langham Rd, Plumtree Road and Hooks Lane and other isolated areas across the town. It is difficult to distinguish between direct rainfall flooding (runoff) and water backing up from drains across the urban area.

Surface water flooding occurred in the area in June 2007, like with other urban areas in the overall catchment such as Ottringham and Keyingham. Despite the area of Thorngumbald also covering the East Yorkshire Chalk Aquifer there are no notable instances of flooding driven by groundwater sources.

Current flood risk

There hasn't been any significant flooding to Thorngumbald in recent years, although there has been isolated incidents of surface water flooding such as that experienced in early 2020.

The [flood hazard and risk maps](#) show that in the Thorngumbald FRA some 3,003 people live in areas at risk of flooding from rivers of which none are considered to be in areas of high risk.

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

- 33 non-residential properties
- 127.83ha of agricultural land
- areas of listed buildings

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Thorngumbald FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders. These include East Riding of Yorkshire Council (ERYC), South Holderness IDB, Gilberdyke Parish Council and Yorkshire Water.

The South Holderness Internal Drainage Board (IDB) is responsible for a number of watercourses within the area around Thorngumbald. Part of Old Fleet Drain, Preston New Drain, Reedmere Sewer, part of Burstwick Drain, part of Thorngumbald Drain and part of Skeffling Drain. The IDB doesn't have any pumping stations in the area, through the operation and maintenance of outfalls and the channel system in the area. The IDB seek to maintain a general standard capable of providing flood protection to agricultural land from a 5% chance of flooding in any one-year event and to developed areas from a 1% chance of flooding in any one year event.

ERYC – Lead Local Flood Authority main responsibility flood risk from surface water and ordinary watercourses.

Environment Agency – Responsibility primarily main rivers in the FRA and major watercourses. Watercourses aren't maintained by the Environment Agency or IDB, responsibility falls to riparian owners. Environment Agency also responsible for the operation and maintenance of Thorngumbald Pumping station.

Yorkshire Water – the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

Riparian Owners – Ownership of watercourses which aren't major and overlap on property/land owned. Maintenance and responsibility of any that do overlap into owned land lies with riparian ownership. Inspection work/cleaning could be carried out by the LLFA dependent on circumstances.

Regular meetings are held between the Environment Agency and ERYC with regard to incident management, ongoing capital projects and future investment. ERYC is also part of the East Yorkshire Flood Risk Partnership, enabling broader tactical and strategic approaches to be agreed with neighbouring LLFAs and other partners.

The Environment Agency monitor river levels on Thorngumbald Drain at Thorngumbald Pumping Station. Levels in Keyingham Drain are monitored on Keyingham Road Bridge at Ryehill and at Stonecreek Outfall, where Keyingham Drains discharges into the Humber Estuary. Tidal levels are monitored at both Thorngumbald Pumping Station and Stone Creek Outfall.

The nearest rain gauge to the FRA is located approximately 9km to the east of the FRA, at the Environment Agency's Winestead Booster Pumping Station, on Winestead Drain.

Thorngumbald is within the Burstwick and Keyingham Drains Flood Alert area. There are currently no flood warning areas that cover the FRA.

The flood response in Thorngumbald is generally well-rehearsed, with the EA, ERYC and other partners, including the IDB, taking action at specific levels to issue flood alerts and undertake operational arrangements.

Water level and flow information is used to inform and calibrate mathematical modelling of the drainage network. The Environment Agency has recently completed the Humber Tributaries Modelling Study (2020), which provided a greater understanding of flood risk on both Thorngumbald Drain and Keyingham Drain.

In addition, in 2021 the Humber 2100+ Project, which is undertaking a comprehensive review of the Humber Flood Risk Management Strategy (FRMS), modelled the first set of consistent extreme water levels around the estuary. This set of levels cover those sections of the Humber Estuary that pose a flood risk to the FRA.

ERYC have developed an Integrated Catchment Model (ICM) for the wider Holderness area, which includes the FRA.

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

Some detailed integrated modelling, taking account of combined surface water, fluvial and sewer risk, has been undertaken in Thorngumbald by ERYC as part of HHFAS Phase 2.

The area in general around Thorngumbald (HHFAS) has a 0.5% chance of flooding in any one-year tidal defence, however each of the main rivers and watercourses can be tidally locked for long periods. Each of the major outfalls from a fluvial course into the tidal Humber Estuary is controlled by a pumping station (Thorngumbald Drain) or by a gate that locks during high tides. As such high tides can increase fluvial and pluvial flood risk in the FRA.

Thorngumbald and the surrounding area is flat and low-lying, thus without tidal defences the area would be subject to regular tidal flooding. As a result the FRA is reliant on flood defences to prevent inundation. The banks of the Humber Estuary to the south of the FRA are lined by a tidal flood embankments. These flood defences are operated and maintained by the Environment Agency.

The Environment Agency owns and operates Thorngumbald pumping station, located on the downstream end of Thorngumbald Drain where it meets the Humber Estuary south of the FRA. This station manages water levels in Thorngumbald Drain during periods of high flows and tide locking, thereby reducing flood risk to the FRA and surrounding area.

Stone Creek Clough is located at the downstream end of Keyingham Drain, where it discharges into the Humber Estuary. This outfall structure stops high tidal levels propagating up the drain and flooding the surrounding area.

In 2018 the Environment Agency completed capital maintenance works to reinstate the level of protection offered to the FRA and surrounding area by the flood defence embankments that run along the banks of the Humber. This work was undertaken to address a stretch of the defence at Paull Holme Strays that had sunk over a short length (approximately 100m) since its construction in 2003.

The Environment Agency also has future investment identified to deliver further capital maintenance works to the tidal defences along the Humber Estuary, which provide flood protection to the FRA. These works will be required to keep the defences in the required condition in order to ensure that the current level of flood protection is sustained to Thorngumbald and the surrounding area.

The future management of flood risk around the Humber Estuary, including the FRA and surrounding area, is set out in the Humber FRMS. A comprehensive review of the existing Humber FRMS is currently underway.

The Humber 2100+ project, which is a partnership project including 12 local authorities, is redefining the strategic approach to managing tidal risk on the Humber. It will identify the most sustainable, credible and cost-effective approach to managing tidal flooding over the next 100 years, taking into account predicted sea level rise and climate change.

The conclusions of the Humber 2100+ project will set the future direction of defence needs around the whole estuary, including around Thorngumbald.

ERYC are currently developing a flood alleviation scheme to address surface water flood risk in Thorngumbald. Current proposals are to upgrade the existing drainage network to provide additional capacity, make alterations to the west of the study area to ensure the drainage network can discharge, and construct a new flood embankment with possible flood storage to the north of the settlement to reduce flood risk to local properties. Current expectations are that the scheme will be delivered by 2026 at an estimated cost of £3M.

The 2nd phase of Hull and Holderness Flood Alleviation Scheme (HHFAS) is being undertaken by ERYC. A scheme to reduce integrated risk, driven predominantly by surface water accumulation, is being developed in Thorngumbald. Further development and construction of output proposals are subject to all appraisal elements and funding.

The impact of climate change and future flood risk

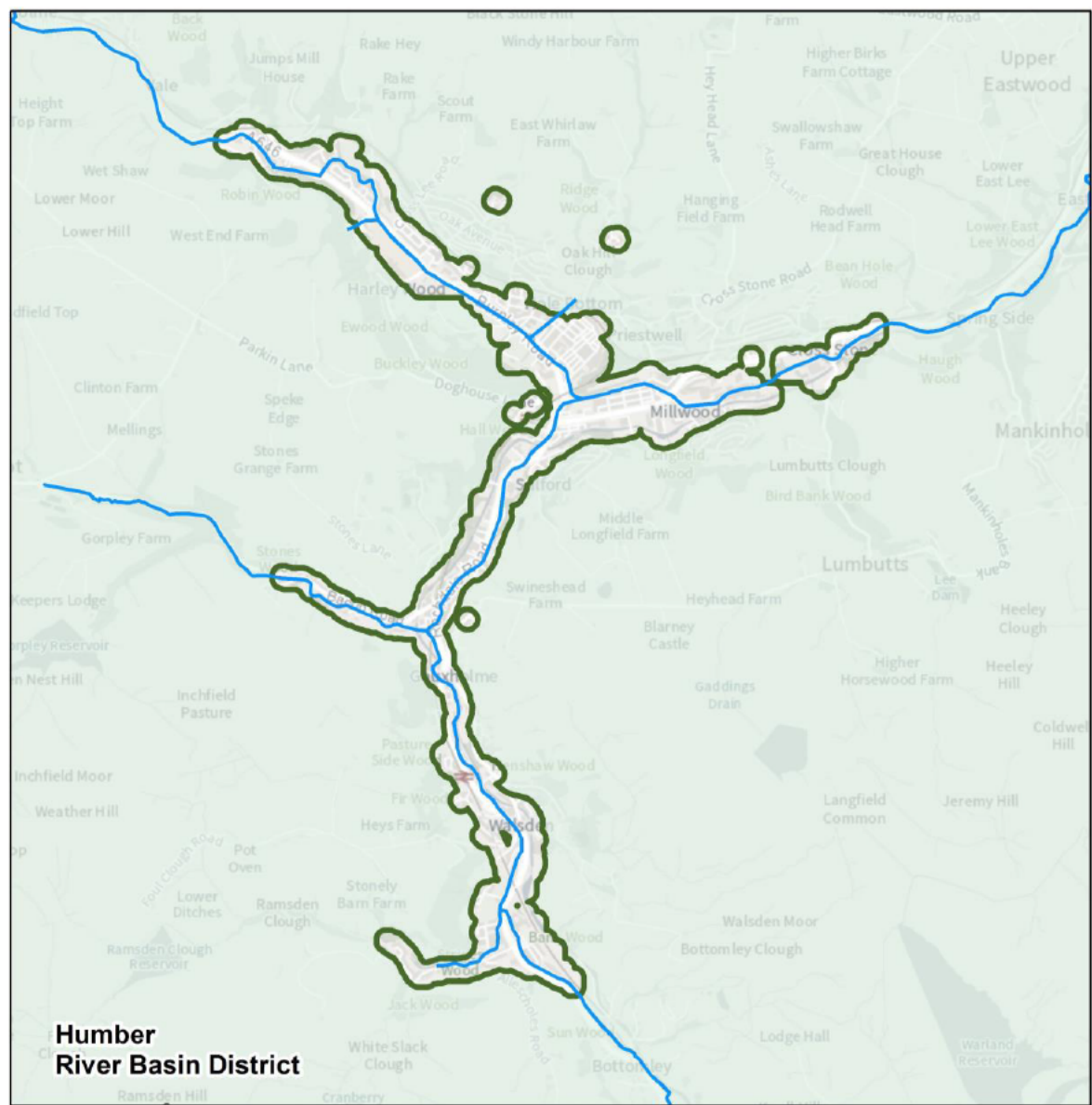
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Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the Thorngumbald FRA

