2020

Environment Agency

National Flood and Coastal Erosion Risk Management Strategy for England

Environment Agency

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This publication is available at www.gov.uk/official-documents.

Any enquiries regarding this publication should be sent to us at enquiries@environment-agency.gov.uk.

ISBN 978-1-5286-1791-8

CCS0919045990 07/20

Printed on paper containing 75% recycled fibre content minimum

Printed in the UK by the APS Group on behalf of the Controller of Her Majesty's Stationery Office

Front cover image, clockwise starting from top left: Fowey, Cornwall; Salthouse, Norfolk; Thames Barrier London; Herne Bay, Kent; Whaley Bridge, Derbyshire

Back cover image, clockwise starting from top left: Hull tidal barrier, Hull; view of The Prince of Wales Bridge (Second Severn Crossing); Cross Guns Pumping Station, The Fens, East England (ADA); New development in the OxCam Arc; Hall Leys Park, Matlock, Derbyshire

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Our vision

A nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100.

Foreword

When it comes to water, England is blessed. We have good rainfall, a network of rivers and lakes and an extensive coastline with beautiful beaches. We all depend on water every day of our lives. Rain falls, water flows over and through our land, and the sea is constantly changing our coastline. Flooding and coastal erosion are part of this, natural processes which have happened since time began.

In creating our living and working environments we have interfered with these natural processes. We have historically built our towns and cities close to water because we use it for so many of our domestic and industrial activities and because we all enjoy a sea or river view. But being close to water also brings risks.

Flooding and coastal erosion can be devastating. As well as the potential for loss of life and damage to property, they can affect people's health and well-being; disrupt essential infrastructure and services, and cause loss of business and national income, and damage to the environment. As climate change leads to sea level rise and more heavy storms and we build more housing and infrastructure, these risks are growing.

The government's policy statement on flooding and coastal erosion has set out our long-term ambition for managing these increasing challenges and boosting our resilience. It describes the government's policies to better protect and better prepare the country.

This Environment Agency strategy for flood and coastal erosion risk management in England has been developed collaboratively with a wide range of organisations and sets out the approach to delivering government's policies. It will guide the operational activities and decision making of all those involved in flood and coastal erosion risk management activities. Working together to manage the risks and deliver the right actions will mean we can all continue to enjoy our beautiful coasts and watercourses into the future. I am delighted to lay this national strategy for flood and coastal erosion risk management before Parliament.

Rebecca Pow MP, Parliamentary Under-Secretary of State

Foreword

The world is currently managing the impacts of the coronavirus pandemic, but that doesn't stop rain from falling or the sea level from rising. February 2020 was England's wettest ever and it was the UK's fifth wettest winter on record. Environment Agency flood schemes protected 129,600 properties even though water levels were higher than the summer floods of 2007 when 55,000 properties flooded.

For every £1 spent on protecting communities, we avoid around £5 in property damages. These protections are essential to the health and economy of the country, and are why it was extremely welcome news that the Chancellor announced in the Budget £5.2 billion of capital funding to better protect 336,000 properties, including homes, businesses and hospitals.

Now, as winters are getting warmer and wetter and the Intergovernmental Panel on Climate Change says once-a-century sea level events will be annual events by 2050, we also need to look towards a longer term future. When we talk about resilience, we are talking about enabling lives to be lived and planned comfortably alongside the climate impacts of the future. That includes the necessary immediate and medium term protections for communities, but it is more than that.

This Strategy sets out practical measures to be implemented by risk management authorities, partners and communities, which will contribute to longer term delivery objectives and our vision: A nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100.

The Strategy has three core ambitions concerning future risk and investment needs:

1. Climate resilient places: working with partners to bolster resilience to flooding and coastal change across the nation, both now and in the face of climate change
2. Today's growth and infrastructure resilient in tomorrow's climate: Making the right investment and planning decisions to secure sustainable growth and environmental improvements, as well as resilient infrastructure.
3. A nation ready to respond and adapt to flooding and coastal change: Ensuring local people understand their risk to flooding and coastal change, and know their responsibilities and how to take action.

As everyone looks to rebuild and renew after the coronavirus pandemic, this Strategy will help to ensure a clean, green recovery with sustainability and natural processes at its heart. Resilience isn't only about risk avoidance, there's a world of social and economic opportunities in helping communities to protect against, manage, and build back better following, the physical impacts of climate change.

This country's domestic experience and expertise in flood and coastal risk management protects millions of people every year and is internationally sought after. This Strategy will help us adapt and improve for the next generation.

Emma Howard Boyd, Chair of the Environment Agency

Executive summary

"Climate change is making the UK warmer and wetter, and we will be visited by extreme weather more frequently in the future. So we need to shift gears, to ensure we adapt and become more resilient."

George Eustice, the Secretary of State for the Environment, Food and Rural Affairs

A Strategy for flooding and coastal change

The Flood and Water Management Act 2010 places a statutory duty on the Environment Agency to develop a National Flood and Coastal Erosion Risk Management Strategy for England. This Strategy describes what needs to be done by all risk management authorities involved in flood and coastal erosion risk management for the benefit of people and places. This includes the Environment Agency, lead local flood authorities, district councils, internal drainage boards, highways authorities and water and sewerage companies, who must exercise their flood and coastal erosion risk management activities, including plans and strategies, consistently with the Strategy. Through its 'strategic overview' role the Environment Agency exercises its strategic leadership for all sources of flooding and coastal change. This Strategy seeks to better manage the risks and consequences of flooding from rivers, the sea, groundwater, reservoirs, ordinary watercourses, surface water and sewers and coastal erosion.

The Strategy provides a framework for guiding the operational activities and decision making of practitioners supporting the direction set by government policy.

This Strategy will not be effectively delivered by risk management authorities working on their own. We all need to take action now so that we are ready for what the future will bring. We need individuals, communities, the third sector, businesses, farmers, land managers and infrastructure providers to contribute to planning and adapting to future flooding and coastal change.

It is for this reason that the Environment Agency has worked collaboratively with practitioners in a wide range of organisations to develop this Strategy. The Strategy provides a framework for guiding the operational activities and decision making of practitioners supporting the direction set by government policy which includes its flood and coastal erosion risk management policy statement (Defra, 2020e). The Strategy sets out the long-term delivery objectives the nation should take over the next 10 to 30 years as well as shorter term, practical measures risk management authorities should take working with partners and communities.

This Strategy recognises that every place is different and that local people will define their place in different ways. For some it might be their county, city, town or village. For others, a place could mean a river catchment, a tidal estuary or part of the coast.

Progress towards a nation resilient to flooding and coastal change

Significant progress has been made since the original National Flood and Coastal Erosion Risk Management Strategy for England was published in 2011. Risk management authorities, working with local partners, will have invested £2.6 billion of government funding in flood and coastal risk management, better protecting 300,000 homes between 2015 and 2021 (Environment Agency, 2019m).

We cannot eliminate the risk of all flooding and coastal change. But the nation's investment in flood and coastal defences has been effective at better protecting properties and reducing the impacts of flooding on peoples' lives and livelihoods. We have seen progressively fewer properties flooded following recent incidents. In the floods of summer 2007, about 55,000 homes and businesses were flooded. In the winter 2015/16 floods it was around 21,000 (Environment Agency, 2018a) and during the winter 2019/20 floods it was around 4,600 (Environment Agency, 2020e). Our defences have also helped to avoid significant economic damages to people, businesses, landowners and infrastructure. The economic losses from the winter 2019/20 flooding are estimated to be about £333 million. But the economic damage avoided from the protection provided is at least 14 times greater (Environment Agency, 2020e).

In the 2020 Budget, the government committed to doubling expenditure on flood and coastal risk management to £5.2 billion between 2021 and 2027 (HM Treasury, 2020). This record-breaking spending will better protect a further 336,000 homes and properties as well as avoid £32 billion of wider economic damages to the nation. In addition, the government provided £200 million between 2021 and 2027 for a resilience programme that will support 25 local areas to take forward wider innovative actions that improve their resilience to flooding and coastal erosion (HM Treasury, 2020).

Importantly, government policy and evidence has also continued to evolve since the 2011 Strategy was published. In 2018 the government's 25 Year Environment Plan published its aspiration to be the first generation to leave the environment in a better state than when we found it (Defra, 2018a). According to the 2018 UK Climate Change Projections average sea level could increase by over a metre by the end of the century (Met Office, 2019), underlining the importance of acting now to adapt to flooding and coastal change. In 2019 the government set a new target requiring the UK to bring all greenhouse gas emissions to net zero by 2050 (BEIS, 2019). The government's Environment Bill (Parliament

UK, 2020a) and Agriculture Bill (Parliament UK, 2020b) recognise that we need to make nature's power part of our solution and support farmers and land managers to take a more integrated approach to flood risk and water resource management through the Environmental Land Management scheme.

Internationally our understanding of future climate hazards has significantly improved, impacting the way governments and public bodies around the world are preparing, responding and adapting to future flood and coastal risks. According to the World Health Organisation climate change is one of the greatest threats to global health in the 21st century (WHO, 2015).

Collectively improvements in our understanding of climate science, learning from flood events and developments in government policy mean that now is the right time to produce a new Strategy. This Strategy presents an opportunity to create climate resilient places that facilitates a greener, cleaner, and more resilient future. In doing so it mirrors the direction given by the government on World Environment Day 2020 (Twitter, 2020).

The 2020 Flood and Coastal Erosion Risk Management Strategy

This Strategy's long-term vision is for: **a nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100**.

It has 3 long-term ambitions, underpinned by evidence about future risk and investment needs. They are:

- **Climate resilient places:** working with partners to bolster resilience to flooding and coastal change across the nation, both now and in the face of climate change
- **Today's growth and infrastructure resilient in tomorrow's climate:** making the right investment and planning decisions to secure sustainable growth and environmental improvements, as well as infrastructure resilient to flooding and coastal change
- **A nation ready to respond and adapt to flooding and coastal change:** ensuring local people understand their risk to flooding and coastal change, and know their responsibilities and how to take action

This Strategy calls for the nation to embrace a broad range of resilience actions including better protection to flooding and coastal change.

Climate resilient places

This Strategy calls for the nation to embrace a broad range of resilience actions including better protection to flooding and coastal change.

We must continue to do what we have been doing: building and maintaining strong defences to reduce the risk of places being flooded. In the face of a changing climate, we need to also make our places more

resilient to flooding and coastal change, so that when it does happen it causes much less harm to people, does much less damage, and ensures life can get back to normal much quicker.

Alongside flood and coastal defences, we need a broader range of actions for achieving climate resilient places. This includes avoiding inappropriate development in the floodplain and using nature based solutions to slow the flow of or store flood waters. It involves better preparing and responding to flood and coastal incidents through timely and effective forecasting, warning and evacuation. Furthermore, it needs to be about helping communities and local economies recover more quickly after a flood or 'building back better' so that properties and infrastructure are more resilient to future flooding.

Looking out to 2100, we need to help local places better plan and adapt to future flooding and coastal change. This will mean being agile to the latest climate science, growth projections, investment opportunities and other changes to our local environment. We call this 'adaptive pathways' that enable local places to better plan for future flooding and coastal change and adapt to future climate hazards. As a nation we need to improve the way we integrate adaptation to flooding and coastal change into daily activities and projects, as well as long-term strategic investment plans and strategies for places and catchments. By doing so we can better equip practitioners and policy makers to make the best decisions, taken at the right time to benefit people, infrastructure, the economy and the environment.

Looking out to 2100, we need to help places better plan and adapt to flooding and coastal change across a range of futures.

In some places the scale and pace of future flooding and coastal erosion will be very significant. Over a period of time, some of these communities may choose to transition and adapt with support from risk management authorities.

What will be different?

Risk management authorities will work with partners to:

- deliver practical and innovative actions that help to bolster resilience to flood and coastal change in local places
- make greater use of nature-based solutions that take a catchment led approach to managing the flow of water to improve resilience to both floods and droughts
- maximise opportunities to work with farmers and land managers to help them adapt their businesses and practices to be resilient to flooding and coastal change
- develop adaptive pathways in local places that equip practitioners and policy makers to better plan for future flood and coastal change and adapt to future climate hazards

Today's growth and infrastructure resilient in tomorrow's climate

This Strategy sets out a long-term objective for risk management authorities to work with infrastructure providers to ensure all infrastructure investment is resilient to future flooding and coastal change. Over two-thirds of properties in England are served by infrastructure sites and networks located in, or dependent on others located in, areas at risk of flooding (Environment Agency, 2019a). Recent floods have demonstrated the vulnerability of critical infrastructure, such as electricity sub-stations and water treatment plants, causing considerable disruption and economic damage. This directly affects peoples' everyday lives by disrupting the essential services they rely on.

As the population grows, we are likely to see the number of properties in the flood plain almost double over the next 50 years. We must ensure that all new development is resilient to flooding and protects and enhances the environment. Risk management authorities have a key role to play in engaging and advising developers and planners to get the right kind of sustainable growth in the right places. They should also be seizing opportunities for flood and coastal resilience activities to play their part in contributing to environmental net gain for development proposals.

This Strategy identifies ways in which investments made to adapt to the threats from flooding and coastal change can enable growth in a sustainable and climate resilient way. More focus is also needed on encouraging property owners to 'build back better' after a flood and to mainstream property flood resilience measures that reduce flood damages and enable faster recovery for local communities.

What will be different?

Risk management authorities will work with partners to:

- put greater focus on providing timely and quality planning advice that helps avoid inappropriate development in areas at risk of flooding and coastal change
- leave the environment in a better state by contributing to environmental net gain for new development proposals
- ensure that spending on flood and coastal resilience contributes to job creation and sustainable growth in local places
- mainstream property flood resilience measures and to 'build back better' after flooding to reduce damages and enable faster recovery for local communities
- provide expert advice on how infrastructure providers (road, rail, water and power supplies) can ensure their investments are more resilient to future flooding and coastal change avoiding disruption to peoples' lives and livelihoods

A nation ready to respond and adapt to flooding and coastal change

This Strategy seeks to build a nation of people who understand their risk to flooding and coastal change, and know their responsibilities and how to take action. Over 5.2 million homes and properties in England are at risk from flooding and coastal erosion (Environment Agency, 2019n). Yet only a third of people who live in areas at risk of flooding believe their property is at risk. Many more people are affected when transport services, energy or water infrastructure are damaged or disrupted. For every household directly affected during a large flood, about 16 people suffer knock-on effects from losses of utility services (Environment Agency, 2019a – derived).

For every household directly affected during a large flood, about 16 people suffer knock-on effects from losses of utility services.

We have a world class flood forecasting and warning service. It provides people, businesses and the emergency services with information to help them prepare for a flood. Over 1.4 million properties are signed up to receive free flood warnings (Environment Agency, 2020a). The Environment Agency will continue to work with partners to transform its warning and informing services to better reach people living, working or travelling though flood risk areas. We also need to continue to develop digital services that better communicate flooding and coastal change and increase awareness of the risks people face. Risk management authorities, local responders and the insurance sector also have a key role to play in helping people and businesses recover more quickly after flooding. We also need to be better at mobilising support from the third sector following significant flooding.

The threats posed by a changing climate are a global challenge and we are not facing them alone. We want our nation to be recognised as a world leader in researching and managing flooding and coastal change. Meeting the challenge of reaching net zero carbon emissions by 2050 will need new ideas and innovation across all sectors. Through this Strategy we need to actively develop the flooding and coastal erosion skills and talent we need to create the climate resilient places of the future.

What will be different?

Risk management authorities will work with partners to:

- support communities to better prepare and respond to flooding and coastal change, including transforming how people receive flood warnings
- ensure people and businesses receive the support they need from all those involved in recovery so they can get back to normal quicker after flooding

— help support communities with managing the long-term mental health impacts from flooding and coastal change
— develop the skills and capabilities needed to better support communities to adapt to future flooding and coastal change
— become a world leader in the research and innovation of flood and coastal risk management to better protect current and future generations

Engagement and monitoring of progress

This Strategy has been developed collaboratively with practitioners in over 90 organisations. The Environment Agency established an advisory group to test the Strategy's objectives and measures which included representatives from risk management authorities, including local government and internal drainage boards, as well as other national and civil society organisations. A draft Strategy was also consulted on in May 2019. It received significant media coverage and over 400 responses which have informed the Strategy's final long-term objectives and shorter term measures. The result is a final Strategy with significant support that will result in positive and practical changes to the way flooding and coastal change is managed in England.

The Environment Agency will report annually to ministers on the progress risk management authorities are making with the Strategy's objectives and measures (Flood and Coastal Erosion Risk Management Reports – 'Section 18' reports, under the Flood and Water Management Act 2010). Alongside the Strategy the Environment Agency will develop an action plan with partners for taking forward the Strategy which will be published by April 2021. The next review of the Strategy is planned for 2026.

Setting the context

A Strategy for flooding and coastal change

The Flood and Water Management Act 2010 places a statutory duty on the Environment Agency to develop a National Flood and Coastal Erosion Risk Management Strategy for England. This Strategy describes what needs to be done by all risk management authorities involved in flood and coastal erosion risk management. This includes the Environment Agency, lead local flood authorities, district councils, internal drainage boards, highways authorities and water and sewerage companies, who must exercise their flood and coastal erosion risk management activities, including plans and strategies, consistently with the Strategy.

This Strategy provides a framework for guiding the operational activities and decision making of practitioners, and helps to deliver government's flood and coastal erosion policy statement (Defra, 2020e).

This Strategy will not be effectively delivered by risk management authorities working on their own. We all need to take action now so that we are ready for what the future will bring. Landowners, householders, businesses, insurers, emergency responders, environmental groups, community action groups, catchment partnerships, consultancies, regional flood and coastal committees, government agencies and many more, all have a vital part to play.

This Strategy describes what needs to be done by all risk management authorities involved in flood and coastal erosion risk management.

Figure 1: The River Ouse overflows following a period of heavy rain and floods the streets of central York in the United Kingdom, 2012.

The impacts of flooding and coastal change on people and the environment can be devastating, no matter where the water comes from. There are many sources of flooding in England. A joined-up approach across all sources by risk management authorities and other partners is needed to help create resilient places. Throughout this Strategy, when we refer to flooding, we mean from all sources which includes rivers, the sea, groundwater, reservoirs, surface water and sewers.

The changing landscape for flooding and coastal change

England has a long history of flooding and coastal change. Climate change means that these events will increase in frequency and as a result, the way we manage the risks will need to change too.

The original National Flood and Coastal Erosion Risk Management Strategy for England, published in 2011, provided the overarching framework for action by all risk management authorities to tackle all sources of flooding and coastal change.

A lot has happened since 2011, including significant events such as the 2013 east coastal tidal surge, the 2013 to 2014 winter flooding in the south of England, the 2015 to 2016 winter flooding in the north of England and the loss of homes to coastal erosion in Hemsby during the storms of March 2018. In 2019 we also saw a number of incidents including the flooding in Wainfleet, damage to the Toddbrook Reservoir Dam in Whaley Bridge and significant flooding around Doncaster. The winter of 2019 to 2020 saw further flooding, including from Storms Ciara and Dennis, across many parts of England.

Importantly, government policy and evidence has also continued to evolve. In 2018 the government's 25 Year Environment Plan published its ambition to be the first generation to leave the environment in a better state than when we found it. According to the 2018 UK Climate Change Projections average sea level could increase by over a metre by the end of the century, underlining the importance of acting now to adapt to future flooding and coastal change. In 2019 the government set a new target requiring the UK to bring all greenhouse gas emissions to net zero by 2050. The government's Environment Bill (Parliament UK, 2020a) and Agriculture Bill (Parliament UK, 2020b) recognise that we need to make nature's power part of our solution as well as supporting farmers and land managers to help reduce flood risk through the Environmental Land Management scheme.

Significant progress has been made since the 2011 Strategy was published. Risk management authorities, working with local partners, will have invested £2.6 billion of government funding in flood and coastal risk management, better protecting 300,000 homes between 2015 and 2021.

Between 2015 and 2021

£29.4 billion
in benefits through damages avoided from 300,000 households being better protected

Over **£2.7 billion**
of government funding and
over **£600 million**
of partner contributions invested to reduce the risk of flooding and coastal change

Over **280,000**
hectares of agricultural land better protected

45%
spent on coastal flood and erosion risk management

500 kilometres
of railway and
9400 kilometres
of motorways, roads and local streets will be better protected

55%
spent on inland flood risk management

Figure 2: Existing activity to manage flooding and coastal change in England (Environment Agency, 2019).

We cannot eliminate the risk of all flooding and coastal change. But the nation's investment in flood and coastal defences has been effective at better protecting properties and reducing the impacts of flooding on peoples' lives and livelihoods. We have seen progressively fewer properties flooded following recent incidents. In the floods of summer 2007, about 55,000 homes and businesses were flooded. In the winter 2015 to 2016 floods it was around 21,000 and during the winter 2019 to 2020 floods it was around 4,600. Our defences have also helped to avoid significant economic damages to people, businesses, landowners and infrastructure. The economic losses from the winter 2019 to 2020 flooding is estimated to be about £333 million. But the economic damage avoided from the protection provided is at least 14 times greater than that, at around £4.6 billion – £9.3 billion (Environment Agency, 2020e).

NATIONAL FLOODING EVENTS

2007
Yorkshire and the Midlands

55,300 Properties flooded
100,000 Properties protected
£3,901 million Estimate of economic damages*

2012
Many events across England

4,662 Properties flooded
52,000 Properties protected
£276 million Estimate of economic damages*

2013/14
South east and coastal flooding on East Coast

13,604 Properties flooded
1.4 million Properties protected
£1,387 million Estimate of economic damages*

2015/16
Cumbria and Yorkshire

20,925 Properties flooded
23,400 Properties protected
£1,697 million Estimate of economic damages*

2019/20
(preliminary estimate)

4,630 Properties flooded
129,600 Properties protected
£333 million Estimate of economic damages*

Figure 3: Significant national flooding events since 2007 – with properties flooded, properties protected, and economic losses.

*Best estimate of economic damages (£ million, 2018 prices) based on historical records and reports.

Flood and coastal risk management investment has taken place where the risk is highest, wherever it is across the country. Over the period between April 2015 and March 2021, government investment in flood and coastal risk management per home at risk of flooding is the equivalent of £430 – the equivalent of £700 in the North, £380 in the Midlands and £335 in the South (Environment Agency, 2019c).

