

**Yorkshire** Leaders Board  
*The voice of our region*

# Yorkshire and Humber Flood Resilience Forum 2022

# Welcome

Dear all,

On behalf of the Yorkshire Leaders Group, we welcome you to the Yorkshire & Humber Flood Resilience Forum 2022, initiated and led by the Yorkshire & Humber Chief Executive Officers Flood Risk Group.

It goes without saying that the history of flooding across our region has left an indelible mark on our communities, institutions and businesses

While there are other networks, event and conferences on flood risk management and response, our best hopes are that this event helps to raise the profile of flood resilience for its wider strategic benefits, as part of the bigger picture of a response to climate change and a wellbeing economy.

We hope to illustrate and promote discussion about the extended longer term benefits for the region's communities and businesses of partnership collaboration, investment, and innovation.

To this end, we have invited Local Authority and public sector leaders across the region in the belief that we can support the integration of flood resilience into wider strategy and policy – not just a 'single issue.'

Climate change challenges us all to recognise our place in global systems, hence we have input from speakers who will bring in some relevant lessons from around the world.

Flood resilience also challenges us to think in terms of water management and land use at landscape and catchment levels – 'bioregions' – that often cut across our traditional administrative boundaries. We will also provide case study presentations and further information in the delegates pack.

And together these issues challenge us to think long-term, for the benefit of future as well as current generations, and for the future prosperity and wellbeing of Yorkshire and the Humber.

I would like to thank Yorkshire & Humber Chief Executive Officers Flood Risk Group for leading this event, and to Yorkshire Water and the Yorkshire Regional Flood and Coastal Committee for their financial and organisational support.

**Best wishes**

**CLlr Carl Les and CLlr Sir Stephen Houghton MBE**  
- Co-chairs of Yorkshire Leaders Group

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Dear all,

Yorkshire & Humber Chief Executive Officers Flood Risk Group is grateful for the support of the Yorkshire Leaders Board for this event. Our communities are more frequently struggling with the challenges of flood resilience, protection and recovery, but at the same time we can see significant progress in wider collaboration and innovation. Investment in flood resilience not only protects properties and businesses, it has a wide range of knock-on benefits not only in the economic sphere, but also in the sense of security and rootedness in place and therefore the prosperity and wellbeing of communities. We would suggest that our public sector leadership across the region may wish to use this event to consider how the issue of flood resilience may be embedded with in a broader range of strategies and policies. This event is intended to shed some light on how this can happen, and indeed is already happening across Yorkshire.

**Damian Allen - Chair of Yorkshire & Humber Chief Executive Officers  
Flood Risk Group and CEO of Doncaster Council**

# Facts & Figures



Total investment 2015-2021  
**£611,477,323**



Total properties better protected 2015-2021

**66,520**



Forecast investment  
2021/22-2026/27  
**£872,158,483**



Forecast properties better protected 2021/22-2026/27

**21,754**



Funding still required  
2021/22-2026/27

**£156,378,306**

# East Riding of Yorkshire Council - Hull and Haltemprice Flood Alleviation Schemes

## £55m Flood Alleviation Schemes successfully delivered in partnership to deliver catchment wide benefits

In the summer of 2007, the East Riding of Yorkshire was affected by severe flooding along with much of the country. In response to this flooding, East Riding of Yorkshire Council embarked on a series of detailed studies across the region, with the objective of better understanding integrated flood risk and developing mitigation measures to reduce the risk.

Due to the significant flooding experience in 2007 in the Hull and Haltemprice area, this location was prioritised for delivery of a catchment wide study. A key success of the project was working closely in partnership with Hull City Council in the knowledge that floodwater does not respect the confines of administrative boundaries. Another key success of the project was the partnership developed Hull and Haltemprice Flood Risk Management Plan which provided the strategic case for undertaking FCERM investment and was supported by the development of an integrated hydraulic model. This study was completed in partnership with other key Risk Management Authorities including the Environment Agency and Yorkshire Water.

Work undertaken on the modelling for Haltemprice and West Hull identified that the best measures to reduce risk across the area were intercepting excess flows during an extreme flood event and temporarily storing them, thus slowing release into the City. The Council carried an initial pilot scheme in 2011/12 on the Raywell Valley which proved successful. This allowed the further design and modelling works to continue on larger infrastructure with a programme for the delivery of three major surface water flood alleviation schemes developed as a result; Willerby and Derringham Flood Alleviation Scheme, Anlaby and East Ella Flood Alleviation Scheme and Cottingham and Orchard Park Flood Alleviation Scheme. These schemes are some of the largest surface water flood alleviation schemes in the country.

Following preparation of multiple business cases, successfully securing a range of partnership funding, the Council has now completed the projects. The three projects are summarised below:

### Willerby and Derringham Flood Alleviation Scheme (WADFAS)

Completed in 2016, the £14m scheme consists of a series of flood storage lagoons and associated infrastructure along the Great Gutter Valley. Together the lagoons have the capability to store over 230,000 cubic metres of floodwater. WADFAS reduces the risk of surface water flooding to approximately 8000 homes and has already operated as designed on multiple occasions to reduce flood risk to properties in the benefit area.

### Anlaby and East Ella Flood Alleviation Scheme (AEEFAS)

The £21m scheme will reduce risk of surface water flooding to over 4,000 properties. AEEFAS has been delivered in three phases and includes a new flood storage lagoon capable of storing up to 115,000 cubic metres of water constructed on the site of the former Sydney Smith School. Flood water is diverted away from residential areas in the West Ella Valley and into the lagoon through a series of newly constructed interconnected watercourses, upgraded culverts and a stormwater tunnel. This 1.5km long tunnel was constructed using two 17-tonne tunnel boring machines. The scheme also utilises an existing storage lagoon alongside Beverley Road to provide additional floodwater storage.

## Cottingham and Orchard Park Flood Alleviation Scheme (COPFAS)

The £20m scheme will reduce the risk of surface water flooding to over 4,000 properties. COPFAS was delivered into two phases. Phase 1 consists of a large floodwater lagoon constructed in the Orchard Park area. The lagoon temporarily stores water diverted away from residential property through a series of flow control structures and a 500m long siphon. A new fishing pond and wildlife area has been created as part of the scheme to enhance the amenity value of the neighbourhood. Phase 2 consists of a series of 9 interlinked flood storage lagoons along Westfield Road and Eppleworth Road in the Raywell Valley, Cottingham. Together both phases of COPFAS have the capacity to store over 330,000 cubic metres of floodwater.