Measures have been developed which apply specifically to the Thorngumbald FRA. These measures have been developed in addition to measures covering a wider geographic area but which also apply to the Thorngumbald FRA. You can find information about all of the measures which apply to the Thorngumbald FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The Todmorden Rivers and Sea Flood Risk Area



Flood Risk Area: Todmorden, Humber

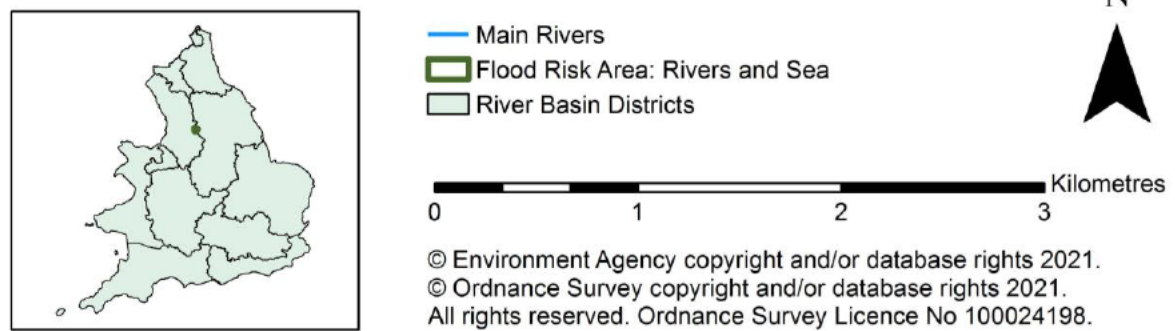


Figure 54: A map showing the boundary of the Todmorden Flood Risk Area

Introduction to the Todmorden Flood Risk Area

The Todmorden 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 FRMP for this FRA.

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

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The Todmorden FRA covers businesses and residential properties in the vicinity of the River Calder and Rochdale Canal. The FRA lies on a bedrock of mudstone and siltstone hebdon formation and sandstone Todmorden grit overlaid with alluvium. Predominant soils in Todmorden are coarse loamy very acid upland soils over rock with a wet peaty surface horizon and thin ironpan.

There are a couple of Local Wildlife Sites in Todmorden; Central Vale and the Rochdale canal as well as one designated ancient woodland 'longfield wood'. There are also several listed buildings in the town.

The FRA is susceptible to fluvial flooding from the River Calder, Walsden Water and minor watercourses. Associated with this is the residual risk of flooding from the Rochdale Canal when high inflows exceed the canal capacity during storm events. Walsden Water joins the River Calder in Todmorden. The FRA also suffers from surface water flooding in particular where submerged drainage outfalls cause surface water to back up behind raised defences when flood levels are high in the receiving watercourses. A surface water management plan has been created for the town. Several stretches of the A646 road regularly flood causing road closures.

Current flood risk

Todmorden has a history of flooding. Businesses and the local community have been impacted by devastating flood incidents which have severely affected the local economy, most recently in 2012 (more than 800 properties were affected) and on Boxing Day 2015 and February 2020.

The [flood hazard and risk maps](#) show that in the Todmorden FRA 5,278 people live in areas at risk of flooding from rivers of which 37% are in areas of high risk.

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

- 467 non-residential properties
- 5.94km of road

- 1.85km of railway
- areas of listed buildings and water abstraction and discharge points

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the Todmorden FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders for example Calderdale Council and Yorkshire Water.

Following the devastating flooding experienced on Boxing Day 2015 the Calderdale Flood Recovery and Resilience Programme Board was set up which is led by Calderdale Council but includes all key partners including:

- Environment Agency
- Yorkshire Water
- The Canal & River Trust
- Network Rail
- local councillors

The aim of the Board is to oversee the delivery of all the work contained in the Calderdale Flood Recovery and Resilience Programme, with its aim of reducing the risk of flooding within the borough of Calderdale and building the resilience of local communities to withstand the effects of any future flood events. Feeding into the board are four operational groups which include Flood Reduction and Investment, Natural Flood Management, Community Resilience and Resilient Infrastructure.

The Calderdale Flood Action Plan contains the actions that communities and partners feel are essential to help Calderdale recover from the floods and to improve resilience and reduce the risk of flooding over the next 20 years. The actions have been gathered through workshops, drop-in sessions and meetings held over summer 2016. Actions have been developed at a series of workshops with partners and the wider community and have been informed by local knowledge and specialist consultant modelling, use of existing data, and linking to strategic plans.

There are four continuous surface water level monitoring sites around Todmorden, three measuring levels on the Calder and one measuring levels on Walsden Water.

There is one flood alert for the Upper River Calder catchment and 4 flood warning areas covering the River Calder at Todmorden.

The water level and flow information is used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have hydraulic models from 2015 and these are currently being updated.

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 for flood defence walls or embankments along the River Calder and Walsden Water in Todmorden. The Environment Agency and partners have completed a flood defence project to better protect Todmorden against flooding from Walsden Water and the River Calder.

The three-year Todmorden Flood Defence project saw all parties work collaboratively to complete a 1.1km section of watercourse along Walsden Water, which flows from south to north through the town centre, upgrading the existing flood defences, retaining walls and culverts located along this length.

Work included:

- fitting non-return valves to all protruding pipework in the culverts along the watercourse to prevent the back flow of water into the various drainage pipes
- removal of a supermarket delivery area access bridge, which in a storm event was a major obstacle to the flow of water in Walsden Water, and construction of a new access road
- raising the existing flood walls, where required
- culvert strengthening and new head walls
- removal of the weir structure to reshape the river to create a smoother flow with rock armour installed to protect the walls and offer a natural habitat

Some of the culvert work was undertaken underneath Todmorden Market Hall, which remained fully operational throughout.

During the February 2020 floods, part of one of the Todmorden FAS flood walls was damaged so emergency works took place to repair it. There are now legato blocks in position whilst a permanent solution is investigated.

Shade Chapel on Walsden Water has been demolished and the culvert repaired after the building was badly damaged during the February 2020 floods. This has reduced flood risk to 250 properties in Todmorden. The culvert has been removed, and scour protection installed to the river and beds. Stone facing of walls to restore a natural looking river channel in keeping with adjacent areas has also been completed. Landscaping to create two low maintenance areas for the community and school on each side of the river is on-going.

A permanent solution is being investigated for the damaged wall in Todmorden.

Backwater Loo, Walsden Water is a project to remediate the movement of river bed material and rock armour.

Walsden Flood Alleviation Scheme, the main benefits of the scheme are:

- reduction of flood risk to 147 residential, as well as commercial properties within Walsden
- reduce the vulnerability to existing hydrological system
- better protect existing transport infrastructure
- avoid detrimental impact on areas at risk downstream
- enhancing environmental opportunities

The preferred option is a suite of measures that act together to reduce flood risk in Walsden.

The implementation of Natural Flood Management measures will play a significant part in the reduction of overland flows and represents an opportunity to incorporate environmental improvements within the scheme that could create new habitats.

The impact of climate change and future flood risk

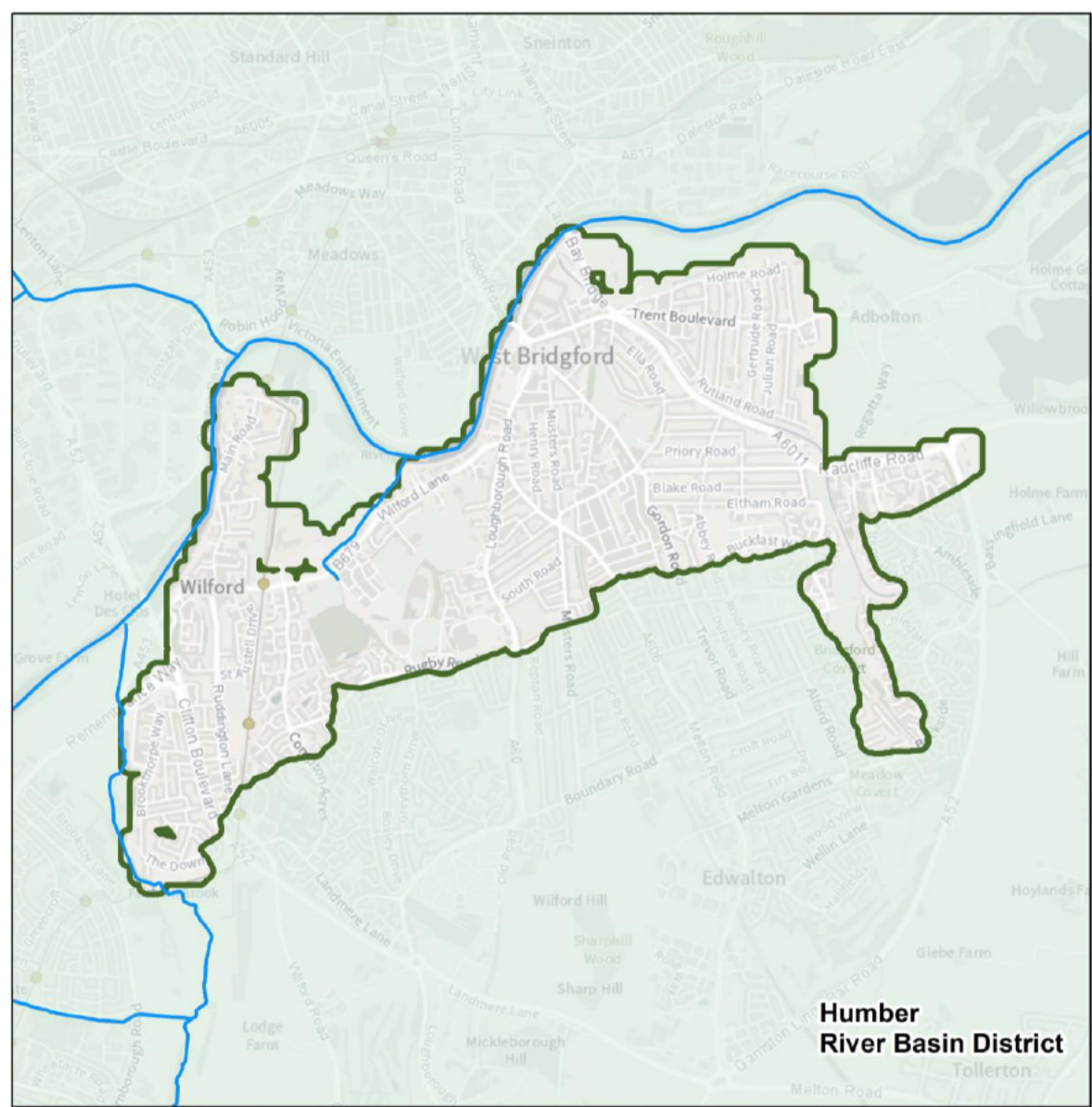
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Objectives and measures for the Todmorden FRA