The government's partnership funding approach has generated further significant investment from those benefitting from the programme, with contributions of over £600 million from private and other non-central government sources (Environment Agency, 2019d). Some of the non-central government investment to manage flooding and coastal change has been made available from funds linked to local economic growth such as the funding from local enterprise partnerships.

Partnership funding

The government uses a partnership funding approach to allocate grants for flood and coastal erosion risk management projects. The Partnership Funding policy approach was introduced in 2011 to replace a priority scoring system which fully funded the highest priority projects, leaving the lower priority projects unfunded. The approach to funding flood and coastal erosion risk management projects shares the costs between national and local sources of funding. Any project where the benefits are greater than the costs can qualify for a contribution from government funding.

The amount of funding a project can attract will depend on the benefits it provides. The benefits that determine the grant available are mainly the benefits to people and property that result from reduced flood and coastal erosion risk. Projects in more deprived areas, and ones that provide environmental or other wider economic benefits may attract more grant.

Where the grant available to a project does not cover its full cost, it will need to be 'topped up' through partnership funding from local partners or the local community in order for it to go ahead. Partnership funding has enabled more projects to go ahead overall, giving communities a bigger say in the flood and coastal risk solutions being developed in their local places.

In 2020 the government amended the Partnership Funding rules to improve the way Government funding is allocated to flood coastal erosion schemes, in part by recognising the wider benefit they bring (Defra, 2020a). These changes include:

- updating payment rates to reflect inflation and new evidence on flood damages since 2011 (including people impacts such as mental health)
- amending the flood risk bands for qualifying schemes to add a new intermediate risk band between high and medium risk. This will mean more schemes that reduce surface water flood risk are likely to receive government funding in the future
- accounting for the future impacts of climate change by also including people and properties that would potentially become at risk over the lifetime of a project
- improving the payment rates for environmental benefits to capture more fully the wider environmental benefits delivered by flood and coastal erosion risk management projects and to help support nature based solutions

The Environment Agency's Partnership Funding calculator (Defra and Environment Agency, 2020) enables practitioners to determine how much government funding they might be eligible for project proposals.

Building on these changes, the government intends to conduct a public consultation to test stakeholder support for further changes to floods funding policy (Defra, 2020e).

In the 2020 Budget, the government committed to doubling expenditure on flood and coastal risk management to £5.2 billion between 2021 and 2027. This record-breaking spending will better protect a further 336,000 homes and properties as well as avoid £32 billion of wider economic damages to the nation. In addition, the government provided £200 million between 2021 and 2027 for a resilience programme that will support 25 local areas to take forward wider innovative actions that improve their resilience to flooding and coastal erosion (HM Treasury, 2020).

Collectively, improvements in our understanding of climate science, learning from flood events and developments in government policy mean that now is the right time to produce this new Strategy.

The changing climate

Climate change is upon us, and its impacts are getting more severe with each passing year (Global Commission on Adaptation, 2019). We're already seeing evidence of more frequent and more extreme flooding, faster and more extreme coastal erosion; more frequent and more extreme droughts, water shortages and wildfires; and potentially permanent damage to habitats, plants, wildlife and cultural heritage.

According to the World Health Organisation climate change is one of the greatest threats to global health in the 21st century (WHO, 2019). Global average temperatures have already warmed 1˚C above preindustrial temperatures, and summer heat waves like 2018 are likely to happen every other year by 2050. The government's 25 Year Environment Plan (2018) states that current global commitments under the Paris agreement are insufficient to limit the average temperature rise to well below 2°C.

This Strategy is seeking to better prepare us for 2°C warming in global temperatures as well as planning for higher scenarios, such as a 4°C rise in global temperatures.

There are 2 main ways we can tackle climate change: mitigation (reducing or limiting the effects of greenhouse gases that bring about climate change) and; adaptation (changing our lifestyles, economy, infrastructure and local places to make us more resilient and adaptable to future consequences). We need to both limit future climate change as well as adapt to the climate change that now cannot be stopped.

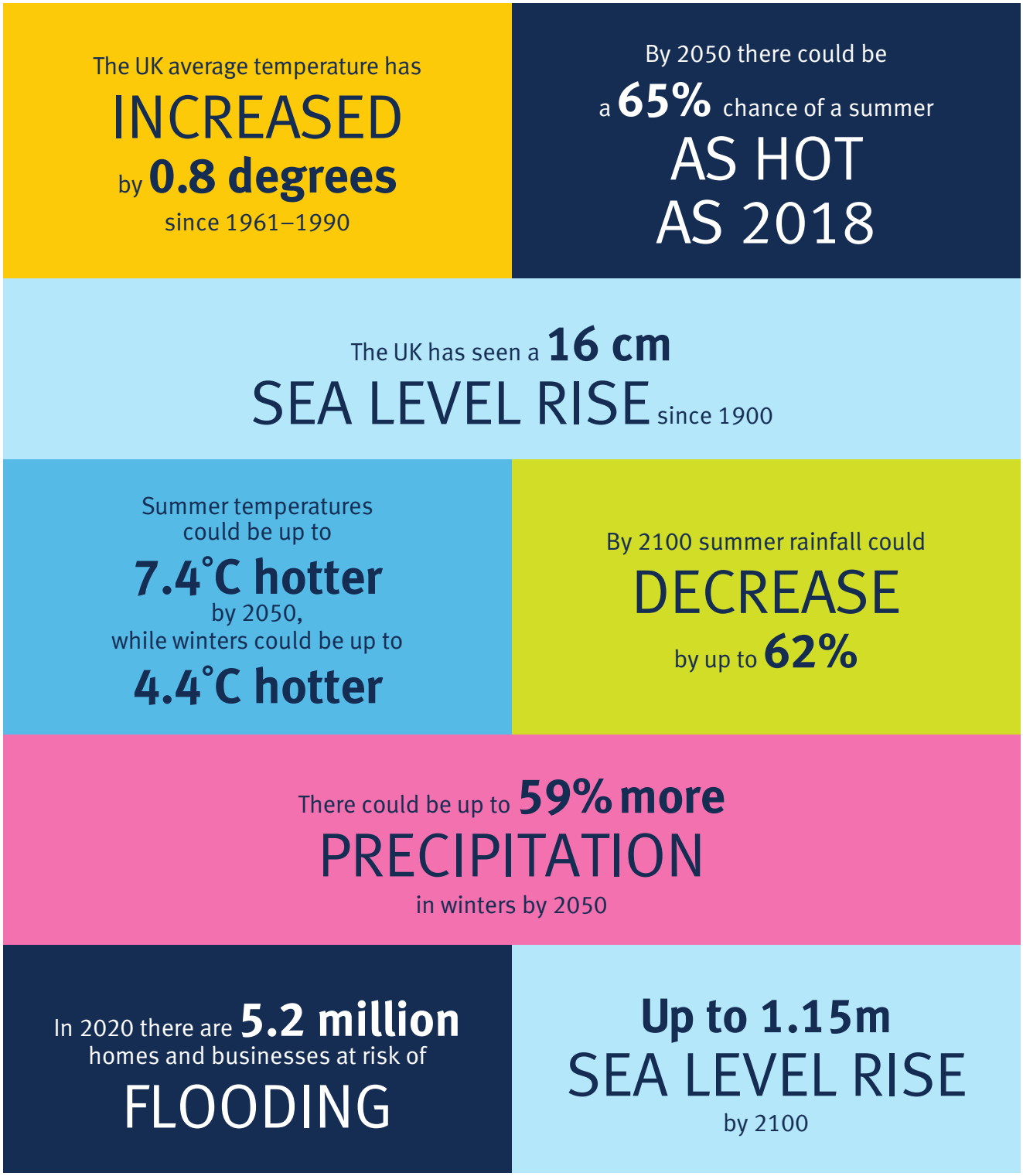


Figure 4: Current and future climate, flooding and coastal change risks (sources, Environment Agency, 2019 & Met Office, 2018, UKCP18 Headline Findings).

In response to tackling the problem of climate change, the government has enshrined in law a commitment to reach net zero carbon emissions by 2050. It is important all those involved in flooding and coastal change show leadership in achieving this ambitious target. The Environment Agency is aiming to be a net zero organisation by 2030 (Environment Agency, 2019e). Many local authorities and other public bodies in England are already leading actions and working with local people to reduce carbon emissions. This has included many

local authorities declaring climate emergencies with the number of declarations continuing to grow (ADEPT, 2019). Practitioners involved in managing flooding and coastal change have a vital contribution to make to achieving net zero and driving change at a local level.

Environment Agency – net zero 2030

TThe Environment Agency (2019) has set itself a goal to become a net zero organisation by 2030. It is also exploring whether it can become an absolute zero organisation – one that does not produce any carbon emissions at all – by 2050. The Environment Agency has committed to reducing its emissions in line with the Paris Agreement's central aim to limit global temperature rise this century to 1.5°C degrees celsius above pre-industrial levels.

The Environment Agency will seek to reduce its emissions by at least 45% by 2030 and offset the impacts of its remaining emissions through tree planting and other measures that will lock up carbon harmlessly and deliver other benefits such as improving habitats. The Environment Agency will adopt an approach that not only accounts for the carbon emissions it produces itself but also those produced through its supply chain.

The Environment Agency's main carbon footprint comes from constructing flood defences and pumping water to alleviate flood and drought. The emissions from these activities will need to significantly reduce to achieve net zero, which will require innovation as some of the technologies needed to achieve this do not yet exist. This does not mean the Environment Agency will stop building flood and coastal defences or pumping water out of people's homes if they flood. But it does mean that over time, and working with its partners, it will need to find better ways to be more resilient to flooding and coastal change whilst producing fewer emissions.

Even with ambitious global and national actions to reduce greenhouse gas emissions, some further climate change is now inevitable. It is therefore essential that we get ready for the unavoidable impacts of climate change.

In all future climate scenarios, we'll experience a continued rise in sea level well into the next century due to the long response time of sea levels to past emissions of greenhouse gases. According to the 2018 UK Climate Change Projections, average sea level has already risen by around 16 centimetres since 1900 and could increase by over a metre by the end of the 21st century – compared to the 1981 to 2000 average (Met Office, 2019). The Intergovernmental Panel on Climate Change has found that extreme sea level events that used to occur once a century are projected to occur frequently (at least once per year) in most locations by 2100 under all emission scenarios (IPCC 2019). Higher sea levels will cause waves to carry greater energy to

shore, which will affect our coastal defences and cause further impact to communities already affected by coastal flooding and erosion.

Research from the Environment Agency and Met Office shows that sea level projections are expected to continue to rise to 2300 under all greenhouse gas emission scenarios, possibly as much as 4.5 metres (Environment Agency/Met Office, 2019). Some of our existing flood and coastal defences have life spans that go beyond the end of the century. It is therefore important that risk management authorities are planning for the impacts of sea level rise to ensure today's flood and coastal erosion protection infrastructure is resilient to tomorrow's climate.

As a nation we need to be 'climate ready' so that we are resilient to future climate hazards and potential economic shocks that impact our prosperity.

Resilience and adaptation

This Strategy calls for the nation to embrace a broad range of resilience actions including better protection to flooding and coastal change.

We frame **resilience** in terms of the capacity of people and places to plan for, better protect, respond to, and recover from flooding and coastal change. This includes making the best land use and development choices, protecting people and places, responding to and recovering from flooding and coastal change whilst all the time adapting to climate change. This aligns with the description of resilience in the government's Flood and Coastal Erosion Risk Management Policy Statement which describes actions to better protect the country grouping together the protect and plan, and actions to better prepare the country, grouping together the respond and recover elements (Defra, 2020e).

We must continue to do what we have been doing: building and maintaining strong defences to reduce the risk of places being flooded. We have a world-class track record of delivering high quality flood and coastal defences and this will remain vitally important. In the face of a changing climate, we need to also make our places more resilient to flooding and coastal change, so that when it does happen it causes much less harm to people, does much less damage, and ensures life can get back to normal much quicker.

Flooding and coastal change is not static but constantly changing. It requires an iterative and dynamic approach for places that can be reviewed over time in response to changing risks. Looking out to 2100, we will need to help places plan and adapt to flooding and coastal change, being agile to the latest climate science, growth projections, investment opportunities and changes to our environment and natural systems.

With higher temperatures, protecting against or accommodating sea level rise particularly in low lying areas is likely to become increasingly

difficult. It's therefore important that we think about resilience to flooding and coastal change and adaptation to future climate risks going hand in hand. As the 2019 United Nations Global Commission on Adaptation stated, 'we need bold ideas to inspire innovation beyond what people think is possible' (Global Commission on Adaptation, 2019).

A flexible approach to places

This Strategy recognises that every place is different and that people will define their place in different ways. The Strategy considers a 'place' to include the people, businesses, infrastructure and the environments in which we all live and work. For some it might be their county, city, town or village. For others, a place could mean a river catchment, a tidal estuary or part of the coast. There's no right or wrong definition of place in terms of its scale or characteristics. A place should be determined, in the most appropriate way, by the people who live and work there taking account of its local characteristics and recognising the importance of local leadership.

This Strategy recognises that every place is different and that people will define their place in different ways.

By taking this flexible approach, this Strategy can fit into relevant plans and strategies for places. A plan for a place may fit in with the administrative boundary for a neighbourhood plan, a local authority local plan or a city region. However, flooding and coastal change does not respect administrative boundaries. It may be more appropriate in some cases to align a plan for a place with existing flood risk and shoreline management plans (See strategic objective 1.2). Putting people and places at the heart of decision making for planning and adapting to future flooding and coastal change will be essential, whatever approach is taken.

Creating better places for people and wildlife

Flooding and coastal change has shaped many of the places people enjoy and is an important part of how our natural environment works.

We depend upon the natural environment for all elements of our health and wellbeing, including clean water, air, food, storing carbon and managing flood and coastal change. Whenever we act to manage flooding and coastal change, we change the way the natural environment functions, with both positive and negative effects for people and wildlife. Understanding and reducing the negative impacts is an important task for all risk management authorities and also helps to ensure we maintain the resilience of the environment. We should also seek opportunities to encourage nature based solutions, particularly at a river catchment scale, as well as net gains in environmental benefits.

It is not possible to separate the management of our natural and built environment from the way we manage and reduce risk of flooding and coastal change. Risk management authorities must comply with environmental legislation, for example on habitats and wildlife, water quality and the historic environment. They should also aim to minimise damage to, and improve, local natural, historic and built environments through their activities and investments. In many cases this will be informed by undertaking local assessments to help identify and manage potential environmental impacts associated with specific plans and projects. The Environment Agency's Habitat Compensation programmes play a key role in monitoring habitat gains and losses, while also supporting the development of replacement habitat to overcome the losses and increase carbon sinks.

There are many examples where investments by risk management authorities have created or restored natural habitats such as salt marsh, meadows, woodland and supported tree planting. Since 2000, the Environment Agency has worked with partners to create over 900 hectares of inter-tidal saltmarsh and mudflat and a further 300 hectares is currently being created (Environment Agency, 2019b). In particular, large projects in the Humber Estuary such as Alkborough Flats, have helped to achieve this. Investing in the management of flooding and coastal change may also have recreation and amenity benefits by improving the public realm and the provision or accessibility of green space.

The objectives and measures in this Strategy are intended to ensure that, while managing flooding and coastal change, risk management authorities also support the achievement of wider environmental objectives. This is primarily in relation to supporting the 25 Year Environment Plan which sets out the government's ambition to leave our environment in a better state than we found it. Specifically, this Strategy supports the 25 Year Environment Plan objectives to protect threatened species and provide richer wildlife habitats; reduce the risk from natural hazards; and adapt to and mitigate climate change. It also supports the government's forthcoming Tree Strategy and its commitment to plant up to 30,000 hectares per year by 2025 (Forestry Commission, 2020). This Strategy identifies ways in which risk management authorities can also work with local partners to take a catchment based approach to promoting a healthy water environment for the benefit of people and wildlife.

Risk management authorities should also contribute towards sustainable development. Government guidance to the Environment Agency and to other risk management authorities sets out what these contributions should be (Defra, 2011a). This Strategy helps risk management authorities contribute towards sustainable development by seeking to reduce the risks to people and the environment in a way that balances social, economic and environmental outcomes. It also complements the UK's commitment towards global initiatives, such as the United Nations Sustainable Development Goals.

The roles and responsibilities for managing flooding and coastal change

One of the purposes of the national Flood and Coastal Erosion Risk Management Strategy is to set out the roles and responsibilities for risk management authorities in managing flooding and coastal change in England.

The Environment Agency, lead local flood authorities (county councils and unitary authorities), district councils (which may also be called borough or city councils), internal drainage boards, highways authorities and water and sewerage companies are collectively known as risk management authorities.

Lead local flood authorities have a leadership role on local flood risk management in their area. The responsibilities differ between risk management authorities. Some of this is related to the source of flooding or coastal change – rivers and streams, reservoirs, ordinary watercourses, the sea, eroding coastlines, water that runs off land (surface water), groundwater or the sewer.

Under the Flood and Water Management Act 2010, all risk management authorities are expected to exercise their flood and coastal erosion risk management functions consistently with this Strategy and to exercise all other functions that may affect flooding or coastal change having regard to this Strategy. For example, local flood risk management strategies produced by lead local flood authorities must be consistent with this Strategy. The Environment Agency and coast protection authorities may only carry out works where they are desirable having regard to this Strategy.

The Environment Agency, lead local flood authorities, district councils, internal drainage boards, highways authorities and water and sewerage companies are collectively known as risk management authorities.

Figure 5: Damage caused by the River Don, Sheffield, Yorkshire, UK bursting its banks in the November Flood near Meadowhall, 2019.

Flooding can span country boundaries so risk management authorities that border Scotland should work with the Scottish Environmental Protection Agency and other relevant authorities in Scotland. Risk management authorities which border Wales must co-operate with Natural Resources Wales and other Welsh risk management authorities.

Annex A includes a more detailed explanation of the current roles and responsibilities of the organisations with statutory flood and coastal erosion risk management responsibilities.

Co-operation, partnership working and information sharing

Working better together will help to achieve better outcomes for flood and coastal erosion risk management in England. All risk management authorities have a duty to co-operate with each other. They may share information with each other to help further such cooperation. The Environment Agency is a committed Open Data organisation and aims to make as much of its data as possible available free of charge.

An example of where co-operation and partnership working have delivered good outcomes is through the use of public sector cooperation agreements which enable one risk management authority to carry out work on behalf of another. Under these agreements the Environment Agency can carry out work on an ordinary watercourse or an internal drainage board or a local authority can carry our work on a main river. For example, the North Level District Internal Drainage Board have, in partnership with the Environment Agency and other organisations, undertaken extensive repairs to the Cradge Bank along the tidal River Nene in Cambridgeshire. The embankment is an integral part of the strategic flood storage area, known as the Whittlesey Washes, to the east of Peterborough (Association of Drainage Authorities, 2019). Working in this way we are able to improve efficiency and achieve value for money, whilst also taking advantage of local skills and experience.

Risk management authorities should work in partnership, share expertise and engage with communities to help them understand and prepare for flooding and coastal change. Across the country there are many formal and informal groups and partnerships which have been set up. For example:

- Many lead local flood authorities have set up local flood risk management partnerships which bring together risk management authorities and others in their areas to help with the development, maintenance, application and monitoring of their local flood risk management strategies.
- Local resilience forums bring together all the organisations in an area which have responsibilities for responding to emergencies, including flooding and coastal change events. Members of local resilience forums work together to plan and prepare for localised incidents and catastrophic emergencies.

— Regional flood and coastal committees bring together individuals appointed by government, the Environment Agency and lead local flood authorities to engender mutual understanding of flood and coastal erosion risks in their regions. They include elected members from lead local flood authorities. The committees are also a mechanism for sharing information and helping to achieve the best use of resources across a whole region. They are responsible for ensuring there are coherent plans for identifying, communicating and managing flood and coastal erosion risks across catchments and shorelines.
— Coastal groups bring together the key partners in coastal management in a place to develop strategic plans for their coastline, address issues of concern and share best practice. Members include local community representatives, local authorities, government bodies, local businesses, water companies, port and harbour authorities and non-governmental organisations. Where coastal groups exist that border Scotland and Wales they also cooperate with the cross border authorities.

Overview and assurance

There are a number of arrangements in place to provide an overview and assurance that the bodies involved in flood and coastal risk management are meeting the relevant governance and performance requirements. These include the regional flood and coastal committees, local authority Overview and Scrutiny Committees and the Environment Agency's strategic overview role.

The Environment Agency's strategic overview

The Environment Agency is legally required to exercise a general supervision over all matters relating to flood and coastal erosion risk management in accordance with the Flood and Water Management Act 2010 – what is known as its 'strategic overview' role. This role is distinct from the Environment Agency's operational role. It allows the Environment Agency to act in a strategic capacity and to provide strategic leadership for the management of flooding and coastal change from all sources. This includes sources where other risk management authorities have operational responsibilities. It also allows the Environment Agency to facilitate a joined up and consistent approach towards tackling future flood and coastal erosion risks across the nation.

The strategic overview role encompasses the Environment Agency's development and application of this Strategy. This Strategy is a good example of what we can achieve by working together and provides a strategic operational direction for flooding and coastal change management in England. Risk management authorities must exercise their flooding and coastal change functions in a manner which is consistent with this Strategy.

Other activities undertaken by the Environment Agency in relation to its strategic overview role include:

- providing an overview of the current and future risks from all sources of flooding and coastal erosion
- advising government on the management of risks from all sources of flooding and coastal change, including the impacts on people, businesses, infrastructure and the environment, as well as the future investment needs
- providing data and evidence – through risk mapping, modelling and assessment – to help inform the decisions made by risk management authorities at a range of spatial scales
- providing advice and guidance on improving information sharing and collaboration between risk management authorities and between the owners of flood and coastal defences
- facilitating effective partnerships in local places where there is local support that partnership working will help to reduce risk from flooding and coastal change
- providing evidence and advice to inform risk management authorities, planning authorities and national infrastructure providers on how they can plan and adapt to all sources of flooding and coastal change in the face of a changing climate
- providing advice to risk management authorities on how investments to manage flooding and coastal change projects can deliver integrated nature based solutions that protect and enhance the environment
- providing advice on the skills risk management authorities need to effectively address flooding and coastal change
- coordinating risk management authority investments in managing all sources of flooding and coastal change through regional programmes, which are approved by regional flood and coastal committees
- administering national grants and local levies to support the delivery of regional programmes, with the consent of regional flood and coastal committees

Regional flood and coastal committees

Regional flood and coastal committees have a key assurance role to promote efficient, targeted and risk-based investment in flood and coastal erosion risk management that optimises value for money and benefits to local communities. In pursuit of this they are consulted and give consent to the Environment Agency's flood and coastal erosion risk management investment programmes (see Annex A for further details of statutory obligations of regional flood and coastal committees).

