



Environment  
Agency



# Living better with a changing climate

Report to Ministers under the Climate Change Act

Date: October 2021

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

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

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

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

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# Chair Foreword



Last month, the Prime Minister told the UN “We have the tools for a green industrial revolution but time is desperately short.” The Intergovernmental Panel on Climate Change says climate change is no longer a distant threat. Added to this is the increasing weirdness of weather patterns: the heat dome in Vancouver, polar vortex in Texas and floods in Germany show no one can be complacent. We should be prepared for “atypical” shocks as well as chartable events. Without adaptation the economic transition to net zero will be knocked off course by sea level rise, storms and droughts.

Climate adaptation is integral to everything the Environment Agency does. This year, we completed the government’s six year capital programme on time and on budget, enhancing flood protection to over 300,000 homes, then we began the new £5.2 billion flood programme. We have also made 320 abstraction licences more sustainable, returning 47 billion litres of water a year to the environment, equivalent to supplying over 850,000 people every year.

The success of such large-scale national infrastructure projects rests on locally-led adaptation action and partnership. The climate crisis is global, but its impacts are in your village, your shop, your home. In England, more than 76,000 incidents were reported to our incident management service last year, including flood, drought, fires, fish kills and pollution incidents: one every seven minutes, 24 hours a day. Climate change is increasing their severity, frequency and duration. We are preparing but the burden of emergency response will increasingly divert our staff and resources from other activities.

This report shows the Environment Agency must sustain its efforts to prepare for worsening climate impacts but that we cannot do this alone. Adaptation action needs to be integral to government, businesses and communities too and people will soon question why it isn’t.

One recommendation of this report is that adaptation needs both public and private finance. In an uncertain world investors want steady long-term returns (and more and more want these to also deliver for nature and the climate). That’s an opportunity for the UK, as the City is a leader in global green finance. However, if we fail to invest now, people won’t be forgiving about paying a higher, avoidable, premium in a few years. It is much cheaper to invest early in climate resilience than to live with the costs of inaction.

This is important to COP26. The Environment Agency’s second adaptation report was published in early 2016, just after the Paris Agreement was signed. I attended COP21 as part of a UK finance delegation calling for emissions reduction and the transition to a low carbon economy. I have the vivid memory of leaving the main negotiating hall to take a briefing from an Environment Agency colleague about some of the worst flooding England has ever seen in Cumbria, Lancashire, Yorkshire and Northumberland.

Limiting carbon emissions is the most effective way to combat climate change, but while mitigation might save the planet, it is adaptation, preparing for climate shocks, that will save millions of lives. Choosing one over the other on the basis of a simple either/or calculation is like telling a bird it only needs one wing to fly, yet adaptation is in danger of being grievously undercooked at COP26. Not by the UK government, which has rightly set dual targets for the summit: to secure global net zero and adapt to protect communities and natural habitats. But by the world at large. If people feel that the gap between telegenic global conferences and the lived experience of climate impacts is too wide, the compact allowing leaders to make huge climate commitments on people's behalf will rupture.

Adaptation should be a cornerstone of any net zero ambition, not as a competing priority but as roots to a tree. It helps avoid disruption to the low carbon transition and provides investor confidence. In setting its own 2030 net zero target, the Environment Agency is showing how reducing emissions and preparing for impacts are mutually beneficial on a project by project basis.

The Environment Agency is calling for much stronger focus on adaptation from everyone, starting now. We want to ensure no group is left behind by climate change in line with the government's levelling up commitments. Adaptation is still in the country's gift but time is desperately short.



**Emma Howard Boyd**

**Chair**

# Executive summary

This is the Environment Agency's third adaptation report under the Climate Change Act. It sets out how the impacts of climate change affect our work and how we are preparing for those impacts. The report is primarily about how the Environment Agency will adapt our own work and partnership work in the face of climate change, but it also has wider messages for national adaptation and the part that we play in enabling the country to make a resilient transition to net zero.

Our key messages are that:

- **Significant climate impacts are inevitable** especially for flood and coastal risks, water management, freshwater wildlife and industrial regulation
- **The Environment Agency is preparing for climate impacts** by working with government, businesses and communities
- **We can successfully tackle the climate emergency** if we do the right things. Early action counts

The risks from climate impacts are recognised in all the Environment Agency's major strategies, including for flooding, coasts, water and catchment management, and industrial regulation. Despite more than a decade of concerted effort to reduce these risks, the speed and scale of climate change means that many are either increasing or remain significant. This broad conclusion matches recent assessments from the Climate Change Committee, the Intergovernmental Panel on Climate Change and others.

The technical section of this report presents a detailed assessment of our climate risks. Almost every aspect of the Environment Agency's work will become more difficult due to climate risks. Many of these (58%) are rated as both Severe and Urgent, meaning there is a very high chance of impacting our (statutory or non-statutory) duties and that we are running out of time to implement effective adaptation measures. These findings align with the Climate Change Committee's evidence report on national climate risks.

Many of the country's biggest risks relate to flooding, coastal change and water management, and already have policy frameworks in place to address them. But our main concerns are those risks that are either newly identified, or do not yet have clear adaptation goals. We agree with the Climate Change Committee that climate risks to freshwater habitats and species are a particular concern as a result of increasing temperatures, invasive species and competing water demands. We also highlight that most current environmental regulations do not anticipate how climate change will exacerbate environmental risks.

Our climate risks also have far-reaching consequences for England's communities, economy and environment. These fall under five headings that we call climate 'reality checks', because the reality is that significant climate impacts are inevitable despite all the measures that are in place.



1. **The Environment Agency alone cannot protect everyone from increasing flood and coastal risks.** Climate change will accelerate sea level rise and alter rainfall patterns. Traditional flood defences will not be able to prevent all flooding and coastal erosion, and this has prompted a shift towards flood resilience approaches to live with increasing risks more effectively (for example, property resilience measures).
2. **Climate change makes it harder to ensure clean and plentiful water.** England's water environment is already under pressure from increasing water demand, pollution, rising temperatures and physical modification. Climate change will exacerbate this. The National Framework for Water Resources and River Basin Management Plans address these pressures, but bold, transformative and sustained action is required to ensure clean and plentiful water for future generations.
3. **Environmental regulation is not yet ready for a changing climate.** Climate change will exacerbate risks from (and to) regulated industries, for example, by reducing water availability and increasing pollution risks from heavy rainfall. Environmental regulations were generally not conceived to accommodate such rapid environmental change, and more flexible approaches will be needed.
4. **Ecosystems cannot adapt as fast as the climate is changing.** There is a biodiversity crisis as well as a climate crisis. Freshwater ecosystems are particularly at risk from rising temperatures, water demand, pollution and invasive species. Efforts are underway to enable ecological adaptation, but the pace of climate change could outstrip these without transformative action as set out in the Dasgupta Review.
5. **There will be more and worse environmental incidents.** Climate change is causing more extreme weather to increase the frequency, severity and complexity of environmental incidents, such as, flooding, water shortages and pollution. The Environment Agency is preparing for this, but the burden of emergency response will increasingly divert our staff and resources from other activities.

These risks are serious but can be addressed through early action. The Environment Agency puts climate change at the heart of everything we do, indeed the first goal of our current corporate strategy is to create a nation resilient to climate change.

Our adaptation approach set out in this report falls under eight themes:

1. **Thinking differently – 'business as usual' is not an option.** Climate impacts are inevitable and our thinking must change faster than the climate. This must be anticipated in all the Environment Agency's work and advice. Our staff play a pivotal role in preparing communities and the environment for a changing climate, especially through their work on flooding, coastal risks and catchment management.
2. **Collaborating adaptation works through partnerships.** The Environment Agency is an important delivery body for local adaptation through our flooding, environmental management and planning roles. We work with local government, businesses, non-government organisations, and communities, and are well placed to see how the

climate risks they face interact. We provide advice on adaptation, develop joint plans with local partners (such as the National Flood and Coastal Strategy Action Plan) and work with local partnerships and volunteers to restore habitats.

3. **Investing in change – adaptation needs public and private finance.** Adaptation is only possible with investment, but it is much cheaper to invest early in climate resilience than to live with the costs of inaction. The Environment Agency invests public money in local adaptation through flood and water resilience measures, such as flood defences, river locks and pumping stations. We also work to secure private investment through partnership funding for flood defence schemes and by supporting the government's Green Finance initiative.
4. **Working with nature – tackle the biodiversity and climate crises together.** 'Nature-based approaches', such as wetlands, can create valuable habitat to support ecological resilience and provide societal resilience by supporting flood protection and water management. The Environment Agency compliments traditional engineering with nature-based approaches where possible.
5. **Designing low carbon futures – support the low carbon economy.** Limiting carbon emissions is the most effective way to combat climate change. The Environment Agency supports the development of low carbon technologies that are climate resilient and sustainable (for example, by advising against inappropriate developments in high flood risk locations). We have also made a corporate commitment to reduce our own carbon footprint to net zero by 2030 which means thinking differently about how we work as well as well as being innovative through our procurement, for instance of low carbon concrete for flood defences.
6. **Strengthening community resilience – support local adaptation for everyone.** The Environment Agency supports community resilience through our role under the Civil Contingencies Act and our strategic planning roles on flooding and water management. Climate change will exacerbate existing environmental inequalities, since some groups will be more affected by climate risks or have less capacity to prepare for them. In line with the government's levelling up agenda, we want to ensure no group is left behind in preparing for climate impacts.
7. **Helping businesses prepare – flexible and climate-proof regulation and advice.** Climate change will exacerbate environmental risks from (and to) regulated industries. We are helping industries to manage these risks by providing advice and, where we have powers to do so, adjusting our regulatory permits to account for climate change. We will also support the development of more flexible regulatory approaches to accommodate rapid environmental change.
8. **Stepping up to level up – show what it takes to live better with a changing climate.** The Climate Change Committee have said that the country needs a step change in adaptation to prepare for even the minimum expected climate impacts, especially for those communities and businesses at greatest risk. We will support

government and partners to understand future climate risks and put in place measures to prepare for them.

These themes shape our detailed 5-year adaptation plan set out in the technical annex of this report. Our main actions are to:

- Deliver the national flood and coastal erosion risk management strategy.
- Tackle pressures on England's water environment
- Improve the resilience of wildlife species and ecosystems
- Manage (environmental) climate risks to and from regulated industry
- Prepare for bigger, more frequent and complex environmental incidents
- Reduce our corporate climate footprint and climate risks

The required scale and urgency of national action is daunting, but we can adapt to the changing climate by doing the right things. The Environment Agency is playing its part in achieving our transition to a climate resilient net zero nation.