Measures have been developed which apply specifically to the Todmorden FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Todmorden FRA. You can find information about all the measures which apply to the Todmorden FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

The West Bridgford Rivers and Sea Flood Risk Area



Flood Risk Area: West Bridgford, Humber

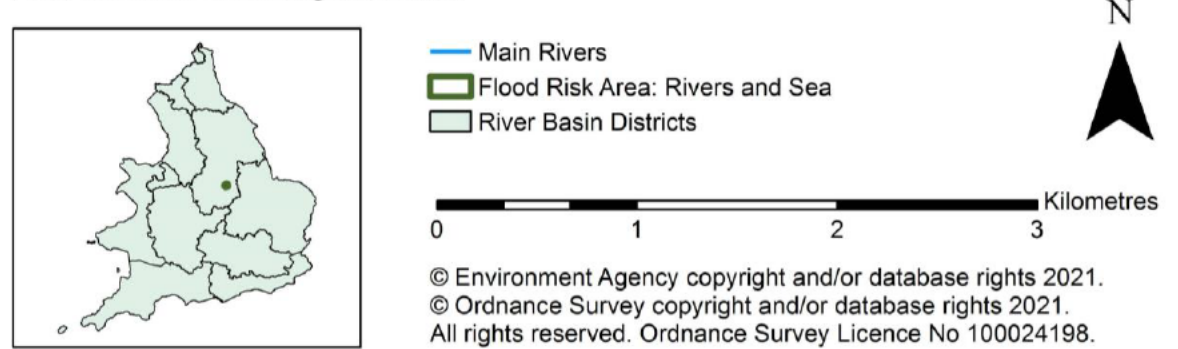


Figure 55: A map showing the boundary of the West Bridgford Flood Risk Area

Introduction to the West Bridgford Flood Risk Area

The West Bridgford (Rivers and Sea) 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 is responsible for the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Lead Local Flood Authorities (LLFA), Nottingham County Council and Nottingham City Council, are responsible for surface water and ordinary watercourses, and Severn Trent Water is the sewerage undertaker for this area.

The West Bridgford (Rivers and Sea) FRA covers the West Bridgford area and extends into areas including Silverdale, Wilford and Gamston. The area is characterised by a compact town centre surrounded by residential suburbs, business and amenity areas with the River Trent (main river) skirting the northern edge of the FRA.

West Bridgford is located on an area of low hills in the lower River Trent valley. The Greythorne Dyke flows northwards through the FRA, and joins the River Trent to the north of the FRA.

Much of the area is built on Triassic sandstones and mudstones which are relatively permeable. The Trent valley is floodplain alluvium, and much of the area is covered by the Holme Pierrepont sand and gravel member.

There are various Local Wildlife Reserves and sites in the West Bridgford FRA, such as Compton Acres, Fairham Brook and Wilford Disused Railway. There are also several listed buildings.

Flooding from rivers can occur as a result of the channel capacity being exceeded, a blockage occurring, or as a result of surcharge from culverted sections. There are extensive flood protection assets maintained by the Environment Agency in the FRA, which include raised defences and outfalls.

The Grantham Canal is owned and maintained by the Canal & River Trust. The Grantham Canal runs from Grantham to Nottingham and joins the River Trent at near to Lady Bay bridge. Although not navigable by boat, the Grantham Canal still holds water and is a valuable wetland habitat.

West Bridgford is served by a mix of foul, combined and surface water sewers. The sewerage network has been extended and upgraded in areas over many years as West Bridgford has grown. Severn Trent Water has developed and maintains a hydraulic model of the public sewerage system and information is available for the capacity and condition of the network. Flooding has been recorded at numerous locations in the FRA. This includes both surface water and foul water, and both internal and external flooding. Severn Trent Water has undertaken schemes to increase the capacity of the sewers in West Bridgford to reduce the risk of sewer flooding.

Current flood risk

West Bridgford is at risk of flooding from a variety of sources. The primary sources include flooding from rivers, surface water and sewers. This presents challenges to flood risk management, particularly in areas around river confluences where raised defences could protect property against flood risk from one source but increase flood risk from another source.

There are no records of main river fluvial flooding in the FRA since the Trent defences were improved, following the widespread floods of 1947. The River Trent was widened and deepened during the 1950's, the Greythorne Dyke Pumping station was also constructed. The defences at Wilford were improved in the 1990's and extensive improvements to Lady Bay were also undertaken in the early 2000's.

The [flood hazard and risk maps](#) show that in the West Bridgford (Rivers and Sea) FRA approximately 26,641 people live in areas at risk of flooding from rivers. Of these, less than 0.01% are in areas of high-risk.

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

- 1,139 non-residential properties (including hospitals, schools and colleges, retail parks, community centres)
- 6 km of roads
- 2.2 km of railway lines
- 63.5 ha of agricultural land
- areas of environmental designated sites, scheduled ancient monuments, listed buildings, parks and gardens, and water abstractions

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of river flooding for the FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to manage risk of flooding and the current and future impact it could have on the FRA.

How the risk is currently managed

The Environment Agency maintains flood risk management assets for example river channels, flood defence walls or embankments, throughout the FRA. There are several significant assets in the FRA including the Greythorne Dyke pumping station, extensive raised defences and outfalls to the River Trent.

Similarly, the LLFA and Severn Trent Water maintain assets that perform a flood risk management function on the drainage network. The Canal & River Trust maintains the Grantham Canal. The Canal & River Trust manages and maintains its network to reduce risks of asset failure.

The Nottinghamshire Local Resilience Forum (LRF) is a multi-agency partnership made of representatives from local public services:

- emergency services
- local authorities
- NHS
- Environment Agency and others

Partners are required to respond in the event of emergencies, in their respective roles and jointly, to safeguard the lives, property and wellbeing of residents, communities and businesses and to mitigate the consequential impacts. Flooding is one of the risks addressed by the LRF through community flood preparation

The Environment Agency monitors river and rainfall conditions in the FRA. This information is used to inform activities related to Flood Warning Areas that cover the FRA which enable people to receive a warning when flooding could occur along the River Trent.

The Environment Agency undertakes hydraulic modelling to understand flood risk. In the FRA modelling has been undertaken for the main rivers the Trent and 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

The West Bridgford Right Bank flood risk management Scheme was completed 2009 protecting 5,600 homes and businesses.

Future projects planned to manage flood risk in the West Bridgford FRA include the review of the Silverdale Embankment, which would seek to ensure that any improvements and asset renewals are identified with a view to continuing a high standard of flood protection from the River Trent and Fairham Brook.