Regional flood and coastal committees have a key assurance role to promote efficient, targeted and risk-based investment in flood and coastal erosion risk management.

Local authority overview and scrutiny committees

Under the Local Government Act 2000, overview and scrutiny committees have the ability to review and scrutinise risk management authorities in relation to their flood management work. Local

authorities have flexibility to decide how these local scrutiny arrangements should operate, and are responsible for ensuring that there is effective local democratic oversight of the work of risk management authorities. For example, if there was a flooding event in a specific place, the overview and scrutiny committees would be able to undertake a review of the event or review the current arrangements for local flood risk management in the area. Risk management authorities have to comply with requests for information from overview and scrutiny committees.

Post-flood investigations

Lead local flood authorities also have a duty under section 19 of the Flood and Water Management Act 2010 to undertake formal investigations for some incidents of flooding in their area, including investigating whether risk management authorities have exercised their functions, and to publish a report of their findings.

Other assurance mechanisms

As well as these overarching arrangements, all of the organisations involved also have their own accountability requirements. For example, they may be accountable to other regulatory bodies such as the economic regulator of the water sector in England and Wales (Ofwat), the United Kingdom's communications regulator (OFCOM), auditors appointed under the Local Audit and Accountability Act 2014 or the charities commission.

Monitoring and Reporting

Under section 18 of the Floods and Water Management Act 2010, the Environment Agency must produce Flood and Coastal Erosion Risk Management Reports' (the 'section 18' reports). These reports must include information about the application of the national flood and coastal erosion risk management strategy.

Reporting of this Strategy to the minister will be carried out and submitted annually. An outline of the main reporting activities is set out in Annex B.

Alongside the Strategy the Environment Agency will develop an action plan with partners, for taking forward the Strategy's measures which will be published by April 2021. The next review of the Strategy is planned for 2026 at which point the Environment Agency will review and update the shorter term measures to ensure we remain on track to support the Strategy's vision and longer term objectives.

Future risk and investment

Strategic objective A: Between now and 2025 the Environment Agency will have better evidence to inform future risk and investment needs for managing all sources of flood and coastal change.

A single picture of flood and coastal risk

Risk mapping, modelling and assessment provides the essential data and evidence underpinning every investment decision risk management authorities make. At the local level, this includes informing decisions about spatial planning, prioritising investments in flood and coastal infrastructure and targeting the work of emergency responders when planning their incident response. Nationally, it is used to quantify the overall scale of risk and the investment needed to manage it, and provides evidence to support the national Strategy.

Under the Flood and Water Management Act 2010, the Environment Agency has a strategic overview role for flooding and coastal change, and a range of roles relating to assessing, planning, advising and warning on flood and coastal erosion risk. The Environment Agency needs to maintain national information on the current and future risks arising from all sources of flooding and coastal erosion to carry out these roles.

Our current National Flood Risk Assessment tool is based on technology from the early 2000s and provides risk assessment data and information on flooding from rivers and the sea. Since then our mapping and modelling has significantly improved, as well as our understanding of flood risk from other sources such as surface water. We have also invested in local modelling that provides more detail and accuracy. The Environment Agency is currently developing a new National Flood Risk Assessment that will provide a single picture of current and future flood risk from rivers, the sea and surface water, using both existing detailed local information and improved national data.

The new risk assessment will be available as open data and will provide risk management authorities, infrastructure providers, insurers and members of the public with more accessible and trusted data and information for making good investment decisions. The new assessment will launch by 2024 and will be continuously improved

to provide the nation's flood and coastal risk assessment needs over the next 15 years. For instance, the Environment Agency will look to work with other risk management authorities and infrastructure providers to extend the new National Flood Risk Assessment after 2024 to cover other sources of flooding, from groundwater and sewers, when the risks from these sources are better understood.

Between now and 2024, the Environment Agency will continue to make targeted improvements in surface water mapping and detailed local modelling for supporting flood risk projects and strategies. For example, the Environment Agency is working with local partners to improve our understanding of the risk in targeted areas, and will be including the new information in the surface water maps on GOV.UK, alongside other local information where it exists. These improvements will be integrated into the new National Flood Risk Assessment by 2024. The Environment Agency will also invest in improving coastal monitoring and coastal erosion data to strengthen our evidence base for informing coastal adaptation plans and activities.

Long-term investment scenarios

One important function of the National Flood Risk Assessment, alongside the best available evidence for surface water flooding, is to provide the baseline for the Environment Agency's long-term investment scenarios. These were updated in 2019, and provide an economic assessment showing what flood and coastal risk management could look like over the next 50 years (Environment Agency, 2019a). The scenarios set out the total national level of investment needed in places where the benefits are greater than the costs. The assessment is largely based on the costs and benefits of traditional flood and coastal protection – such as building and maintaining flood barriers, embankments and sea walls – although it also considers the potential for some other ways of improving resilience.

The long-term investment scenarios show that for every £1 spent on protecting communities, we avoid around £5 in property damages.

The assessment factors in a wide range of possible climate futures including a high climate change scenario (4°C warming). It assumes investment from central and local government alongside partnership funding contributions, but does not suggest how much each sector should pay.

If we are to avoid risk getting worse, the Environment Agency estimates that in the long-term as a nation we need to spend an average of over £1 billion a year – which is a minimum of £50 billion in flood and coastal protection over the next 50 years (Environment Agency, 2019a). This illustrates the challenge of managing flood and coastal risks in the face of climate change. The long-term investment scenarios show that for every £1 spent on protecting communities, we avoid around £5 in property damages.

The Long-term investment scenarios are an economic assessment showing what future flood and coastal erosion risk management could look like over the next 50 years in England

Figure 6: Environment Agency long-term investment scenarios for managing flooding and coastal change.

We can also draw out the following findings from the long-term investment scenarios:

Flood and coastal risk management activities

- Raising flood and coastal defences will become technically and socially challenging with higher climate change scenarios. For instance, to contain an extreme flood through an urban area may require high flood walls deemed to be unacceptable to a local community.
- The long-term investment scenarios consider the role that other flood and coastal risk management activities could play in combination with traditional flood and coastal defences including natural flood management and property flood resilience. They demonstrate that natural flood management activities have an important role to play in working with natural processes to slow the flow or store floodwaters.
- A greater take up of property flood resilience could help to significantly reduce flood risk for individual property owners. The long-term investment scenarios show the potential for an estimated 200,000 homes in England to be fitted with property flood resilience over the next 50 years (Environment Agency, 2019a).

Development in the floodplain

- Population growth projections, and the resultant need for new homes, means we are likely to see almost double the number of properties in the floodplain, an increase from 2.4 million to 4.6 million over the next 50 years (Environment Agency, 2019a). Government planning policy steers new development away from areas at highest risk. This should mean many of these new properties will be in areas with low to very low likelihood of flooding due to the presence of existing flood and coastal defences. Where it is not possible to avoid development in flood risk areas, government planning policy requires it to be made safe for its lifetime without increasing flood risk elsewhere.

If the floodplain is to be subject to increased development pressure, effective local implementation of government planning policy will play a key role.

This includes requiring developers to take suitable mitigation measures such as raising floor levels to improve the resilience of properties to flooding.

— If the floodplain is to be subject to increased development pressure, effective local implementation of government planning policy will play a key role in mitigating future flood damages. The long-term investment scenarios suggest that as long as local planning authorities implement national planning policy effectively, the increase in future property damage from flooding should be relatively modest at 4%. However, if national planning policy or its local implementation is weakened, the outlook could be very different, with property damages potentially increasing by over 30% over the next 50 years (Environment Agency, 2019a).

Infrastructure resilience

— The long-term investment scenarios team commissioned experts at the University of Oxford to examine the impacts of flooding from rivers and the sea on transport and utilities infrastructure including: road, rail, electricity, gas and water. This research found over two-thirds of properties in England are served by infrastructure sites and networks located in, or dependent on others located in, areas at risk of flooding (Environment Agency, 2019a). The analysis shows that impacts are sensitive to the resilience of infrastructure and therefore are the upper estimate. Many infrastructure owners have invested to improve infrastructure resilience, as outlined in the National Flood Resilience Review (Cabinet Office, 2016). As a result, some infrastructure on the floodplain is resilient to a very high level of protection.

Future long-term investment scenarios

The findings from the long-term investment scenarios highlight the importance of effective spatial planning decisions and resilient infrastructure, which we cover further in this Strategy's second ambition: 'today's growth and infrastructure – resilient to tomorrow's climate.

The Environment Agency will be able to update its long-term investment scenarios in 2025, making use of the richer information in the new National Flood Risk Assessment to produce more detailed insights into future flood and coastal risk, options for managing risk and the costs involved. The new scenarios will provide important evidence for informing future policy and investment choices for improving resilience and adaptation to future climate risks.

Measure A.1: By 2023 the Environment Agency will work with coast protection authorities to improve the National Coastal Erosion Maps to strengthen the evidence base for coastal adaptation investments and decisions.

Measure A.2: By 2024 the Environment Agency will produce a new national assessment of flood risk that will help places better plan and adapt to future risks from flooding from rivers, the sea and surface water.

Measure A.3: By 2025 the Environment Agency will produce a new set of long-term investment scenarios to inform future policy and investment choices for achieving flood and coastal resilience.

Strategic objective B: Between now and 2030 risk management authorities will make greater use of funding and financing from non-public sector sources to contribute to the investment needs of flood and coastal resilience.

Finding new funding and financing sources

Figure 7: Bacton to Walcott Sandscaping Scheme, Norfolk.

The Environment Agency's long-term investment scenarios show that we need sustained investment in flood and coastal resilience over the coming decades. To achieve this we need to explore and develop new and innovative opportunities to secure funding and finance from all sources across public and private sectors. Finance means borrowing

money now which we pay back over a number of years. Funding means finding new sources of money each year to pay for activities that make places more resilient to flooding and coastal change.

Traditionally the public sector has contributed the majority of funding towards flood and coastal change projects. About 90% of partnership funding contributions from the flood and coastal erosion risk management programme (2015 to 2021) are coming from local authorities or other public authorities (Environment Agency, 2019d). In the future we will need more partnership funding from non-public sources.

Identifying new sources of funding is not a new challenge. There are already examples of where new sources of partnership funding have helped to enable flood and coastal change projects to go ahead. In most cases these work by getting beneficiaries: communities, businesses, developers, infrastructure providers and others to make a contribution to the cost of a project.

Risk management authorities need financially confident people with the skills and capabilities to secure funding from other sources. This involves being able to describe the physical, financial and emotional impacts of flooding and coastal change in a way that directly relates to businesses and communities. For example, major flood related financial risks include loss of takings and supply chain failures which impact on earnings, profits, jobs and livelihoods. By helping businesses realise the financial benefits of becoming more resilient to flooding and coastal change it makes it easier to secure contributions.

Case studies on innovative funding

Securing funding from infrastructure providers

The Bacton Sandscaping project has been the culmination of 5 years of close and successful working between risk management authorities and private sector partners. The project entailed placing 1.8 million cubic metres of sand on the foreshore in front of Bacton Gas terminal and nearby villages at risk of both coastal erosion and sea flooding. It is the first project of its kind in the UK and closely mirrors the Dutch ‘Zandmotor’ which was trialled on the Dutch coast in 2011. The Bacton Gas terminal is critical infrastructure providing about one third of the United Kingdom’s gas supply. This coastal frontage was badly impacted during the December 2013 surge. The total project costs were approximately £20 million with the majority of funding coming from the Bacton Gas terminal operators. Whilst better protecting the site and nearby villages from coastal erosion and flood risk, the project also provides time for risk management authorities and the community to work together on a longer-term solution (North Norfolk District Council, 2019).

Using business improvement districts

The Sheffield Lower Don project was the first of its kind in the UK to have business owners contributing to the costs of the flood protection through the creation of a formal business improvement district – a business-led partnership created to bring additional services to local businesses. The total project cost was £21 million, with £1.4 million of contributions secured from local businesses. Sheffield City Council led on development of the project with support from the Environment Agency and the Lower Don Valley Business Improvement District. The project better protects 500 businesses, 36 homes and thousands of jobs. The defences are designed to protect against a flood with a 1% chance of occurring within any given year and are designed to take into account future climate change impacts up to the year 2040 (GOV.UK. 2018).

Establishing community interest companies

Individuals very rarely contribute directly to the costs of a flood or coastal project. Where they do, they are generally brokered via the local authority or local community lead and will be relatively small. An example of communities making direct contributions to managing coastal flood risk are in the Norfolk holiday parks at Heacham, Snettisham and Hunstanton. In this case, a community interest company was established to raise funds to maintain the coastal defences along the Wash on the East Coast. This was done in partnership with the Environment Agency and local district council (Environment Agency, 2015).

This Strategy identifies opportunities for risk management authorities to seek wider partnership funding contributions to flood and coastal projects. The Strategy Ambition: Climate Resilient Places identifies how new and innovative financing options could be aligned to long-term adaptive approaches to planning for flooding and coastal change.

The Strategy Ambition: Today's Growth and Infrastructure in Tomorrow's Climate identifies ways in which risk management authorities can work with planners, developers and infrastructure providers to align investments and identify opportunities for partnership funding of flood and coastal change projects.

Improving the disclosure and transparency of information held by businesses on the climate risks they face can help secure finance from other private sector sources. The Task Force for Climate Related Financial Disclosure has developed a framework that allows companies to disclose information and report on the climate risks they face to their investors, lenders, insurers, and other stakeholders. In the Green Finance Strategy, the government recognised the importance of such disclosures, to manage risk and meet the

nation's climate ambitions. Helping private sector partners to better understand their exposure to climate resilience challenges should make it easier to make the business case for potential contributions to flood and coastal change projects. Developing and testing new and innovative financing is an area this Strategy will seek to test and develop with risk management authorities and private sector partners in the coming years.

Measure B.1: From 2021 the Environment Agency will work with other risk management authorities and private sector partners to trial new and innovative financing to improve flood and coastal resilience.

Measure B.2: By 2025 risk management authorities will encourage the development of the skills and capabilities they need to help secure new and innovative funding and financing for flood and coastal resilience.

Climate resilient places

Climate resilient places

Climate change is already changing our weather and increasing our risks of flooding and coastal change. The government's 25 Year Environment Plan (Defra, 2018) states that current global commitments under the Paris agreement are insufficient to limit the average temperature rise this century to well below 2°C above pre industrial levels. We need bold and transformative action if we are to become a climate resilient nation. We need to be able to plan to adapt to a range of climate change scenarios, including higher scenarios such as a 4°C rise in global average temperatures.

Progress towards climate resilient places

Risk management authorities and other partners have already made progress towards having more climate resilient places in the following ways.

- Between 2015 and 2021, risk management authorities will have invested over £2.7 billion of government funding to reduce the risk of flooding and coastal change to over 300,000 homes. This includes £1.2 billion of investment in projects that manage coastal erosion and sea flooding. In addition, partners and other public sector organisations have also already contributed over £600 million, enabling more homes to be better protected (Environment Agency, 2020c).
- Between 2015 and 2021, risk management authorities will have completed flooding and coastal change projects that better protect over 280,000 hectares of agricultural land, helping to avoid more than £500 million worth of economic damage to agricultural land production (Environment Agency, 2019f).
- Between 2015 and 2021, risk management authorities will have completed flooding and coastal change projects that enhance the ecological quality of approximately 650km of waterbodies (Environment Agency, 2020b).
- Between 2015 and 2021, risk management authorities will have completed flooding and coastal change projects that create or enhance approximately 4,700 hectares of habitat (Environment Agency, 2020b).
- Since the early 2000s, the Environment Agency has had a national Habitat Compensation Programme. Over 900 hectares of inter-tidal habitat has already been created providing compensation for internationally protected habitats we expect will be lost as a result of building flood and coastal defences elsewhere (Environment Agency, 2019b).

Existing approaches to flood and coastal risk management have been developed through our response to flood events in the past rather than the climate challenges we will face in the future. While it will never be possible to prevent all flooding and coastal change, we all have a role to play in taking action now so that we are ready for what the future will bring. Risk management authorities need to support individuals, communities, businesses, farmers, land managers and infrastructure providers to better plan and adapt to future flooding and coastal change.

This Strategy calls for the nation to embrace a broad range of resilience actions including better protection to flooding and coastal change.

We must continue to do what we have been doing: building and maintaining strong defences to reduce the risk of places being flooded. In places like the Thames Estuary it makes economic sense to continue to invest heavily in engineered solutions to improve resilience. But the protection provided by flood and coastal defences can only ever be part of the solution for creating more climate resilient places. Building our way out of managing future climate risks will not always be the right approach, particularly as the changing climate drives more extreme weather patterns, higher rainfall in shorter periods, and faster coastal erosion.

This is supported by the Environment Agency's long-term investment scenarios which tested the benefits of investing in very high levels of protection across the country. Very high levels of protection could make a big positive difference to managing long-term flood and coastal risks. But, technical, social and environmental limitations can make this difficult to achieve in some places. For instance, to contain an extreme flood through an urban area may require unacceptably high flood walls, or a lot more space for accommodating flood waters.

The value people put on the look and feel of a place means we have to think even more creatively about how to reduce risk and create climate resilient places. For instance, in Keswick the Environment Agency agreed with the local community and local partners to use glass panels instead of stone to increase the effective height of defences whilst retaining much loved views of the town's river. In Cockermouth, a self-raising barrier was used to allay local concerns about the appearance of the flood project.

In the face of a changing climate, we need to also make our places more resilient to flooding and coastal change, so that when it does happen it causes much less harm to people, does much less damage, and ensures life can get back to normal much quicker.

Alongside flood and coastal defences, we need a broader range of actions for achieving climate resilient places. This includes avoiding inappropriate development in the floodplain and using nature based solutions to slow the flow of or store flood waters. It involves better preparing and responding to flood and coastal incidents through timely and effective forecasting, warning and evacuation. And it means

helping communities and local economies recover more quickly after a flood or 'building back better' so that properties and infrastructure are more resilient to future flooding. Furthermore, we need to recognise the emotional connections people have to the places in which they live and work and how this influences their engagement with risk management authorities on planning for resilience.

Figure 8: New flood defences in Keswick, Lake District.

Flood resilience internationally

Resilience can be framed in different ways, but there are common themes to how resilience is referred to internationally. To a large extent, resilience is specific to the socio-economic context where it's applied. In the Netherlands, flood resilience is linked to loss of life. The Dutch model assesses risk to life, but also considers the economic damages from flooding and the role of spatial planning in avoiding and minimising future risks. Historically, many countries have focussed on achieving resilience by investing in flood defences to protect farmland, industry and communities, but are now left with the common challenge of deteriorating defences. For example, the average age of levees in the USA is 50 years and the Dutch have some flood and coastal defences that are hundreds of years old. Such approaches may no longer be sustainable and we're starting to see the international community promote the use of nature-based solutions to manage flood risk (World Bank, 2017). For example, the US Army Corps of Engineers promoted community resilience following Hurricane Sandy in 2013 by engineering with nature, recognising the lower cost and more resilient solutions that working with natural processes could deliver.

It's important that we think about resilience to flooding and coastal change and adaptation to future climate risks going hand in hand. Approaches to resilience need to be monitored over time against changes in climate, growth projections and environmental conditions.

Taking an adaptive approach will ensure that the costs of making our homes, businesses, infrastructure and land use more resilient to a changing climate are far smaller than the considerable damage that flooding and coastal change could cause.

What will be different?

Risk management authorities will work with partners to:

- Deliver practical and innovation actions that help to bolster resilience to flood and coastal change in local places.
- Make greater use of nature-based solutions that take a catchment led approach to managing the flow of water to improve resilience to both floods and droughts.
- Maximise opportunities to work with farmers and land managers to help them adapt their businesses and practices to be resilient to flooding and coastal change.
- Develop adaptive pathways in local places that equip practitioners and policy makers to better plan for future flood and coastal change and adapt to future climate hazards.

Strategic objective 1.1: Between now and 2050 the nation will bolster its resilience to flooding and coastal change.

The consensus from stakeholders who have contributed to the development of this Strategy is that **flood and coastal resilience** involves the capacity of people and places to:

- **Plan for, better protect, respond to, and to recover from flooding and coastal change.**

This includes:

- **Making the best land use and development choices, better protecting people and places, responding to and recovering from flooding and coastal change and all the time adapting to climate change.**

There are 4 approaches to managing flood and coastal resilience that risk management authorities can progress with partners. They are to:

- **Improve place making:** Making the best land use and development choices for managing flooding and coastal change
- **Better protect:** Building and maintaining defences and managing the flow of water in a catchment or a place
- **Ready to respond:** Planning for and responding effectively to incidents
- **Recover quickly:** Getting back to normal and building back better.