# Introduction

## Change is coming

This is our third adaptation report to ministers under the Climate Change Act. Much has changed since our first in 2010, and even since our second in 2016. Many governments, communities and businesses have declared that there is a climate emergency and set out their plans to tackle it. The focus has rightly been to reduce greenhouse gas emissions in line with national commitments under the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement and limit the devastation of runaway climate change. This is essential to avoid the more dangerous scenarios of extreme climate change.

This year's UNFCCC Conference of Parties (COP) summit in Glasgow (COP26) is critical. Under the Paris Agreement, countries committed to:

- Hold the increase in global average temperature to well below a 2°C increase on pre-industrial levels
- Make efforts to limit the increase to 1.5 °C above pre-industrial levels.

Unfortunately, global land temperatures have already risen by about 1.1°C, and further increase is inevitable due to the carbon emissions of the past. Temperatures will soon be teetering on the edge of +1.5°C, which is the most optimistic international goal, with +2°C in sight.

We are increasingly seeing the devastating impacts of increasing floods, heatwaves, droughts and wildfires across the world.

In the UK, we are already experiencing extreme weather, rising sea levels and sustained increases in temperature that disrupt lives, livelihoods and nature.

We need to be clear that neither +1.5°C nor +2°C increases are 'safe'. The IPCC has shown that the global impacts of even +1.5°C are significant, and the severity of climate impacts increase rapidly as temperatures go up (IPCC, 2018). An increase of +2°C may sound similar to +1.5°C but it is much, much worse for people and the environment. In the UK, the Climate Change Committee has also shown that England faces substantial climate impacts under +2°C.

Even more worryingly, as we publish this report, the world is on track for an increase that is more like +3°C given the measures that countries have actually put in place (UN Environment Programme (UNEP), 2020).

As we look ahead to the COP26 summit in Glasgow later this year, we can be sure that this is the last chance to keep global temperature rise close to 1.5°C or even 2°C. We can also be sure that even this scenario implies significant environmental and societal change.

This change will reshape the natural environment and the systems that support our communities and our economies, including food, water and how we use our land.

The inevitability of this change gives us a choice. We can ignore it and crash-land into our new future as our support systems collapse. Or we can accept that change is coming and better prepare for it. We can then plan a 'soft landing' that harnesses new approaches, uses natural resources more sustainably and works with nature rather than against it.

This shift requires transformative action, investment and long term, coordinated action – but for now, adaptation is still in the country's gift.

# The context for this report

## The Environment Agency's role

The Environment Agency is England's statutory environmental regulator, a statutory adviser in the planning system, a Category 1 responder under the Civil Contingencies Act and a Navigation Authority. We have a wide remit that includes:

- Protecting communities from floods and coastal change
- Managing water
- Regulating industry (pollution)
- Looking after freshwater wildlife

Very little of the domestic or international environmental legislation that defines our role has explicit adaptation provisions. However, we aim to embed adaptation throughout our work by:

- Preparing for current and future impacts
- Securing investment in climate resilient net zero infrastructure and places
- Changing how we do things, including regulation and planning advice

Because of our broad remit, we are well positioned to feel the urgency of the climate change challenges. We see the effects of climate change first hand through our incident management service. We help the country to be better prepared for climate impacts, where we lead on managing and responding to the wide range of risks associated with too much and too little water. We also have a vital role in tackling risks to the viability and diversity of freshwater habitats and species, which was recently identified by the Climate Change Committee as a national adaptation priority.

Whilst this report focuses on our adaptation role, we also support government to shape the policy and investment to get the UK on a path to becoming net zero by 2050. We have a central role in reducing greenhouse gas emissions and improving energy efficiency through the industries we regulate, including as the administrator of the UK Emissions Trading System and of the quota system for fluorinated gases and ozone depleting substances.

We are also leading by example with our own ambitious target to become a net zero organisation by 2030.

## Interaction with other national priorities

The climate risks and the adaptation plans set out in this report reflect other national priorities including:

- Recovery from the COVID-19 pandemic and a focus on the development of a National Resilience Strategy

- National and international efforts to achieve net zero carbon emissions
- The Prime Minister's 10 point plan for a green industrial revolution
- The UK's strategy for green growth and a shift towards low carbon technologies
- The 'levelling up' agenda and ensuring a fair transition to a low carbon economy
- Policies to support nature recovery from the biodiversity crisis
- Collaboration on the development of national infrastructure
- The 25 Year Environment Plan, which includes a commitment for all government policies, programmes and investment decisions to account for the full range of climate risks this century
- Reform to land use including development planning and agricultural land management

The report also reflects advice from the Climate Change Committee.

## **Our Third Adaptation Report**

This is our third adaptation report under the Adaptation Reporting Power of the Climate Change Act, which empowers ministers to ask organisations to report on their climate risks and plans for managing them. However, most of the Environment Agency's detailed adaptation planning takes place outside of the adaptation reporting process, as we deliver our wider statutory and non-statutory duties.

Our approach in producing this report is to:

- Refer to published strategies that provide detail on specific areas of our adaptation work, such as the Flood and Coastal Erosion Risk Management Strategy (EA, 2020a) and the National Framework for Water Resources (EA 2020b)
- Assume that these strategies will remain in place and therefore to focus on what additional adaptation is needed (i.e. to address the residual risk)
- Propose new actions on these residual risks where it is possible to do so.
- Indicate our approach to adaptation, where further work is needed to frame new actions

The report focusses particularly on risks where transformative action is needed to address inevitable environmental change. We call these climate 'reality checks' because the reality is that significant climate impacts are inevitable despite all the measures that are in place.

The section on 'Technical Material' includes our climate risk assessment, methodology and assumptions, adaptation actions and their interdependencies. This addresses technical requirements of the adaptation reporting process.

The word 'resilience' is used colloquially in this report to mean preparedness for climate risks and the ability to recover quickly from disruption (as opposed to technical definitions).

# The environmental change we face

## Climate change in England

The Environment Agency relies on the UK climate projections, produced by the Met Office Hadley Centre Climate Change Programme, other Met Office products, and the national Climate Change Risk Assessment for our understanding of past and future climate change and its effects.

### Observed changes

The latest Independent Assessment of UK Climate Risk (CCC, 2021a) and the Met Office State of the UK Climate 2020 Report (Met Office, 2021) note clear patterns in our changing climate.

Variable	Observed changed
<b>Average annual temperature</b>	+0.9°C increase from mid-1970s to mid-2010s
<b>Annual mean rainfall</b>	+4.5% increase from mid-1970s to mid-2010s
<b>Sunshine</b>	+9.2% increase from mid-1970s to mid-2010s
<b>Weather extremes</b>	UK-wide increase in extreme heat events Little evidence yet on changes in extreme rainfall
<b>Sea level rise</b>	UK-wide increase of approx. 1.4mm/year since 1901 (16cm to date)

**Table 1.0 Observed climate changes (CCC, 2021b)**

Average land temperatures across England were 0.9°C warmer in the decade 2010-2019 than in the period of mid-1970s to mid-2010s. The Central England Temperature record shows that the 21st century has so far been warmer overall than any of the previous three centuries (CCC, 2021b) and the top 10 warmest years for the UK in a series from 1884 have all occurred since 2002 (Met Office, 2021).

There has been a 4.5% observed increase in annual mean rainfall in recent decades, from an average of 827mm from mid-1970s to 864mm by mid-2010s. Six of the 10 wettest years for the UK in a series from 1862 have occurred since 1998 (Met Office, 2021).



A clear trend is emerging for increasing sunshine hours in England, where there was a 9.2% increase in average sunshine hours from the period of mid-1970s to mid-2010s. Spring 2020 was the sunniest on record since 1929 (CCC, 2021b).

Whether these trends are resulting in more extreme weather events is less clear. The latest climate science suggests that the effects of climate change on daily extreme rainfall events are only just beginning to emerge. Extreme heavy rainfall events appear to be more intense, and more frequent, but the record is as yet too short to be conclusive. The evidence is clearer however, that extreme maximum summer temperatures are becoming more frequent and more extreme. This is illustrated by how many of the UK’s record extreme monthly temperatures have been set in the most recent decade along with a tendency for more heatwaves in London in recent years (CCC, 2021b).

Sea level rise is difficult to observe and varies across the country. A UK-wide sea level index suggests that sea level has risen by between 1.2 and 1.6mm per year since 1901.

### Expected future change

The changes that England is already experiencing are projected to continue and intensify. Table 1.1 below shows the latest set of projected changes in climate for England compared to a 1981-2000 baseline, as presented in the CCRA3 summary for England (CCC, 2021b) and taken from the latest climate change projections (UKCP18). The climate information and underlying assumptions used in our risk assessment for this report are summarised in the technical annex.

	2050s +2°C	2050s +4°C	2080s +2°C	2080s +4°C
<b>Annual temperature</b>	+1.3°C	+1.2°C	+1.4°C	+2.4°C
<b>Summer rainfall</b>	-15%	-14%	-15%	-22%
<b>Winter rainfall</b>	+6%	+6%	+8%	+13%
<b>Sea level rise</b>	+23cm	+29cm	+45cm	+78cm

**Table 1.1 Projected climate changes in England compared to a 1981-2000 baseline**

Note: The Climate Change Committee uses RCP2.6 50<sup>th</sup> percentile and RCP6.0 50<sup>th</sup> percentile as proxies that are roughly equivalent to a +2°C and +4°C above pre-industrial scenarios by 2100 respectively. The exception is sea level rise where the RCP8.5 is used for the +4°C scenario as for the marine projections this is closer.

Annual temperatures in England are expected to rise by approximately 1.3°C (above the 1981-2000 baseline) by the 2050s, and between 1.4°C and 2.4°C by the 2080s, with greater increases in the summer.

Winter rainfall is expected to increase by approximately 6% by the 2050s, and by 8% to 13% by the 2080s. Meanwhile summer rainfall is expected to decrease by approximately 15% by the 2050s, and by 15% to 22% by the 2080s.