The impact of climate change and future flood risk

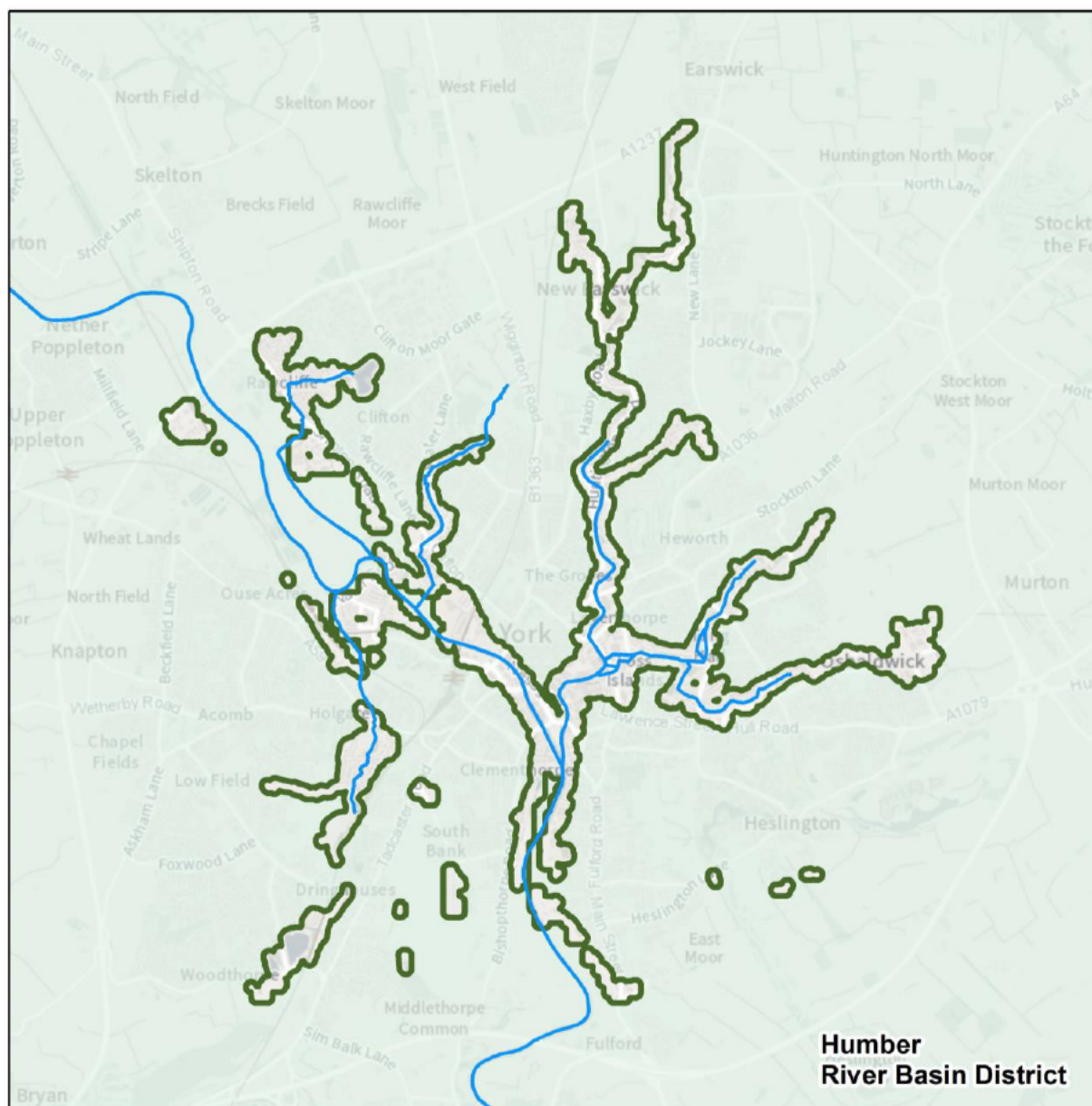
Rainfall intensity is expected to increase in future and causing higher river flows and levels. As rainfall intensity increases, it means that surface water flooding will become more frequent as higher rainfall totals will be seen more often.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

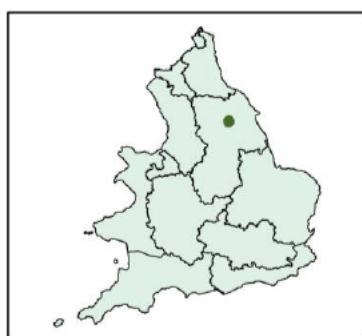
Objectives and measures for the West Bridgford (Rivers and Sea) FRA

Measures have been developed which apply specifically to the West Bridgford (Rivers and Sea) FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the West Bridgford (Rivers and Sea) FRA. You can find information about all the measures which apply to the West Bridgford (Rivers and Sea) FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'.

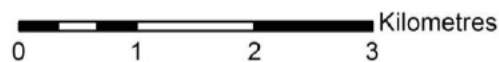
The York Rivers and Sea Flood Risk Area



Flood Risk Area: York, Humber



- Main Rivers
-  Flood Risk Area: Rivers and Sea
-  River Basin Districts



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Figure 56: A map showing the boundary of the York Flood Risk Area

Introduction to the York Flood Risk Area

The York 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 FRMP for this FRA.

City of York Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Yorkshire Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in the FRA.

The York FRA covers many of the districts of York which feature businesses and residential properties that are within the immediate area of the rivers Foss, Ouse and their tributaries.

Soils in York are predominately of clay and loam types and the flat nature of the Vale of York means that water generally moves slowly into watercourses, but runoff rates can be rapid when the ground is waterlogged. Although some modelling suggests that there is some potential for groundwater flooding in York, there are no records of groundwater emergence causing significant flooding.

There are several Sites of Special Scientific Interest (SSSI) located within the York FRA. These include:

- Askham Bog
- Clifton Ings
- Rawcliffe Meadows
- Fulford Ings

In addition to this, there are multiple Registered Parks, Listed Buildings and Scheduled Monuments within this area of coverage. The view of historic buildings alongside the River Ouse is often considered to be an iconic image of the city.

York is home to two universities and is a popular tourist destination, with recent development in the residential, (including student accommodation) commercial and service sector. Future development of brown-field sites will include some work in flood risk areas, and City of York Council have ambitions to improve the public realm and public access along the river corridors.

The FRA is most susceptible to flooding from the river Ouse during times of increased rainfall or snowmelt in the Yorkshire Dales to the north-west, but high levels in the Ouse can also be caused by more localised rainfall. The River Foss has a smaller catchment with lower average rainfall, but flooding can occur relatively rapidly here in certain conditions. There can also be flood risk from the smaller becks that drain parts of the

urban area, and this is most seen in combination with high levels in the Ouse and Foss restricting drainage. Surface water risk in York is generally confined to discreet areas and has not historically been a cause of significant or widespread flooding.

Current flood risk

York suffers from some flooding most years, but this is generally confined to riverside access routes and to properties which have a high level of resilience and water-compatible infrastructure.

The [flood hazard and risk maps](#) show that in the York FRA 11,615 people live in areas at risk of flooding from rivers of which 25% are in areas of high risk.

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

- 703 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 0.04km of roads
- 1.34km of railway
- 65.78ha of agricultural land
- areas of environmental designated sites, listed buildings, parks and gardens

The [flood hazard and risk maps](#) provide more detailed information on the likelihood and consequence of flooding for the York FRA.

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

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 Risk Management Authorities (RMAs) and other stakeholders. These include City of York Council, Yorkshire Water, the Internal Drainage Boards who manage some smaller watercourses that flow into the city, and other members of the Dales to Vale catchment partnership.

Regular meetings are held between the Environment Agency and City of York Council regarding incident management, ongoing capital projects and future investment. City of York Council is also part of the North Yorkshire Flood Risk Partnership, enabling broader (catchment scale) tactical and strategic approaches to be agreed with neighbouring LLFAs and other partners.

The Environment Agency monitor river levels on the Ouse at the 'Viking' site in central York as well as at Naburn Lock downstream of the city and at a large flow-gauging site upstream of the city at Skelton. On the Foss levels are monitored at the Foss Barrier, at

Huntington and at West Lilling. There are also several gauges on various operational sites such as pumping stations (notably the Foss Barrier) and trash screens in the city.

There are two rain gauges in the city, in Acomb and on the Foss catchment, and the network of monitoring and gauging stations upstream of York feed into a well-developed flood forecasting system for the city.

There are 26 flood warnings in the FRA, with a proportion of these being issued frequently to a relatively small number of properties and other being reserved for more extreme flooding that would affect a larger number of homes and businesses. The flood response in York is generally well-rehearsed, with the EA, CYC and other partners taking operational action at specific levels and residents responding to flood warnings to put property level resilience measures in place.

Water level and flow information is used to inform and calibrate mathematical modelling of the river network. The York Detailed Flood Model, covering the rivers Ouse and Foss, was created in 2015, and then updated in 2016 to account for data collected in the floods of the winter of 2015-16 and to inform the York Flood Alleviation Scheme. Smaller watercourses in York have also been modelled, but some of these models are simpler in nature and may use older modelling methods.

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 several significant flood risk assets in York, including flood defence walls, embankment, gates and pumps. The largest single asset is the Foss Barrier, a combined gate and pumping station that prevents flood water in the Ouse flowing up the Foss and causing extensive flooding in the Foss corridor. When flooding is expected CYC carry out several operational actions, and the Environment Agency also has locations where temporary pumps can be sited if required.

Since 2016 the Environment Agency has been working with CYC on the York Flood Alleviation Scheme, an extensive programme of works to ensure that existing flood defences meet the challenges of a changing climate and to build new assets in places that were previously undefended. This includes raising walls and embankments, building new walls, extensively upgrading the Foss Barrier and a programme of Property Level Resilience works. A new flood storage area on the Foss will reduce flows into the FRA, and work is underway to assess options for reducing peak flows on the Ouse through activity upstream of the city.

The York Flood Alleviation Scheme is ongoing and will continue for several years and will provide a high and consistent standard of flood defence throughout the FRA. Following this there will be planned interventions to maintain and sustain assets as required, and periodic review of the standard of defence provided by the scheme. Upstream flood risk

management measures are expected to be implemented in the future to mitigate the impact of climate change on the hard defences in the FRA. City of York Council have ongoing work on surface water management in the Nunthorpe Road area, and similar projects could arise from future modelling of extreme local rainfall events or from post-flood analysis.

The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future and cause higher river flows and levels. As rainfall intensity increases, it means that flooding from rivers and the sea will become more frequent.

Please refer to the [Climate Change and the Humber RBD](#) section in this document for more information on what we know are likely to be the implications of climate change in the Humber River Basin District.

Objectives and measures for the York FRA

Measures have been developed which apply specifically to the York FRA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the York FRA. You can find information about all the measures which apply to the York FRA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

Strategic Area objectives and measures

Strategic Areas are areas with a similar geography or strategic ambition, where it is important to consider flood risk management across administrative boundaries and river catchments. For example, the Humber Estuary Strategic Area lies within the Humber RBD and bounds the Anglian RBD at Saltfleet. It is therefore discussed entirely within the Humber plan. The Fens & Lowland Strategic Area meanwhile straddles the Humber and Anglian RBD boundary and is therefore included in both plans.

3 measures have been developed that apply to the Humber Estuary Strategic Area. In addition to this, there are 4 measures that have been developed for the Fens & Lowlands Strategic Area that apply to the section of the Humber RBD where the Fens & Lowlands Strategic Area has coverage.

You can find information about all the measures that apply to the strategic areas in [Flood Plan Explorer](#), an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

The strategic areas are described below.