Resilience in places

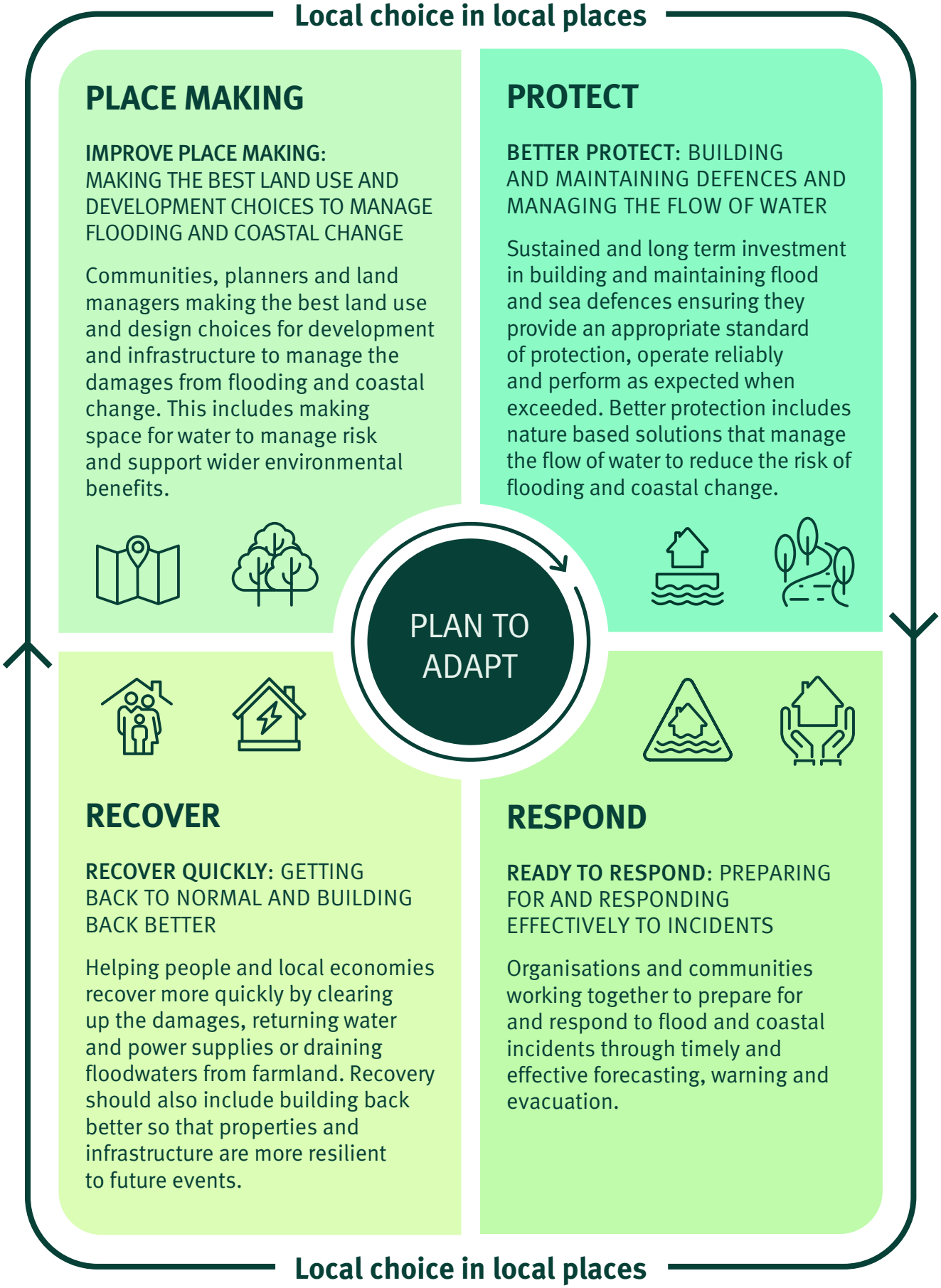


Figure 9: The different components of resilience.

These 4 approaches need to:

- **Cover all sources of flooding and coastal erosion:** The Environment Agency's updated National Flood Risk Assessment, due in 2024, will support improvements to the evidence base for fluvial, coastal and surface water flooding.
- **Be flexible to local places and reflect local choices:** There are many actions that people and places can use to improve resilience to flooding and coastal change. Every place is different and so the exact combination of resilience actions will be tailored to a particular place. We need to take an approach that reflects the different circumstances of places – not just their population size, but also their distinctive characteristics, be they coastal, urban or rural. Local people and local partners should be at the heart of making local choices about the best combination of resilience actions for achieving greater flood and coastal resilience in the places in which they live and work.
- **Be adaptable to future climate risks:** Planning and adapting to future climate risks is crucial to making sure places remain resilient to future flooding and coastal change over the longer term. This means looking out to 2100 and beyond to ensure we are resilient to future climate hazards. Adaptation planning needs to be integrated across all four of these resilience approaches (see strategic objective 1.3). The Environment Agency will also work with the government to review its appraisal guidance for flooding and coastal change projects, so that investment decisions better account for a wider range of resilience actions and climate change scenarios.

There are a wide range of actions that can be chosen by local places to improve resilience to flooding and coastal change.

RESILIENCE APPROACH	RESILIENCE ACTION	EXAMPLES
Improve place making	Making decisions on land use that reflect current and future flooding and coastal change	– Establishing climate resilient local spatial planning policies – Avoiding inappropriate development in flood and coastal erosion risk areas
Improve place making	Planning for coastal transition	– Developing long term approaches to help coastal communities transition and adapt to a changing climate
Improve place making	Designing places, buildings and infrastructure more effectively	– Encouraging flood resilient building standards – Fitting property flood resilience measures to homes and properties – Retrofitting sustainable drainage systems in urban areas

Figure 10: Examples of resilience actions (continues).

RESILIENCE APPROACH	RESILIENCE ACTION	EXAMPLES
Better protect	Investing in building and maintaining flood and coastal defences	– Building flood and coastal defences to provide an appropriate standard of protection – Ensuring that the flood and coastal defences operate reliably and perform as expected when exceeded – Deploying demountable barriers where permanent defences are not feasible
Better protect	Reducing flood risk through river channel maintenance	– Clearing vegetation – De-silting around flood defences – Dredging where appropriate and effective
Better protect	Managing the flow of water through the environment	– Implementing nature-based solutions in places and catchments – Utilising upland water storage and better land management practices – Investing in wetland creation in coastal areas
Ready to respond	Enhancing community resilience	– Working with emergency responders, community groups and volunteers to set up local flood groups – Training and supporting flood wardens based in local communities
Ready to respond	Responding quickly and effectively to flood and coastal erosion events	– Improving the flood warning service to better target local areas at risk – Ensuring multi-agency flood plans are up to date and tested regularly
Recover quickly	Helping people and local economies recover more quickly	– Building voluntary sector capacity and skills to support communities with recovery following flooding – Developing contingency plans so that utility providers return water/ power/ communications as soon as possible after flooding – Draining floodwaters from farmland as quickly as possible
Recover quickly	Enabling people and businesses to build back better after flooding	– Ensuring flood repairs provide a greater level of resilience post-event (for example property flood resilience) – Improving access to affordable flood insurance

Figure 10: Examples of resilience actions.

Ultimately, the effectiveness of different resilience actions will depend on a number of factors including funding arrangements, local application of national policy as well as local leadership and support from the local community. Some of the actions for delivering resilience go beyond the role and direct influence of risk management authorities and so it will be vital that they work closely with land managers and the business and environment sectors. It will also be important to involve local elected members who have a democratic mandate for representing local community views as well as regional

flood and coastal committees. In places like Cumbria, members of the local community are already working with risk management authorities and other local partners to develop an action plan based on applying a combination of resilience actions.

Cumbria strategic floods partnership

The Cumbria strategic floods partnership was formed following the devastating flooding experienced during the winter of 2015 to 2016. The partnership is made up of public and private organisations, local partners and local community representatives who are working in partnership with catchment management groups. The Cumbria flood action plan was developed by the partnership and commits to about 100 actions to increase local flood resilience.

This includes investing in flood defences in combination with upstream land management and techniques to slow the flow of flood water upstream of places at risk, whilst maximising the amount of flood water that can be carried safely by local river channels. Importantly the plan also contains actions for farmers and land managers which has helped to foster community ownership of the action plan. (Environment Agency, 2016a).

Figure 11: Photograph of flooding in Keswick, Cumbria during the winter 2015 floods.

In the 2020 Budget, the government provided £200 million between 2021 and 2027 for a resilience programme. The programme will enable local places to test, develop and implement practical and innovative resilience actions to help communities at risk of flooding and coastal change. Examples of resilience actions are shown in Figure 10. The programme will support over 25 places in urban, rural and coastal areas, from the North, the Midlands and the South, to take forward resilience actions. The funding will be available at a strategic scale reflecting county and catchment boundaries and be for risk management authorities to apply for in collaboration with local partners and local communities. The places selected will serve as

exemplars for flood and coastal resilience showing the way for other places in the country.

The resilience actions will complement the protection provided by flood and sea defences enabling local places to progress resilience actions that would be outside the scope of what government usually funds. Examples could include some of the actions listed in Figure 10. The resilience programme will also be able to test and develop new approaches such as spearheading innovative funding and financing mechanisms for local flood and coastal resilience projects (see strategic objective B). Through its strategic overview role, the Environment Agency will lead and coordinate this programme working closely with government. The Environment Agency will work with the government to develop a prospectus for the programme with a menu of possible resilience actions local places can choose from for improving flood and coastal resilience.

International examples of assessing flood resilience

The Zurich Flood Insurance Resilience Measurement for Communities (2019) assesses communities' resilience to flooding based on quantitative and qualitative measurements across 44 indicators of flood resilience. Each indicator is assessed on a 4 point scale from 'best practice' to 'significantly below standard', providing evidence of how community resilience to flooding can change over time.

The FEMA Community Rating System (2018) in the United States credits communities for implementing certain flood risk management actions (such as flood defences, warning and informing, relocation, spatial planning and floodplain mapping) rewarding them with reduced flood insurance premiums. Different actions attract a certain amount of credit. Communities make local choices on the types of tools to implement to obtain enough credits to attain reductions in flood insurance premiums.

To improve the nation's flood and coastal resilience, we need to understand how different resilience tools can contribute to reducing the costs and consequences of flooding and coastal change. Internationally, both public and private sector organisations have developed different ways of describing resilience, driving community action and demonstrating how community resilience can be improved over time (Zurich, 2019; FEMA, 2019). In England, a recommendation for improving the nation's resilience to flooding was proposed in the 2018 National Infrastructure Assessment (NIC, 2018), which suggested developing a longer term strategy for delivering national standards of resilience by 2050. The government's Call for Evidence on flooding and coastal erosion policy has also sought to understand how the different aspects of resilience could usefully be brought

together into one overall concept. It provides a summary of the advantages and disadvantages of using different metrics to describe, drive and monitor flood and coast outcomes (Defra, 2020f).

The evaluation and learning from the resilience programme will allow us to expand our approaches for analysing the costs and benefits of a wider range of resilience actions. This will enable funding to be targeted to where it can have the greatest effect on reducing the likelihood and consequences of flooding and coastal change for people, infrastructure, the economy and the environment.

To achieve our objective we have the following measures:

Measure 1.1.1: By 2021 the Environment Agency will enhance the appraisal guidance for flooding and coastal change projects, so that investment decisions can better reflect a wider range of resilience actions and climate change scenarios.

Measure 1.1.2: From 2020 the Environment Agency will work with the government to lead the delivery of the resilience programme supporting 25 local places to take forward innovative actions that help to bolster resilience to flooding and coastal change.

Measure 1.1.3: By 2025 the Environment Agency will work with government to use the evaluation and learning from the resilience programme to better understand the benefits and costs of different resilience actions.

Strategic objective 1.2: Between now and 2050 risk management authorities will help places plan and adapt to flooding and coastal change for a range of climate scenarios.

To be better prepared for climate change we need to take action now, so we are ready for the impacts and can make sure the places people live and work in are safe and resilient to future flooding and coastal change. The Committee for Climate Change (2019) and Organisation for Economic Co-Operation and Development (2019) have highlighted the importance of adaptation to rising sea levels and flood and coastal risks. Both indicate that the longer-term costs to society of not pursuing adaptation will be far greater than the costs of investing in resilience and adaptation today.

Adapting now to a changing climate is in our economic self-interest. Research by the United Nation's Global Commission on Adaptation has found that the overall rate of return on investments in improved resilience is very high and that failing to seize the economic benefits of climate adaptation with high-return investments could undermine trillions of dollars in potential growth and prosperity. Specifically, it found that investing $1.8 trillion globally in climate resilient

infrastructure, finance initiatives and other areas from 2020 to 2030 could generate $7.1 trillion in total net benefits (Global Commission on Adaptation, 2019).

Flood and coastal adaptation internationally

Many megacities are in low-lying coastal areas, which are highly vulnerable to rising seas and coastal change. Public authorities in these cities are already embracing adaptive approaches to managing the future risks and uncertainty from climate change. Following Hurricane Sandy in 2012, the New York (USA) state authorities and emergency responders have developed an adaptive pathway approaches to planning for future flood resilience, with three-yearly reviews to monitor progress with resilience actions and decisions (Rosenzweig, C. and Solecki, W., 2014). Similar approaches have been adopted in Los Angeles (USA), where future flood risk is simulated for a range of sea level rise and climate scenarios to inform the economic appraisal of longer term investment decisions (De Ruig, L. T. et al, 2019). On the other side of the world in Shanghai (China), an adaptive pathway has also been developed to inform strategic investment choices for reducing the risk from future coastal and river flooding to the city's population, businesses and economy (Ke, Q., Haasnoot, M. and Hoogvliet, M., 2016).

Planning for climate change adaptation can sometimes be challenging and can often feel daunting. It is often easier to plan for one scenario of future climate but much more difficult to plan for a range. We need to manage this climate uncertainty to enable investment in suitable resilience actions at the points when they will provide maximum benefit. This avoids making investments in flood and coastal resilience too early, too late, too little or too much, avoiding unnecessary flooding and recovery costs. For practitioners and policy makers, this means remaining agile to the latest climate science, growth projections, investment opportunities and other changes to our environment, to ensure that the capacity to adapt is built into all investment decisions.

Flooding and coastal change requires an adaptive approach that allows local decision makers to identify the best combination of resilience actions and the right time to take action. It is also vital to secure buy in from local partners to make them happen. We call this **'adaptive pathways'**, which enable local places to better plan for future flood and coastal change and adapt to future climate hazards. They can also be referred to as strategic investment pathways. Taking an adaptive approach is recommended in the government's Green Book Supplementary Guidance (HMT, 2009) and can reduce overall

costs by improving the timing and effectiveness of investments. Adaptive pathways can help to ensure that as a nation we can be more economically resilient to future climate hazards to better manage future flood and coastal risks.

Looking out to the year 2100, every place needs to identify the decisions for managing flooding and coastal change to be taken now and those which can be made in the future. The Thames Estuary is a world-leading example of this approach.

Thames Estuary 2100

The Thames Estuary benefits from a world-class system of defences providing protection to 1.3 million people and £275 billion of property and infrastructure from tidal flooding. Climate change, ageing defences, growth and other pressures mean the risk of tidal flooding is increasing over time. The Thames Estuary 2100 Plan, approved by government in 2012, was developed to provide strategic direction for managing flood risk to the end of the century.

The plan has climate change at its core. It includes a series of pathways for different climate change and socio-economic futures.

The current plan has 3 phases:

- 2010 to 2034 focuses on maintaining the current flood defence system and safeguarding land for future improvements through local strategies and spatial plans
- 2035 to 2049 will see work to reshape the riverside with improvements to many flood walls, embankments and small barriers
- 2050 to 2100 is when the plan expects decisions to be needed on long-term investments, including the construction of a new Thames Barrier

Throughout each phase, the plan aims to: manage the risk of flooding to people, property and the environment, adapt in response to climate change, and enhance and restore ecosystems, making the Thames Estuary a better place for people and wildlife.

The plan takes an adaptive pathways approach, with options for managing future tidal flood risk being continuously reviewed and revised in line with how the estuary is changing over time. It sets out a range of pathways for managing differing amounts of sea-level rise, river flows and increasing risk of storm surges.

The first full review of the plan will begin in 2020 and will consider how the climate, environment and socio-economic conditions in the estuary have changed and are expected to change in the future. This will influence whether the Environment Agency and partners need to

alter the current pathway and how this may impact future investment and management of the tidal flood defences.

(Environment Agency, 2012).

Figure 12: The Thames Barrier, London.

As a nation we need to be better at integrating adaptation to flooding and coastal change into daily activities and projects, as well as longer term strategic investment plans and strategies for places and catchments. This applies to all risk management authorities and other partners. To help do this we need to pioneer adaptive pathways in a range of different geographical places at high flood or coastal erosion risk where major investments are likely to be needed in the coming decades.

The Environment Agency will develop approaches to adaptive pathways in a selection of places to identify the best timing and location for flood and coastal defences and other resilience actions looking out to 2100 and beyond. These adaptive pathways will enable the Environment Agency to work with partners to develop and explore:

- how different resilience actions could help to better plan for, better protect, respond to, and recover from flooding and coastal change over pathways to 2100 and beyond
- more effective investment in the maintenance and replacement of the existing flooding and sea defences that people rely upon
- local land use and development choices by accounting for a range of climate futures and reducing economic damages from flooding and coastal change
- better coordination of planning and investment cycles with infrastructure, utilities and land managers to unlock investment in flood resilient infrastructure and services as well as sustainable water management
- opportunities for delivering integrated water level management that improves flood and coastal resilience whilst also enhancing water quality and the natural environment (such as flood resilience, drought and water quality)

The evaluation and learning from the adaptive pathways will form the core of a new package of guidance, web-based resources and adaptation tools

for places, which the Environment Agency will develop. This package will enable risk management authorities to better integrate adaptation to future flooding and coastal change into projects, investments and strategic plans. The learning will also help to inform the development of the Environment Agency's next set of long-term investment scenarios (see strategic objective A) and inform future national policy and investment choices for achieving flood and coastal resilience.

There are already ways risk management authorities can influence long-term planning choices through strategic flood and coastal risk management planning. Shoreline management plans provide a framework to plan for coastal adaptation, investment and spatial planning over a 100 year time horizon. In doing so, shoreline management plans can provide a basis for local engagement, consultation and political acceptance of future coastal change.

The Environment Agency is working with coastal groups to refresh the shoreline management plans in England to ensure they consider a range of future climate scenarios and are informed by the best available evidence, including the latest climate change projections. Flood risk management plans, covering inland areas, will also be evolving to better plan for a range of future climate change.

Strategic objective 2.1 in this Strategy explores how shoreline management plans can be used to better inform spatial planning policies for the coast. Alongside the refresh of shoreline management plans Defra in their Flood and Coastal Erosion Risk Management Policy Statement (Defra, 2020e) have also committed to a review of the national policy for shoreline management plans.

The learning from the adaptive pathways will help to inform the Government's commitment to reform local flood and coastal erosion plans by 2026 to enable more resilient places through a catchment-based approach (Defra, 2020e).

Strategic flood and coastal planning and climate adaptation

Shoreline management plans cover the English coastline and some are considered to be world leading in planning for coastal adaptation. There are 20 shoreline management plans produced and updated by coastal groups in consultation with local communities and local partners. The plans identify a sustainable management approach for each stretch of coastline, based on 4 policy options that can change across 25 year time horizons:

- **hold the line**: maintaining or upgrading the level of protection provided by defences
- **advance the line:** building new defences seaward of the existing defence line

- **managed realignment:** moving or allowing the retreat of the shoreline and the creation of inter-tidal habitat where appropriate
- **no active intervention**: a decision not to invest in providing or maintaining defences. This requires engagement and adaptation where it affects communities

The Environment Agency is working with coastal groups to improve the access and use of shoreline management plans through the development of a web-based tool. The Environment Agency is also refreshing the evidence and technical guidance which underpins shoreline management plans. Coastal groups will then be able to use this evidence and technical guidance to review their shoreline management plans, update action plans and where appropriate change shoreline management policies.

Flood risk management plans (under the Flood Risk Regulations 2009) describe current and future risk of flooding from rivers, the sea, surface water, groundwater and reservoirs, including specific actions to manage risk. The first cycle of plans for 2015 to 2021 were developed in partnership with the Environment Agency, lead local flood authorities and water and sewerage companies.

The second cycle of flood risk management plans will set out specific actions between 2021 and 2027 and encourage authorities to start to take an adaptive approach to strategic flood risk planning using the 2018 UK climate change projections.

Both shoreline management plans and flood risk management plans will be assessed to meet requirements for environmental assessment, which includes the consideration of designated sites.

To achieve our objective we have the following measures:

Measure 1.2.1: From 2020 the Environment Agency will update the technical guidance for shoreline management plans to support coastal groups to generate the best evidence, actions and policies to plan and adapt for coastal change.

Measure 1.2.2: From 2020 the Environment Agency will work with other risk management authorities and local partners to develop adaptive pathways that enable local places to better plan for future flood and coastal change and adapt to future climate hazards.

Measure 1.2.3: By 2025 the Environment Agency will use the learning from adaptive pathways to develop a package of guidance, resources and tools to better integrate adaptation to future flooding and coastal change into projects, investments and strategic plans.

Measure 1.2.4: By 2025 coastal groups will review their shoreline management plans, update action plans and where appropriate change shoreline management policies to better reflect adaptive approaches to managing coastal change.

Strategic objective 1.3: Between now and 2050 risk management authorities will help coastal communities transition and adapt to a changing climate.

England has some of the fastest eroding coastline in Europe, for example along the Norfolk and Yorkshire Coasts. Coastal erosion is a natural and ongoing process that has been happening for thousands of years. But with sea levels continuing to rise well into the next century, the rate of coastal erosion in some places will accelerate. The Committee on Climate Change (2018) found that implementing current shoreline management plan policies to manage the risk to coastal communities would cost £18 to £30 billion over the rest of the century, and would not be cost-beneficial for at least 149 to 185 kilometres of coastline.

For some coastal locations it will unfortunately no longer be technically, socially or economically feasible to continue to provide protection from flooding and coastal change. In these places, the focus of resilience both now and in the future, will be on keeping people safe from harm and to develop resilience actions that minimise the impacts of flooding and coastal change on communities. In some places the scale and pace of change may be very significant that over a period of time risk management authorities will need to also support communities to transition and adapt to a changing climate. In East Riding of Yorkshire (East Riding of Yorkshire District Council, 2020) and North Norfolk (North Norfolk District Council, 2020), the local authorities already offer advice and assistance to their communities with coastal transition and adaptation. This includes facilitating community engagement, finding alternative housing for those at risk and in some cases supporting businesses to find opportunities in neighbouring areas.

Happisburgh – Norfolk coast

An example of where of an adaptive approach has been used is Happisburgh on the North Norfolk coast. The seaward edge of the Happisburgh cliffs had been a coastal management challenge since the 1980s. Beginning in the 1930s, a small community of non-standard chalet-style dwellings were built behind the cliff top along Happisburgh beach. More substantial brick-built houses were constructed further back from the edge. Defences were installed to help reduce erosion in the 1960s, after the 1953 storm surge.

The defences along this section of coast began to fail in the late 1980s due to the low beach levels. In the 1990s and early 2000s, North Norfolk District Council promoted several coast protection projects to try to address the problem. Continued competition for government funds around this time meant these projects were not delivered.