The frequency and intensity of extreme temperature and rainfall events may also increase in future. By 2100, many areas in the north are likely to exceed 30°C at least once per decade. In the south-east, temperatures above 35°C become increasingly common, and temperatures exceeding 40°C also become possible. Summers that experience days above 40°C somewhere in the UK have a return time of 100-300 years at present, but without mitigating greenhouse gas emissions, this can decrease to 3.5 years by 2100.

The intensity of rainfall is projected to increase particularly in winter. In particular, in the south-east where the wet day intensity<sup>1</sup> could increase by as much as 25% by 2070 (compared to the 1981-2000 baseline). Although summers will be drier overall, with fewer wet days, summer rainfall is also projected to be more intense.

Sea level rise will vary locally, but is generally greater in the south of England than other parts of the UK (due to the movement of land as well as the sea). London's sea level is expected to rise by between approximately 23cm and 29cm by the 2050s and by approximately 45cm to 78cm by the 2080s.

As a result of changing rainfall patterns, river flows are also projected to change. Monthly low flows could reduce by 82% by the 2050s and 87% by the 2080s but this will vary between catchments, with changes expected to be greatest in the relatively 'flashy' hard rock catchments in North West and South West England. Peak river flows will increase by up to 27% by the 2050s and 52% by the 2080s, again with variation between catchments.

## Our climate risks

Despite concerted adaptation work over the past decade, the Environment Agency faces a large number of climate risks to our corporate objectives – reflecting the risks that the country faces. This section describes our top risks (that scored highly for either severity or urgency) for each of the three long term goals.

Highly urgent risks are those where the time needed to respond is likely to be greater than the time available. High severity risks are either:

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<sup>1</sup> Where a wet day is classed as one where precipitation is more than 1mm

- More than 50% likely to significantly impact achievement of aims or objectives
- Those with financial losses of at least 20% (of the total relevant budget)
- More than 80% likely to result in moderate impacts on achievement of aims and objectives and financial losses of at least 10%

These top risks include some that are nationally significant:

- Flooding and coastal change risks to communities, businesses and infrastructure.
- Water scarcity risks to public water supply, and for agriculture, energy generation and industry
- Risks to nature and coastal, marine and freshwater ecosystems
- Environmental risks arising from the combined pressures of climate change and industry (or agriculture)
- Risks to people from bigger, more frequent and more complex environmental incidents, including floods, drought and pollution

Flooding and water scarcity have long been recognised as significant climate risks. The latest independent assessment of UK climate risk (CCC, 2021a) concludes that while more action is needed to deliver climate resilience for these, there are established adaptation policy frameworks to achieve this.

The Climate Change Committee identify eight priority risk areas for the country. Most notable for the Environment Agency are ‘risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards’, where urgent additional action is needed to prevent irreversible losses in species and habitats and protect the services they provide (CCC, 2021a).

The following sections summarise climate risks to the Environment Agency’s corporate objectives.

## **A nation resilient to climate change**

Climate change will (obviously) make it harder to achieve the Environment Agency’s goal for a climate-resilient nation. However, our knowledge, experience and remit mean there is a significant opportunity for us to provide leadership and technical support to partners.

All the risks assessed against this goal were scored as either moderate or high in severity, and moderate or high urgency and are shown in Figure 1.2 below.

Flooding, drought and coastal change have significant consequences for health, wellbeing and livelihoods (RP7, RP8, RP9). As these hazards increase, it will become more difficult for the Environment Agency to ensure the climate resilience of places and infrastructure. The number of properties and infrastructure in flood plains is also increasing and is estimated to almost double from 2.4 million to 4.6 million over the next 50 years.

The rising strain on our flood and water resource assets means more investment is needed for capital and maintenance. This has a consequential impact on energy usage

and further drives our need to move to low or zero carbon construction and operation of these assets. It also increases the chance of operational failure (RP2 and RP1). For example, higher sea levels causing waves to carry greater energy will increase maintenance and repair costs by between 30% and 80% depending upon the severity of climate change. Meanwhile, there is a possibility that new property and infrastructure developments ignore our planning advice and do not implement effective flood, coastal and water resilience measures (RP3, RP5).

Environmental incidents, such as flooding and drought, will increase in frequency, scale and complexity. Our incident management service will need to cope with the changing scale and nature of incidents (IM1, IM2) as well as a changing spatial pattern, including a geographical shift in water resource pressures to steep upland catchments of the North West and South West (IM3). These catchments are often used as 'donors' to relieve water stress in the South East. Increased frequency and severity of environmental incidents reduces community resilience and their ability to recover, adding further expectation and pressures to the Environment Agency's incident management service (IM4, IM8).

The Environment Agency prioritises its Category 1 emergency response role by diverting resources from other activities according to demands. The cumulative effect of more frequent incidents will therefore reduce our capacity and focus on long term planning, engagement and strategy implementation (IM5). The higher workloads and pressure arising from increased incident duty (IM6) also place heavy burdens on the health, safety and wellbeing of staff.

## Key

### Risks to EA2025 aim on resilient places

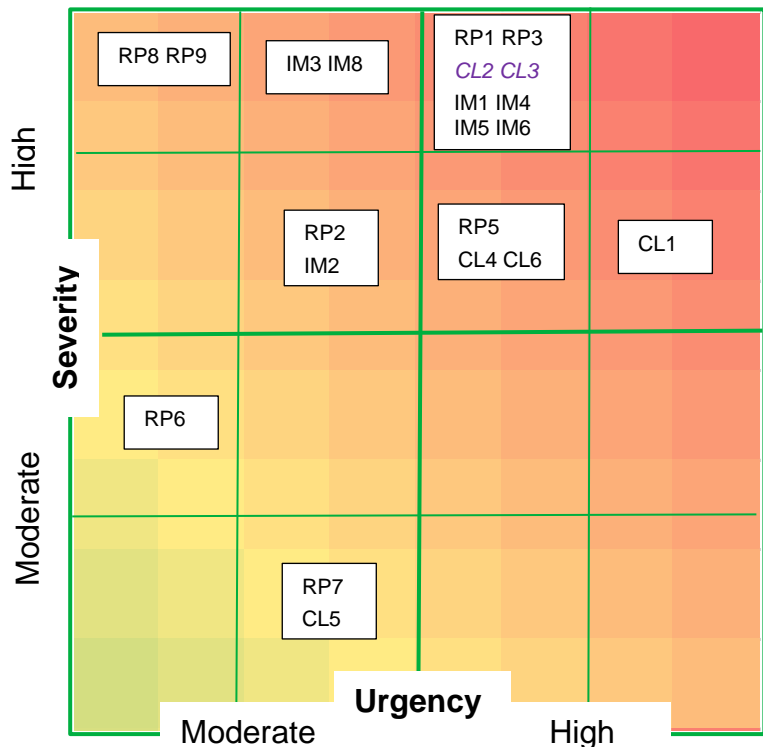
- RP1: Conventional asset led approaches face rising investment needs
- RP2: Increased maintenance and refurbishment of assets
- RP3: New development that does not follow our flood risk advice
- RP4: Groundwater flooding and its effects on communities and critical infrastructure.
- RP5: New development that does not follow our water resource risk advice.
- RP6: Morphological response causes rapid flooding
- RP7: Waterside amenities inaccessible
- RP8: Community health and wellbeing deteriorates due to more frequent flood or drought
- RP9: Permanent population displacement due to flooding

### Risks to EA2025 aim on climate leadership

- CL1: Adaptation shortfall (perceived or real) affects our ability to influence
- CL2: *Opportunity for green finance*
- CL3: *Opportunity to be credible advisor on adaptation*
- CL4: Surface water flooding and its effects on communities and critical infrastructure
- CL5: Health effects of heat on the vulnerable
- CL6: Unable to meet increasing demands for our data and advice

### Risks to EA2025 aim on incident management

- IM1: A 'new scale of incidents', for which the current service will not be able to deal with
- IM2: Wider variety of different types of incidents
- IM3: Altered spatial pattern of incidents
- IM4: Disruption to movement of staff/ equipment or power during incident response
- IM5: Increased frequency and duration of incidents means stop and slow of other work
- IM6: Effects on staff health, safety and wellbeing of due to increased incident duty
- IM7: Loss of public confidence in mapping and modelling of incidents
- IM8: Reduced resilience of communities



**Figure 1.2 – Heat map showing urgency and severity of climate risks to EA long term goal for climate resilience**

The Environment Agency aims to be a strong leader on climate adaptation and resilience. We have the opportunity to play our full part in this using our data and expertise (CL3), our experience and influence and through enabling green finance (CL2). This can help unlock investment in infrastructure development and regeneration while providing climate resilience and improved environments. However, it may be impossible to satisfy the rapidly growing national demand for technical support on adaptation (which is often outside our publicly funded role). Any perceived shortfall in our own adaptation action, or ability to provide data or advice, undermines our credibility and influence (CL1, CL6), for example, as part of our strategic oversight role on surface water flooding (CL4).

## **Healthy Air, Land and Water**

Climate change is putting increasing pressures on air, land and water, making it a greater challenge for us to improve and protect the environment, with consequences for people, the economy and wildlife.

Almost all of the risks assessed against this goal were scored as either moderate or high in severity and moderate or high urgency and are shown in Figure 1.3 below.

Climate change is contributing to air pollution by changing atmospheric chemistry, increasing the risk of wildfires, and driving increasing emissions of ammonia from agriculture and natural sources (A1). Responses to weather or climate change, whether planned or reactive can also increase emissions, for example, due to cooling technologies or increased energy use for repair or maintenance (A2).

Population growth and climate change combine to increase water demands. If no further action is taken between 2025 and 2050, over 3,400 million extra litres of water per day will be needed for resilient public water supply. Industry, agriculture (including biomass) and the environment all compete with public water supply for water resources. In addition, the 1000+km of Environment Agency navigational waterways support both commercial and recreational vessels and provide a further recreational benefit to in excess of 15 million 'bankside' visitors per year.

Hotter, drier summers and rising sea levels, along with pressures from development, are increasing tension from these competing demands, especially where there are chalk streams (W1, W13). If no action is taken between 2025 and 2050 then about 1100 million extra litres of water per day could be needed to address the impact of climate change on water availability (400 million litres per day) and to replace unsustainable abstractions and improve the environment (720 million litres per day) (EA, 2020b).