The Humber Estuary Strategic Area

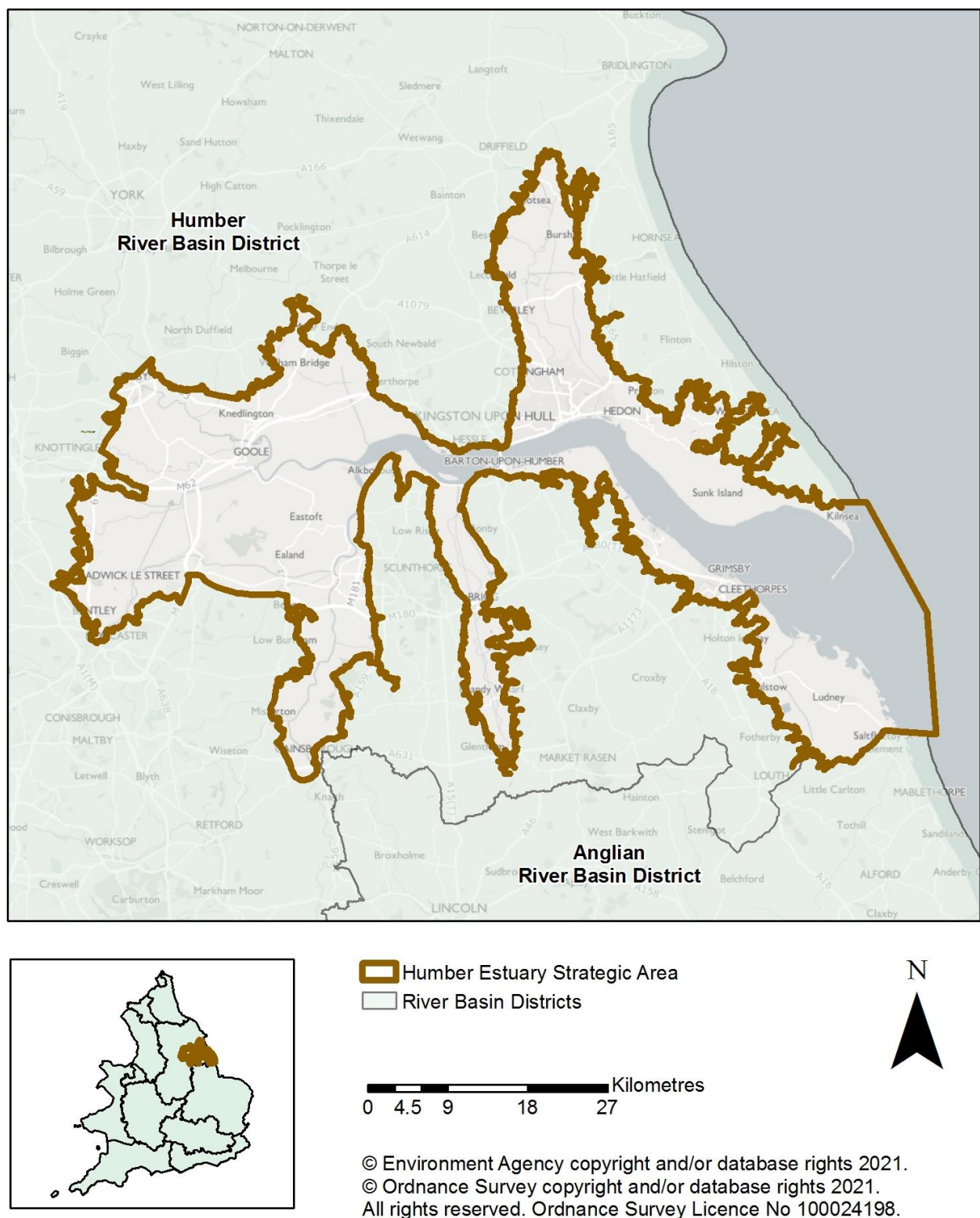


Figure 57: A map showing the boundary of the Humber Estuary Strategic Area

Introduction to the Humber Estuary Strategic Area

Strategic areas are areas where it is important to consider flood risk management across more than one sub-area, so that interested parties can work in a co-ordinated way to set out objectives, measures to manage risk, and conclusions.

The Humber Estuary has been designated as a Strategic Area, as shown in Figure 57. The estuary and its tidal tributaries are covered by 8 management catchments, including:

- Hull and East Riding
- Derwent (Humber)
- Aire and Calder
- Don and Rother
- Lower Trent and Erewash
- Idle and Torne
- Louth, Grimsby and Ancholme
- Wharfe and Lower Ouse
- Witham

This area contains over 120,000 hectares and around 540,000 people and 20,000 businesses which are served by 12 LLFAs, 3 Regional Flood and Coastal Committees (RFCCs) and several IDBs.

The Humber estuary and its surrounding areas are of huge importance to the UK economy. The area contains a range of industries and important infrastructure that is vital to the region and the wider country. Due to the low-lying nature of the land around the estuary, many of these properties and businesses are at risk from tidal flooding from the estuarine rivers within its catchment.

The Humber Estuary Strategic Area covers parts of 3 Environment Agency Administrative Areas: Lincolnshire and Northamptonshire Area and Yorkshire Area and East Midlands. All these areas have partnership arrangements with Lead Local Flood Authorities (LLFAs), Internal Drainage Boards (IDBs) and other risk management authorities.

Business and Industry

As the home of the UK's largest port complex (by tonnage), the Humber estuary is the eastern gateway to the Northern Powerhouse. Ports at Grimsby, Immingham, Hull and Goole are a key trade gateway, linking the UK market with those in Europe and beyond. Over 70 million tonnes of cargo pass through the ports each year, including fuel, vehicles, food and timber – that's around 12% of the UK's total!

Known as the UK's 'Energy Estuary', the Humber contributes to over a quarter of the UK's power. This has attracted an impressive number of energy producers and fuel manufacturers, as well as high energy users in the process, manufacturing and chemical sectors. Coal and natural gas are imported via the Humber ports and a third of the UK's oil refineries are based around the estuary.

The Humber is also establishing itself as an exemplar region for the growth of clean energy. It is at the forefront of the offshore wind sector following large investments from companies such as Ørsted and Siemens Gamesa. The Humber sees itself as central to 50% of the UK's offshore wind projects – that's a lot of power! Other initiatives in the region include the conversion of Drax power station generating units to burn biomass instead of coal, made possible by the supply of biomass via the Port of Immingham.

The hub of industry around the Humber is supported by vital transport infrastructure, including around 800km of railway links and 600km of major roads, including the iconic Humber Bridge.

The Humber has a diverse economy which presents a wide range of future growth opportunities, particularly around the acceleration of clean energy generation. For example, with a third of UK electricity to be generated from offshore wind by 2030, there is great potential associated with the manufacture and servicing of wind turbines, helping to place the Humber at the heart of the offshore wind economy and providing employment for thousands of people. The Humber is also home to the UK's only manufacturer of petroleum graphite coke. As a key component of electric vehicle batteries, this could put the Humber on the map as a hub for the electric vehicle supply chain.

The Humber has been identified as a key location for implementing Carbon Capture and Storage. The ambition is that by drawing on its existing skills and infrastructure, the Humber can become the base for the UK's first net zero carbon industrial cluster, helping to create a cleaner environment for future generations whilst delivering new jobs and export opportunities for British businesses. This initiative is being championed by Zero Carbon Humber, a partnership to build the world's first net zero industrial cluster and decarbonise the North of England.

Food and Agriculture

There are over 120,000 hectares of agricultural land around the Humber estuary and much of this is high-grade, which means it is amongst the best land in the UK for growing crops. For this reason, the Humber is an integral part of the UK's largest food producing region. The scale of the Humber's food and agricultural sector is made possible by local farming infrastructure, such as pumping stations and drainage channels. These are required to keep the land dry enough for growing crops.

Clearly, the estuary is an important resource. It is the largest trading estuary in the UK (by tonnage) and activities such as energy production, commercial and recreational fishing, agriculture, navigation with associated ports and harbours, aggregate extraction, energy production and recreation and tourism contribute to the economic importance of the estuary, and wider region. The area is currently seeing significant investment and development in the energy, renewable and carbon capture sectors, associated with the Humber's 'Energy Estuary' ambitions and the Zero Carbon Humber partnership.

Environment & Nature

The Humber Estuary is recognised as one of the most important estuaries in Europe for nature conservation. It is protected by multiple international designations; the estuary is a Special Area of Conservation (SAC), Special Protection Area (SPA) and a Ramsar site, which means it is seen as an internationally important wetland. The estuary also has national designations such as Sites of Special Scientific Interest (SSSI).

The estuary consists of a mosaic of habitats including mudflats, saltmarsh, coastal lagoons, peatlands and sand dunes. These habitats support a diverse range of wetland birds including avocet, lapwing and ringed plover.

In recent years, habitat creation schemes have been delivered or are ongoing in various locations around the estuary, including Paull Holme Strays, Alkborough Flats and Donna Nook, to compensate for habitat losses due to the coastal squeeze. Further inland, there are a range of other nature conservation sites, such as the River Derwent SSSI and SAC and Lower Derwent Valley SAC/SPA. which supports a range of waterfowl as well as rare plants and fish.

Flood History

There have been two significant tidal surges in recent history that have resulted in widespread flooding around the estuary. On the night of 31st January 1953, a storm surge in the North Sea resulted in extreme water levels along the East Coast of England and mainland Europe. Between Yorkshire and the Thames Estuary the surge resulted in the loss of over 300 lives, damage to 24,000 homes and flooding of almost 100,000ha of land. Following the flood significant works were undertaken to improve the defences around the estuary.

On December 5th 2013, another storm surge in the North Sea resulted in water levels in the estuary surpassing all previous records. As a result of an improved system of flood defences, and advances in forecasting and warning, the impacts of the extreme water levels were much less severe than in 1953. In the Humber area it is estimated that around 1,200 properties and 7,000ha of land were flooded.

Whilst these are the two most significant tidal floods on record to impact the Humber estuary-wide, high water levels have resulted in localised flooding on a more frequent basis to the communities and land around the estuary.