In 2010, North Norfolk District Council was awarded £3 million of government funds to test an alternative adaptive approach as part

of the pathfinder projects. This investigated and implemented the acquisition and removal of properties immediately at risk, and cleared the site, making it a more attractive cliff-top area and a safer place to live and visit, by improving access to the beach (Defra, 2012).

Since 2010, North Norfolk District Council continue to intervene at this dynamic location to address safety and access challenges, whilst 'roll back' policy is still in operation.

Figure 13: A property at risk of coastal erosion being demolished (image courtesy of North Norfolk District Council).

To achieve our objective we have the following measure:

Measure 1.3.1: From 2020 risk management authorities will support coastal communities to transition and adapt to a changing climate, where the scale and pace of future flooding and coastal change is very significant.

Strategic objective 1.4: Between now and 2030 risk management authorities will use nature based solutions and improve the environment through their investments in flood and coastal resilience.

Nature based solutions have an important contribution to play in achieving climate resilient places particularly at a community led, river catchment scale. They can support flood and coastal resilience, improve water supply and quality as well as contribute to wider climate change and sustainable development objectives. In doing so, nature based solutions help to achieve the ambitions of the government's 25 Year Environment Plan.

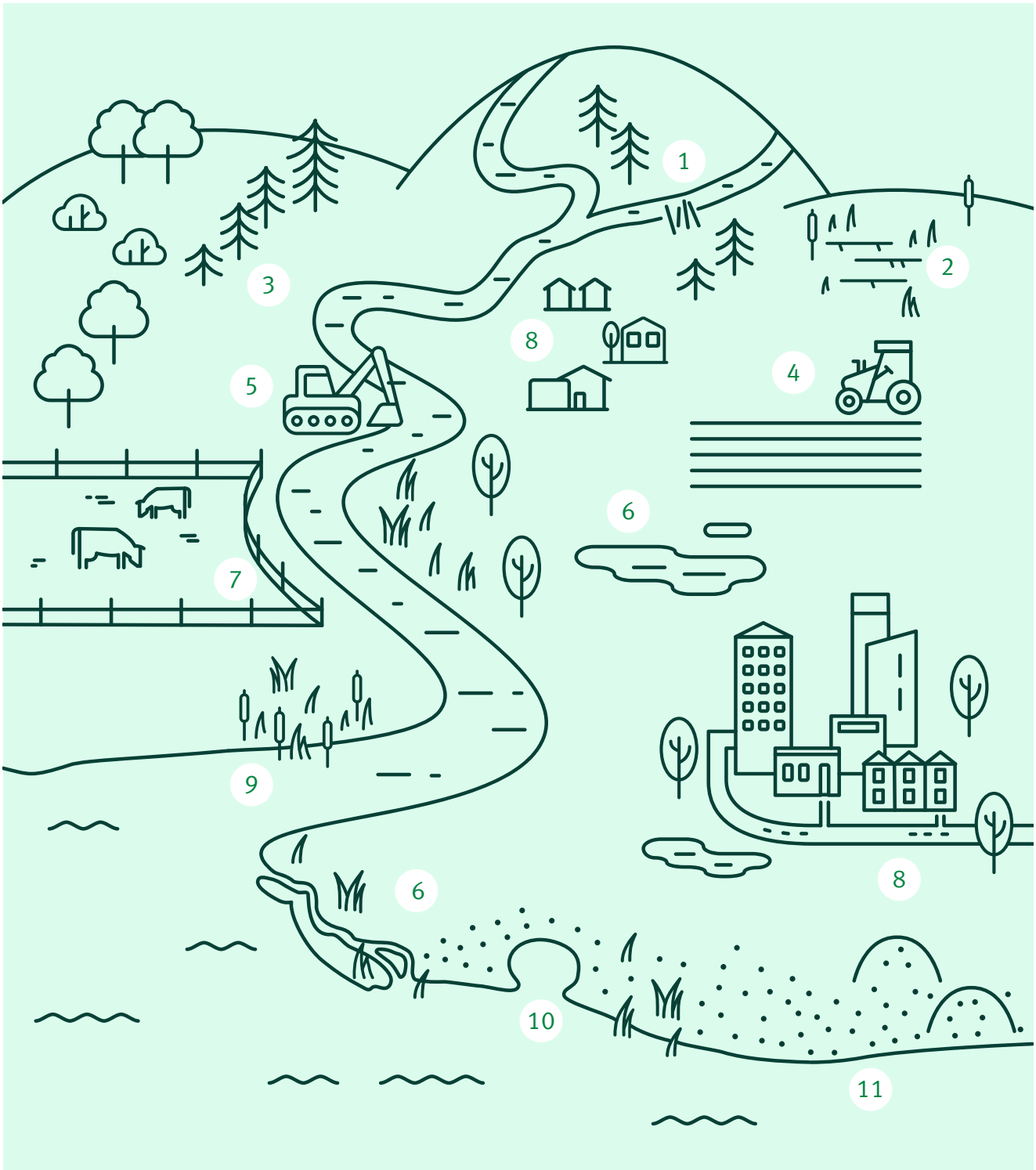
Nature based solutions involve a range of local activities, often undertaken through partnerships between risk management authorities, farmers, landowners, environmental groups and communities. In some places, solutions involve making space for water away from vulnerable development. Examples include, reconnecting rivers with their natural floodplain or creating new areas where water can be stored such as the

Lincoln washlands and Louth and Horncastle flood storage reservoirs. Where there is space, natural flood management techniques can store and slow water running off land in response to rainfall, to help reduce flood levels downstream. This can include tree planting. In towns and cities, green infrastructure and sustainable drainage systems can reduce surface water flooding while also helping enhance biodiversity and access to green spaces for promoting wellbeing. In coastal areas, creating wetlands, beach nourishment and managed realignment of the coastline can play a vital role in both supporting environmental protection and enhancement as well as adapting to coastal change.

Nature based solutions can play a key role in reducing flood risk but they are rarely enough to make a step-change in the risk faced by communities and businesses alone in the face of the most significant flood events. They work best when a 'catchment-based approach' is taken, to manage the flow of water from the source of our rivers to the sea, across our towns, cities, countryside and coasts. This way, nature based solutions and engineered flood and coastal defences can complement each other to manage flood risk to communities. There are over 100 catchment-based partnerships across England and cross border with Wales taking a community led approach to engaging with risk management authorities, land managers, businesses and civil society to promote a healthy water environment for the benefit of people and wildlife (CABA, 2020).

Significant evidence of the benefits of working with natural processes already exists in the Environment Agency's natural flood risk management evidence base and case studies (Environment Agency, 2017a). The government has also published a literature review on the research findings and best practice from stakeholders involved in delivering natural flood management projects (Defra, 2020c). International case studies such as those published in the 'Engineering With Nature: an Atlas Book' (US Army Corps of Engineers, 2019) also adds to this evidence. There are a growing number of demonstration projects that improve our understanding of natural flood management techniques and how they can work best in practice. In 2017 the government announced a £15 million pilot programme to learn more about natural flood management working with communities, land managers, catchment partnerships and coastal groups around England (Defra, 2017).

The government announced a significant amount of tree planting in the 2020 Budget (HMT, 2020). Trees help to mitigate climate change through their ability to absorb carbon from the air. Planting trees can also help us to better adapt to a changing climate and contribute to more flood resilient places.



1. In stream structures for example woody debris
2. Blocking of moorland drainage channels
3. Woodland planting
4. Land and soil management practices, cover crops, hedgerows, suitable crops
5. River morphology and floodplain restoration for example removal of embankments and remeandering
6. Inland storage ponds and wetlands
7. Protecting riverbanks for example stock fencing
8. Sustainable urban drainage systems for example swales, wetlands in urban areas, green roofs, permeable pavements, detention ponds, filter strips
9. Saltmarsh restoration
10. Coastal managed realignment
11. Coastal change management

Figure 14: ‘Nature based solutions’.

Many of our natural habitats have disappeared or are in poor condition. Many of our plant and animal populations are declining (State of Nature Partnership, 2019). Loss of biodiversity is a significant risk because we depend upon our natural ecosystems for our health and wellbeing. Nature based solutions for flood and coastal risk management can make an important contribution to improving the environment for wildlife and people by enhancing river and coastal waters and creating and improving natural habitats.

Statutory requirements for protecting and improving the water environment are set out in river basin management plans, drawn up by the Environment Agency with partners. The government's 25 Year Environment Plan includes the goal that 75% of our waters (such as rivers and streams) should be close to their natural state as soon as practicable. When making investments in flood and coastal defences, risk management authorities will support mitigation measures that contribute to achievement of the river basin management plans. These measures could include, for instance, providing passage for fish or eels to migrate along the river as part of a planned investment in constructing a flood barrier or upgrading a pumping station. Risk management authorities should also support the long-term goal of the 25 Year Environment Plan to enhance the water environment for people and wildlife.

Risk management authorities will also need to support the development of the new local nature recovery strategies which are intended to help restore wildlife rich habitats to enable nature to recover and thrive. These Strategies will also help to implement the wider Nature Recovery Network intended to improve, expand and connect habitats for the benefit of wildlife and people. Local nature recovery strategies could be led by local councils, national parks, Natural England or other bodies depending on local circumstances. By working closely with those seeking to create or restore natural habitats, risk management authorities can help ensure the natural environment contributes to improving flood and coastal resilience.

One of the important benefits of nature based solutions is that they can contribute to reducing carbon emissions. Planting trees and restoring wetlands such as peatlands and coastal habitats increases the amount of carbon stored in the natural environment. This helps mitigate climate change at the same time as helping us to reduce the risk of flooding and coastal erosion.

Nature based solutions provide opportunities for local communities and local groups, such as flood groups and catchment partnerships, to become actively involved in how flood resilience is achieved in their local areas. When communities are involved directly in making improvements in their own local environment it can result in better solutions that meet local needs, boost wellbeing and reduce the mental stress that can be associated with living with flood risk.

Adaptation to future flooding and coastal change also needs to account for the impacts to habitats and natural landscapes. This is important because we know that the current pattern of protected habitats cannot be sustained exactly as it is, due to climate change. For example, in some places along the coast, freshwater habitats protected by coastal defences may change into salt-water habitats as the sea rises. Risk management authorities and Natural England should work together to develop innovative approaches to conservation that enable adaptation to sea level rise and a changing climate. This will need to allow habitats and landscapes time and space to change in a sustainable way while retaining protecting high quality environments overall.

Stroud rural sustainable drainage project

After areas of Stroud flooded in 2007 and 2012, residents established community flood action groups to campaign for better protection from flooding. Studies showed large engineered storage solutions were not appropriate so local authorities made a bid for local levy funding to develop a natural flood management project.

A strong local, supportive partnership is a key strength of the project, and helps to maintain local political support. The way the project works encourages local responsibility and builds skills by working with local landowners and contractors to design and construct natural flood management measures on their own land.

This has led to working with over 20 landowners to reduce flood risk across the 250 square kilometre catchment. Over 400 measures such as leaky woody dams, earth field bunds, silt traps, dry ponds and offline storage areas now intercept flows from about one quarter of the catchment area (Short et al, 2018).

Figure 15: Leaky dam; one of the measures used in the Stroud rural sustainable drainage project.

To achieve our objective we have the following measures:

Measure 1.4.1: From 2020 risk management authorities and Natural England will jointly develop new approaches for the conservation of protected sites, species and natural landscapes that enable adaptation to sea level rise and a changing climate.

Measure 1.4.2: From 2021 risk management authorities will work with catchment partnerships, coastal groups, land managers and communities to mainstream the use of nature based solutions.

Measure 1.4.3: From 2021 risk management authorities will contribute to improving the natural, built and historic environment by investing in projects that manage flood and coastal risks where this is appropriate.

Measure 1.4.4: From 2021 investments in flood and coastal projects by risk management authorities will help to achieve objectives in river basin management plans and contribute to the government's aim for 75% of waters to be close to their natural state as soon as practicable.

Measure 1.4.5: From 2021 risk management authorities will work with Natural England and other partners as they develop Local Nature Recovery Strategies that enable new and restored habitats to contribute to flood and coastal resilience.

Strategic objective 1.5: By 2030 risk management authorities will work with farmers and landowners to help them adapt their businesses and practices to be resilient to flooding and coastal change.

Approximately 12% (1.4 million hectares) of agricultural land in England is at flood risk from rivers or the sea; or from both. This includes 57% of the Grade 1 agricultural land (Defra, 2011b). Agriculture contributes around 0.5% to the United Kingdom's economy as well as providing half of the food we eat and employs nearly half a million people (Defra, 2019a).

Some of our most productive and highest value agricultural land is in the floodplain or in low-lying areas, significant parts of which are below sea level. It is the past history of flooding that has created the productive soils in floodplains but, in order to take most advantage of this, the land needs to be freely drained and defended from lengthy inundation. Changing weather patterns could impact the productivity of agricultural land whilst rising sea levels could lead to the permanent loss of land in some areas by the end of the century.

The uplands are home to 44% of breeding ewes and 40% of beef cows in England which are also key to our food security (NFU online, 2019a). Upland areas can also play an important role in helping to reduce flooding by storing and slowing the flow of water.

Long-term, large scale land use change will be crucial in helping us reach net zero, adapt to the changing climate and restore nature. The National Farmers Union has set a goal of reaching net zero greenhouse gas emissions across England by 2040 (NFU online, 2019b).

Flooding has a significant impact for farmers and agricultural productivity. In the winter 2013 to 2014 floods, 45,000 hectares of agricultural land was flooded, including some coastal areas, at a cost of £19 million to the sector. Farmers and land managers were then impacted again in the winter 2015 and 2016 floods which led to costs of £7 million when 17,000 hectares of farmland was flooded (Environment Agency, 2018a). In early 2020, farming was once again affected by Storm Ciara and Dennis where 35,000 hectares of farmland were flooded.

Many farms benefit from investment in flood and coastal defences. Between 2015 and 2021, risk management authorities will have completed flooding and coastal change projects that better protect over 280,000 hectares of agricultural land, helping to avoid more than £500 million worth of economic damage to agricultural land production (Environment Agency, 2019f).

Figure 16: Managing the land well can help reduce the risk of flooding and coastal change.

Farming can also contribute to increasing flood risk through poor land use and management practices. For instance, some practices can affect the ability of the soil to accept and store water increasing runoff leading to localised flooding (Soil Association, 2020). Farmers and land managers therefore have a key role to play in creating climate resilient places and helping communities to plan for and adapt to future flooding and coastal change.

Many farmers and land managers are already raising awareness of climate change issues and more climate resilient farming practices. This includes planting crops and using farming techniques that limit soil erosion and reduce run-off; working with local partners on natural

flood management measures that help to store excess flood waters; as well as supporting the creation of inter-tidal habitat in coastal areas that help to reduce the impact of erosion on coastal defences.

More sustainable farming businesses and practices also have wider benefits such as helping to improve resilience to droughts and improving biodiversity and water quality. Farmers and land managers are also well placed to provide local insight to risk management authorities on the flood risk and coastal change affecting local land use choices. With the unavoidable impacts of climate change and rising sea levels, farmers and land managers should have a prominent voice in identifying the most appropriate resilience actions for a place.

By taking a longer term adaptive approach to land management, farmers and land managers can also deliver wider benefits for the public good. The government is currently developing and will pilot a new Environmental Land Management scheme to be launched in 2024 (Defra (2020), The Future of food, farming and the environment: policy statement). It will be the cornerstone of future agricultural policy. Founded on the principle of 'public money for public goods', the Environmental Land Management scheme is intended to provide a powerful vehicle for achieving the goals of the 25 Year Environment Plan and commitment to net zero carbon emissions. Protection from and mitigation of environmental hazards, including flooding and coastal erosion, and mitigation of and adaptation to climate change are public goods identified in the 25 Year Environment Plan and important objectives of the Environmental Land Management scheme. There is therefore an opportunity to develop the Environmental Land Management scheme to help reduce flood and coastal risks as a public benefit. This could potentially include on farm water storage.

Farmers and land managers will have to address some difficult issues in the future. In particular they will need to be supported to explore what climate adaptation means in low-lying catchments where premium food production is dependent on flood risk management and land drainage such as in the Fens. These areas are some of the most vulnerable to flooding and it is therefore vital that farmers and land managers plan to adapt to a changing climate.

As part of its strategic overview role, the Environment Agency will work with farmers, land managers, water companies and internal drainage boards in the Fens to better assess these risks and the climate adaptation that will be needed in low-lying catchments. There is also opportunity to engage major supermarkets and the food and drinks sector in developing strategic options for sustainable food production in the Fens.

Future Fens

Much of the Fenland in eastern England lies within a few metres of sea level. As with similar areas in the Netherlands, much of the Fens originally consisted of fresh or salt-water wetlands which were first drained in the 1600s to create valuable land for farming. The present-day landowners are the modern-day custodians of one of the richest legacies of flood risk and drainage management in the country. We need innovative, co-ordinated and sustainable solutions from landowners, businesses, planning authorities, communities and risk management authorities, to manage this landscape for the long-term.

The Fens are particularly fertile, containing around half of the grade 1 agricultural land in England. Overall nearly 90% of the farmland in the Fens is either Grade 1 or 2 (NFU Online, 2008). The Fenland has become a major arable agricultural region in Britain for grains and vegetables.

In recent years, flood and water management in the Fens has been undertaken in a somewhat piecemeal approach and reactive manner. With climate change projections and many of the flood and water management structures in the Fens coming to the end of their design life, we collectively need to take a more strategic and long-term approach. This will require changes to current flood risk and drainage activities coupled with significant investment.

An adaptive approach is needed to manage this catchment to balance the needs of people, the environment and agriculture, to ensure we create the right legacy for the next 100 years. This approach will identify the decisions which need to be taken now and those that will need to be taken in the future. This could include a variety of long-term agreements between farmers, land managers, supermarkets and water companies about the future of the Fens and the contribution that flood risk investments will play in sustaining agriculture and future growth in the Fens.

Figure 17: Ouse Washes in the Fens.

To achieve our objective we have the following measures:

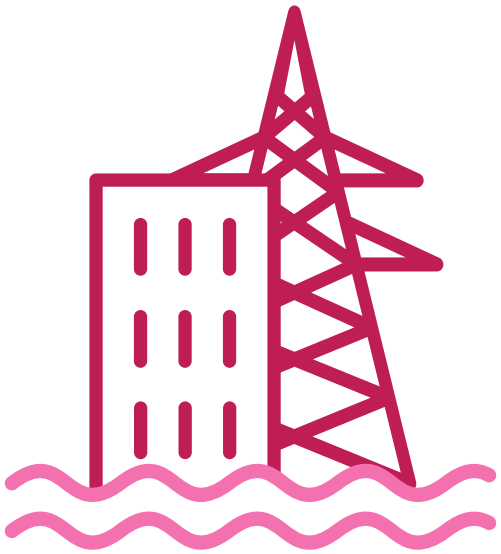
Measure 1.5.1: From 2020 risk management authorities and Natural England will work with farmers and land managers to encourage land use and land management practices that help contribute to greater resilience to both floods and droughts.

Measure 1.5.2: From 2020 the Environment Agency will continue to work with the government and other partners to develop the Environmental Land Management scheme and pilot ways of reducing flood and coastal risks.

Measure 1.5.3: From 2024 risk management authorities will work with farmers and land managers to maximise the opportunities for the Environmental Land Management scheme to help reduce flood and coastal risks as a public benefit.

Measure 1.5.4: By 2025 the Environment Agency will work with farmers, land managers, water companies, internal drainage boards and other partners to develop a long-term plan for managing future flood risk in the Fens.

Today's growth and infrastructure – resilient to tomorrow's climate



Today's growth and infrastructure – resilient to tomorrow's climate

Getting the right kind of growth in the right places is one of the main ways of achieving climate resilient places. Effective spatial planning is an essential tool for making land use choices that help to achieve greater flood and coastal resilience in places as well as wider environmental benefits. People and places are served by utility providers, connected by transport links, supported by hospitals, schools and care homes, and sustained by shops and businesses. It is vital that this infrastructure and these services are also resilient to flooding and coastal change to avoid disruption to peoples' lives and livelihoods. In communities at risk of flooding, it is also important to mainstream property flood resilience measures and to 'build back better' after flooding to reduce damages and enable faster recovery.

Progress made towards ensuring today's growth and infrastructure is resilient to tomorrow's climate

Previous and ongoing work of the Environment Agency and other risk management authorities has ensured we are already making progress towards ensuring today's growth and infrastructure is resilient to tomorrow's climate. This includes:

- between 2018 and 2019, over 99% of new homes included within planning applications were decided in line with the Environment Agency's advice on flood risk – of those cases where the Environment Agency recorded the outcome (Environment Agency, Managing flood and coastal erosion risk annual report 2018 to 2019, unpublished)
- between 2018 and 2019, the Environment Agency provided advice and information to inform around 180 strategic spatial plans, the majority (over 90%) including flood and coastal risk advice (Environment Agency, Managing flood and coastal erosion risk annual report 2018 to 2019, unpublished)
- between April 2015 to March 2020, the Environment Agency will have invested over £1 billion in maintaining existing flood and coastal defences. Between 2018 to 2019 Environment Agency staff carried out more than 90,000 inspections to ensure they operate reliably during a flood or coastal incident

— between 2015 and 2021, risk management authorities will have completed flooding and coastal change projects that better protect critical infrastructure including 6,900 utility sites (including electricity sub stations, telecommunications and water and waste water treatment works) 9,400 kilometres of road and 500 kilometres of railway (Environment Agency, 2019f)

Local planning authorities have the democratic accountability for deciding on proposals for new development in their local places. Risk management authorities have a key role to play in advising and working with planners, developers and communities to ensure that they take the current and future impacts of flooding and coastal change into account in the location and design of new development. The Environment Agency has found that for every pound it has invested in providing spatial planning advice, around 10 pounds of flood damages have been avoided (JBA, 2015).

Figure 18: The redevelopment at Longbridge integrates the River Rea and ensures buildings are resilient to flooding.

Government planning policy is clear that place making should take a proactive approach to managing future climate risks. Local planning authorities have a legal duty to include policies in their spatial plans to ensure that development and the use of land contributes to the mitigation of, and adaptation to, climate change (Planning and Compulsory Purchase Act, 2004). The Environment Agency and other risk management authorities, such as lead local flood authorities, coast protection authorities and internal drainage boards, should provide advice to planning authorities on how long-term, adaptive approaches for flooding and coastal change can inform spatial plans and growth strategies.