### Learning from project

The projects have been well received by local residents and stakeholders. The schemes have already operated successfully on multiple occasions since completion to reduce flood risk in the project area. This provides confidence and reassurance to the local residents that the schemes are operating as designed to provide significant benefit to both the local and wider area.

The projects have gained regional and national recognition for their engineering and social impacts.

### Examples of project awards

#### WADFAS

Carr Lane Lagoon, one of four lagoons constructed as part of WaDFAS, operating as designed to reduce flood risk.

Filling Station Lagoon in operation

Rawdales Lagoon and Robsons Cottages Lagoon in operation

#### COPFAS

Orchard Park Lagoon one of 9 lagoons constructed as part of COPFAS, operating as designed to reduce flood risk.

Green Lane Lagoon in operation



# Flood Resilience - Harrogate

Over the last ten years the AONB team have worked on a number of projects and schemes focussing on the land management aspects of flood resilience. Below are a few examples as way of case studies and more information or images can be provided if required.

- The Skell Valley Scheme is a partnership between National Trust at Fountains Abbey and Nidderdale AONB. We were awarded £2.5m from the National Heritage Lottery Fund (NHLF) to deliver a scheme with a range of partners from 2021 – 2024. The key driver for the project is that the unique cultural and natural heritage are under threat from extreme flooding events which have caused irreparable damage to the World Heritage Site. Silt is also affecting sites at Grantley, Eavestone and in Ripon. The Skell Valley Scheme is exploring different approaches to managing the land and water through a Natural Flood Management (NFM) project. Despite their best efforts, the NT team had failed to secure funding over many years prior to this project to address flooding issues at the site. The NHLF money will start to address the issues but the works we have scheduled are limited by the funding available. There are a couple of images from FASR below which I think are particularly striking.
- The 'Enterprising Landscape' project within the Skell Valley Scheme is linked to the NFM project and may be of interest. Working closely with the York, North Yorkshire and East Riding Local Economic Partnership we will develop an innovative model, based on the Landscape Enterprise Networks (LENs) approach, recognising the role that landscape plays in the success of the local economy. This project will seek to understand the value that a healthy landscape brings to businesses in Ripon and the wider catchment, for example how valuable flood mitigation and the ability to produce good quality local raw materials is to businesses in the catchment. The model will look at how businesses can come together to invest in landscape outcomes in which they have a common interest, for example the natural flood management services that the farmers upstream will be delivering. The model can also provide a mechanism for the long-term sustainability and maintenance of the landscape and economic improvements achieved during the four years of the scheme.
- In 2019 Nidderdale AONB were awarded a grant of £229,284.54 by the Environment Agency (Water Environment Grant), to address physical modification, pollution from waste-water, pollution from rural areas, invasive non-native species and changes to natural flow and level of water in the Humber river basin district. One of the objectives is to take action to reduce sediment loads and diffuse pollution from agriculture – we have been working with agricultural and equestrian landowners in The Crimble and Park Beck Catch (tributaries of the River Nidd) to reduce phosphate, ammonia and sediment loadings by implementing changes to land management practices and creating new riparian habitat. This model has been very successful and with the availability of additional funds could be extended.
- Dales to Vale Rivers Network: A catchment partnership which brings together local people, communities, organisations and businesses to make decisions on managing the interconnected bodies of water in the catchment area. Nidderdale AONB team attend the quarterly meetings – the partnership has everyone you would expect on it and is a useful networking structure. As far as I'm aware the partnership doesn't have a budget for delivery but provides an opportunity to help co-ordinate activity across the catchment.



# Flood Resilience – Scarborough

Scarborough Borough Council

## Start and end dates of project

Works commenced in summer 2019 with successful completion of the scheme in summer 2021.

## Project objectives

Significant flood events occurred in Filey during 2002 and 2007 demonstrating the need to improve surface water runoff management in and around Filey.

The 2007 event was the most severe flood event in recent times with the cost of remedial work estimated at approximately £6.4 million; over 80mm of rain fell in just one and half hours, with water reported to be waist deep in places. Significant damage and disruption occurred, including:

200 homes affected by internal flooding;

- 8 people had to be rescued from the swimming pool at Filey School;
- Filey inshore lifeboat was used within the town to rescue people stranded in their homes;
- Over 30 people had to be evacuated from their homes and an emergency centre was set up in the Evron Centre and Trinity Church;
- Classrooms, swimming pool, and other buildings were flooded at Filey School, closing it for a short period;
- Both main roads into Filey (Muston Road and Scarborough Road) were closed at one stage of the flood; and
- North Yorkshire Fire Service received over 150 calls in five hours seeking help.

The total cost of repair works during the 2002 flooding event was estimated at approximately £3.0 million while the cost of remedial work following the 2007 flooding event was estimated at approximately £6.4 million. Scarborough Borough Council therefore developed a Flood Alleviation Scheme (FAS) for the town, with the objective of reducing flood risk in Filey.

The objective of the scheme was to slow down overland flows from the surrounding catchment during storm events and control the rate at which flows enter the existing urban drainage system in Filey to reduce the risk of it becoming overwhelmed.

In summary, the scheme comprised:

- a series of earth bunds to encircle large areas of the town of Filey;
- storage areas at specific locations to store floodwater; and-
- drainage channels and culverts to redirect floodwater flows into the new storage areas and to allow its controlled release after heavy rainfall events.

As well as the measures to reduce flooding, additional funding was secured to implement environmental enhancement works with wildflower planting and wetland scrapes to create varied habitats. In addition, new footpath routes have been created, providing access to new public open space areas.

## Partners

SBC, NYCC, EA, YRFCC, Filey Town Council, Filey Flood Working Group.

## Funding received and sources

FDGiA £2.269m  
YRFCC Local Levy £1.71m  
SBC £361k  
Filey Town Council £30k

## Project outcomes

Better protection from flooding for 490 households at reduced risk with 167 households moved from very significant risk of flooding to low or moderate risk.

## Learning from project

Early landowner engagement with provision for compulsory land purchase if required.

# Flood Resilience - Tickhill

Ruddle Dyke is a watercourse which runs from Maltby in Rotherham through the villages of Braithwell and Stainton in Doncaster, before joining the Mill Pond Dyke just out side of Tickhill. This watercourse is a local fast reacting catchment that drains an area of over 8 Square miles.

Properties along the watercourse have suffered from flooding (most recently) in 2003, 2007, 2013 and 2019. There are numerous pinch points and culverts along the watercourse which cause over topping leading to property and highway flooding in Stainton and Tickhill.

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## The Problem

The southern bank of Paper Mill Dyke is flush with the adjacent footpath/highway

This bank has overtopped on several occasions causing internal property flooding in 2007 The northern side of the banks adjoin a meadow which also floods during heavy rain.