Current flood risk

At present, tidal flood risk from the estuary and its tributaries affects an area of over 120,000 hectares. This area is home to around 540,000 people and 20,000 businesses, many of which are concentrated within the city of Hull and large towns such as Grimsby and Goole. Over 200,000 properties are at risk of flooding. Inland areas including parts of Doncaster, Selby and Gainsborough are also at risk as high tides move up-river.

Designated FRAs at risk of flooding from rivers and the sea within the Humber Estuary Strategic Area include:

- Brigg
- Grimsby
- Cleethorpes
- Immingham
- Bentley
- Duncroft
- Stainforth
- Thorne and Moorends
- Goole
- Gilberdyke
- Kingston-upon-Hull
- Hessle
- Hedon
- Thorngumbald

Tidal flood risk affects major industries based around the Humber too. This includes power stations, refineries and the UK's largest port complex, as well as over 120,000 hectares of productive agricultural land. The national importance of these industries means that tidal flooding on the Humber has a much wider impact.

Tidal flooding isn't the only source of flooding on the Humber; the area is also at risk of flooding from rivers, sewers, surface water and groundwater. For example, the area around Hull experienced river and surface water flooding in 2007, with around 10,000 properties affected.

The focus of the Strategic Area is tidal; however, it is important to understand the interaction with the wider fluvial catchments. This is because a high tide coinciding with high river levels can cause significant flooding as rivers are unable to discharge into the estuary until tidal levels fall.

The flood hazard and risk data shows that in the Humber Estuary Strategic area some 543,818 people live in areas at risk of flooding from Rivers and Sea. 2% of these are in areas of high risk.

Also shown to be in areas at risk of flooding from Rivers and Sea are:

- 21,108 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 130.11km of roads
- 212.82km of railway
- 119,114 ha of agricultural land
- areas of environmental designated sites, listed buildings, parks and gardens and water abstraction points

Flooding from Surface Water

The [flood hazard and risk maps](#) show that in the Humber Estuary Strategic Area some 67,374 people live in areas at risk from flooding from Surface Water, of which 2% are in areas of high risk.

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

- 2,564 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 18.53km of roads
- 11km of railway
- 15,084.82ha of agricultural land
- areas of environmental designated sites, listed buildings, parks and gardens and water abstraction points

How the risk is currently managed

There are 12 LLFAs and District Councils within the Humber Estuary Strategic Area:

- Bassetlaw District Council
- City of Kingston upon Hull
- Doncaster Metropolitan District Council
- East Lindsey District Council
- East Riding of Yorkshire Council
- Lincolnshire County Council
- North Lincolnshire Council
- North East Lincolnshire Council
- North Yorkshire County Council
- Nottinghamshire County Council
- Selby District Council
- West Lindsey District Council

We will work with the LLFAs to ensure the Humber Estuary and Humber 2100+ strategy are reflected within updated versions of their local flood risk management strategies (LFRMS).

LFRMS, produced by LLFAs, will incorporate the interests of the affected communities with those of the rest of the LLFA area, and aim to promote a consistent approach across the Strategic Area as a whole. This consistency is crucial to all RMAs, who often span more than one local authority and whose practices will be similar throughout their area.

The Environment Agency have the strategic overview of flood risk across the Strategic Area, and provide the tactical management and operational delivery for the risk from rivers and the sea. This is done in collaboration with the LLFAs and Internal Drainage Boards (IDBs). Further support is given to Yorkshire Water and Anglian Water who manage the

sewerage network. The flood risk management investment is coordinated through the 3 Regional Flood and Coastal Committees (RFCC), Anglian (Northern), Yorkshire and Trent.

Tidal flood risk on the Humber is currently managed via the Humber Flood Risk Management Strategy 'Planning for the Rising Tides'. This document, published in 2008, was the first of its kind in England and Wales, taking a joined-up approach to tackling flood risk. It set out the Environment Agency's vision for managing tidal flood risk from the Humber Estuary in the face of climate change and sea level rise, taking into consideration the impacts this could have on people, industry and wildlife.

Since the publication of the existing Humber Strategy, more up-to-date technical information has become available, for example:

- the December 2013 tidal surge provided us with a better evidence of tidal flood mechanisms and estuarine processes
- updated UK Climate Projections were released in 2018 (UKCP18)

There have also been policy changes that provide new opportunities for funding future tidal risk management schemes.

These changes have made a case for a comprehensive review and update of the Humber Strategy. The Humber 2100+ Partnership, comprising the Environment Agency, 12 Local Authorities and the Humber Local Enterprise Partnership (LEP) has been set up to develop a new strategy which will set the direction for the next 100 years. The area covered by the Humber 2100+ work and the updated Strategic Area has been expended from that of the 2008 Humber Strategy to reflect the extent of the dominance of tidal flood risk in the tidal river tributaries as a result of sea level rise.

The future is uncertain, and it is important that the new Humber Flood Risk Management Strategy is flexible and can respond to changes as they arise. Ultimately, the ambition is for the new Humber Strategy to be a living entity that will continue to evolve over time.

The impact of climate change and future flood risk

Flood risk management in the Humber estuary requires a strategic approach, as much of the floodplain is hydraulically connected and the presence of defences in one location may impact flooding elsewhere. Work carried out to help manage tidal flood risk has ensured that the Humber continues to be a hub for trade, industry, agriculture and renewable energy. However, the way we manage tidal flood risk needs to change to meet the future challenges posed by sea level rise and climate change.

The latest information suggests that as a result of Climate Change impacts, the Humber could experience over 1.0m of sea level rise in the next 100 years. During this time, flows on the tidal rivers are also expected to increase by up to 50%. Whether these actual changes are experienced or not, there will be increased pressure on flood defences, meaning it is more likely that they will be overtopped or damaged. The likelihood of high river flows coinciding with high tides and tidal surge events will also increase.

Objectives and measures for the Humber Estuary Strategic Area

Measures have been developed which apply specifically to the Humber Estuary SA. These measures have been developed in addition to measures covering a wider geographic area that also apply to the Humber Estuary SA.

You can find information about all the measures which apply to the Humber Estuary SA in '[Flood Plan Explorer](#)', an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

Table 11: Summary of River and Sea Flood Risk to People in the Humber Estuary SA

Risk to people	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of people in area	543,818	9,506	136,832	328,148	69,332
Number of services	3,967	173	1,147	2,149	498

Table 12: Summary of River and Sea Flood Risk to Economic Activity in the Humber Estuary SA

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	21,108	752	5,859	10,907	3,590
Number of airports	0	0	0	0	0
Length of road (kilometres (km))	238.48	5.41	41.05	62.51	21.14
Length of railway (km)	305.12	14.70	86.63	77.90	33.59
Agricultural land (hectares (ha))	151,614.88	19,229.71	61,984.71	32,475.48	5,424.24

Table 13: Summary of River and Sea Flood Risk to the Natural and Historic Environment in the Humber Estuary SA

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)	1	0	0	1	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	173	42	53	41	10
Area of Special Area of Conservation (SAC) within area (ha)	38,614.01	2,025.52	1,274.16	723.29	8.72
Area of Special Protection Area (SPA) within area (ha)	45,590.24	1,909.33	1,458.78	749.10	3.95
Area of Ramsar site within area (ha)	37,011.89	2,055.73	290.16	87.23	3.20
Area of World Heritage Site within area (ha)	0	0	0	0	0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	39,407.61	2,314.37	1,573.79	833.46	14.99
Area of parks and gardens within area (ha)	75.79	10.82	19.44	31.90	9.39
Area of scheduled ancient monument within area (ha)	305.38	17.55	39.35	89.14	9.87
Number of listed buildings within area	1,906	107	414	593	135
Number of licensed water abstractions within the area	712	244	191	141	50

Table 14: Summary of Surface Water Flood Risk to People in the Humber Estuary SA

Risk to people	Total in RBD	High risk	Medium risk	Low risk
Number of people in area	67,374	1,424	5,356	60,594
Number of services	377	16	51	310

Table 15: Summary of Surface Water Flood Risk to Economic Activity in the Humber Estuary SA

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk
Number of non-residential properties	2,564	79	285	2,200
Number of airports	0	0	0	0
Length of road (kilometres (km))	238.49	2.99	3.88	11.66
Length of railway (km)	305.12	0.73	2.52	7.75
Agricultural land (hectares (ha))	151,614.87	1,836.64	2,154.25	11,093.93

Table 16: Summary of Surface Water Flood Risk to the Natural and Historic Environment in the Humber Estuary SA

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)	1	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	173	25	37	73
Area of Special Area of Conservation (SAC) within area (ha)	38,614.01	4.51	16.05	318.15
Area of Special Protection Area (SPA) within area (ha)	45,590.24	4.76	15.92	315.11

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Area of Ramsar site within area (ha)	37,011.88	1.99	5.90	57.43
Area of World Heritage Site within area (ha)	0	0	0	0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	39,407.60	10.22	21.13	357.47
Area of parks and gardens within area (ha)	75.79	0.14	1.68	13.81
Area of scheduled ancient monument within area (ha)	305.39	6.00	6.45	21.41
Number of listed buildings within area	1,906	17	7	51
Number of licensed water abstractions within the area	712	93	40	127