Better cooperation in place-shaping should also extend to the insurance sector. Risk management authorities should be working with the insurance sector to help people and businesses to 'build back

better' after a flood so they recover more quickly and improve their resilience to future flooding.

The Environment Agency's long-term investment scenarios highlight the importance of today's infrastructure being resilient to tomorrow's climate. Over two-thirds of properties in England are served by infrastructure sites and networks located in, or dependent on others located in, areas at risk of flooding (Environment Agency, 2019a). Recent floods have demonstrated the vulnerability of critical infrastructure, such as electricity sub-stations and water treatment plants, causing considerable disruption and economic damage to communities.

We need the nation's infrastructure – including our roads, rail, power stations, communications and water and waste water treatment plants and water and waste water treatment plants – as well as local services provided by schools, hospitals and businesses to be resilient to flooding and coastal change.

The National Infrastructure Commission's 2019 study looked at all aspects of the regulation of energy, telecoms and water services and concluded that while the current model has mostly achieved what it was set up to do, it has created a culture of short-termism. Among its recommendations are new duties for regulators to promote the achievement of net zero and improve the resilience of the UK's infrastructure (NIC, 2019).

What will be different?

Risk management authorities will work with partners to:

- put greater focus on providing timely and quality planning advice that helps avoid inappropriate development in areas at risk of flooding and coastal change
- leave the environment in a better state by contributing to environmental net gain for new development proposals
- ensure that spending on flood and coastal resilience contributes to job creation and sustainable growth in local places
- mainstream property flood resilience measures and to 'build back better' after flooding to reduce damages and enable faster recovery for local communities
- provide expert advice on how infrastructure providers (road, rail, water and power supplies) can ensure their investments are more resilient to future flooding and coastal change avoiding disruption to peoples' lives and livelihoods

Strategic objective 2.1: Between now and 2030 all new development will contribute to making places resilient to flooding and coastal change.

About 12% of England is in the floodplain (Defra, 2011) and 9,000km of our coast are at risk of sea flooding, erosion and landslips (Environment Agency, 2019 – Jacobs, Futurecoast data, 2002). Many more areas are at risk of flooding from surface water. As the nation's population grows, the demand for new homes will increase and place an even greater pressure on available land. It is therefore essential to continue to avoid inappropriate development in areas at high risk of flooding and coastal change. The Environment Agency's long-term investment scenarios show the importance of local planning authorities implementing government planning policy effectively if we are to minimise the impact of this on future flood damages (Environment Agency, 2019a).

The government's National Planning Policy Framework makes clear that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. In some places it will be difficult to avoid these areas due to limited land outside the floodplain or because of other sustainable development objectives. Where avoidance is not possible, government planning policy requires that development is designed to be safe for its lifetime, without increasing flood risk elsewhere. Following the winter floods in 2020, the government will consider what further options can be taken to reform national planning policy to ensure future development is safe from floods (MHCLG, 2020 and Defra, 2020e).

The government's National Planning Policy Framework makes clear that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk.

As a statutory planning consultee, the Environment Agency has a key role to play in advising planners and developers to avoid inappropriate development in flood risk areas and to enable climate resilient development. This includes identifying opportunities to protect and enhance the environment. Lead local flood authorities are statutory consultees for major planning applications with surface water drainage implications, as run-off from new development can affect localised flooding.

Environment Agency's role as a place shaper

The Environment Agency has 3 place-shaping roles. In carrying out these roles, its principal aim in law is to protect or enhance the environment, so as to contribute to achieving sustainable development.

Statutory advisor: The Environment Agency is a statutory consultee on planning matters, providing advice on flood risk and environmental issues for local planning authorities to make decisions on proposed development. This includes advising on planning applications where proposed development is at risk of river or sea flooding or could affect flood risk elsewhere. Where the Environment Agency considers that major development is inappropriate in flood risk areas, it can require local planning authorities to refer the planning application to the

Secretary of State for Planning. This gives the Secretary of State the opportunity to 'call in' the application for their own determination.

The Environment Agency also advises on neighbourhood, local and strategic plans as well as strategic environmental assessments. The Environment Agency is also a statutory consultee for nationally significant infrastructure projects providing advice to the Planning Inspectorate and the government on flood risk and other environmental issues.

Infrastructure provider: The Environment Agency builds and maintains flood defences inland and at the sea. Many of these defences will require planning approval from the local planning authority. Some of the projects can help to enable sustainable growth and prosperity in a climate resilient way, and can therefore attract funding from other sources such as local enterprise partnerships or major growth programmes. They can also contribute to local environmental objectives and can complement and, in some cases, attract funding from other environmental initiatives.

Strategic overview: Through the Environment Agency's strategic overview role, it can also help to inform place shaping by:

- Providing evidence and advice to inform government policy and guidance, including on sustainable drainage systems and surface water flood risk.
- Producing guidance for planning authorities on preparing strategic flood risk assessments, interpreting the latest climate science, and undertaking site-specific flood risk assessments.
- Supporting the update of shoreline management plans and advising planning authorities on how they can inform spatial plans and coastal change management areas.
- Creating and sharing environmental evidence to inform local planning decisions, including on flood risk from surface water and reservoirs.
- Sharing best practice on how new developments and spatial plans can help deliver environmental improvements through working with natural processes.

On the coast, the government's National Planning Policy Framework is equally clear about reducing the risk from coastal change by avoiding inappropriate development in vulnerable areas and not exacerbating the impacts of physical changes to the coast. Local planning authorities are encouraged to embed local shoreline management plan policies in their spatial plans. They are also encouraged to identify coastal change management areas where rates of shoreline change are significant over the next 100 years, taking account of climate change. Coastal change management areas should make provision for any vulnerable properties and infrastructure that may need to be relocated at a future point. This could include supporting roll back of the coastline or development facing the threat of coastal erosion. The Environment Agency will support coast protection authorities in updating and maintaining shoreline management plans and will advise planning authorities on the designation of coastal change management areas.

The government's National Planning Policy Framework recommends that local planning authorities identify places which are, or are expected to be in future, unsustainable. This could include places subject to coastal erosion or disruptive or hazardous flooding. It is therefore important that risk management authorities work closely with local planning authorities to ensure spatial plans take an adaptive approach to planning for future climate risks.

Figure 19: Aerial views of the North Cornish Coastline from the mouth of the River Camel at Padstow along the coast towards Newquay.

To achieve our objective we have the following measures:

Measure 2.1.1: By 2020 the Environment Agency will update its guidance to planners and developers on flood risk assessments to account for the 2018 UK Climate Projections.

Measure 2.1.2: From 2020 the Environment Agency will continue to provide quality and timely planning advice to help avoid inappropriate development in areas at risk of flooding and coastal change.

Measure 2.1.3: From 2020 the Environment Agency and coast protection authorities will advise planning authorities on how shoreline management plans can better inform planning policies for the coast, including designation of coastal change management areas.

Measure 2.1.4: From 2021 risk management authorities will support the development of planning skills and capabilities they need to ensure new development and spatial plans are resilient to flooding and coastal change.

Measure 2.1.5: By 2025 risk management authorities will provide advice to planning authorities on how to integrate long-term adaptive approaches into their spatial plans and growth strategies.

Strategic objective 2.2: Between now and 2030 risk management authorities will encourage environmental net gain in all new development to support resilience to flooding and coastal change.

We know growth will not be sustainable if its net impact is to harm our natural environment. The National Planning Policy Framework is clear that planning policies and decisions should contribute to and enhance the natural, local and historic environment in various ways, including by protecting and enhancing valued landscapes, and minimising impacts on and providing net gains for biodiversity.

'Net gain' is an approach to development that aims to leave the natural environment in a measurably better state than it was before (Defra, 2018c). There is specific guidance for local planning authorities on securing net gains for biodiversity when determining planning applications (GOV.UK, 2019). Government has signalled an intention to mandate that certain new developments must achieve 'biodiversity gain' (UK Government, 2020). This should improve how the planning system addresses the impact of development on habitats enabling new development to proceed without negatively affecting our wildlife. Biodiversity gain will apply to risk management authorities where they are a developer seeking planning approval for constructing flood and coastal defence projects and programmes, in line with the government's mandate.

'Net gain' is an approach to development that aims to leave the natural environment in a measurably better state than it was before.

The government's 25 Year Environment Plan sets the ambition 'to be the first generation to leave the environment in a better state than we found it' (HM Government, 2018). It also recognises the government's ambitions for a major increase in housebuilding and infrastructure investment, and the importance that these have for people's lives and economic growth. The 25 Year Environment Plan sets an aspiration to put the environment at the heart of planning and development, and a commitment to seek to embed a 'net environmental gain' principle for development. This provides an opportunity for risk management authorities to work with developers and planners to achieve environmental benefits far wider than biodiversity, for example improving resilience to hazards like flooding.

In practice these gains could be secured using planning contributions to invest in sustainable drainage systems or natural flood management linked to the design of new development. In many places, there may also be opportunities for integrating benefits for the local, natural, built or historic environments and their use and enjoyment by people.

Oxford to Cambridge Arc

3.3 million people live in the Oxford to Cambridge (OxCam) Arc. It hosts some of the most productive and fastest-growing cities in the UK. Too much and too little water, alongside ageing infrastructure, are key considerations in the proposals for up to one million new homes by 2050. This will be double the previously proposed growth, and is estimated to increase gross value added from £90 billion to £250 billion a year (HM Treasury, 2018).

Government and local partners recognise the value of the natural environment and have committed to deliver the government's 25 Year Environment Plan goals and environmental outcomes, including embedding a local natural capital planning approach, with the aim to meet their economic and housing ambitions while improving overall, rather than degrading, the environment in the Arc.

In the government's 2018 Budget, it confirmed funding for a pan-Arc Local Natural Capital Plan to coordinate investment in housing, infrastructure and the environment to support transformational growth across the Arc. The aim is to make sure new development maximises its economic potential, increases resilience to flooding and integrates environmental infrastructure with other development to provide high quality and productive places for people to live and work.

The principle of environmental net gain could provide a lever, not only for improvements in biodiversity, but also for improvements in sustainable flood and water infrastructure to support OxCam ambitions to be a model for climate-resilient growth.

The government's 2020 Budget committed to developing a new spatial framework and up to 4 new development corporations for the Arc, to give certainty about the location and timing of green growth, housing and infrastructure, as well as a potential new town at Cambridge.

Figure 20: New development in the OxCam Arc.

To achieve our objective we have the following measures:

Measure 2.2.1: From 2021 risk management authorities will plan all flood and coastal defence projects and programmes to deliver biodiversity gain, in line with the government's mandate, and seek to encourage other environmental benefits.

Measure 2.2.2: From 2021 risk management authorities will work with developers and planners to maximise the opportunities for flood and coastal resilience as part of contributing to environmental net gain for development proposals.

Strategic objective 2.3: Between now and 2030 risk management authorities will support investments to manage flooding and coastal change that enables growth in a sustainable and climate resilient way.

A long-term objective is for all local places to grow and prosper in a sustainable and climate resilient way. Investments by risk management authorities in flood and coastal change projects can help support this objective by stopping economic blight in places that have experienced repeated flooding or ongoing erosion. Spending on flood and coastal resilience can also open up opportunities for a greener, cleaner, and more resilient future.

Flooding and unmanaged coastal change harms local economies. We know after flooding there are generally more small business failures, and other employers move away (Environment Agency, unpublished, 2019). We also know flood victims can suffer serious mental health problems, affecting their ability to work, and further harming businesses (BMC, 2017 and see strategic objective 3.3). These impacts may last for several years after a flood, resulting in local economies falling behind other parts of the country. The impacts of coastal change can have similar effects when those affected do not feel supported or able to shape where they live and work. Improving flood and coastal resilience could potentially help to avoid this local economic decline.

Improving flood and coastal resilience has the potential to increase confidence in existing developments or attract new businesses and employment opportunities. In places of national economic importance, such as cities, major estuaries or ports, investment in flood and coastal resilience has the potential to contribute to national economic growth. The extent to which these benefits are significant at a national level is an area of ongoing research.

Improving flood and coastal resilience has the potential to increase confidence in existing developments or attract new businesses and employment opportunities.

There are many examples around the country of where local investments in flood and coastal changes projects have made available areas of land previously thought undevelopable. Projects

have created opportunities for new homes, businesses, jobs and environmental improvements. These benefits are of key interest to local funding partners such as Local Enterprise Partnerships and private sector businesses. Risk management authorities are well placed to work with local partners to identify the synergies between flood and coastal change investments and supporting growth in a sustainable and climate resilient way.

Leigh flood storage area

The Leigh flood storage area was built in 1982 following the 1968 flood, to reduce the risk of flooding to 1,200 homes and businesses in Tonbridge in Kent. It played a key role in protecting homes and businesses during the winter 2013 to 2014 floods. It was in operation again during the December 2019 flooding in Kent.

The Environment Agency has been developing a project to enlarge the flood storage area, working with local councils. The total costs are approximately £21.5 million, with a quarter of the funding coming from local sources, including from the South East Local Enterprise Partnership (Environment Agency, 2019h).

The project has succeeded in securing local enterprise partnership funding because it will help to create opportunities for more housing and employment to support the growth and infrastructure strategy in Kent. The local economic benefits will include 200 businesses being better protected from flooding, and the creation of 50 direct jobs and 100 associated jobs.

The Leigh flood storage area is one of the flagship projects in the Medway Flood Partnership, a consortium of local partners in Kent, who have come together to develop a shared action plan for better managing flood risk in the Medway (Environment Agency, 2017b, Medway Flood Action Plan).

Figure 21: Leigh Flood Storage Area in operation, Kent.

To achieve our objective, we have the following measures:

Measure 2.3.1: From 2021 risk management authorities will identify how investments in flooding and coastal resilience can minimise the local economic impacts of flooding and coastal change, improve investor confidence and enable sustainable growth.

Strategic objective 2.4: Between now and 2040 risk management authorities will work with the finance sector and other partners to mainstream property flood resilience measures and to 'build back better' after flooding.

Property flood resilience measures can help to reduce the flood damages experienced by property owners, occupiers and businesses and enable faster recovery in local communities.

A key component of resilience is helping local people and businesses to recover by 'building back better' after a flood (see strategic objective 3.3). Flood-resilient measures which help people return to their homes quickly after flooding will need to consider the type and age of the building. Measures such as raised electrics, hard flooring, waterproof plaster and flood doors, can sometimes cost more than typical non-flood resilient alternatives. If a property owner is already paying for clean-up and other related activities, it can be quicker and cheaper for them to just return their property to how it was before the flood. This risks being short sighted given the unavoidable impacts of climate change mean we will see more frequent flooding in the future.

Property flood resilience measures can help to reduce the flood damages experienced by property owners, occupiers and businesses and enable faster recovery in local communities.

In high flood-risk areas, it is better in the long run if flood resilience measures can be installed in properties before flooding happens. The Environment Agency's long-term investment scenarios found scaling up the introduction of property flood resilience across the country could help to reduce future flood damages (Environment Agency, 2019a). Risk management authorities can apply for government grants from the Environment Agency for supporting property flood resilience projects in communities at high flood risk.

The 2016 report from the Property Flood Resilience Roundtable, chaired by Peter Bonfield, called for a better national understanding of what property level resilience is amongst individuals, communities and businesses. Its ambition was for all those at high flood-risk to have the knowledge, capability and means to adapt their properties in ways that limit the physical damage of flooding on homes and businesses, and speed up their recovery (Defra, 2016).

Figures 22 and 23: Examples of property level flood resilience measures.

Following the Roundtable's report, the government has continued the Property Flood Resilience Roundtable as a means of bringing together key public, private and civil society partners to raise awareness of the benefits and promote the take up of property flood resilience measures. This has included industry producing a property flood resilience code of practice, for homeowners, businesses, developers and local authorities for installing and managing effective resilience measures. A number of organisations also provide advice to local communities on property flood resilience measures including the Building Research Establishment and the National Flood Forum.

Property flood resilience pathfinder project

In July 2019, the Department for Environment Food and Rural Affairs (Defra) awarded almost £3 million of government investment to help communities across England be better protected against the impacts of flooding. Three pathfinder projects across Yorkshire, the Oxfordshire to Cambridge Arc, and Devon and Cornwall were selected to reduce the potential impacts of flooding and encourage more people to make their homes resilient to flooding.

The projects will receive support from the insurance and construction industries and key representatives of the Property Flood Resilience Roundtable. The funding will go towards new research initiatives, demonstration centres and advice portals that will help local communities learn about the benefits of installing property flood resilience measures in their homes. The Environment Agency will support the evaluation of the projects and let partners across the country know what was learnt (Defra, 2019b).

The financial sector, including mortgage lenders and insurers, have a role to play in helping to stimulate the market in property flood resilience measures and tackling the barriers to building back better following flooding.

Flood Re, the joint initiative between government and the insurance sector have gone further in suggesting how to promote property flood resilience measures. They have recommended the freedom to offer lower insurance premiums for properties that have been made more resilient to flooding and to be able to support insurers who decide to encourage more resilient repairs following a flood (Flood Re, Quinquennial Review, 2019). Such proposals are designed to encourage the wider insurance sector to incentivise home owners and businesses to build back better to reduce future flood damages, and not just put back what was there before.

To achieve our objective we have the following measures:

Measure 2.4.1: From 2021 risk management authorities will work with the finance sector, Flood Re and the property flood resilience industry to increase the uptake of property flood resilience measures in communities at highest risk.

Measure 2.4.2: By 2025 the Environment Agency will work with government and other partners to tackle the policy, financial and behavioural barriers to mainstreaming property flood resilience measures and 'building back better' after flooding.

Strategic objective 2.5: Between now and 2030 owners of flood and coastal defences will understand and take responsibility for achieving flood and coastal resilience.

Building and maintaining flood and coastal defences will remain a critical action for creating climate resilient places. Flood and coastal defences can include flood and sea walls and embankments, pumping stations, upstream flood storage areas, natural features like river channels, as well as structures like sluices, harbour walls, trash screens or culverts.

Defences should be designed to provide protection to an appropriate likelihood of flooding and erosion both inland and coastal. For defences to provide resilience to flooding and coastal change, they must also operate reliably when needed and resist damage when exceeded in extreme events. Well designed, constructed and maintained defences have a key role in achieving greater resilience in places alongside other actions for better preparing, responding and recovering to flooding and coastal change.

The majority of flood and coastal defences in England that provide community level protection are maintained by a risk management authority but remain in riparian ownership. But there are also defences that are privately maintained or even where the ownership may be unknown. Some of these private defences provide protection to single properties and others provide protection to multiple properties. Owners of land adjacent to watercourses have 'riparian' responsibilities in law, including to ensure that the flood defences they are responsible for are reasonably well maintained so as not to increase flood risk elsewhere.

This mixture of defence owners creates a complex picture of responsibility for the operation, maintenance and management of flood and coastal defences. For some parts of our coastline, the ownership of defences can appear particularly fragmented, with defences being owned and maintained by, amongst others, the Environment Agency, a coast protection authority or a private landowner. Failure of one piece of defence potentially compromises the effectiveness of neighbouring defences, and, ultimately, the safety of people living and working behind them. It is therefore vital for flood and coastal defence owners to take a joined-up approach to safeguard the protection of people, property, infrastructure and the environment.

It is vital for flood and coastal defence owners to take a joined-up approach to safeguard the protection of people, property, infrastructure and the environment.

In some cases this may mean transferring ownership of either a single defence or an entire watercourse. Where a change of responsibility or ownership is the best solution, risk management authorities must come together to ensure the available funding and delivery options are in place to maintain and improve the defence.

Part of the Environment Agency's strategic overview role is to oversee the condition of the nation's flood and coastal defences, regardless of ownership. To support this, we need to adopt a common approach for the inventory, inspection and monitoring of all flood and coastal defences. This would enable information on the condition of defences to be provided in a more consistent way.

Under the Flood and Water Management Act 2010, lead local flood authorities are required to maintain a register of flood defence structures and features (drains, ditches, pipes, gullies etc.) which are likely to have a significant effect on flood risk in their area, including details of who has responsibility for ownership and their state of repair. The government's Surface Water Management Action Plan places a commitment on the Environment Agency to work with lead local flood authorities and other expert bodies to develop guidance setting out best practice for local flood defence management and record keeping (Defra, 2018b). There is also a need to improve information sharing and collaboration between flood and coastal defence owners and maintainers for all sources of flooding.

The Environment Agency, lead local flood authorities, district councils, coast protection authorities and internal drainage boards

have a variety of legal powers to intervene at their discretion where the condition of a defence presents risk to people, property or the environment; for example, where a defence has collapsed or is near to collapse. There is no responsibility for flood and coastal defence owners to maintain their defences to a particular standard and risk management authorities cannot enforce a particular level of maintenance.

Risk management authorities may however designate defences in private ownership. This does not impose any additional obligations on the owner to maintain the defence but does place greater regulatory requirements upon them. Where a defence is designated the owner must obtain the relevant consent before altering, removing or replacing such defences. Where land owners do not meet the relevant regulatory requirements the appropriate risk management authorities can take enforcement action.

The government's flood & coastal erosion risk management policy statement (Defra, 2020e) commits by the end of 2021 to reviewing the statutory powers and responsibilities to map, monitor, inspect and maintain all assets.

To achieve our objective we have the following measures:

Measure 2.5.1: By 2021 the Environment Agency will work with government, lead local flood authorities and other expert bodies to develop guidance setting out the best practice for local flood defence management and record keeping (as per the Surface Water Management Action Plan, 2018).

Measure 2.5.2: By 2021 the Environment Agency will raise awareness and communicate the responsibilities of flood and coastal defence owners, best practice actions as well as the action relevant risk management authorities will take to ensure responsibilities are being met.

Measure 2.5.3: By 2024 the Environment Agency will work with government and risk management authorities to develop guidance setting out a common approach for inspecting and managing all flood and coastal defences to improve resilience, information sharing and collaboration.

Strategic objective 2.6: Between now and 2030, owners and operators of large raised reservoirs will ensure they are safe in a changing climate.

To achieve the Strategy's vision we need all of today's infrastructure to be more resilient to the climate challenges of tomorrow – not just flood and coastal defences. It is critical that infrastructure does not increase flood or coastal change risks, either during its operation or

if it is damaged. In England, there are 2,086 large raised reservoirs for use by industry, water supply and recreation. These large raised reservoirs hold at least 25,000 cubic metres of water. Of these the Environment Agency operates 215 large raised reservoirs in England, which are used for flood risk management.