## Key

### Risks to EA2025 aim on cleaner, healthier air

A1: Impacts on air pollution and its effects on health and ecosystems

A2: Impacts of adaptation (and mitigation) on emissions to air

### Risks to EA2025 aim for rivers, lakes, groundwater and coasts

W1: Increasing tension from competing demands for water

W2: Crossing of ecological tipping points

W3: Current water quality standards become meaningless in 'a new ecology'

W4: Decreased suitability of temperature sensitive species

W5: Coastal squeeze

W6: Water pollution/ contamination due to flooding

W7: Decline in water quality due to reduced dilution

W8: Increased eutrophication due to warmer water

W9: Remobilisation of contaminants due to warmer water

W10: Saline intrusion

W11: Reduced sediment availability increasing coastal flood risk

W12: Impact of increasing extreme weather on angling activity

W13: Insufficient water for boats

W14: Obstructed navigation due to deposition of eroded materials

W15: Damage to natural functioning of catchments exacerbates climate impacts

### Risks to EA2025 aim on protecting nature and land

NL1: Loss of special habitats

NL2: Land contamination due to mobilisation of contaminants

NL3: Reduced infiltration due to drier periods

NL4: Altered geomorphological processes due to wetter periods

NL5: Changes to suitability of crops

NL6: Fewer slurry spreading days

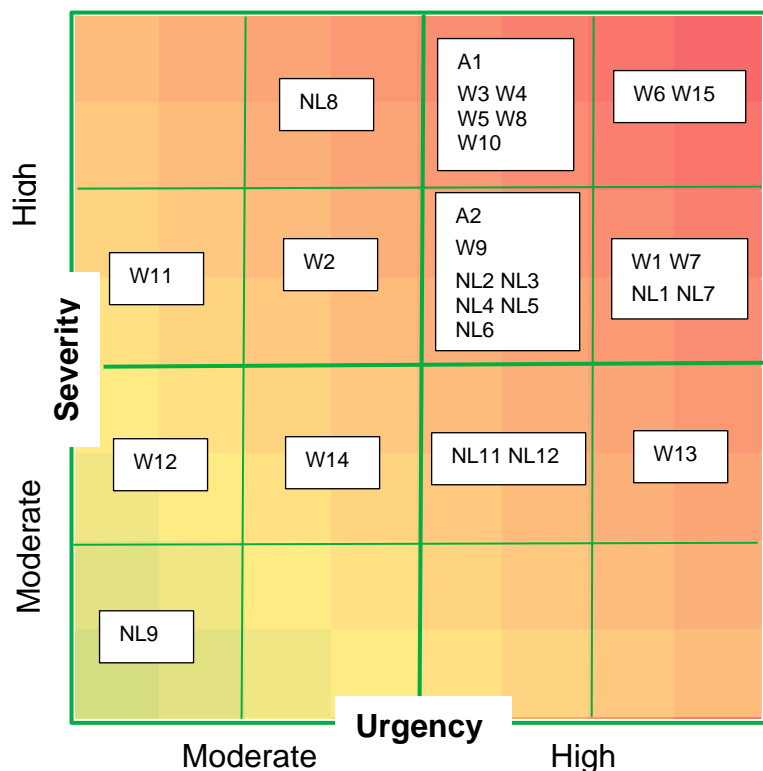
NL7: Insect decline affecting pollination of crops

NL8: Invasive species or plant and animal disease hampers our direct work

NL9: Landfill caps drying out and losing integrity during heatwaves

N11: Species re-introductions become unsustainable

NL12: Protected area objectives become obsolete



**Figure 1.3 Heat map showing urgency and severity of climate risks to EA long term goal for clean and healthy air, land and water**

Water resource risks interact with water quality risks, with low river flows meaning less water is available for dilution and dispersion of pollutants, contaminated sediments and heavy metals (W7). The longer pollutants stay in a water body, the greater the risks from eutrophication and algal blooms (W8). Rising water temperatures, in particular when combined with higher temperatures of consented discharge from power stations (W9), increase the likelihood of algal blooms and are leading to a declining suitability of temperature sensitive species (W4). Conversely, flooding also presents water quality risks as it can lead to increased runoff and contamination of water bodies (W6).

Modifications to rivers and coasts over many years have altered the natural functioning of catchments. This makes it more likely that the impacts of climate change (including from droughts, storms, surface runoff, and rising sea levels) could outpace the ability of rivers, coasts and estuaries to naturally adapt or be managed. As well as exacerbating flood risks and affecting groundwater recharge, there is potential for significant damage to habitats and further loss of ecosystem services (W5, W15), such as, from saline intrusion (W10).

Climate change driven processes such as this will accelerate the loss of special habitats, such as wetlands, or of key species (NL1), while contributing to an increase in non-native invasive species and the spread of plant and animal diseases (NL8). Research by the Climate Change Committee found that 35% of 402 terrestrial species in England are at risk of range loss and 42% may expand their range in future (CCC, 2021a).

Taking all of this together, climate change is driving a 'new ecology' for which today's water quality standards could become redundant (W3), protected area objectives inappropriate (NL12) and species re-introductions unsuitable. In some cases, thresholds or tipping points may be crossed, with significant irreversible consequences for species decline and for ecosystem services and the communities and industries that rely on them (W2).

Climate change will have impacts on land and soil as wetter winters and more extreme rainfall events change the rate and scale of geomorphological processes, such as, soil erosion, sedimentation, waterlogging and capping of soils (NL4). These impacts can cause danger to people from landslides, loss of nutrient uptake and land contamination as heavy rainfall mobilises contaminants (NL2). Impacts on land can also affect the water environment, such as, through reduced land infiltration due to dry periods increasing surface runoff during a subsequent rainfall event, with associated flooding, erosion and loss of nutrients (NL3).

Climate change presents challenges to land management, including for agriculture and carbon sequestration. New or traditional crops that are unsuited to the climate could have negative consequences for soil and water as well as for food security and nutrition (NL5). The decline of insect pollinators is exacerbated by climate change and presents a risk to crops (NL7). Wetter winters and more extreme rainfall events will make it more difficult to manage risks from agricultural wastes that are normally spread on land (NL6).



## Green growth and sustainable future

Economic growth must be climate resilient to be sustainable and deliver shifts to new technologies, energy security and sustainable resource use (GG1). Risks to this goal are shown in Figure 1.4 below, 8 of which fall into the high severity and high urgency categories.

The impacts of climate change in combination with industrial activity could lead to increased pollution, reduced compliance (GG2) and an increase in frequency and severity of industrial accidents (GG3). This could, for example, be caused by flooding, extreme rainfall, wet weather, coastal inundation, wind damage, low river flows, waste fires or reduced process efficiencies. For agriculture industries too, wetter winters and heavy rainfall could exacerbate diffuse pollution (GG8).

Other environmental incidents at industrial sites can result from high temperatures, dry weather or wind. These include fugitive emissions, pest infestation, odour, litter and dust (GG4) or stockpiling of waste due to bad weather conditions, including illegal waste storage and abandonment (CE1).

Community health, wellbeing and resilience could deteriorate due to combined effects of more frequent and severe environmental incidents, and temporary displacement of communities can strain local services (RP8).

The effects of climate change could cause increasing disruption to our operations (SB2, SB3) as well as to regulated industries (GG12). For example, energy generation can be disrupted by flooding, lack of water availability for abstraction, extreme high river flows or severe weather, sea level rise threatens nuclear waste disposal. Industries often rely on complex global supply chains, which can be disrupted by impacts on transport systems, producers and the supply of materials (GG5, GG7).

## Key

### Risks to EA2025 aim for cleaner, healthier air

- GG1: Our regulation fails to support adaptation
- GG2: More pollution incidents from regulated sites
- GG3: Escalation in number and consequences of industrial accidents
- GG4: Increase in other environmental concerns at industrial sites
- GG5: Risks to water abstraction for industry
- GG6: Increased energy use due to industry responses to weather or climate change
- GG7: Disruption to energy generation
- GG8: Increased diffuse pollution from agriculture
- GG9: Opportunity for multiple benefits from land use change as part of wider net zero
- GG11: Renewable technologies suffer damage or loss of efficiency
- GG12: Business disruption in industries we regulate

### Risks to EA2025 aim for rivers, lakes, groundwater and coasts

- CE1: Stockpiling of waste due to bad weather

### Risks to EA2025 aim to protect nature and land

- SB1: Reduction in our ability to achieve net zero by 2030
- SB2: Disruption to our own supply chain
- SB3: Flooding of our own operations
- SB4: Reduced capacity of carbon sinks contributing to EA Net Zero
- SB5: Negative effects on staff health and wellbeing (other than related to incident duty)

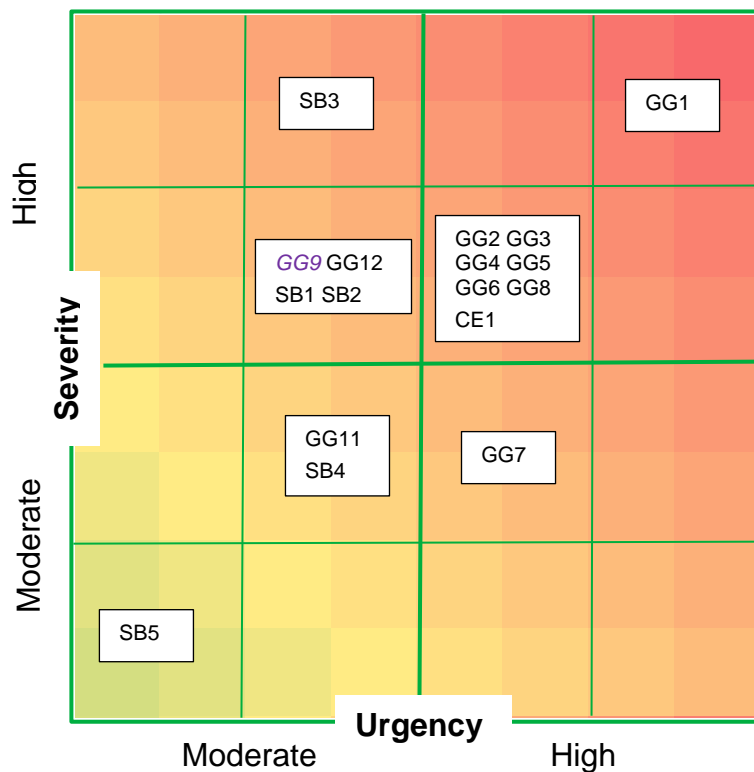


Figure 1.4 – Heat map showing urgency and severity of climate risks to EA long term goal for green growth and a sustainable future

The transition to a low carbon economy may create unintended environmental risks, such as, energy use or air quality (GG6). For example, shifts to new low carbon energy generation could increase water demand while increased energy consumption and emissions can result from cooling technologies, changes in behaviour and water pumping.