The Fens & Lowlands Strategic Area

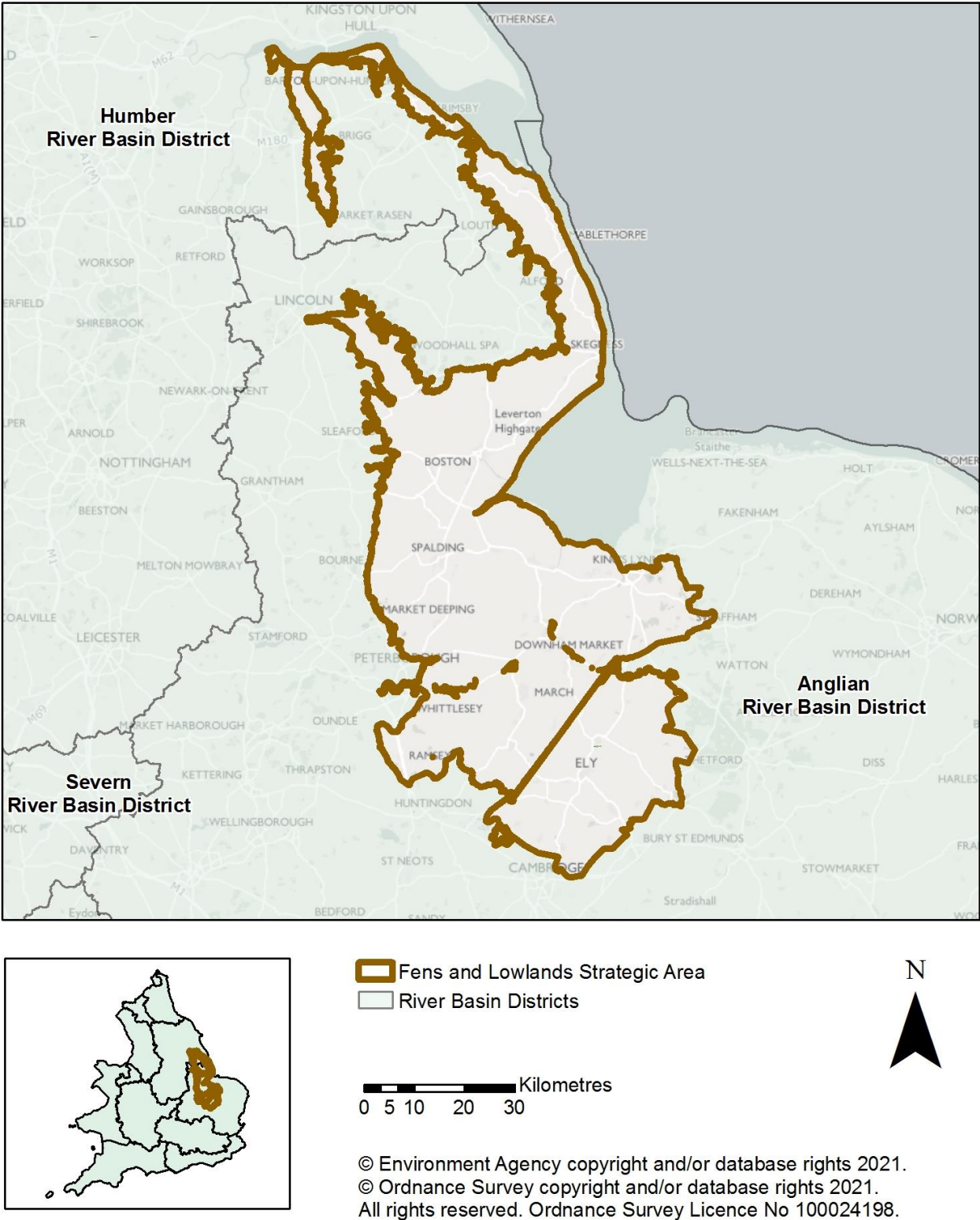


Figure 58: A map showing the boundary of the Fens & Lowland Strategic Area

Introduction to the Fens and Lowlands Strategic Area

The Fens Strategic area has been extended since the publication of [first cycle FRMPs](#). It now includes most land below the 6-metre contour line within Greater Lincolnshire, Norfolk and Cambridgeshire, and was renamed the Fens and Lowlands Strategic Area. The area straddles both the Anglian and Humber river basin districts.

The Fens and Lowlands Strategic Area is an area where it is important to consider flood risk management across more than 1 sub-area. This is so that interested parties can work in a co-ordinated way to set out conclusions, objectives and measures to manage risk. The National FCERM strategy includes a measure to develop a long-term plan for managing future flood risk in the Fens, highlighting the importance of the area. The Anglian FRMP measures provide local actions to contribute to delivering this measure.

The underlying geology of the area broadly encompasses impermeable clays and mudstones. This geology, combined with the level topography of the area, results in standing water over the land.

The soils of the area are typically characterised as peaty and/or alluvial silts, sands and gravels.

The area is protected from both tidal inundation and fluvial flooding through a network of drainage channels, water control structures and embanked defences. Without these interventions the area would revert to marshy fens and lowlands, subject to frequent flooding from both the sea and rivers. The impact of this would be that homes and businesses in the area would have to be abandoned, as well as a significant loss in productivity of prime agricultural land.

Four river catchments carry water from surrounding uplands, through the Fens and out into The Wash:

- Witham
- Welland
- Nene
- Great Ouse

The extended lowland area includes the main rivers:

- New River Ancholme
- Steeping River and
- Coastal rivers along the East Coast and South Humber Bank

This area contains around 640,000 people, covering an area of over 460,000ha, divided between 17 district and 7 county councils.

The Fens and Lowlands Strategic Area covers 2 Environment Agency Administrative Areas: Lincolnshire and Northamptonshire Area and East Anglia Area. Both areas have

partnership arrangements with Lead Local Flood Authorities (LLFAs), Internal Drainage Boards (IDBs) and other risk management authorities.

The Fens are an artificial, man-made landscape that has been reclaimed from coastal and estuarine wetlands over many centuries. These marsh areas, which are at or below sea level, have been artificially drained and continue to be protected from floods by flood banks, land drainage channels and pumps. With the support of this drainage system, the Fens and Lowlands have become a major arable agricultural region in Britain for grains and vegetables. These drainage systems also provide flood protection to many Fenland and Lowland settlements and properties, and to the infrastructure that serves those communities. IDBs play a critical role in managing land drainage and flood defences within these low-lying areas. The IDBs within the Fens and Lowlands have been in existence for many years due to the unique water level, drainage and flood risk management needs within this area.

Farming contributes significantly to the success of the local economy, supporting many businesses involved in the production of food and rural tourism. The area accounts for 50% of the Grade 1 agricultural land in England producing:

- 37% of all vegetables
- 24% of all potatoes grown in the country
- 17% of its sugar beet
- 38% of its bulbs and flowers

The area also supports significant dairy farming, livestock and outdoor pig production as well as producing approximately 18 million hens, ducks, turkeys and geese per annum in the Lincolnshire Fens alone. This in turn supports a large well-established food processing industry throughout the area. It is critical, therefore, that appropriate flood risk and drainage management measures are taken to protect this nationally important food production area.

In addition to food production the Fens and Lowlands are popular for tourism, attracting significant numbers of visitors each year, particularly to sites along the Lincolnshire and Norfolk coastline.

The area provides a unique and rich habitat for wildlife and include the Ouse and Nene Washes which, whilst acting as flood storage reservoirs, also provide important wetland areas for birds. The area forms three sides of the Wash Site of Special Scientific Interest (SSSI), which is internationally designated for animal and plant biodiversity. There are also numerous inland local sites of importance ranging from SSSIs to Local Nature Reserves.

In the area there is a risk of flooding from the rivers Ancholme, Steeping, Witham, Welland, Glen, Nene and Great Ouse and their tributaries. Many lengths of these rivers are 'high level carriers' that transport water through the Fens with normal water levels retained way above ground levels within the Fens. Flood embankments are therefore working 24/7 365 days a year. As the communities have expanded, development has increasingly taken place located on land at higher risk of flooding. This provides

opportunities for innovative sustainable drainage solutions to reduce flood risk to these areas.

Significant historic flood events in the Strategic Area include:

- 1937 – Fluvial event
- 1947 – Fluvial event
- 1953 – Tidal Surge
- 1978 – Tidal Surge
- 1981 – Fluvial event
- 1988 – Fluvial event
- 2013 – Tidal Surge

The focus of the Strategic Area is fluvial. However, it is important to understand the interaction with the tides. This is because a high tide coinciding with high river levels can cause significant flooding as rivers are unable to discharge until tidal levels fall.

Current flood risk

Flooding from Rivers and Sea

With approximately 645km of coastal and tidal defences and 2073km of main river defences, the area is classified as a defended flood plain.

Tidal flooding from breaching or overtopping of tidal defences could inundate communities along the East Coast, The Wash but also potentially 20-30km inland. Breaching or failure of main river embankments poses a significant flood risk. This type of flooding is difficult to predict, and while the likelihood of this happening is low, the consequences could be significant resulting in the rapid inundation of the areas immediately behind the embankments leading to a severe risk to life.

Major transport networks including road and rail, as well as residential property and critical infrastructure (water, gas and electricity) would be affected if the area were to flood.

High rainfall events in recent years has led to flooding within the area, caused by both overtopping and breaches of the defences.

Recent flood events include:

- 2019 – Steeping Catchment
- 2019 – Lower Witham Catchment
- 2020 – Lower Witham Catchment
- 2020 – Nene Catchment
- 2021 – Great Ouse Catchment

More details on significant flood events (affecting 20 or more properties) can be found in the [Main Flood Risk Issues and Changes in the Humber RBD](#) section in this document of this plan.

The flood hazard and risk data shows that in the Fens and Lowlands Strategic area some 381,506 people live in areas at risk of flooding from Rivers and Sea. 6% of these are in areas of high risk.

Also shown to be in areas at risk of flooding from Rivers and Sea are:

- 20,131 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 288.39km of roads
- 259.49km of railway
- 367,622ha of agricultural land
- areas of environmental designated sites, listed buildings, parks and gardens and water abstraction points

Flooding from Surface Water

The [flood hazard and risk maps](#) show that in the Fens and Lowlands Strategic Area some 56,596 people live in areas at risk from flooding from Surface Water, of which 5% are in areas of high risk.

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

- 2512 non-residential properties, including community centres, hospitals, schools/colleges, retail parks and public utilities
- 31.86km of roads
- 7.5km of railway
- 37,382.06ha of agricultural land
- areas of environmental designated sites, listed buildings, parks and gardens and water abstraction points

Flooding from reservoirs

There are a number of large, raised reservoirs within the Strategic Area, including the Ouse Washes and Nene Washes. These are used directly for flood storage and wetland habitat.