England has a history of robust legislation to manage the likelihood of reservoir failure. The Reservoirs Act 1975 provides the legal framework to ensure reservoir safety in England. Reservoir owners and operators are responsible for ensuring reservoirs meet safety requirements. Current reservoir design and inspections already account for the impacts of extreme events. It is important that owners and operators also ensure reservoirs continue to have appropriate funding for their continued maintenance and operation, so they remain resilient to the future impacts of climate change. Damage or failure of large raised reservoirs can result in a significant threat to life from the sudden, unintended release of water.

The damage to the Toddbrook Reservoir in 2019 was one example of the vulnerability of existing infrastructure. After heavy rain, the spillway of Toddbrook Dam partially collapsed leading to the evacuation of 1,500 people from the town of Whaley Bridge in Derbyshire – located directly downstream. Residents were only able to return to their homes and businesses once emergency safety work to reduce the water level in the reservoir was complete. The government commissioned an independent review to investigate the partial collapse of the spillway. The independent review concluded that a combination of heavy rain, poor design and intermittent maintenance led to the partial collapse of the spillway. Although Toddbrook Reservoir was compliant with existing legislation, the report makes a number of recommendations applicable to future reservoir safety particularly around the maintenance of spillways (Defra, 2020b). The Environment Agency will take forward the recommendations applicable to its role as the regulator of reservoir safety. The government has commissioned a second part of the Reservoir Review which will report on current reservoir safety legislation, its interpretation and implementation.

Research from the Environment Agency has also found that in particular, dams with earth embankments are likely to be vulnerable to climate change through increased erosion, extreme fluctuations in water levels, changes in vegetation and prolonged drying during hot weather. Furthermore, overflow structures and spillways may be vulnerable as the frequency and magnitude of flows increases (Environment Agency, 2013). To ensure high risk reservoirs continue to be resilient, the Environment Agency plan to review guidelines for reservoir owners and operators against the latest UK climate projections.

Reservoir regulation

Reservoirs across England have an excellent safety record, with the last fatal failure being nearly 100 years ago. Large raised reservoirs in England are regulated by the Reservoirs Act 1975, which sets out stringent conditions for the operation of reservoirs to ensure high levels of safety. They are designed and operated in a way to ensure the likelihood of failure is incredibly low, including during very extreme events. Responsibility for ensuring the safety of reservoirs lies with their owners and operators. Our job, as the regulator is to ensure they comply with the legal safety requirements. We monitor compliance at all 2,086 large raised reservoirs in England and employ a range of enforcement options to address non-compliance. These can include:

- enforcement notices requiring reservoir owners and operators to complete outstanding safety works
- requiring reservoir owners and operators to appoint government appointed supervising and inspecting engineers
- powers of entry to conduct surveys, inspections and physical works
- powers to intervene to carry out safety measures where an owner or operator has not done so

Measure 2.6.1: From 2020, the Environment Agency will implement the recommendations of the government's independent review into the Toddbrook Dam failure applicable to its role as the regulator of reservoir safety.

Measure 2.6.2: By 2025, the Environment Agency will review the latest climate science to update guidelines for reservoir owners and operators of high risk reservoirs, to ensure they continue to be resilient to extreme flood events and climate change.

Strategic objective 2.7: By 2030 water companies will plan for their infrastructure to be resilient to flooding and coastal change.

Water companies own and operate a wide range of infrastructure, from water supply reservoirs and sewers to sustainable drainage systems. Infrastructure owned by water companies plays a vital role in draining urban areas and reducing the likelihood and impact of sewer and surface water flooding. But this infrastructure is vulnerable to all sources of flooding and coastal change and if it fails can cause misery to customers. The National Infrastructure Commission has recommended that water companies and local authorities work together to build on their existing plans and take action on local flood risk including surface water, for example through investing further in sustainable drainage

systems, where this is possible (NIC, 2018). Ofwat has also approved water sector guidance which will allow water companies to adopt certain sustainable drainage systems (Ofwat, 2020).

A growing population and the risks of increased rainfall as a result of climate change means that drainage and wastewater services need to be better understood, planned and managed to protect customers and improve flood resilience. To enable this, drainage and sewerage management plans provide a framework for organisations to work together to improve drainage and environmental water quality (Water UK et al, 2019). Drainage and sewerage management plans should set out long-term aspirations and medium-term investment needs for drainage and wastewater and offer opportunities to take forward adaptive approaches with other risk management authorities. The government has committed to putting these plans on a statutory footing (Environment Bill, 2020).

Our natural environment goes through periods where there is too much water or too little water and we should be looking at adaptive approaches that address both of these challenges for the benefit of people and wildlife. Water companies and other risk management authorities should work together to manage water in a more integrated way to improve flood and drought resilience, enhance the natural environment and deliver value for customers. In 2019 the Institution of Civil Engineers called for more water management, where the demand for water and wastewater infrastructure can be managed with the installation of sustainable urban drainage, dual wastewater and storm water networks, grey water reuse and rainwater harvesting in new developments. In 2020 the Council for Sustainable Business identified opportunities for capturing flood water in reservoirs and using it to refresh rivers in time of drought. All these options could make a positive contribution to delivering greater flood and drought resilience in a place.

It is also important that water companies work in partnership with other risk management authorities to contribute to flood and coastal change projects, where this is an efficient delivery of their service to customers. For example, Anglian Water has contributed £3 million to a coastal erosion project led by Tendring District Council in Essex that has a total cost of £36 million. The project will reduce risk of coastal erosion to about 1,570 homes and will also protect Anglian Water's sewerage infrastructure alongside this section of coastline. It is a good example of sharing costs to deliver shared outcomes between partners and value for money for water bill payers. As the drainage and sewerage management plans develop they could also be used to underpin early engagement with beneficiaries to help unlock co-funding opportunities.

As the environmental regulator of the water industry, the Environment Agency's ambition is to achieve a water environment that is cleaner, healthier and managed in a way that is more resilient to floods and drought and better supports people, wildlife and the economy. As the economic regulator of the water industry, one of Ofwat's objectives

Infrastructure owned by water companies plays a vital role in draining urban areas and reducing the likelihood and impact of sewer and surface water flooding.

is to secure the resilience of water supply and sewerage systems and ensure water companies take steps to meet long-term customer needs for water supply and sewerage services (Water Industry Act, 1991). Through its strategy, 'Time to Act, Together', Ofwat has committed to transform water companies performance and drive companies to meet long-term challenges through increased collaboration and partnerships that deliver more for customers, society and the environment (Ofwat, 2019a).

Water companies set out their investment priorities in 5-year business plans which are then scrutinised by Ofwat through 'price reviews'. They describe how water companies will meet their obligations in relation to flooding and coastal change, water supply and treatment, and the environment. The Environment Agency, Ofwat, Water UK and water companies have a track record for working together to inform the investment priorities in price reviews. Following the 2019 Price Review process, covering the period between 2020 and 2025, the water sector will be investing more than £1 billion to help protect properties from sewer flooding. In addition, the sector will be investing £2.6 billion in better protecting customers and the environment from the risks of extreme weather conditions such as flooding and drought (Ofwat, 2019b).

Ahead of the next price review, the Environment Agency and Ofwat will develop a joint approach for how all water companies should consider flood and coastal resilience in the context of their statutory roles and duties. This will build on the Environment Agency's Water Industry Strategic Environmental Requirements' (Environment Agency, 2018b) and be informed by the views of the wider water sector, including the Consumer Council for Water.

To achieve our objective we have the following measures:

Measure 2.7.1: From 2020 water companies and other risk management authorities will work together to inform drainage and sewerage management plans to improve resilience to surface water and drainage flood risks.

Measure 2.7.2: From 2020 the Environment Agency and Ofwat will develop a joint approach for how water companies should consider flood and coastal resilience in the context of their statutory roles and duties.

Measure 2.7.3: By 2025 water companies and other risk management authorities will ensure that long-term adaptive planning for flooding and coastal change is better coordinated with the next and subsequent cycles of planning for water and wastewater investments.

Strategic objective 2.8: Between now and 2050 risk management authorities will work with national infrastructure providers to contribute to more flood and coastal resilient places.

The impacts of flooding on national services provided by transport, utility and communications infrastructure can result in widespread disruption and damage. The Environment Agency's long-term investment scenarios underline the importance of national infrastructure resilience. Over two-thirds of properties in England are served by infrastructure sites and networks located in, or dependent on others located in, areas at risk of flooding. The impacts on properties will vary as some of this infrastructure will already have high levels of protection (Environment Agency, 2019a).

Over two-thirds of properties in England are served by infrastructure sites and networks located in, or dependent on others located in, areas at risk of flooding.

The economic damages from flooding of national infrastructure was evidenced during the winter 2015 to 2016 flooding, following Storms Desmond, Eva and Frank that brought flooding to many parts of the North of England. Tens of thousands of properties in Lancaster lost power when an electricity sub-station was flooded; there were 850 road flood incidents on the strategic road network; and the West Coast Mainline between England and Scotland closed for 2 days following two metres of floodwater affecting the line around Carlisle. The best estimate for the total economic damages from the winter 2015 to 2016 flooding was £1.7 billion (in 2018 prices) of which about 28% was from damages to utilities and transport. The damages from flooding to energy and water supplies was estimated to be about £104 million and the damages to road and rail services was about £341 million (Environment Agency, 2018a).

Following the 2015 to 2016 winter floods, the government undertook the National Flood Resilience Review. The review assessed the resilience of key local infrastructure such as energy, transport, water and communications, and identified ways to make it more resilient (HM Government, 2016, National Flood Resilience Review). The Environment Agency has undertaken work with the University of Oxford to explore the impacts of flooding from rivers and the sea on transport and utilities infrastructure, as shown in figure 24 (Environment Agency, 2019).

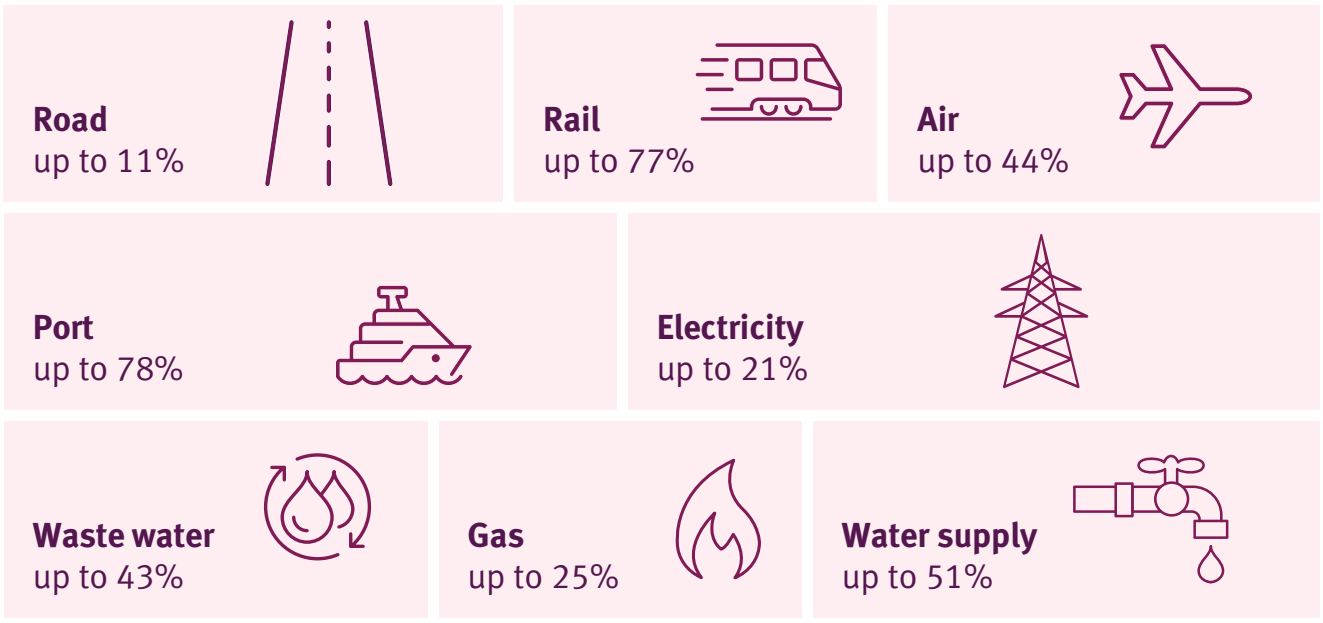


Figure 24: National infrastructure at risk from flooding (Environment Agency, 2019).

Many government departments and agencies are reviewing opportunities for improving the climate resilience of infrastructure. Notably:

- in 2018, the government's national adaptation programme and its third strategy for climate adaptation report set a clear expectation for utility companies and major industries to report on how they are adapting to climate change (Defra, 2019c)
- the Green Finance Taskforce's report to government also recommended a national unit to coordinate and champion climate resilience (Green Finance Taskforce, 2018)
- In 2020, the National Infrastructure Commission's 2020 resilience study recommended that the resilience of the nation's energy, water, digital, road and rail infrastructure could be improved and maintained through a new framework for resilience. This includes government setting resilience standards for infrastructure every five years; infrastructure providers carrying out regular stress tests for better managing future disruptions that are overseen by regulators; and the development of long term resilience strategies (NIC, 2020).

As part of its strategic overview role the Environment Agency can provide expert advice, evidence and data on flooding and coastal change to help national infrastructure providers ensure their investments are resilient to flooding and coastal erosion. The improvements the Environment Agency are making to the national assessment of flood risk will also help infrastructure providers better plan and adapt to future risks from flooding from rivers, the sea and surface water.

The investments risk management authorities make in flood and coastal change projects and programmes can play a part in better coordinating investments in wider climate resilience in a place. For instance, one of the aims of the Humber flood risk management strategy is to support businesses and industries critical to local economic regeneration and growth in the region plan and adapt to future tidal flood risks (see also strategic objective 1.2).

Humber flood risk management strategy

The Humber estuary is of national importance. It includes key ports such as Hull, Grimsby, Immingham and Goole, significant transport infrastructure and well-established chemicals and manufacturing industries. The estuary is a globally important environmental asset, supporting a rich variety of wildlife. It's also home to over half a million people and around 17,000 businesses.

Climate change is a significant challenge for the region, which is low lying and vulnerable to tidal surges. Rising sea levels mean that between 2015 and 2021 over £150 million is being invested to better

protect 70,000 homes at risk of tidal flooding (Environment Agency, 2019k). During the same period and beyond further investment is also being made to manage the risks from river and surface water flooding, on a coordinated basis with tidal spending to ensure that benefits for those at risk are maximised. However, this will not be enough to keep up with future climate risks, especially if key infrastructure is to remain resilient.

To help ensure long-term resilience across this vital estuary, the Humber 2100+ partnership, made up of the Environment Agency, Humber Local Enterprise Partnership and 12 local authorities, are working together to develop a new adaptive strategy for managing current and future tidal flood risk.

The strategy will seek to drive culture change and enable those at risk to take ownership of the challenge of tidal flooding. This will involve giving equal weight to the actions local people and partners can use to improve their resilience, alongside developing a strategic investment pathway which will map out the economic opportunities from taking a proactive approach to managing future tidal flood risk across the estuary. Together the improved ownership of risk and future investment will ensure the estuary is able to adapt to a changing climate and continue to prosper.

Figures 25 and 26: Aerial photographs of the Humber estuary.

Following the 2020 Budget, the government announced its intention to create a specific fund to enable the Environment Agency to allocate more funding to flood and coastal defence projects which directly protect key public infrastructure, such as roads, railways, schools and hospitals (Defra, 2020a). This fund will mean there is a higher government grant contribution for flood and coastal defences that also contribute to wider infrastructure resilience in local places.

The current plans and strategies of many risk management authorities go part of the way to providing the ambition for better resilience to flooding and coastal change. But to understand the full resilience picture in a place, the current and future priorities of national infrastructure providers need to be considered alongside the needs of local people, the economy and environment. This was exemplified

when Highways England and the Environment Agency worked together with local partners on a jointly-funded flood storage reservoir that provides better flood protection to the A1 motorway at Catterick as well as better protection to 149 properties in the area (Environment Agency, 2016b). There is opportunity for national infrastructure providers to better share information about their investment programmes to identify places where there are win-win opportunities for improving resilience in places.

To achieve our objective we have the following measures:

Measure 2.8.1: From 2021 the Environment Agency will provide expert advice, evidence and data on flooding and coastal change to help national infrastructure providers ensure their investments are resilient to flooding and coastal erosion.

Measure 2.8.2: From 2021 the Environment Agency will work with national infrastructure providers to better share information about long-term investment planning to identify win-win opportunities for improving flooding and coastal resilience in places.

A nation ready to respond and adapt to flooding and coastal change

A nation ready to respond and adapt to flooding and coastal change

We need to build a nation who understand their risk to flooding and coastal change, and know their responsibilities and how to take action. To do this, we need to educate and inspire people to take action before flooding or coastal change happens. Preparing and responding to incidents is an essential component of greater flood and coastal resilience. We already have a world class flood forecasting and warning service. We need to continue to develop digital services that better communicate flooding and coastal change and increase awareness of the risks people face. Risk management authorities, local responders and the insurance sector have a key role to play in helping people and businesses recover more quickly after flooding. Through this Strategy, we also want our nation to be recognised as a world leader in researching and managing flooding and coastal change to better protect current and future generations.

Progress towards a nation ready to respond and adapt to flooding and coastal change

Progress is already being made, flooding and coastal change is recognised as a key impact of climate change. There are many individuals and organisations providing leadership and helping to champion better communication and management of the risks from flooding and coastal change.

For example:

- the Met Office, the Environment Agency and the Flood Forecasting Centre provide a world-class forecasting and warning service with approximately 1.4 million properties signed up to receive free flood warnings
- the Environment Agency has taken a leading role in using digital services to better communicate risk from flooding and coastal change – three-quarters of the 8 million visits a year to the Environment Agency's web pages on GOV.UK are flood related
- local resilience forums have continued to improve the quality of local Flood Plans to better coordinate preparing and responding to incidents, building on the recommendations of the 2018 Multi-Agency Flood Plan Review

- since the floods of winter 2015 to 2016, the Environment Agency has invested in new incident response kit including 40km of temporary flood barriers and 250 high volume pumps. It has around 6,500 trained staff across the country, ready to respond to flooding (GOV.UK, 2016)
- the Research Councils and academic community in the United Kingdom have commissioned world leading research into the future challenges posed by flooding and coastal change in a changing climate
- many third-sector organisations and local flood groups continue to lead the way in supporting communities to plan, respond and recover from flooding, taking shared ownership of managing future flood and coastal risks
- since 2002, the Environment Agency has supported the Flood and Coastal Engineering Higher Education programme. In this time, over 460 people have graduated with either a Foundation Degree, BSc or Masters in River/Flood and Coastal Engineering
- the Environment Agency has committed to become a net zero carbon organisation by 2030, working with its suppliers and other partners. The Environment Agency will reduce its carbon emissions by at least 45% by 2030 and offset the effect of its remaining emissions by planting trees and through other measures that lock up carbon harmlessly

As a nation, we are becoming more alert to the increasing risks from flooding and coastal change. It is estimated that over 5.2 million homes and businesses in England are at risk from flooding and coastal erosion. Creating a nation ready to respond and adapt to flooding and coastal change will take time, and a great deal of work will be needed. In 2019, only 39% of those with properties in areas classified by the Environment Agency as being at risk, actually believed their property was either ‘definitely’ or ‘probably’ at risk. (Environment Agency, 2019n).

It is estimated that over 5 million homes in England are at risk from flooding and coastal erosion.

Many more people are affected when essential transport services, energy and water infrastructure are interrupted or schools and workplaces are damaged by flooding or coastal change. Research shows for every household directly affected during a large flood, about 16 people suffer knock-on effects from losses of utility services (Environment Agency, 2019a, derived).

The impact of flooding on people can be devastating and, generally, lasts long after the floodwaters have subsided. It can be months, or even years, before people can return home, and irreplaceable personal possessions are often lost forever. Even when formal recovery has ended, the implications of living with the knowledge of risk are substantial.

There is compelling evidence linking floods to mental health and wellbeing. Research has found that people who had experienced storm and flood damage to their homes were around 50% more likely than other residents to experience poorer mental health (Environment Agency, 2019i).

People want to have a voice in shaping how resilience to flooding and coastal change is achieved in the places in which they live and work. Risk management authorities need to ensure that people and places are at the heart of local decision making. They also need to invest in the engagement skills needed to take a more inclusive approach to the future challenges flooding and coastal change present.

People want to have a voice in shaping how resilience to flooding and coastal change is achieved in the places in which they live and work.

England has a world-class flood forecasting and warning service. It provides people, businesses and the emergency services with the information to help them prepare for a flood. Approximately 1.4 million properties are signed up to receive free flood warnings. The Environment Agency has been continually improving its warning service to enable people to take timely and appropriate action. Greater use of digital services has the potential to also transform the way we communicate flood and coastal risk management information to people so they can make better local choices.

Figure 27: A community engagement event showing residents learning about their local flood risk and flood scheme developments.

There are many organisations that play a role in managing what happens to people and the environment during and after flooding and coastal erosion. This Strategy seeks to continue to better join up the organisations involved in providing incident response and recovery to provide a consistent and coordinated service. This includes risk management authorities, local responders and the insurance sector but it also needs to more actively involve third-sector partners.

The threats posed by flooding and coastal change as a result of a changing climate are a global challenge, and we are not facing them alone. We want our nation to be recognised as a world leader in the research and management of flooding and coastal change. We need to develop the skills and talent we need to create the climate resilient places of the future. Importantly we need to start young to raise awareness and understanding of climate change risks.

What will be different?

Risk management authorities will work with partners to:

- support communities to better prepare and respond to flooding and coastal change, including transforming how people receive flood warnings
- ensure people and businesses receive the support they need from all those involved in recovery so they can get back to normal quicker after flooding
- help support communities with managing the long-term mental health impacts from flooding and coastal change
- develop the skills and capabilities needed to better support communities to adapt to future flooding and coastal change
- become a world leader in the research and innovation of flood and coastal risk management to better protect current and future generations

Strategic objective 3.1: Between now and 2050, people will understand the potential impact of flooding and coastal change on their lives and livelihoods and will take action to reduce that impact.