The Environment Agency also needs to manage the impacts of climate change on our own Net Zero and sustainable business commitments (SB1). In particular, without the necessary levels of innovation, our flood defence programme could generate significant new construction. Similarly, the increasing frequency and severity of environmental incidents can increase carbon emissions from travel, pumping, water transfers, or operating flood barriers and navigation assets.

There are significant opportunities for the Environment Agency to collaborate with industry partners to embed climate adaptation and supply chain resilience as an integral part of regulated activities. We could achieve multiple benefits from land use change, building resilience as we rapidly make a fair transition to a low carbon future (GG9).

# Five climate reality checks

Our plans for managing our climate risks are presented in the next section. However, the uncomfortable truth remains, that these actions represent only a partial response to the scale and nature of expected climate impacts.

On this basis, we want to share five ‘reality checks’ that we believe make the urgent case for taking strong action now. These reality checks are inevitable even under the best-case scenarios of climate change.

The future looks challenging, but it doesn’t mean that we should give up. Instead, we must be more clear-sighted about the scale of the challenges, the action needed, and the urgency. In confronting these challenges, we can start to develop a more positive picture for an England that is adapting to climate risks.

1. We cannot protect everyone from increasing flood and coastal risks
2. Climate change makes it harder to ensure clean and plentiful water
3. Regulation is not yet ready for a changing climate
4. Ecosystems cannot adapt as fast as the climate is changing
5. There will be more and worse environmental incidents

We call these ‘reality checks’ because we want people to be aware of the huge potential for disruption to our communities, wildlife and economy – and this disruption is already starting to happen. A combination of inevitable and progressive environmental change, and a society built on the assumption that climate change would not happen, has led us to where we are now.

We must not be complacent in thinking that the country is better prepared for climate impacts than it is.

We also need to emphasise that global action to limit further climate change is imperative, but is not in itself a complete solution. We need to be better prepared for climate impacts now as well as to adapt to a different future. These five reality checks present a dilemma. We cannot avoid them because climate change will continue to increase even if we achieve significant carbon reductions.

We cannot prepare for these realities by slightly adjusting our relationship with the environment. Rather they call for coordinated, long term planning, action and investment as well as shifting our expectations of the environment and the environmental services that we take for granted.

We are only starting to understand what these changes should be, and the country needs a stronger consensus on the need for changes and how they should be made.

We want to engage in national conversations on these topics so that, wherever possible, we avoid abrupt climate shocks and have a clear coping strategy to live, work and ultimately thrive in a changing climate.

# **We cannot protect everyone from increasing flood and coastal risk**

## **Flood and coastal risks are increasing**

We are already seeing evidence of rising sea levels, more frequent and more extreme flooding and faster and more extreme coastal erosion.

Under all future climate scenarios, we will experience a continued rise in sea level well into the next century due to the long lag between historic release of greenhouse gases and consequent rise in sea level. According to the UKCP18 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 (CCC, 2021b). Extreme sea levels that used to occur once a century could occur once per year in most locations by 2100 under all emission scenarios (IPCC, 2018).

The number of properties and infrastructure in flood plains is also increasing, and we estimate this will almost double from 2.4 million to 4.6 million over the next 50 years. 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 (EA, 2019).

## **We cannot protect everyone**

To avoid flood and coastal risk getting worse, the Environment Agency estimates that in the long-term we need to spend an average of over £1 billion a year (EA, 2021).

In some cases, it will be impractical to defend against increasing risks. With higher temperatures, protecting against or accommodating sea level rise particularly in low lying areas is likely to become increasingly difficult. In some areas, the frequency of flooding from rivers and rainfall will become more regular, making it difficult for existing communities to remain resilient to the impacts of flooding. Raising flood and coastal defences will become technically and socially challenging with higher climate change scenarios.

It will also become more expensive to maintain existing defences. For example, higher sea levels causing waves to carry greater energy will increase maintenance and repair costs by between 30% and 80% depending upon the severity of climate change (EA, 2021).

## **We must focus on resilience**

The 2021 national strategy for flood and coastal risk management presents an explicit shift in approach from flood protection (traditional flood defences) to flood resilience (a systemic approach to reduce and live with increasing risk).

We must continue to do what we have been doing: building and maintaining strong defences to reduce the risk of places being flooded.

But protection can only ever be part of the solution. 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.

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.

## **Climate change makes it harder to ensure clean and plentiful water**

### **England's water environment is under pressure**

Our waters serve many roles. As a water source for drinking water supplies, industrial use and agriculture. As a precious habitat for aquatic and marginal species. As a conduit for both controlled effluents and chemicals carried by natural run-off. As transport infrastructure for navigation. As industrial centres for fisheries, aquaculture and hydroelectric power, and as amenity for bathing, angling and leisure.

The Environment Agency must balance all of these pressures on our waters. This is already becoming more difficult and between 2016 and 2019, just 16% of water bodies (14% of rivers) met the criteria for good ecological status under the Water Framework Directive. This is a decrease from 25% in 2009 and from 23% in 2013.

### **Climate change will exacerbate water stress**

Climate change will alter temperatures, rainfall patterns and evaporation of water into the atmosphere, in turn increasing the water demands of plants. These changes are combining with pressures from agricultural pollution, the physical modification of water bodies, wastewater discharges, urban pollution, over-abstraction and invasive species to exacerbate water stress.

The most obvious pressure is on public water supply, which will require over 3,400 million extra litres of water per day if no action is taken before 2050 (EA 2020b). This includes:

- 1150 million litres per day to make water supplies more resilient to drought
- 1040 million litres per day to supply the growing population
- 720 million litres per day to replace unsustainable abstractions and improve the environment
- 400 million litres per day to address the impact of climate change on water availability (water companies have included additional impacts from climate change of around 640 M/l/d in their plans up to 2025 which is before the start date of this analysis)

Around 50% of national additional need for public water supply by 2050 is in the South East. Table 1.2 shows the regional breakdown of projected additional water need for different regions and sectors.

Region	Public water supply (million litres/ day)	Power (million litres/ day)	Industry (million litres/ day)	Agriculture (million litres/ day)
North	233	73	63	56
West	638	40	167	76
East	570	75	85	284
South East	1765	66	56	53
West Country	227	27	122	44

**Table 1.2: Additional water needs by 2050 for public water supply and other sectors. From: Meeting our future water needs: a national framework for water resources (EA 2020b)**

But the wider pressures on our waters are more complicated and difficult to manage:

- Water levels will fluctuate wildly to affect river flows, water supplies, water quality, wildlife and amenity use
- Reduced water availability to replenish reservoirs, aquifers and rivers
- Sea water will be driven inland to contaminate aquifers and rivers
- Flood risk to water supply infrastructure
- Warmer water temperatures favour invasive species, reduce oxygen levels, and accelerate chemical processes
- Increase pollutant loads in water bodies, especially when river levels are lower in summer, and when heavy rainfall overwhelms sewage overflows or washes contaminated soils into rivers

In many cases, it will be these pressures that dominate.

### **Concerted action is needed to improve England’s water environment**

Bold, transformative and sustained action is required to meet all the pressures on the water environment, and to ensure clean and plentiful water for future generations.

Measures to secure safe, reliable water supplies and to create resilient catchments are described in the National Framework for Water Resources and River Basin Management Plans.

Many of the identified measures, for example to secure new water supplies, to improve water quality and enhance riverine habitats will help achieve the aspirations of government's 25 year plan for the environment and adapt to climate change.

Some actions such as peat restoration, creation of saltmarsh in estuaries, tree planting and wetland creation in the right places can enhance water quality, reduce flood risk, improve the reliability of water abstraction and absorb carbon at the same time.

There are opportunities to create a high quality water environment that is resilient to climate change but it is clear is that a strategic approach to water management, coupled with faster progress on delivering improvements is needed.

## **Regulation is not yet ready for a changing climate**

### **A changing climate alters the regulatory context**

The changing climate presents a challenge to environmental regulation.

Climate change modifies the impacts and risks from a given activity – often for the worse, including increasing the likelihood of major pollution incidents. For example, lower river flows coupled with increased water demand, mean there is less and less water available to dilute effluent or to reduce the impact of diffuse pollutants. Moreover, it will become increasingly difficult to anticipate these risks if the environment changes rapidly on an annual or seasonal basis.

The need to support and enable innovation on the journey to Net Zero emissions will add further stress to the regulatory system; so the challenge is even greater and needs to be considered in that broader context.

### **Legislative and regulatory standards and approaches were not conceived for this**

Most environmental policy and legislation that applies to industry was designed to protect the environment and people from the specific risks posed at that time, based on past events. Particular activities were viewed in isolation rather than as part of a whole, interdependent system. Not all regulatory standards and approaches are designed to:

- Respond quickly to changing pressures
- Deliver enhancements to recover climate-impacted environments
- Adapt to future hazards, which may arise as the climate crosses tipping points



It is inevitable that our current regulatory approaches will struggle to cope with the speed, breadth, severity and frequency of anticipated environmental change and innovation. The National Audit Office describes forward-looking approaches in their Principles of Effective Regulation. We will explore what more we can do within our existing powers and work with government to design the flexibility we need into future environmental legislation and regulatory policy and interventions.

## **Ecosystems cannot adapt as fast as the climate is changing**

### **Our wildlife is under impossible pressure**

Wildlife is fundamental to our society, health and economy. Quite aside from any intrinsic value, wildlife provides essential 'ecosystem services' that support our way of life – food, water, flood protection, insects that pollinate crops and so on.

But there is a biodiversity crisis as well as a climate crisis, and our wildlife is already in decline. Several centuries of industrialisation and urbanisation has left the UK as one of the most nature-depleted countries in the world, ranking 189 out of 218 countries for terrestrial 'biodiversity intactness' in 2016 (RSPB, 2016).