This dyke is controlled by a culvert which runs under the highway and then continues along Water Lane, before it eventually discharges into the River Torne During high flows, the culvert quickly becomes fully surcharged, and the water will eventually back up and overtop the southern bank immediately upstream.

During periods of heavy rainfall the current infrastructure is not designed to deal with such high volumes of water leaving the surrounding properties vulnerable to property flooding in some places above 1.2 m in depth.

Although a full catchment approach is required to tackle the full scale of the problem, space is limited within Tickhill, meaning keeping the water in channel along with improved water management of the Mill Pond and sluice valve, is the only realistic option to provide resilience to the Lindrick area of the village and the numerous properties at risk in this area.

Therefore following a short study and modelling exercise automation and telemetry of the Mill Pond sluice valve along with the construction of the flood defence wall, were the measures pursued under phase 1 with a full catchment NFM review proposed under phase 2.

## Phase 1 - Localised Resilience

The proposed project will create a flood defence wall which will protect properties in the Lindrick area of Tickhill.

At present there are no flood defences or resilience along the banks of Paper Mill Dyke.

In 2007 properties in Lindrick experienced internal flooding after the Paper Mill Dyke overtopped, and it subsequently overtopped in 2008 ..(although no property flooding occurred)

Improvement works on Paper Mill Dyke, including the replacement of a sluice gate on the Tickhill Mill Dam Was carried out in partnership with the Friends of Tickhill Mill Dam, along with Tickhill Parish Council, local residents and Doncaster Council.

Private funding to assist with this maintenance was provided by these groups, which together with Doncaster Council and Local Levy funding enabled this first phase of measures to be constructed.

Properties within this area now have a high standard of protection to future flood events.

## Phase 2 - Natural Flood Management

Following the localised resilience works carried out in Lindrick and on the Mill Pond Dam, a full catchment review and modelling was carried out to identify opportunities to slow the flow and provide off line storage that could be utilised during heavy storms to even out the peak flow of Ruddle Dyke, offering greater resilience to Braithwell, Stainton and Tickhill.

Partnership working with land owners and farmers is key in delivering sustainable slow the flow measures in the upper catchment of Ruddle Dyke Land management measures across the catchment that seek to improve and maintain good soil structure and increase infiltration rates will contribute to an overall reduction in the generation of surface runoff.

With the full upstream catchment surveyed for possible sites suitable to deploy natural flood management, a series of in channel leaky barriers, arable field buffer strips, hedgerows, bunds will create the on and offline storage required, to reduce the peak flow of this water course. Funding to deliver this phase of works have been secured through partnership working between Doncaster Council, the EA and Sheffield City Region.

## Funding & Partnership Working

Without the understanding, cooperation and persistence of the local residents Friends of Tickhill Mill Dam, Tickhill Parish Council, EA, SCR and Flood Risk Engineers from Doncaster Council, both phases of this project would not have been possible.

Tickhill and its residents now have more resilience to flood risk through the construction of the flood defence wall, that will only be enhanced through the delivery of phase 2 of the project, which will see natural flood management measures through out the upper catchment, creating both additional attenuation along with aiding in the wider area's ecology and habitat creation, as well as enhancing the water quality of the watercourse through partnership with the land owners and changes to farming technics.



# Growing Resilience – Wessenden and Calder Natural Flood Management

The Growing Resilience Natural Flood Management and Woodland Creation project encompassed three project sites in the Calder and Colne Valleys: National Trust Hardcastle Crag (near Hebden Bridge), Yorkshire Water Gorpley Reservoir catchment (near Todmorden) and NT/YW owned areas of the Wessenden Valley catchment (near Marsden). It was a 2-year project lead by National Trust and Yorkshire Water; funded by West Yorkshire Combined Authority (£1.3M) and significant match from partner organisations including Woodland Trust, White Rose Forest, Moors for the Future Partnership, Environment Agency, Calderdale Council and others.

The main drivers of the project were flood risk reduction to downstream communities such as Todmorden, Hebden Bridge, Mytholmroyd and Marsden which have all been affected by flooding in recent years. Working with natural processes is increasingly recognised as an important tool in our fight against climate change. The project delivered nature-based solutions, which were designed to protect communities who are witnessing first-hand the impacts of climate collapse, affected by droughts, floods and moorland fires.

Natural Flood Management (NFM) and sustainable drainage interventions, along with landscape restoration (such as moorland restoration, invasive species control or woodland creation) were undertaken across the three project sites, designed to reduce flood risk to downstream communities.

It was also recognised that natural flood management has a variety of additional benefits to people, climate and wildlife.

## Natural Flood Management Interventions

Leaky dams are a classic NFM intervention, designed to store small volumes of water (generally <10m<sup>3</sup>) for short periods of time (generally <36hrs). The benefit of leaky dams is realised when multiple interventions are installed across a catchment with their combined storage volumes resulting in a reduction to peak flow.

A variety of leaky dam techniques were used across the project sites, dependent on materials available, ease of access, sensitivity of the site, size and gradient of watercourse and contractor safety whilst installing the interventions.

## Moorland Restoration

Healthy, thriving moorlands are vital habitats for a variety of threatened upland specialist species as well as important carbon sinks and sources of clean water. Healthy moorlands have the ability to store huge volumes of water, providing NFM benefit and a reduced flood risk downstream. Re-wetting of moorlands reverses the drying process caused by historic management and industrialisation, and leads to the accumulation of peat soils. At the two moorland sites within the project area, we undertook a variety of moorland restoration techniques designed to improve water storage on the moorland.

## Woodland Creation

Clough woodland creation contributes to reducing flooding by reducing erosion, slowing down surface water and floodwater and increasing water infiltration into soils. It also brings other benefits such as increased biodiversity, carbon sequestration and climate change mitigation. An ambitious clough woodland project was delivered at Gorpley with the creation of 102 hectares of woodland. Woodland creation was also planned for Wessenden, however, due to a variety of complex factors including lack of support from a key stakeholder, it did not happen.

## Invasive Species Control

An important programme of invasive non-native species (INNS) control was undertaken in the Wessenden Valley, focusing on rhododendron ponticum. This plant exacerbates flooding in steep-sided flashy catchments such as the Wessenden Valley, by out-competing native ground flora and creating bare slopes. This causes rapid runoff of rainwater and silt into watercourses. Rhododendron is an additional problem on moorlands because it further dries out vulnerable peat soils and outcompetes native moorland flora.