The likelihood of flooding from reservoirs is extremely low. However, in the unlikely event that a reservoir embankment failed, a large volume of water may be released and flooding could happen with little or no warning.

Flooding from Groundwater

Groundwater levels within the Strategic Area are normally kept artificially low by the activities of the IDBs. While this management activity continues, the risk of groundwater flooding in the lowlands is low, although recently it has been noticed that as prolonged wet periods continue, groundwater does become an increasing issue, particularly in low lying settlements or other areas not specifically drained by the agricultural drainage system.

Conclusions

Based on the information, flooding within the Strategic Area could have a significant impact on people, the economy and the environment. The risk from Rivers and Sea is particularly highlighted by the data and is the focus for strategic planning within the area.

It is recommended that landscape scale adaptation plans are developed specifically for the Fens and Lowlands Strategic Area catchments. This will allow development of a sustainable, integrated and long-term flood risk management approach for this landscape area.

How the risk is currently managed

There are Seven LLFAs within the Fens and Lowlands Strategic Area:

- North Lincolnshire Council
- North East Lincolnshire
- Cambridgeshire County Council
- Lincolnshire County Council
- Norfolk County Council
- Peterborough City Council
- Suffolk County Council

We will work with the LLFAs to ensure the Fens and Lowlands are reflected within updated versions of their local flood risk management strategies (LFRMS).

LFRMS, produced by LLFAs, will incorporate the interests of the affected communities with those of the rest of the LLFA area, and aim to promote a consistent approach across the Strategic Area as a whole. This consistency is crucial to all RMAs, who often span more than one local authority and whose practices will be similar throughout their area.

The Environment Agency have the strategic overview of flood risk across the Strategic Area and provide the tactical management and operational delivery for the risk from rivers and the sea. This is done in collaboration with the LLFAs and Internal Drainage Boards (IDBs). Further support is given to Anglian Water who manage the sewerage network. The flood risk management investment is coordinated through the two Regional Flood and Coastal Committees (RFCC), Anglian (Northern) and Anglian (Great Ouse).

Across the areas, the Environment Agency and several IDBs have in place public sector co-operation agreements, which enables both parties to undertake works on the others' behalf should it be more efficient and cost-effective for them to do so. Cambridgeshire, Lincolnshire, North Lincolnshire, North East Lincolnshire, Peterborough and Norfolk have in place flood risk management partnerships comprising local RMA partners who meet to co-ordinate the approach to local flood risk management.

There are multiple pieces of work already being undertaken across the Fens and Lowlands to consider how best to manage this complex area in face of the climate emergency.

The Future Fens Integrated Adaptation taskforce (led by Anglian Water, Water Resources East and the Environment Agency) is a multi-sector taskforce which is seeking to creating an integrated approach to water management for the Fenlands Landscape that will deliver resilience and adaptation to the changing climate. Alongside this, the Environment Agency will continue to build on work undertaken through the [Future Fens: Flood Risk Management](#). We aim to work in partnership to extend our asset baseline understanding across all the Fens and Lowlands catchments. This will then support development of long-term catchment adaptation plans which will outline future investment requirements for Flood and Coastal Risk Management.

The impact of climate change and future flood risk

The climate is changing and this will have an impact on flooding and coastal erosion. As sea levels rise, coastal and tidal flooding will become more frequent as higher water levels and storms will be seen more often. For the Fens and Lowlands this will also mean increased pressure on embankments and reduced ability to discharge fluvial water to the sea. More frequent and prolonged rainfall events will increase main river flows from the uplands. This combined with longer periods of tide lock due to sea level rise, will result in more water being stored in the lowland systems and affect communities at the edges of the Fens and Lowlands. Whilst this is waiting to be discharged to the sea, increased and prolonged pressure will be placed on the embankments. Changes in weather patterns and an increase in rainfall intensity is likely to increase flood risk from surface water and ordinary watercourses as well as from main rivers.

Despite being low-lying, the extensive artificial drainage networks mean that the Fens and Lowlands Strategic area is currently relatively resilient during normal rainfall events. However, the changing climate means that these defences and drainage systems will have to cope with more water, more frequently. Maintenance and improvements are therefore important to ensure that these assets can withstand the pressures from future climate change. At the same time, there will be longer periods of dry weather, resulting in scarcity of water resources in the area. This could have serious consequences for the water environment, and the water-dependant horticultural and arable industries located in the area. Dry periods can also damage earth embankments as they dry out and fissure.

Climate change poses a serious threat and an enhanced programme of investment and maintenance in flood defences and drainage systems will be needed if society wishes for existing standards of protection - including provision for climate change - to be maintained in the medium and long term.

Objectives and measures for the Fens and Lowlands Strategic Area

Measures have been developed which apply specifically to the Fens and Lowlands SA. These measures have been developed in addition to measures covering a wider geographic area, but which also apply to the Fens and Lowlands SA. You can find information about all the measures which apply to the Fens and Lowlands SA in the interactive mapping tool - '[Flood Plan Explorer](#)'. This includes information on which national objectives each measure helps to achieve.

Table 17: Summary of River and Sea Flood Risk to People in the Fens and Lowland SA

Risk to people	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of people in area	640,798	23,342	122,631	173,062	62,471
Number of services	5,627	291	1,196	1,343	444

Table 18: Summary of River and Sea Flood Risk to Economic Activity in the Fens and Lowland SA

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk	Very low risk
Number of non-residential properties	31,910	907	6,929	7,903	3,571
Number of airports	0	0	0	0	0
Length of road (kilometres (km))	499.68	10.63	124.10	122.22	31.45
Length of railway (km)	331.27	19.99	104.04	90.92	27.24
Agricultural land (hectares (ha))	461,126.03	52,034.09	177,608.37	117,077.19	20,902.93

Table 19: Summary of River and Sea Flood Risk to the Natural and Historic Environment in the Fens and Lowland SA

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)					
Number of Environmental Permitting Regulations (EPR) installations within 50m	184	40	60	36	14
Area of Special Area of Conservation (SAC) within area (ha)	4,605.39	344.88	339.95	148.71	4.78
Area of Special Protection Area (SPA) within area (ha)	8,576.13	3,817.13	369.61	133.97	34.42
Area of Ramsar site within area (ha)	8,349.45	3,900.68	576.76	120.92	3.78
Area of World Heritage Site within area (ha)	0	0	0	0	0
Area of Site of Special Scientific Interest (SSSI) within area (ha)	10796.47	4136.20	992.17	331.77	131.83
Area of parks and gardens within area (ha)	243.08	17.80	39.89	19.98	14.64
Area of scheduled ancient monument within area (ha)	1,088.03	70.93	176.20	160.58	37.28
Number of listed buildings within area	2,466	101	496	739	126
Number of licensed water abstractions within the area	1,772	752	519	259	57

Table 20: Summary of Surface Water Flood Risk to People in the Fens and Lowland SA

Risk to people	Total in RBD	High risk	Medium risk	Low risk
Number of people in area	640,798	2,614	6,103	47,879
Number of services	5,627	28	46	222

Table 21: Summary of Surface Water Flood Risk to Economic Activity in the Fens and Lowland SA

Risk to economic activity	Total in RBD	High risk	Medium risk	Low risk
Number of non-residential properties	31,910	134	264	2,114
Number of airports	0	0	0	0
Length of road (kilometres (km))	499.68	4.27	5.10	22.51
Length of railway (km)	331.27	0.83	1.26	5.43
Agricultural land (hectares (ha))	461,126.03	3,923.53	4,901.65	28,556.74

Table 22: Summary of Surface Water Flood Risk to the Natural and Historic Environment in the Fens and Lowland SA

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)	1	0	0	0
Number of Environmental Permitting Regulations (EPR) installations within 50m	184	26	37	72
Area of Special Area of Conservation (SAC) within area (ha)	4,605.39	13.20	23.75	137.94
Area of Special Protection Area (SPA) within area (ha)	8,576.13	4.29	13.12	133.53

Risk to the natural and historic environment	Total in RBD	High risk	Medium risk	Low risk
Area of Ramsar site within area (ha)	8,349.45	12.68	27.44	183.68
Area of World Heritage Site within area (ha)				
Area of Site of Special Scientific Interest (SSSI) within area (ha)	10,796.47	35.21	56.15	323.51
Area of parks and gardens within area (ha)	243.08	13.09	3.60	18.59
Area of scheduled ancient monument within area (ha)	1,088.03	19.12	16.99	67.28
Number of listed buildings within area	2,466	11	7	36
Number of licensed water abstractions within the area	1,772	563	209	354

Links between the FRMP and the RBMP 2022

In parallel to 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](#) (RBMP 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 [Humber 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](#).

The Environment Agency has worked with LLFAs and other RMAs to develop joint measures to reduce flood risk and improve the wider water environment. Aligning measures also helps to simplify the delivery of outcomes and make it more efficient.

By visiting the Humber RBMP 2022 you can find out more information on the objectives and measures for the Humber RBMP 2022.

How we will monitor implementation of the FRMP

For the duration of the second cycle (2021 to 2027), the Environment Agency will work with LLFAs and other RMAs to monitor progress in achieving all of the measures set out in the FRMP. This is a summary of the steps we will follow:

1. The implementation status of each measure in the FRMP will be reviewed and updated every year. This will be done by the authority responsible for implementing the measure.
2. This updated information will be collated by the Environment Agency and analysed to identify any trends in the data. This will allow the identification of possible common interventions which may help measure delivery.
3. Summary statistics will be produced to show how much progress has been made in that year.
4. These statistics and other key messages will be included in the annual report produced under section 18 of the [Flood and Water Management Act \(2010\)](#). This report is published each year and submitted to the relevant regional flood and coastal committee for review. It will also be available online to the public.
5. The updated status of each measure will also be viewable in '[Flood Plan Explorer](#)'.
6. At the end of the 6-year planning cycle, the FRMP will be reviewed and a summary of implementation progress over the duration of the planning cycle will be included. This is a requirement of the Flood Risk Regulations (2009).

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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