- We have lost 90% of wetland habitats in the last 100 years- they make up only 3% of the UK but support about 10% of all our species
- 66% of existing species are in decline
- 41% of species are less abundant than in 1970 (RSPB, 2019)
- of 8431 species, 15% are threatened with extinction (RSPB, 2019)

We are confident that a wide-range of human-made pressures, in addition to climate change, are responsible for this. Such pressures include changes to land-use, habitats and water flows, pollution and invasive non-native species.

### **Ecosystems will inevitably change further**

It seems inevitable that wildlife in England will continue to be altered by climate change and other pressures. Increased temperatures will affect wildlife (for example breeding conditions for fish) and create favourable conditions for the spread of invasive non-native species.

The Environment Agency's wildlife remit is primarily focused on the ecological quality of our waters, and these are under significant pressure, as noted above.

Climate change will impact the distribution of individual species, as well as the composition and abundance of ecological communities. Increasing temperatures, changes in rainfall and wildfire can lead to losses or gains of species in a community or geographic area.

Analysis for the CCRA (CCC, 2021b) suggests that 35% of 402 terrestrial species in England are at risk of range loss, and 42% may expand their range in future.

Not all increases in species range will be beneficial, especially where native or non-native invasive species disrupt fragile habitats or important ecosystem services. Warmer winters have already had a clear influence on outbreaks of some pests and pathogens. It is estimated that England suffers £1.3 billion in damages a year from invasive species, which include 58 terrestrial and 130 freshwater invasive species.

The waterways of South-East England are particularly at risk from invasive species due to increasingly favourable climate and proximity to continental Europe and ports.

The consequences for people and the environment are significant. Biodiversity loss leads to the simplification and subsequent degradation of ecosystems. This in turn undermines their ability to support life, including our own. The importance of the natural environment to our health and wellbeing has been brought into sharp focus during the Covid-19 pandemic.

## **We must support healthy and desirable ecological transformation**

The 2021 Dasgupta Review shows that the unsustainable demands placed on nature undermine our national wellbeing and prosperity. Transformative action is necessary, urgent and possible.

Clearly, ecological adaptation is limited by the physiological requirements of individual species. However, there are also important attitudinal barriers to the management of nature adaptation. Nature is often seen as an impediment to development, or something that must be accommodated around it. This thinking needs to be reversed to recognise that nature provides the essential foundations and services for development.

The Environment Agency is central to the debate around how to secure a more sustainable future. We must support a landscape-scale approach to conservation, guided by Lawton Review principles of 'more, bigger, better and joined' to create a 'Coherent and resilient ecological network' (Defra, 2010).

## **There will be more and worse environmental incidents**

### **Incidents will be bigger, more frequent and more complex**

Climate change is causing more extreme weather, increasing the frequency and severity of floods, heatwaves and water shortages which in turn create more concurrent and prolonged incidents. This increase is set to continue with a projected decrease in summer rainfall of 22% and increase in winter rainfall of 13% by the 2080s (CCC, 2021b).

Meanwhile the number of properties on the floodplain in England is expected to double by 2065 (EA, 2019).

Much of the Environment Agency's work is about minimising the risk of environmental incidents – pollution, droughts, floods. We build flood defences, we regulate industry and work with partners to manage and control risk of major accidents and to provide advice. But we cannot totally remove the risk.

Some incidents are driven by natural events, like flooding or drought. Others, like industrial accidents, are the direct result of human activity and their interaction with natural hazards, such as extreme weather events.

Four million people and £200 billion of assets are at risk of flooding from rivers or sea (OST, 2004). While 40 million early warning messages sent for river and sea flooding over the past 10 years, there are still 3 million properties are at risk of surface water flooding where no early warnings are available (Defra, 2021).

We know from past experience that the cost of incidents can be significant. For example:

- The 2007 floods had an economic cost of £3.9bn (EA, 2010)
- Buncefield cost £1 billion in environmental damage (MIIB, 2008)
- There is a 50% increase in mental ill health after flooding (Graham et al, 2019)

The infrastructure that supports our society was not designed for these new extremes and can fail, in turn creating more complex environmental incidents through a cascade effect. For example:

- Combined sewer overflows will need to be operated more frequently, causing contamination to be washed into rivers, lakes, estuaries and the sea
- A flood can overwhelm drains at an industrial site, polluting a river and killing fish
- A drought can lead to low flows and poor water quality, again killing fish - we are seeing about 30% more fish kills in drought years

We operate a successful and highly respected Incident Management Service but it is not sustainable in the face of growing incident risk.

We need to change to be ready for the future so that we continue to keep people safe, protect the environment from serious and lasting damage and support the nation to be resilient in the face of bigger, more frequent and complex incidents associated with climate change.

# Meeting the challenge

We are already experiencing the impacts of a changing climate. These will continue to become more severe over coming decades due to the lag between carbon emissions and their environmental effects, even if the world gets on a path to net zero. Reducing emissions remains the best way to tackle climate change but this must be accompanied by preparation for inevitable climate impacts.

The analysis in this report show that the Environment Agency must escalate its efforts to prepare for these climate impacts. This reflects the Climate Change Committee's more general finding that the UK is not yet prepared for even the best case scenario of climate impacts, and that the country must make a step change on adaptation.

These risks are serious but can be addressed through early action. The Environment Agency has puts climate change at the heart of everything we do, and indeed the first goal of our current corporate strategy is to create a nation resilient to climate change.

Our adaptation approach set out in this report falls under eight themes, discussed below. These themes frame our five-year adaptation action plan given in the technical annex to this report.

Although this report focusses on the Environment Agency's adaptation work, it is worth noting that we also play a central role in national mitigation, including by regulating down the level of greenhouse gasses emitted by businesses, running the UK Emissions Trading System, and by committing to become a Net Zero organisation by 2030.

## 1. Thinking differently

### **'Business as usual' is not an option**

New actions under this theme are listed in Table 3.1 in the technical annex.

The speed and inevitability of climate impacts mean that adaptation must be central to all environmental planning – 'business as usual' approaches that disregard climate change are simply not viable, and our thinking needs to change faster than the climate. This is recognised in the government's 25 Year Environment Plan, which includes a commitment to ensure that all policies, programmes and investment decisions take into account the possible extent of climate change this century.

Adaptation is therefore at the heart of the Environment Agency's work, and we will continue to convey the urgency of required adaptation action to national and local partners.

In some cases this means a fundamental change in approach is needed. For example, our strategic approach to flood and coastal management has completely changed from flood

prevention (trying to prevent flooding) to flood resilience (accepting that some flooding is inevitable and preparing to live better with the consequences).

Such transformations are necessary but only possible with high quality evidence and understanding. The Environment Agency is developing this through:

- Science and environmental data to inform our decisions and make it more accessible to users
- Stress-testing our organisation to understand the limits of climate resilience
- Demonstrating adaptive pathway approaches that help decision makers plan for a range of climate scenarios
- Monitoring and evaluation approaches to quantify the effectiveness of our adaptation interventions and inform future investment

Our staff are on the 'front line' of England's biggest climate risks, and are well placed to engage with communities and businesses as they also face up to climate risks. We are supporting our staff to do this by:

- Launching an accredited Climate Academy so our staff can provide high quality advice on climate change
- Using our evidence and stories to bring climate impacts to life and show that adaptation is practical and worthwhile
- Engaging with diverse communities to hear their lived experiences of climate change and understand their adaptation needs

## 2. Collaborating

### **Adaptation works through partnerships**

New actions under this theme are listed in Table 3.2 in the technical annex.

The Environment Agency is an important delivery body for local adaptation through our flooding, environmental management and planning roles.

Much of our adaptation work is developed or delivered through national and local partnerships. We work with local government, businesses, non-government organisations, and communities, and are well placed to see how the climate risks they face interact. For example:

- The National Flood and Coastal Erosion Strategy is delivered through an action plan in which partners have made their own commitments
- National Framework for Water Resources where we have collaborated with water companies, Ofwat and others to plan for future water needs
- We are planning for resilience in our critical infrastructure with the National Infrastructure Commission, Major Projects Authority and the major utilities

- Through our incident management service we work as part of one multiagency team, preparing, responding and protecting lives and livelihoods
- Together with flood risk management authorities and local partners we are demonstrating an adaptive pathways approach in the Thames and Humber estuaries, River Severn Valley and Yorkshire, to enable local places to better plan for future flood and coastal change and adapt to climate hazards
- Working closely with our external partners in angling and nature trusts collectively gives us access to over 100,000 skilled volunteers, creating and restoring habitats
- We are working with partners on a holistic approach to health, wellbeing and inequalities in the context of climate change
- RAPID, the Regulatory Alliance Promoting Infrastructure Development, is a partnership with Ofwat and DWI to encourage water companies to invest in new, more resilient infrastructure to secure clean water in future

### 3. Investing for change

#### Adaptation needs public and private finance

New actions under this theme are listed in table 3.3 in the technical annex.

Adaptation is only possible with investment, but it is much cheaper to invest early in climate resilience than to live with the costs of inaction. The Environment Agency invests public money in local adaptation through flood and water resilience measures, such as, flood defences, river locks and pumping stations. We also work to secure private investment through partnership funding for flood defence schemes and by supporting the government's Green Finance initiative.

Our work channels substantial investments in local climate resilience:

- The £150m Flood and Coastal Resilience Innovation Programme supports 25 locations to bolster resilience to flooding and coastal change through innovative actions
- We work in partnership with others to embed climate resilience in all investment and development, so that today's places and infrastructure are resilient to tomorrow's climate
- We have developed an online auctioning and trading platform with the Sylva Foundation called NatureBid, which facilitates funding bids for projects that slow the onset of flooding and improve water quality
- The £10million Natural Environment Investment Readiness Fund supports projects until they can provide a return on investment by capturing the value of the enhanced natural assets and benefits. Projects will store carbon, provide natural flood risk management, improve water quality and restore habitats
- We are influencing the future investment into water infrastructure and assets with Water UK and Ofwat as part of the water industry price review 2024

- We are exploring longer term investment strategies and developing approaches that blend funding streams to deliver multiple outcomes nationwide
- Our pension fund is co-leading work with investors internationally on managing physical risks from climate change in investment portfolios and identifying new market opportunities that help society
- The government and Bank of England have set up the Task Force for Climate-related Disclosures (TCFD) to improve understanding of climate risks and potential investment in resilience. We are supporting the implementation of the TCFD through the provision of our data and engaging on the nature related financial disclosures framework (TNFD)

## 4. Working with nature

### Tackle the biodiversity and climate crises together

New actions under this theme are listed in Table 3.4 in the technical annex.