Specialist roped access contractors were needed to undertake cutting and stump treatment of the rhododendron bushes established on cliffs and crags along the valley. The aim of this element of the project was to better control overland flow reaching Wessenden Brook, whilst also removing the significant rhododendron seed source which re-infests the rest of the moorland.

## SuDS Car Park

The project involved the upgrade and expansion of Clough Hole Car Park at Hardcastle Crag to a 2750m<sup>2</sup> Sustainable Drainage Systems (SuDS) car park. Unlike a traditional hard-surfaced and impermeable car park, SuDS designs mimic a more natural surface; reducing runoff and increasing sub-surface water storage. SuDS principles, like other NFM interventions, act to slow down rapid runoff and provide water storage, slowly releasing water after a heavy rainfall event. Due to the large surface area and deep sub-surface construction of the SuDS car park, the car park now provides water volume storage during storm events. The SuDS car park uses different layers of gravel and specially designed ecoblock plastic crates to create a permeable surface which allows water to penetrate deep below the car park surface. Water is then stored for short periods in the gaps between the individual stones making up the gravel surface and is slowly discharged to the neighbouring watercourse over a period of hours following a storm.

## Partnership and Collaboration

The Growing Resilience project was a collaboration between a range of varied organisations including large charities, statutory bodies, NGOs, utilities companies and grassroots volunteer organisations. In kind contributions from partner organisations contributed significant match to the project and massively increased the scope of the project.

## Community Engagement

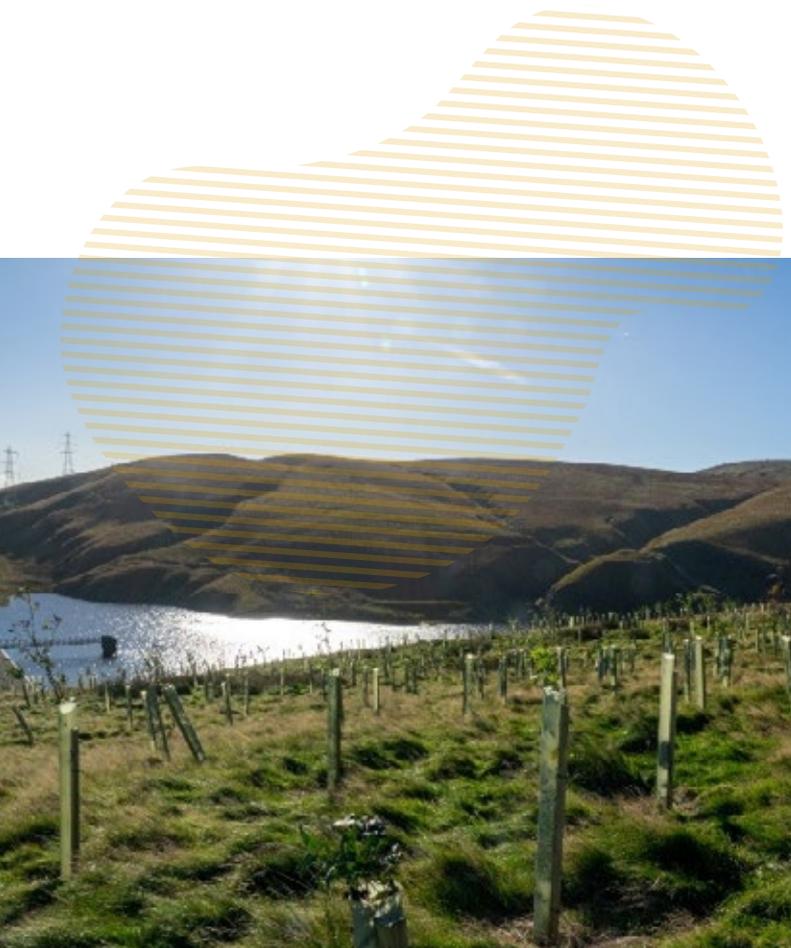
Community engagement helped people learn about the benefits of natural flood management, as well as learn more about upland restoration in the South Pennines. Events such as Our Future Landscapes (2019, 2021), ran in partnership with Kirklees Council, gave people in the Colne and Holme valleys a chance to find out more about ongoing restoration work from an NFM perspective. Delivery of the project involved engaging 65 new volunteers who undertook a variety of task including construction of leaky dams, monitoring of vegetation, tree planting, site checks and species surveys. Volunteers from organisations including Treesresponsibility, Slow the Flow, Moors for the Future and National Trust contributed significantly to the project.

## Project Benefits

- 102ha of new woodland
- 86ha of restored heathland and 103ha of restored peatland
- 862 leaky dams
- 2570m<sup>2</sup> SuDS car park at Hardcastle Crag
- 22,579 tonnes of CO<sub>2</sub> sequestered over 50 years by new woodland\*
- 76.5 tonnes of CO<sub>2</sub> per year sequestered by new wetlands\*
- 65 new volunteers engaged
- Reduced flood risk to 2071 downstream properties\*\*

\*CO<sub>2</sub> figures calculated using the Mersey Forest Green Infrastructure Calculation Toolkit (<https://www.merseyforest.org.uk/services/gi-val/>)

\*\*Based on calculations as set out in FBC



# Leeds Flood Alleviation Scheme (Phase 2)

Phase 2 of the Leeds Flood Alleviation Scheme (LFAS2) is a two-step scheme that aims to reduce flood risk to homes and businesses along the River Aire Corridor, between Leeds railway station and Apperley Bridge, Bradford.

Leeds City Council is working alongside the Environment Agency on the second phase of the scheme, which will invest £112.1 million in flood prevention measures for areas upstream of Leeds city centre. Working closely with partners including BMMjv (a Bam Nuttall Ltd & Mott MacDonald joint venture), Aecom, Yorkshire Water, Network Rail and Bradford Council, we are delivering a scheme that provides a one-in-200-year level of protection against flooding in the Leeds FAS2 area. This will reduce the risk of flooding to a 0.5% chance of occurring in any given year, including an allowance for climate change.

Once delivered in full, the scheme will provide greater flood protection to 1,048 homes and 474 businesses.

Phase 2 of the scheme has been split into two steps:

- **Step 1:** This runs along an 8km stretch upstream of Leeds railway station, along the A65 Kirkstall Corridor. Our work here largely consists of raised flood wall or embankments in the Kirkstall area. Construction began in January 2020.
- **Step 2:** This comprises of a flood storage area near Calverley and flood walls in the Apperley Bridge area. The flood storage area is now under construction, the works in Apperley Bridge began in March 2022.

Natural Flood Management (NFM) in the upper Aire catchment will also complement our works. This approach looks at different ways we can make the ground hold more water during floods. This includes creating new woodland, stemming the flow of water during heavy rain, creating new storage ponds, and land management to improve infiltration.