Over 5.2 million homes and businesses in England are at risk from flooding and coastal erosion. Yet only a third of people who live in areas at risk of flooding or coastal change believe their property is at risk (Environment Agency, 2019n). We need to build a nation who understand their risk to flooding and coastal change, and know their responsibilities and how to take action.

To help achieve this, risk management authorities need to communicate the risks and consequences of flooding and coastal change more effectively and, crucially, to reach a much wider audience than is currently the case. Much can be achieved through more effective use and dissemination of the information risk management authorities already hold and by conveying it in a way that people can most easily understand. In recent years technological advances, such as virtual reality, have helped risk management authorities find new and innovative ways of engaging with communities on flooding and coastal change projects. Community groups also have a key role in communicating risk and helping risk management authorities promote shared ownership of the actions local people need to take.

Todmorden Flood Group, Calderdale

The Todmorden Flood Group was established following the 2012 floods that devastated many homes and businesses in the Calder Valley. The flood group acts as a conduit for the communities concerns, needs and opinions about the actions needed to manage flooding.

The flood group identifies and supports vulnerable members of the community who are at risk and live in properties prone to flooding. It also enables effective communications between residents, councils and other risk management authorities in the area including Calderdale Council, Todmorden Council, Environment Agency and Yorkshire Water. The Flood Group promotes personal household flood resilience, assists with insurance queries and helps create and implement local flood plans.

Digital tools and services provide a powerful way of engaging with large numbers of people to communicate the risks from flooding and coastal change. They can also help to tailor information to meet the needs of end users. For example, individuals may want specific information about the impact of flooding on where they live and work while businesses may want information to inform their flood insurance or investments in property flood resilience.

Digital tools and services provide a powerful way of engaging with large numbers of people to communicate the risks from flooding and coastal change.

It is estimated that 1-in-10 of the adult population of England now use our digital services. Three-quarters of the 8 million visits a year to Environment Agency's GOV.UK web pages are flood related and this is continuing to increase. In 2019 more than 80% of the 500 million hits on Environment Agency open data related to flooding and coastal change information (Environment Agency, 2020d). Digital services are transforming the way the Environment Agency warns and informs people about their flood risk (see strategic objective 3.2).

While we want more people to understand their risk from flooding and coastal change, it is even more important that they understand their responsibilities and know how to take action. Over the past decade, a growing number of risk management authorities have recognised the importance of working closely with local communities to help them be more involved in decision making about flooding and coastal change in their local places. However, such good practice is not universal and there is more to do.

We all work best when we understand and feel involved in what is being discussed and decided. People want a voice to shape how resilience to flooding and coastal change is achieved in the places they live and work. Local people can also provide invaluable local insights and knowledge about past flood events. Risk management authorities need to ensure that people are at the heart of planning and adapting to future climate risks. The engagement practices adopted need to be 'place-sensitive' recognising how people's emotional connections to a place can have a significant impact on whether and how they engage in thinking about the future of it. Engagement can be particularly challenging where the options for future flood or coastal protection may be limited.

Ensuring public participation is fair and inclusive is not always easy. Currently, not everyone is able, or willing, to give their time. Risk management authorities also need to strike a balance between the things they can do and the decisions they make, as well as legal,

financial or practical constraints. Nevertheless, listening to peoples' views and experiences leads to better solutions. It also facilitates more inclusive approaches embracing the views of different cultures in society. It is essential that risk management authorities invest in the engagement skills and capabilities to enable them to better support communities on adaptation to future flooding and coastal change.

Working together to adapt to flooding and coastal change

The Environment Agency has undertaken research to explore how communities and risk management authorities can better work together to plan and adapt to flooding and coastal change. It identifies 5 challenges that risk management authorities need to overcome when working with communities:

- **Readiness:** many communities and risk management authorities are not yet prepared to engage in planning and adapting to future flooding and coastal change especially where climate change is a contributory factor. Engagement methods need to recognise and manage peoples' emotional responses to change, as well as their capacity to engage in deliberations over complex future choices for their places.
- **Framing information:** the way information is presented tends to reflect the interests and assumptions of those producing it. Specific words may mean different things to different people, creating the potential for misunderstanding. The technical terminology used by risk management authorities to talk about flooding and coastal change can sometimes affect community understanding and limit engagement.
- **Climate change, emotions and mental health:** fears and anxieties about climate change can shape peoples' engagement with adaptation planning, and generate complacency and a sense of helplessness. Collaboration in decision making has the potential to positively affect mental health, build community resilience and reassure people that they have a voice.
- **Place attachment, culture and identity:** peoples' emotional connections to the places where they live and work can shape their willingness to take part in adaptation planning. Engagement methods need to be sensitive to the meanings and emotions associated with particular places.
- **Power and politics:** some adaptation discussions and decisions about managing future flooding and coastal change will be inherently political and contentious. Careful attention needs to be paid to developing engagement methods that consider both representation (of community groups and interests) and the representativeness (the extent to which participants represent the wider community). Source: Environment Agency (2019l) 'Working together to adapt to a changing climate: flood and coast'.

Risk management authorities often also work through or with other organisations to support community engagement. Independent organisations, often from the third sector, also have a critical role – helping people both prepare for, and recover from, flooding and coastal change. Organisations such as the National Flood Forum and the Action for Rural Communities in England work closely with communities in different parts of the country, although the work they can do is often limited by their funding. As the risk of flooding and coastal change increases, so will the need for these organisations to continue to provide support to local communities.

Measure 3.1.1: From 2020 the Environment Agency will continue to invest in developing and transforming customer-driven digital services to better communicate risk from flooding and coastal change.

Measure 3.1.2: From 2021 risk management authorities will encourage the development of the engagement skills and capabilities they need to better support communities to manage and adapt to future flooding and coastal change.

Measure 3.1.3: By 2021 the Environment Agency will share learning and best practice with other risk management authorities on working with communities to manage and adapt to future flooding and coastal change.

Strategic objective 3.2: Between now and 2030 people will receive the information and support they need to transform how the nation better prepares and responds to flooding and coastal change.

While we can reduce the risks of flooding and coastal change happening and reduce the impacts when they do, we can never prevent all flooding or coastal erosion. Nature will always be stronger than us, which is why it's always better to work with nature rather than against it. It's also why preparing and responding to incidents is an essential component of achieving greater resilience to flooding and coastal change. We need organisations and communities to work better together to prepare for and respond to flood and coastal incidents through timely and effective forecasting, warning and evacuation. The activities undertaken with partners and communities to support planning for, and responding to flooding, include:

- engaging with partners and communities to raise awareness and prepare plans
- detecting and forecasting rainfall and potential floods
- warning and informing
- operating flood defences
- mobilising barriers, pumps, gates and other protection measures

Whatever the scale of flooding and coastal change, it is essential that local places have effective flood plans to coordinate the response of

local responders to flood incidents. In 2018, the government published the findings from the Multi-Agency Flood Plan review (Defra and the Environment Agency, 2018) which looked at the effectiveness and consistency of flood plans produced by local resilience forums. The review acknowledged the experience category 1 and 2 responders (including the emergency services, local authorities, Environment Agency and others) have gained from past flood and coastal events. But the review also highlighted that there was room for improvement in some aspects of flood response planning. This included: reinforcing success, spreading existing good practice, extending national support measures and increasing resources devoted to flood emergency preparedness. The government's response to the Multi-Agency Flood Plan Review commits the Environment Agency to performing a health-check on Multi-Agency Flood Plans once every three years (Defra, 2019f).

The review also emphasised the power of community resilience in the face of emergency incidents such as flooding. Community resilience should recognise the value of local volunteers and community groups in supporting local resilience forums and working with risk management authorities. For instance, volunteer flood wardens are often the eyes and ears in a community working with the Environment Agency and local authorities. It is important that risk management authorities support the training and development of volunteer flood wardens. Local flood groups can also promote positive action through community led flood plans that help with preparing and responding to as well as recovering from flooding. Third sector organisations, such as the National Flood Forum, can also offer advice to support local flood groups.

When it comes to forecasting and warning, England has a world-class service. Working together, the Met Office and the Environment Agency provide forecasting and warning services to people and businesses for severe weather and flooding. In 2009 the Flood Forecasting Centre was established to combine the meteorology expertise of the Met Office with the hydrology expertise of the Environment Agency. It forecasts all sources of flooding – river, surface water, tidal, coastal and groundwater – ensuring we are resilient and ready to respond to flood and coastal incidents in England. The Centre produces the 'Flood Guidance Statement' which provides an overview of flood risk across 5 days and identifies possible severe weather, which could cause flooding and significant disruption to normal life. This information is important to category 1 and 2 responders in helping them with their emergency planning and resourcing decisions.

Working together, the Met Office and the Environment Agency provide forecasting and warning services to people and businesses for severe weather and flooding.

Flood warnings include vital information on steps people can take to keep themselves and their property safe when flooding from rivers and the sea is expected. Approximately 1.4 million people are signed up the Environment Agency's free flood warning service which sends a message directly to people by voice message, text or e-mail when a flood warning is issued. The Environment Agency has been continually improving its warning service to enable people to take timely and appropriate action. Since 2010 the Environment Agency has been adding those who live

in flood risk areas to its free flood warning service. This began with landlines and was extended to mobile phones in 2014.

Expanding flood warnings

Figure 28: Symbols used to illustrate flood alerts, flood warnings and severe flood warnings.

The Environment Agency's Expanding Flood Warnings project is working to provide all properties at high risk of flooding with flood warnings by 2022. Up until now, technical and cost barriers have made it difficult to provide effective warnings for some properties at high risk. Work started in April 2019 and identified ways of overcoming these barriers while also expanding the existing flood warning areas.

The project is looking to extend best practice using the latest technology, modelling and forecasting to provide warnings to properties at high risk. It is also looking to develop new and innovative ways of providing warning services to communities where existing approaches may be difficult to use, for example, where properties are isolated or in steep catchments. By 2022, the project is aiming for 62,000 additional properties in England to receive a flood warning service.

With the challenges from climate change increasing, we need to transform how our warning and informing services reach people. One innovation is the partnership between the Environment Agency and Google to ensure flood warnings are more accessible alongside internet searches.

Flood warning service and Google alerts

Following collaboration between Google and the Environment Agency, in August 2019, England became one of the first European countries to utilise Google Public Alerts. Flood warnings now appear on Google Search and through Google Maps with live alerts becoming visible seconds after they have been issued. The warnings include vital information on steps people can take to keep themselves and their property safe when flooding is expected.

Work is also under way to shift from the approach of 'warning and informing properties' to 'warning and informing people', some of whom will be on the move. The Environment Agency has been working with mobile phone providers to trial the use of cell broadcasting which allows warnings to be automatically sent direct to any mobile phone in an area at risk of imminent flooding. This type of emergency alerting does not require registration and would allow the Environment Agency to proactively alert people living, working or potentially travelling though flood risk areas by transmitting messages to handsets via mobile phone masts. There are also opportunities to work with other commercial partners to develop customer services and products that tap into the flood warning data and digital services available through GOV.UK.

When flooding is likely and there are no permanent flood defences or property flood resilience measures in place, temporary barriers can often be used. Temporary barriers provide a relatively quick and easy means to protect property and infrastructure against floodwater. They are not suitable for all situations but can be reused many times in a variety of locations. They are more successful when there is early forecasting, pre-planning and well-organised logistics to transport and install the barriers. Working with partners, the Environment Agency has made considerable improvements to its deployment of temporary barriers during a flood incident and barriers can be delivered anywhere in the country within 12 hours. The Environment Agency also routinely trains the Army civil contingency battalions to ensure additional trained support is available to help deploy barriers should a major flood incident occur.

To achieve our objective we have the following measures:

Measure 3.2.1: From 2020 the Environment Agency will continue to work with local resilience forums to develop flood plans that better coordinate preparing and responding to incidents.

Measure 3.2.2: By 2022 the Environment Agency will have expanded its flood warning service to all places at a high risk of flooding from rivers and the sea.

Measure 3.2.3: By 2025 the Environment Agency will work with partners to transform its warning and informing services to better reach people living, working or travelling though flood risk areas.

Measure 3.2.4: By 2025 risk management authorities will support people living in places at high risk of flooding and coastal change to setup flood groups, where they are wanted, and to develop and test local flood plans.

Strategic objective 3.3: Between now and 2030 people and businesses will receive the support they need from all those involved in recovery after flooding so they can get back to normal quicker after flooding.

After a flood or coastal change event, it is crucial people and businesses recover quickly and are supported to build back better. In 2016, the government and the insurance sector established Flood Re, a joint initiative designed to improve the availability and affordability of household insurance for people who live in areas of high flood risk. Flood Re will run for 25 years, until 2039, at which point insurers should be offering policies based on actual risk to property, without householders seeing significant increases in the cost of their flood cover. Nearly 250,000 properties have benefited since the launch of Flood Re (Flood Re, 2020).

It is important that the significant progress achieved through the Flood Re scheme is maintained and developed further. Reflecting this the government announced in April 2020 an independent review to examine the level of insurance cover held by those affected in the Doncaster floods of December 2019 (Defra, 2020d). The review will look at the barriers people may have faced in obtaining cover and whether there are any systemic issues in the provision of flood insurance.

Risk management authorities also have a role to play in helping people and local economies get back to normal. This can include clearing up the damages, returning water and power supplies or draining floodwaters from farmland. Following nationally significant flood events, the government has also provided financial assistance to households, businesses and farmers under the Communities and Business Recovery Scheme and the Defra property flood resilience grants.

Recovery from flooding and coastal incidents can be complex and challenging given the wide range of public, private and third-sector organisations that can be involved. In major incidents, the sheer scale of the event can overwhelm local capabilities and recovery can go on for many months or even years in some cases.

Figure 29: Young family being rescued by the fire service after the River Derwent burst it's banks in the village of Old Malton in North Yorkshire in northeast England, 2012.

Organisations involved in recovery

There are many organisations involved in what happens after a flood or coastal event. Category 1 and 2 responders, other agencies, insurance companies, health workers and waste disposal companies can all offer help. However, beyond these organisations there are often many more who offer vital support. Such organisations include, but are not limited to: local health services helping people cope with the trauma and anxiety that follows flooding; the British Red Cross providing emergency support; local authorities re-homing families whose houses are uninhabitable; and the insurance industry providing repairs and finance. We should ensure that those in need receive a positive and prompt experience, one that effectively links all organisations that can assist the recovery process.

Recovery should also include building back better so properties are more resilient to future events. Following the significant flooding over the winters of 2015 to 2016 and the 2019 winter flooding, the government provided a Flood Resilience Grant for homes and businesses. The scheme provided grants of up to £5,000 to help fund property flood resilience measures where they were appropriate (Defra, 2019d).

The ability of people to cope with, and recover from, flooding and coastal change is also affected by other less tangible factors. Research by the Environment Agency and Public Health England shows mental health impacts are a major part of the householder experience of flooding. Apart from the considerable costs of damage to property and infrastructure, it is estimated, for example, that the mental health impacts of flooding could represent £3,000 to £7,000 per flooded household, depending on the scale of the flooding (Environment Agency, 2019i).

The emotional consequences to the victims of flooding and coastal change can be significant. Those affected suffer from depression, anxiety and post-traumatic stress disorder to levels similar to those seen after major disasters, including terrorist attacks. A study of flooding and public health impacts found that 36% of people flooded suffered symptoms related to probable post-traumatic stress disorder 12 months afterwards and 24% were still suffering after 24 months (Waite et.al, 2017). Children are especially badly affected during and after floods. They lose their homes, friendship networks and familiar surroundings. They also see adults under great strain and witness the exceptional and long-term anxieties flooding brings (Mort, M et al, 2016). These mental health impacts will have knock-on costs to public health services and should be better taken into consideration when planning for recovery.

The emotional consequences to the victims of flooding and coastal change can be significant.

To achieve our objective we have the following measures:

Measure 3.3.1: From 2020 risk management authorities, local responders, the insurance sector and other partners will continue to work together to help people and businesses recover more quickly after flooding.

Measure 3.3.2: By 2025 the Environment Agency will work with government, other risk management authorities and public health services to ensure the mental health impacts from flooding and coastal change are factored into long-term recovery planning.

Measure 3.3.3: By 2025 the Environment Agency will have worked with risk management authorities and local responders to develop a plan for better involving the third sector in supporting significant flood incidents.

Strategic objective 3.4: Between now and 2030 the Environment Agency will have an oversight of skills and capabilities across the flooding and coastal change sector to identify gaps and future needs.

Faced with the challenges of increased flooding and coastal change, we need a thriving and innovative flood and coastal change profession. Risk management authorities, coast protection authorities and the commercial sector have an important role to play in investing and developing the skills and capabilities we will need.

This Strategy has identified several areas where risk management authorities need to make investments to improve their skills and capabilities including new and innovative funding and financing (measure A.2.2), spatial planning (measure 2.1.4) and community engagement (measure 3.1.2). All routes to improve skills need to be used, including apprenticeships.

The Environment Agency estimates that 14,000 people work in the flooding and coastal change sector in England (Environment Agency, 2019j). As the risks caused by climate change increase, we will need a diverse range of skills and capabilities to manage the risks posed by flooding and coastal change. This includes professions working in engineering, communications and engagement and other environmental specialisms. It is important that risk management authorities work with partners to encourage education, employment and training opportunities for all those involved in the management of flood and coastal risk.

We will need to invest in the skills we need in the future. This means inspiring and encouraging young people to develop their careers in flood and coastal erosion risk management. The development of the interest needs to start in schools and be carried through to the higher education and learning provided by universities and colleges.

Working with education providers to develop future flood and coastal change management skills

In 2018, the Environment Agency worked with the Geographical Association to produce materials for geography teachers, which supported the existing national curriculum for GCSE and A level exams. Topics covered include the causes, effects and responses to flooding and coastal change.

Since 2002, the Environment Agency has supported the Flood and Coastal Engineering Higher Education programme. In this time, over 460 people have graduated with either a Foundation Degree, BSc or Masters in River/Flood and Coastal Engineering. The programme is currently offered through Brunel University, London in partnership with HR Wallingford. The courses provide students with a mix of academic study and work-based placements.

To achieve our objective we have the following measures:

Measure 3.4.1: By 2025 risk management authorities and other organisations will work with education providers to encourage opportunities for ongoing learning and career development in engineering and environmental sciences.

Strategic objective 3.5: Between now and 2030 the nation will be recognised as world leader in researching and managing flooding and coastal change.

Climate change is a global threat which requires solutions based on the learning and best practice of other nations as well as the best available international evidence. Risk management authorities in England are already recognised as experts in managing flooding and coastal change. For example, the Environment Agency routinely shares its operational experience with the Rijkswaterstaat in the Netherlands and the United States Army Corps of Engineers. It also contributes to international networks such as I-STORM, which enables the managers of storm surge barriers to share knowledge and experiences on common issues like responding to climate change, sea level rise and flood warning systems.

Climate change is a global threat which requires solutions based on the learning and best practice of other nations.

It's important that risk management authorities develop stretching ambitions for responding to future flooding and coastal change. A good example of this is the Environment Agency's leadership on zero carbon, which is making a positive contribution to the government's commitment to reducing the UK's greenhouse gas emissions to net zero by 2050. Many other risk management authorities, including

local authorities, have also made pledges to address the climate emergency.

The Environment Agency is working with partners to develop new and innovative ways to decarbonise the construction and operation of its flood and coastal defences. Through its supply chain contracts, the Environment Agency is also ensuring that it attracts the best talent and skills from around the globe to help contribute to ideas and innovation needed to meet the zero carbon challenge and wider United Nations Sustainable Development Goals.

Thames Estuary Asset Management Programme for the 21st Century – TEAM2100

The Environment Agency has established the Thames Estuary Asset Management 2100 programme (also known as TEAM2100) which is providing the first ten years of investment in the tidal flood defences as recommended by the Thames Estuary 2100 Plan (Environment Agency, 2015). Valued at £300 million over 10 years (2014 to 2024) it is one of the government's top infrastructure programmes and is taking a collaborative approach with external partners to progress tidal defence improvements and over 300 investigations and appraisals of defences in the Thames Estuary. By taking this approach, TEAM2100 is increasing the value for money to the taxpayer by being more efficient in how tidal defence works are planned, programmed and completed.

In 2018, with the help of the Water Services Association of Australia, TEAM2100 compared their approach with those of others internationally to identify further improvements. TEAM2100 has identified hundreds of innovations from its work, ranging from better data management, to use of drones to inspect defences, to application of digital technologies such as 3D-augmented reality viewers that help visualise potential improvements to defences. The learnings from the programme are helping to define the future of how best to manage flooding both in the UK and around the world.

Being world-leading in flooding and coastal change is not just about having the best forecasting and warning approaches or the best protection solutions (engineered or natural). It' s also about ensuring we have access to the best research and evidence to underpin both national and local policy choices as well as the operational practice of risk management authorities. Research should support what we do now, and inform and prepare us for what we need to do in the future, to rise to the future social, economic and environmental challenges we face. It is essential this evidence and innovation is recognised, valued and informs decisions made by all risk management authorities.

There is a wealth of information and research on flooding and coastal change we can tap into. Many academic institutions have programmes looking into the future challenges posed by flooding and coastal change and are already working together to share knowledge and experience. UK Research and Innovation, principally funded by government bringing together Research Councils, Innovate UK and Research England, helps fund cutting edge research and innovation into climate resilience and approaches to future societal challenges.

The Flood and Coastal Erosion Risk Management Research and Development Programme, jointly supported by the Department for Environment, Food and Rural Affairs, the Environment Agency, Welsh Government and Natural Resources Wales, also has a pivotal role to play. The programme has established a track record of bringing together academics, policy makers, government agencies and practitioners to catalyse and create research targeted at addressing the immediate and future challenges associated with flooding and coastal change.

Being world-leading in our research and the application of its outcomes will be crucial to delivering the ambitions of this Strategy.

To achieve our objective we have the following measures:

Measure 3.5.1: From 2020 the Environment Agency will continue to work with research councils and academic institutions on world leading research that promotes innovation and informs future approaches to flooding and coastal change.

Measure 3.5.2: By 2025 the Environment Agency will share learning and best practice from around the world with other risk management authorities to encourage innovation in how we manage flooding and coastal change.

Measure 3.5.3: By 2030 the Environment Agency will work with its supply chain to develop world leading ways of reducing the carbon and environmental impact from the construction and operation of flood and coastal defences.

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