The 2021 Dasgupta Review shows that the unsustainable demands placed on nature undermine our national wellbeing and prosperity. Transformative action is necessary, urgent and possible to tackle the climate and nature emergencies together.

We are acting with our partners in Natural England and the Forestry Commission, and with environmental non-governmental organisations (ENGO's) to address environmental issues known to be made worse by the changing climate.

We see opportunities to work with nature to help form a low carbon nation that is resilient to climate change by:

- Helping natural systems to retain water through rewetting uplands, reconnecting floodplains and encouraging improved soil management
- Restoring estuarine and coastal habitats to provide the buffering needed to absorb contaminants and compensate for rising sea levels
- Promoting landscape scale planning and management to create habitats that are resilient and connected.

The Environment Agency seeks to integrate action and investment to create a better place for people, nature and the economy, especially through 'nature-based approaches', such as wetlands. These can complement traditional engineering infrastructure to create valuable habitat to support ecological resilience and provide societal resilience by supporting flood protection and water management.

## 5. Designing low carbon futures

### Support the low carbon economy

New actions under this theme are listed in Table 3.5 in the technical annex.

Limiting carbon emissions is the most effective way to combat climate change.

For many sectors, decarbonisation means that new infrastructure, processes and installations are needed by 2050. This new infrastructure will have an operational design life of decades. There is a regulatory challenge to ensure that decarbonisation of industrial sectors is sustainable and does not lead to additional risks, for example, by being located in areas of high flood risk or where water supplies could be inadequate in the future. We also work with trade bodies and researchers to understand the sustainability of new technologies as they are developed.

We have also made a corporate commitment to reduce our own carbon footprint to net zero by 2030. This is a challenging target given that more than half of our current emissions come from the construction of flood defences. We also consume carbon through the pumping and monitoring of water, both to help reduce the risk of flooding and to help manage water resources during periods of prolonged dry weather. This will get more challenging as the changing climate demands greater levels of preparedness, protection and response.

Our Net Zero plan commits us to:

- Use the lowest carbon concrete in our defences that meets our performance requirements and encourage our partners and suppliers to do the same
- Require all business cases to contain full carbon appraisals for different scheme options so that we can prioritise lower carbon solutions
- Develop plans for running our assets on greener fuel and renewable energy wherever possible
- Deploy innovative approaches to monitoring water depth and flow
- Introduce carbon budgets aligned to our investment programmes and use our learning to inform long term investment needs

## 6. Strengthening community resilience

### Support local adaptation for everyone

New actions under this theme are listed in Table 3.6 in the technical annex.

The Environment Agency supports community resilience through our emergency preparedness and response roles under the Civil Contingencies Act, and our strategic and operational roles on flooding and water management.



Climate change will exacerbate existing environmental inequalities, since some groups will be more affected by climate risks or have less capacity to prepare for them. We want to ensure no group is left behind by climate change in line with the government's levelling up commitments. We will do this by:

- Trialling different approaches to flood warning and informing, through stronger community engagement, use of third parties and new technologies
- Understanding how our incident management service will need to evolve to cope with the changing scale, geography and nature of climate related incidents, including surface water flood risk, and the dynamic needs of a changing and increasingly diverse population
- Investing in strong working relationships with our partners in emergency response and recovery, including participation in local resilience fora
- Working with our public health partners to better understand and integrate thinking on how we can reduce inequalities as a result of climate change

## 7. Helping businesses prepare

### **Flexible and climate-proof regulation and advice**

New actions under this theme are listed in Table 3.7 in the technical annex.

We are helping businesses to understand their climate risks and be better prepared for impacts through our regulatory roles.

Where we have the powers to do so, we will ensure regulatory permissions and advice support climate adaptation, so that today's places and infrastructure are resilient to tomorrow's climate. Through our spatial planning role, we will continue to shape development plans and planning applications to ensure adaptation to our changing climate. For example by issuing the Climate Change Allowances to enable councils and developers plan for future flood risk in new developments and helping shape Development Plans promoting the principle of adaptive approaches.

We also want to transform our regulatory approach beyond managing the immediate impacts of an activity. We will explore:

- Systems approaches to account for cumulative impacts and interdependencies.
- Enabling innovation, responding to future challenges and new technologies as part of a transition to a net zero economy
- Opportunities to shift from direct regulation to fostering operator accountability and continuous improvement, for example by making use of national and international standards

We want to work with partners to introduce a range of alternative regulatory options which are more flexible and can better anticipate rapidly changing needs. These interventions need to be simpler and more efficient to deliver. They should encourage and motivate a

measurable step change in the behaviours of those we regulate and support the development of greater resilience throughout supply chains.

## 8. Stepping up to level up

### Show what it takes to live in a changing climate

New actions under this theme are listed in Table 3.8 in the technical annex.

The government's 25 Year Environment Plan commits to improve the environment within a generation, and makes commitments to:

- Ensure that all policies, programmes and investment decisions take into account the possible extent of climate change this century
- Implement a sustainable and effective National Adaptation Programme

We will support government and partners to achieve this aim, noting that the Climate Change Committee have also said that the country needs a step change in adaptation to prepare for even the minimum expected climate impacts, especially for those communities and businesses at greatest risk.

We see three significant opportunities to support this step change:

- Advising on the next National Adaptation Programme being developed in 2022
- Informing the new UK National Resilience Strategy that sets a supportive vision and framework for adaptation and shows the urgency of action now
- Supporting domestic development of the green finance taxonomy which will help form resilient investment into adaptation, net zero and green projects

We will also continue to lead by example by fully accounting for climate impacts in our wider work, developing innovative adaptation approaches and data, and supporting communities, businesses and the environment to live in a changing climate.

## Our main adaptation actions

Our main actions are to:

- Deliver the national flood and coastal erosion risk management strategy.
- Tackle pressures on England's water environment
- Improve the resilience of wildlife species and ecosystems
- Manage environmental climate risks to and from regulated industry
- Prepare for bigger, more frequent and complex environmental incidents
- Reduce our corporate climate footprint and climate risks

These are set out in more detail in in Tables 3.1 to 3.8 of the technical annex of this report.

# Technical material

This chapter provides further technical material requested by ministers for the third round of adaptation reporting under the Climate Change Act.

## Progress since our second adaptation report (2016)

Our second adaptation report (2016) set out 97 actions. In our final year of reporting (2020-21), 72% of these were either complete or on track, including:

- The Restoring Sustainable Abstraction programme is 85% complete. 320 abstraction licences were changed to make them more sustainable. 47 billion litres of water a year have been returned to the environment. This is equivalent to supplying over 850,000 people every year
- We have included the requirement for specific climate change adaptation plans within some permits in the EPR regime
- Publishing our National Flood and Coastal Erosion Risk Management Strategy, which provides the long term vision for a nation ready for, and resilient to flooding and coastal change – today, tomorrow and to the year 2100
- Keeping our guidance for planners updated with the latest climate change scenario information, including the updated 'Flood and Coastal Erosion Risk Projects, Schemes and Strategies: climate change allowances' guidance
- The unused and underused licences programme (Abstraction plan 2019) has revoked 697 abstraction licences across England. These revocations have removed the risk of 309 billion litres being abstracted each year and will prevent the risk of deterioration
- We have worked with the Office for Nuclear Regulation to develop a joint position on the implications of UKCP18 for nuclear sites including disposal sites
- Working with catchment partnerships as part of RBMP21 to ensure that we understand key pressures in their catchments and what action is required to mitigate these pressures, including climate change. This is supported by a series of high level risk assessments considering climate change
- We have built our own adaptive capacity through the Business Continuity Management Strategy action plan, which considers our organisational resilience in preparation for and response to incidents, including those caused by extreme weather
- We published our Long Term Investment Scenarios to show the latest government statistics/ projections on demographics and projected growth to identify optimal investment pathways in FCERM for the next 50 years

The remaining actions (around a quarter) were either delayed, amended or stopped due to:

- Disruption due to Covid-19 and a variety of other pressures

- Changing national priorities meaning that some actions proposed in 2016 were superseded by new commitments
- An internal review of actions in 2019 identified obsolete actions that were amended or stopped

The action plan in our second report (2016) predates commissioning of some notable adaptation actions that we have undertaken since, for example:

- Actions in the second National Adaptation Programme (2017)
- New strategies such as our National Flood Risk and Coastal Erosion risk management strategy for England
- New adaptation science and data, such as peak river flow uplifts for 1km x 1km cells using UKCP18

Additional baseline actions listed in Table 2.0 below were taken into account before our residual risk was assessed.

**Table 2.0 Completed and ongoing actions**

Action	Status
Capital investment programme for flooding and coastal erosion management	Ongoing
<p>Promoting a new approach to flooding and coastal change and setting direction through the Flood and Coastal Erosion Risk Management (FCERM) Strategy for England, which has three long-term ambitions, underpinned by evidence about future risk and investment needs:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> </ul>	Ongoing
Seeking new sources of partnership funding through the FCERM strategy	Underway

Flood and coastal change asset maintenance programme that can flex and adapt	Ongoing
Bringing all assets under our Asset Management System	Underway
Working with the National Infrastructure Commission on resilience standards	Underway
Shoreline Management Plan refresh	Underway
Test of approach to fund measures with flooding and coastal erosion benefit in the National pilot for Environmental Land Management Scheme (ELMS, future funding for agriculture)	Underway
Seek partnership funding for catchment management approaches that can help manage flood risk and other benefits	Ongoing
FCERM Data and Technology Plan to make the most of our data and technology in delivering climate resilience	Ongoing
<p>Provide technical input and advice into the greening finance framework for investors in the UK:</p> <ul style="list-style-type: none"> <li>• Supporting the development of a Green Finance taxonomy</li> <li>• Linking investors' green finance metrics to flood and water management, nature improvement and carbon sequestration through nature</li> <li>• Supporting the implementation of a resilience standard for infrastructure to help pull green finance toward investment in resilience</li> <li>• Supporting the development of tools that quantify the financial benefits of investing in resilience and nature.</li> </ul>	Ongoing
Work with the Office for Nuclear Regulation and the nuclear industry to assess, and advise on the adaptation in nuclear power station development, operation and decommissioning as well as waste disposal	Ongoing