## Background

Nearly 3,000 residential properties and 700 businesses suffered the devastating effects of flooding when unprecedented rainfall led to the highest recorded river levels in December 2015. £60 million of damage was caused to key infrastructure including electricity substations, water assets and a major communications hub.

The first phase of the Leeds Flood Alleviation Scheme (LFAS1) saw formal flood defences installed along the River Aire in Leeds for the first time. This £50 million project

began in early 2014 with works completed downstream in Woodlesford, which proved effective during the Christmas 2015 flooding, before moving into the city centre with measures featuring the introduction of state-of-the-art moveable weirs to control river levels. LFAS1 was completed in October 2017.

## Construction

On LFAS2 in the heart of the city centre, between Leeds Station and Wellington Road, we are working closely with developers to construct flood walls up to 1.2m in height. As part of the environmental enhancement and mitigation to be provided by the scheme, we will install floating riverbanks to provide habitat space upstream of the station on the left bank of the river.

At Armley Mills, which hosts Leeds Industrial Museum, recent large-scale flooding (including the 2015 Boxing Day floods) resulted in significant issues, including loss of power and long-term damage to historic areas and exhibits. Due in part to its original use as a water mill, Armley Mills has historically been impacted by floods and experiences low level flooding every three to five years.

Work here will involve an upstream and downstream flow control structure, installation of a new services bridge, and flood defence walls between 0.8m and 2.1m clad to blend into the existing setting of the museum.

We are working with a heritage expert to ensure the museum's visitor offer and the site's historical integrity remain throughout our works.

We are creating a flood storage area between the areas of Horsforth Vale and Calverley. In order to build this, we diverted the river to create a cofferdam – a dry working area in the riverbed. In January 2022, we successfully sealed the cofferdam by installing sheet piles around its perimeter. Since then, we have excavated almost 10,000 cubic metres of material from within the cofferdam. We are now completing concrete works and steel reinforcements, in order to begin construction of the flow control structure which will facilitate the flood storage area.

## Environmental successes

We continually assess our working methods to minimise the effect our work has on the environment.

We are using clay from a field close to the site compound to construct our embankments for the flood storage area, reducing the carbon impact of our scheme. We would need approximately 5,000 wagon loads to be delivered from elsewhere otherwise. However, as this is being acquired from nearby, we will save on these transportation emissions, reducing the negative impact of construction. We will also restore the field to farmland afterwards.

We trialled the use of 3D printed concrete as part of our landscaping to reinstate the Cardigan Fields Leisure Park. This was received well by owners and visitors of the site.

We are exploring the use of basalt fibre instead of steel reinforcement in concrete. This new material is advantageous in that it produces 60% less CO2 emissions than its steel equivalent and is easier to handle and transport. We hope to incorporate this product in some slabs and minor structures in the flood storage area near Calverley.

We continue to engage regularly with the community, incorporating their views into our design and construction schedule. Using social media, regular publications and monthly drop in events, we ensure that elected members, environmental groups and local communities are able to access information and speak with the project team at will.

Visit our website at [www.leedscitycouncilfloodresilience.commonplace.is/](http://www.leedscitycouncilfloodresilience.commonplace.is/), to see the different works and exclusive drone footage at each zone.



# Flood Resilience - Living with Water

Living with Water Partnership- Hull City Council, East Riding of Yorkshire Council, Yorkshire Water, Environment Agency and University of Hull

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## Start and end dates of project

Partnership created following 2007 floods, strengthened in 2017 with dedicated resource from Yorkshire Water and a shared vision which extends beyond just managing flood risk and creating a resilient city.

## Background

Hull and the surrounding area of Haltemprice in East Riding has a unique and challenging drainage system which was overwhelmed in 2007 when over 9,000 properties were flooded predominantly from surface water. Prior to the creation of living with water, surface water flooding had not been recognised as a significant source of flood risk compared to river and sea, it is now on the National Risk Register.

All surface water flowing from property, roads and land in Hull and the surrounding area has to discharge into the sewer system, along with waste water to be treated at the only Waste Water Treatment Works in the area, it is then discharged into the Humber estuary. The capacity of the system is limited as sewers are not designed to take all run-off. The added complexity is the number of different authorities with roles and responsibilities around their "water", infrastructure and different funding rules and processes for who can manage what.

The flooding issues can not be looked at in isolation it needs an integrated approach by all the authorities involved to mitigate. Hull is also at risk from tidal, river and ground water flooding. The approach taken is to create a Strategic Blue Green Plan which aligns all the various objectives for example; reducing flood risk, adapting to climate change and meeting carbon targets, regenerating housing stock, creating economic growth, sustainable development, active travel and healthy environments. Since 2017 the work has concentrated on community engagement and comms to ensure people know they are at risk and they have the tools to help themselves be more resilient to flooding.

## Project objectives

The partnerships vision is to create a city able to thrive, grow and adapt to the challenges of flood risk and climate change. The principle objectives are building resilience, showcasing our place to attract investment and growth embedding the history and culture of the city and driving sustainable solutions.

## Funding received and sources

£23million has been allocated for the next 5-6 year capital programme of Yorkshire Water OFWAT funding for AMP 7 and currently working on securing further fund through Flood Defence Grant in Aid circa £20million.

## Project Details

The allocated funding for the next 5-6 years is to implement blue green infrastructure/sustainable drainage (SuDs) in key locations within Hull and Haltemprice to reduce flood risk to property and roads. The aim is to mimic natural drainage as much as possible. The 4 pillars of SuDs are; reduce flood risk, increase the quality of water, create habitat/biodiversity and provide amenity and recreation benefits.

The first stage of the project has been to create opportunity mapping to establish priority areas for flood risk and to compare to locations for other infrastructure investment to assess if efficiencies can be found by delivering together. A large element of the costs of delivering retrofit SuDs are the reinstatement of highways and the resource required to work across departments in councils and with communities to help co-create. The Blue Green Plan sets out the longer term 25 year vision which will follow on from the 5-6 year capital programme.

## Learning from project

The first 3 years of the partnership have been dedicated to the comms and engagement around the perception and understanding of flood risk. This is because the type of flood resilience projects we need to deliver are very different to traditional flood defences, pumping stations and walls. The city relies on flood defences but there is always a residual risk that these can fail, overtop or become overwhelmed and therefore everyone has a role to play in increasing their level of personal resilience. The work required to do this is very resource intensive and how you measure success is difficult.

Our first learning point was to work with the University of Hull to carry out a baseline survey in 3 wards in the city and the surrounding villages in East Riding to assess the current level of understanding of flood risk and how resilient communities are. This survey has given us a baseline on which we can measure our engagement through re-surveying or measuring responses at community events to establish any changes.

We also have a dedicated website and social media where we can measure the traffic and touch points. We steer people to these resources using q codes on leaflets, correspondence or by doing targeted media campaigns. Another successful way of engaging was to target schools and educational programmes. We have resources to deliver structured lessons and assemblies for schools, tailored around the curriculum but created to build knowledge on flooding, climate change, the water cycle and resilience.

All of these would not be possible without committed resources to deliver.

We are only in year 1 of delivering the capital programme but already the lessons we are learning are that the key factor in delivering multi benefit SuDs is that its critical to have the existing relationships and allocation of appropriate resources to manage the project between the various council departments; LLFA, Highways, Grounds Maintenance, Street Cleansing, Housing and Regeneration as an example. This includes effective stakeholder relationships at senior management level as well as officer level. What this means on the ground is a different delivery model to the one we may have used to deliver traditional infrastructure projects in the past.

The first private/public partnership in Yorkshire for flooding resilience



# Pocklington Flood Alleviation Scheme (POCFAS)

Completed in 2019 at a cost of £4.7m, POCFAS is designed to reduce the risk of flooding to around 140 properties in the market town of Pocklington. The new scheme involved the construction of a dam upstream of the town on Mill Beck, to create a flood storage reservoir capable of temporarily storing up to 90,000 cubic metres of water during extreme events.

York based Persimmon Homes made a sizable funding contribution which was vital to the formation of the flood scheme. It followed the approval of plans for a housing development nearby. The site had already been allocated for housing in the Councils Local Plan subject to the delivery of a flood scheme to benefit Pocklington.

POCFAS is one of only a minority of flood schemes in the country to be majority funded by the private sector.

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## Start and end dates of project

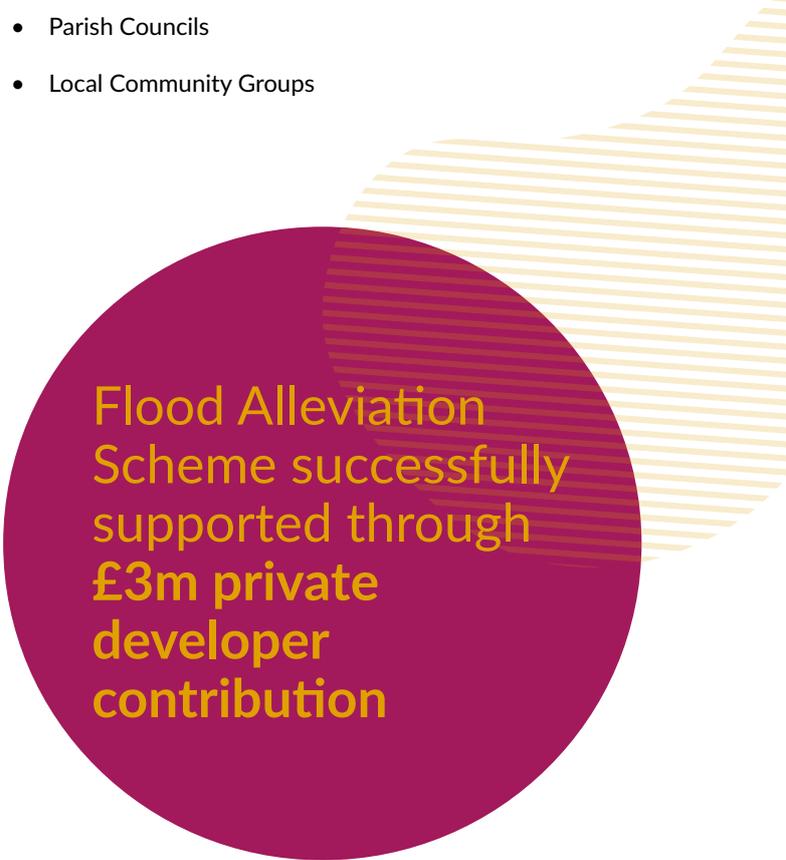
Start date: 2014  
End date: 2019

## Project objectives

- To reduce flood risk to people and property.
- To ensure that the preferred option is a sustainable solution with minimal whole life costs and responsibilities.
- Look for opportunities to address deteriorating waterbodies to assist in meeting Water Framework Directive (WFD) targets.
- To ensure that the preferred option is designed to be safe for the public during construction and operation.
- To ensure that the preferred option does not increase flood risk to any properties.
- To design works to minimise adverse impacts on the environment (both during the construction and operation phases).
- To design works to minimise the long term intrusion on the local landscape.
- To ensure that all enhancement opportunities are explored and realised where practicable.
- To listen to and include the local community and wider stakeholders, to both manage their expectations and ensure acceptance in delivery of an innovative scheme

## Partners

- Environment Agency / Defra
- York and North Yorkshire LEP
- Persimmon Homes
- Parish Councils
- Local Community Groups



**Flood Alleviation Scheme successfully supported through £3m private developer contribution**

## Funding received and sources

The scheme was funded by Defra Flood Defence Grant in Aid (FDGiA) and Local Levy administered by the Regional Flood and Coastal Committee, Local Growth Funding from the York and North Yorkshire LEP (previously York, North Yorkshire and East Riding LEP) and a £3m contribution from Housing developer Persimmon Homes Yorkshire through a Section 106 agreement as described above.

## Project outcomes

- Approximately 140 properties and businesses with a reduced risk of flooding.
- Highway and utilities infrastructure with a reduced risk of flooding.
- Improved health and wellbeing of local residents due to the stress and blight that flooding can bring.
- Positive impact on the local economy due to the long term disruption that flooding can cause.
- Reduced response to flooding for emergency services and responders.
- Reduced costs to the Local Authority and Risk Management Authorities on repairs and clean-up operation from flood damages.

## Learning from project

The scheme was a 2019 finalist at the APSE Awards in the 'Best Public/Private Partnership Working Initiative' category. This was in recognition of the collaborative approach taken by East Riding of Yorkshire Council to secure £3 million of private investment for the scheme. This is a substantial contribution for a £4.7 million scheme. In terms of lessons learned this plan lead approach with early engagement and effective communication is something that can again be taken forward in subsequent Local Plan Reviews to identify similar opportunities. Work to secure the private funding was extremely resource intensive and required the combined efforts of a range of Council services and consultant support. Most importantly the feasibility study for the scheme was taken forward to develop proposals in advance of any formal agreements so that conversations around funding could be based on viable and evidence-based costs, benefits and funding contributions. The Council also had to be flexible

on making funds available upfront for the construction of the scheme as the agreement included a provision for the contribution to be released in a phased manner upon sale of developed property.

Further evidence for the efficacy of the scheme lies with the recent heavy rainfall events of winter 2019/2020. In November 2019, despite exceptionally heavy rainfall, properties directly in the benefit area did not experience flooding. In February of 2020 the area experienced exceptional rainfall once again; and there were no reports of flooding in the benefit area, photographs taken at the time clearly show water being attenuated in the lagoon. Based on the successful operation of the scheme in recent events, we have confidence in the reported benefits for the scheme.

The scheme has already operated on multiple occasions to reduce the flood risk to property in Pocklington as illustrated below:



# Glasshoughton - Drainage Strategy

Wakefield Council

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## Project timeframe

2017 - Ongoing

## Project objectives

The Council's Local Development Framework (adopted 2012) allocated a Special Policy Area in the Glasshoughton area of Castleford which looked to redevelop the area known as the Glasshoughton Colliery and Coke works to deliver a range of mixed use development. Whilst much of this site has been developed there are still development sites available. The site is known as the Junction 32/ Xscape development.

In addition, the Council secured funding from the West Yorkshire Combined Authority to deliver the Glasshoughton Southern Link Road; a new link road which connects existing roads within the site to the southernmost extents of the site.

Wakefield Council were also looking at the flood risk around the Carr Beck catchment which runs through the Glasshoughton site and where a number of residential properties were flooded in June 2007.

Each aspect of development required assessments of flood risk to be made and discussions were held between the private developer of the Glasshoughton site, Wakefield's Highway and Flood Risk Management team to look at whether a combined approach to these assessments could be made.

An existing hydraulic model of Carr Beck had been created using Flood Defence Grant in aid funding in 2012, it was felt that the level of detail in this model was not sufficient to fully assess the flood risks and wider impact of further developments; including the Southern Link Road on the larger Carr Beck catchment.

Following these discussions it was agreed that a combined approach could be taken, a consultant was engaged by Wakefield to update the existing model funded by WYCA funding in regard of the new road, internal Council flood risk capital funding and the Glasshoughton developer offered the use of any excess capacity within their own flood alleviation ponds once their own developments had been accommodated.

Discussion were also held with the Environment Agency so that the new model could be used to update their own flood risk maps, addition surveys were undertaken by the Environment Agency and provided free of charge to the Council's consultant.

## Project deliverables

- Update of the hydraulic model for the Carr Beck catchment.
- Using model outputs to update the Environment Agencies flood maps
- Assessment of and mitigation required for the Southern Link Road
- Assessment of and requirements for the remaining development sites
- Use of private development flood alleviation ponds to balance catchment flows.
- Assessment of wider flood risk within the wider Carr Beck catchment.

## Project partners

Wakefield Council – Highways and Flood Risk Management

## Private developers

Environment Agency

## Project conclusions

The project showed that by working in a collaborative way costs savings were made, this approach also saved time and also ensured that joined up thinking was applied to the project to ensure that the overall flood risk was fully assessed for the whole catchment rather than a piece meal approach.



Photo A - Outfall from Culvert under new link road into Carr Beck



Photo B - Outfall control structure to regulate flows for link road and new development



Photo C - Overflow structure from existing developer pond sized to allow new highway flows



Photo D - New development alongside new link road

# Carr Beck - Drainage Strategy

Wakefield Council

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## Priority Culvert Investigations

### Project timeframe

2017 - Ongoing

#### Project objectives

On review of the existing Wakefield Council's priority catchment management strategies, it was noted that several residential areas affected by significant flooding in 2007 (10+ clustered properties internally flooded), with increased risk of surface water flooding (identified in the Flood Map for Surface Water, 1:100yr), are served by culverted watercourses of unknown condition and capacity.

Eight critical culverts were identified/prioritised, following Wakefield LLFA onsite investigations, the collation of ten years of flood risk data and review of EA national flood maps. The existing culverts range in size, length, material and route confidence, totalling approximately 7000m in length (representing 17% of the total length of culverted ordinary watercourses already inspected by Wakefield LLFA).

Under the Flood and Water Management Act, 2010, Section 21 register of flood risk structures, Wakefield LLFA is to maintain a register of flood risk structures. The magnitude of captured data is not specified in the Act and Defra LLFA funding has to cover a range of duties, in addition to maintenance of an asset register. To ensure Wakefield LLFA captured sufficient intelligence to effectively steer flood risk management prioritisation and internal studies, Council revenue has been used to pay for officer time, over a number of years, to carry out watercourse culvert identification/investigations. This is considered as the match funding, already spent, to arrive at the critical culverts in question.

Local Levy Grant was requested and approved as match funding against works already carried out by Wakefield Council to identify the priority culverts.

Work carried out prior to this project allowed Wakefield LLFA to capture the size, condition, approximate route and ownership of culverted ordinary watercourses. However, the condition and capacity of the culvert lengths beyond the inlet, outlet, or access manholes remained unknown, the project has allowed us to identify the above and identify and prioritise defects.

The majority of culverted watercourses are under multiple riparian ownership (local highways authority, private land owners and property owners). As a consequence, apportioning responsibilities and reclaiming investigation

costs is likely to become a disproportionate and inappropriate use of limited LLFA resource/funding. Principal inspections of these critical culverts will guide existing and future catchment strategy prioritisation by confirming the capacity of existing drainage conduits and by enabling more accurate catchment modelling studies by reducing existing watercourse network assumptions.

### Project deliverables

- Provide a more accurate picture of the priority culverts identified as part of the Catchment Flood Risk Reduction Strategy.
- Identify and prioritise defects within the priority culverts.
- Provide additional information to guide future works on the wider flood risk reduction strategy.
- Provide the evidence for future discussions with parties who have responsibility for the maintenance of culverts identified to have defects.
- Provide evidence to bid for flood grant in aid funding to carry out improvements to the culverted watercourse systems.
- Use the results of the investigations to improve our existing asset records.

### Project partners

Wakefield Council – Highways & Corporate Landlord Teams

Wakefield Council – Flood Risk Management

Wakefield and District Housing

Private landowners.

#### Project conclusions

Confirmation that existing culverted watercourses are fit for purpose, or otherwise, is key to effective day to day flood risk management activities. Any discovered defects will be acted on, enforced by the LLFA, in a timely fashion. Future catchment studies will benefit by reduced hydraulic model assumptions regarding below ground drainage systems.

The EA's flood mapping team will benefit from the LLFA's confirmed details of critical culverts serving flood risk areas. Detail will be made available for the EA to refine their modelled drainage systems.



Photo E - SuDS settlement pond to manage flows from new link road



Photo F - Working with developers to manage flood flows from new developments



Photo G - existing road flooded in 2007 and affected properties, modelling will help to develop solutions to reduce this risk as part of the overall Carr Beck strategy.



Photo H - Existing Yorkshire Water pumping station overwhelmed by surface water in 2007, Wakefield working with YW to remove surface water from the combined sewer system.

# Connected by Water Plan

A South Yorkshire alliance, working together to build flood resilience and respond to the climate emergency. The plan is being led by a partnership of organisations including the Environment Agency, South Yorkshire Mayoral Combined Authority, Barnsley Metropolitan Borough Council, Doncaster Metropolitan Borough Council, Rotherham Metropolitan Borough Council, Sheffield City Council and Yorkshire Water.

## Background

The Connected by Water Action Plan was first conceived following the events of November 2019, where one of the wettest autumns on record led to unprecedented river levels and widespread flooding across South Yorkshire. Communities were evacuated from their homes, precious belongings ruined, businesses devastated, infrastructure disrupted and people unable to return to their homes for months. As the water subsided, communities, businesses and senior leaders realised they were experiencing the impacts of climate change first-hand and made a commitment to work together to tackle the issue.

Since then we've been working in partnership, not only to deliver flood risk management schemes on the ground, but also to plan catchment wide measures for the future to help meet the challenges of climate change. The Connected by Water Action Plan is a vital part of this work. 'Connected by Water' emphasises how South Yorkshire is connected and defined by its network of rivers and rich habitats and signals the strength of the partnership behind the plan.

The plan describes a strong, regional ambition to reduce flood risk and build climate resilience so people can live, work and thrive in South Yorkshire in the face of a changing climate. The catchment plan will provide a compelling programme for investors and create opportunities to build a stronger case for wider investment in South Yorkshire, to support economic growth in a post-covid economy. The plan is a chance to do things differently and become a national example of innovation and excellence.

This plan is a showcase for the actions we're currently taking to reduce flood risk and build climate resilience across South Yorkshire, providing visibility of the projects already underway to support better collaboration. The current plan includes 144 actions which are split into 4 themes. These themes are outlined along with examples of actions within them.

## 1: Responding to the Climate Emergency

This theme is a response to the unprecedented and interdependent crises of climate change and biodiversity loss. These two challenges together are the most pressing issues of our time and an existential threat to human welfare, prosperity and life on earth. This theme seeks to reduce flood risk whilst delivering multiple benefits in support of aiding nature's recovery and transitioning to net zero carbon. This theme will utilise nature-based solutions and integrate policy, best practice and latest research into its approach.

## 2: SMART Investment

This theme is the foundation of this plan, ensuring investment is prioritised, SMART (Specific, Measurable, Attainable, Relevant, Time-based) and based on evidence. Partners will work collaboratively to bring together flood risk data and evidence on all sources of flooding (river, sea, surface water, groundwater and sewers) that impact communities and businesses across the region. This data and evidence will be used to inform future investment in flood risk management to ensure it is targeted to maximise flood risk benefits in South Yorkshire. This collective resource will enable us to prove to potential investors how the funding of flood risk reduction contributes towards the successful delivery of regional and national priorities.

## 3: Technology and Operational Management

Aligning operational resources and technology is key in providing an agile and robust response to flood risk across South Yorkshire. This theme will bring together partner's collective, catchment wide information to shape and inform the future use of technology and operational resources. It will also build on ongoing flood risk maintenance and management activities. Partners will work collaboratively to better understand each partner's existing operational procedures (including incident management), individual priorities, existing data sets, roles and responsibilities, communication processes and available resources. In turn, this will allow partners to work more efficiently and collaboratively on a day-to-day basis and during flood incidents. Establishing data sharing opportunities will allow partners to explore innovative ideas, new technology and networks for operational use.

## 4: Communication, Engagement and Building Resilience

The aim of this theme is to build resilience across South Yorkshire, by working with all our stakeholders to ensure they're at the heart of our decision making. Together, with partner organisations, we'll develop a communication and engagement strategy that all partners are responsible for delivering. We will work collaboratively, ensuring we have 'one joined up voice' for providing key messages. This will allow us to be more streamlined in the way we work, ensuring there is a consistent approach to the delivery of our communication, engagement and resilience measures. We'll continue to work with existing stakeholder groups, including but not limited to, flood action groups, landowners, farmers, flood wardens, parish councils and businesses whilst also developing new relationships with other key stakeholders. We'll work with all these stakeholders to help and support them understand their own flood risk and how the Don catchment works.

### Source to Sea

The landscapes and rivers which make South Yorkshire vulnerable to flooding are also some of its most precious assets. The uplands of the River Porter, Rivelin, Loxley in Sheffield and in the River Dearne in Barnsley provide beautiful moorland landscapes. These uplands lead into wetland nature reserves along the Dearne and Rother in Barnsley and Rotherham, and on to nationally significant lowland peat bogs around the Lower Don in Doncaster. Restoring and developing these natural landscapes will help to slow and store water, help nature recover and provide wildlife-rich environments for people to thrive in. In response to this opportunity, Connected by Water partners are collaboratively developing a > £40m Source to Sea nature-based solutions programme on the River Don catchment. This programme is split into three projects: Upper Don (Peak District National Park and Sheffield), Middle Don (Northeast Derbyshire, Rotherham and Barnsley) and Lower Don (Doncaster). Each of these

will build upon existing projects, partnerships, local strategies and initiatives to implement a variety of naturebased solutions to slow the flow and create space for water.

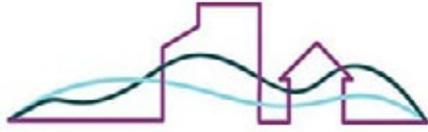
Source to Sea presents an exciting opportunity to work with landowners and communities to deliver multiple outcomes for flood risk management, nature recovery and carbon storage on a landscape scale.

### South Yorkshire Flood Risk Investment Tool

As part of the SMART Investment theme, we're working collaboratively to develop the concept of the South Yorkshire Flood Risk Investment Tool. This tool will bring together flood risk data and evidence from across the region, to inform future investment in flood risk management, ensuring investment is targeted to maximise flood risk benefits in South Yorkshire. This tool will also bring together information on wider investment and funding opportunities and will enable us to proactively identify additional sources of partnership funding to support the delivery of future flood risk management schemes.

1 approach  
40 partners  
4 themes  
27 priority projects  
144 actions





**Yorkshire** Leaders Board  
*The voice of our region*