Work with members of the Chemicals & Downstream Industries Forum (CDOIF) to produce climate change adaptation best practice guidance to support high hazard industry sectors to be better prepared for climate change	Ongoing
Invasive and Non Native Species Strategy	Ongoing
Working with catchment partnerships as part of RBMP21. This is supported by a series of high level risk assessments considering climate change	Ongoing
River restoration driven by WFD and Habitat Regulations.	Ongoing
Operational pollinator schemes	Ongoing
Nature Recovery Network	Ongoing
Water Resource Planning	Ongoing
Work with Defra on Environmental Land Management Scheme	Ongoing
Priority habitat restoration (under corporate measure 'We create more areas of new priority England Biodiversity Strategy habitat')	Ongoing
Abstraction reform	Ongoing
Keeping Rivers Cool	Ongoing
Developing and mainstreaming approaches to work with natural processes and Natural flood management	Ongoing
Working with Natural England and Forestry commission on 'land use options' for net zero, biodiversity and food production	Ongoing
EA Pension Fund takes account of physical risks in its investments	Complete
Support to the TCFD initiative	Ongoing

# Climate Risk Assessment

## Methodology

We identified residual climate risks by updating the risk assessment in our second (2016) adaptation report in light of:

- Adaptation progress
- Aims of our new corporate strategy, EA2025
- Improved understanding of climate change and risks
- Current trends in national policy, technology and socio-economic context

We assessed our residual climate risks in a series of workshops with relevant managers and practitioners from across the organisation using climate information taken from or based on UKCP18 (see assumptions below). We looked at two scenarios (+2°C and +4°C) and two time periods (medium and long term) in order to take account of some of the uncertainty and different business planning horizons respectively. We gave each risk a severity and urgency score (see descriptors below) and combined these into an overall risk rating. We also scoped potential adaptation measures to refine our understanding of our priorities.

## Severity Scoring

Likelihood			
high	4	5	6
medium	3	4	5
low	2	3	4
Impact	Low	Medium	High

## Impact descriptors

### High

- Significant impact on achievement of aims/ objectives
- Significant damage to ability to continue “business as usual”
- Substantial financial impact (>20% of total relevant budget)
- Medium to long term significant effects on the integrity of the Environment Agency (including reputation damage, stakeholder concern and corporate/ media attention) from which is difficult and/or expensive to recover
- For opportunities: significant financial benefit or significant positive effect on the achievement of aims/ objectives or the integrity of the Environment Agency.

### Medium

- Moderate impact on achievement of aims/ objectives
- Moderate damage to ability to continue “business as usual”
- Moderate financial loss (10-20% of total relevant budget)
- Medium term/ moderate effects on the integrity of the Environment Agency from which it may be difficult and/or expensive to recover
- For opportunities: moderate financial benefit or moderate positive effect on the achievement of aims/ objectives or the integrity of the Environment Agency.

### Low

- Minor impact on achievement of aims/ objectives
- Manageable inconveniences to “business as usual”
- Small financial loss (<10% of total relevant budget)
- Short to medium term minor effects on the integrity of the Environment Agency
- For opportunities: minor financial benefit or minor positive effect on the achievement of aims/ objectives or the integrity of the Environment Agency.

## Likelihood descriptors

- High: More than 80% chance of occurring
- Medium: 51-80% chance of occurring
- Low: Less than 50% chance of occurring



## Urgency Scoring

Time it will take to respond (to address risk)			
Long	4	5	6
Medium	3	4	5
Short	2	3	4
Time left to respond (intervention time)	2051 to 2080+	2021 to 2050	Now to 2030

Time to respond descriptors (how long will interventions take to plan/ implement?):

- Long: More than 50 years
- Medium: between 10 and 50 years
- Short: Between 0 and 10 years

Intervention time descriptors (how long have we got?):

- Now to 2030: Major decisions required before 2030 that affect future resilience to climate change
- 2021-2050: Major decisions required before the 2050s that affect future resilience to climate change
- 2051-2080: No major decisions required prior to the 2050s that affect future resilience to climate change

## Climate projections and assumptions

The Environment Agency relies on the UK climate projections, produced by the Met Office Hadley Centre Climate Change Programme<sup>2</sup>. These give probability estimates for climate variables and sea levels during this century under scenarios of varying climate change severity (termed Representative Concentration Pathways, RCP).

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<sup>2</sup> Accessed at UK Climate Projections User Interface. <https://ukclimateprojections-ui.metoffice.gov.uk/ui/home>

The Met Office periodically updates the national projections to reflect advancements in scientific understanding, climate modelling, user needs and environmental observations, with the most recent iteration being UKCP18 and the predecessor being CP09.

The Environment Agency was part of the project team that advised on UKCP18, helping to ensure they meet user needs including what we need to help the country manage the risk of too much and too little water. We also work with partner organisations to model other environmental variables based on the climate projections, particularly river flows and flood risk. Whilst we aim to use the latest available climate projections (UKCP18), it can take a few years to update our environmental models and advice due to the complexity of the modelling involved. This means that some of our data is based on the older UKCP09 projections, although the practical significance of this is marginal due to the similarity of UKCP09 and UKCP18 outputs and the relatively insensitive nature of strategic adaptation planning. Our more climate-sensitive decisions are based on UKCP18 data, such as advice on future flood risk.

The choice of climate scenario depends on the purpose for which the info is used and what is available; for us this often involves screening and considering a range of potential futures. For the purpose of this report, we have focussed on how the environmental variables that are most important for the Environment Agency’s work are expected to change under two scenarios representing the path that meets or exceeds a +2°C and +4°C change in global mean temperature by the end of the century. For the risk assessment workshops, an infographic based on our Climate Impacts Tool (see figure 2.1), updated where possible and necessary using UKCP18 and derived information.

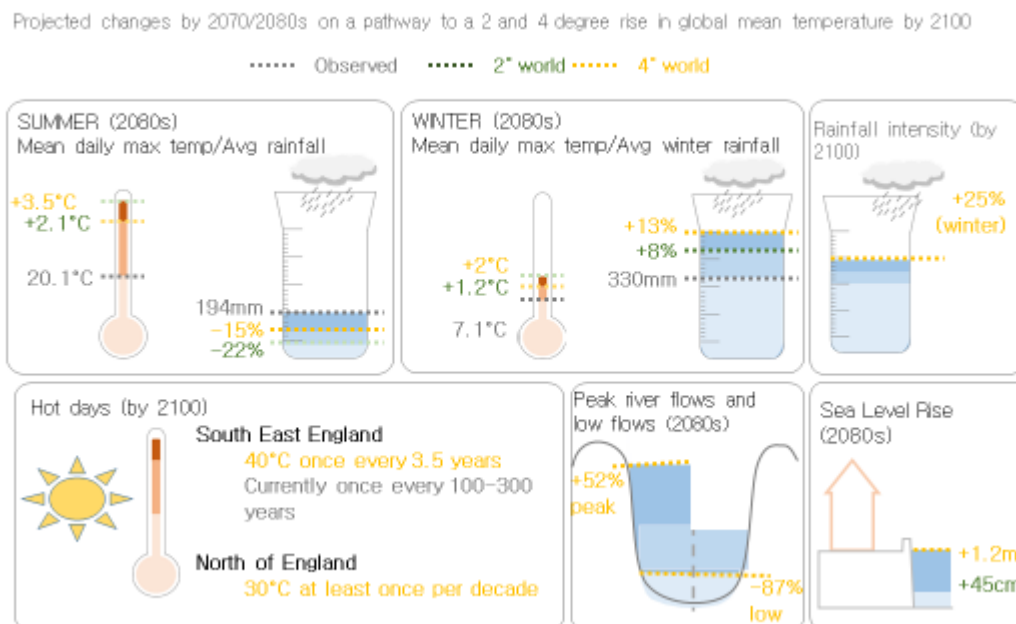


Figure 2.1 Assumed climate impacts for this report

## **Air temperature and precipitation**

We assumed, for a +2°C world, a mean daily maximum temperature rise by 3.2°C in the summer and 1.7°C in the winter by 2080 and average rainfall changes of -15% and +10% for summer and winter respectively. For a +4°C world we assumed a rise of 5.2°C in the summer and 2.9°C in the winter and rainfall changes of -22% and +19% for summer and winter respectively. These values are taken from the UKCP18 probabilistic projections and represent a central (median) estimate of 30-year average change in each variable from a 1981-2000 baseline. We used RCP4.5 and RCP8.5 to represent climate scenarios that meet or exceed global warming +2°C and +4°C above pre-industrial by 2100.

## **Sea level rise**

Our sea level rise assumption of 1.2m by the 2080s reflect our advice on flood risk assessments climate change allowances (EA, 2016 -updated 2020) aimed at helping to ensure development is resilient to sea level rise associated with a global mean temperature rise +4°C. For our FCERM schemes we assess a range from the 70th to the 95<sup>th</sup> percentile of UKCP18 RCP8.5. We used the 95<sup>th</sup> percentile in the risk assessment workshops for our adaptation report.

## **River flows**

Low flow assumption of -82% by 2050 -87% by the 2080s was derived for our Climate Impacts Tool (EA, 2017) from Future Flows Hydrology time series data (Prudholme et al. 2012) available from the CEH future flows maps and datasets. They are based on UKCP09 medium emissions scenario for all available sites (150), over all months (12) all ensemble members (11) and all hydrological models and are relative to a 1961-1990 baseline. Updated low flow information will soon be published by the UKCEH project 'eFLaG', which is based on RCP8.5. We will use this when it becomes available.

Our peak river flow assumptions of +27% by the 2050s and +52% by the 2080s is based on our advice on flood risk assessments climate change allowances (EA, 2016 -updated 2021). This now provides uplifts on a catchment scale with significant variation between catchments. We used the highest uplifts, which are found in the South West River Basin Districts respectively. They are relative to a 1981-200 baseline and based on the 50<sup>th</sup> percentile of UKCP18 RCP8.5, which is consistent with at least a +4°C warming scenario by the end of the century.

## **Future weather**

By 2100 we can expect days reaching 40°C to occur about 3.5 times per year in the South east; this currently only happens every 100-300 years. By 2100 in the North of England, days reaching 30°C will occur once every decade. Wet day intensity will increase, especially in winter when it could increase by 25% by 2100. The projected values for future hot weather and wet weather are taken from UKCP Local (2.2 km) (Met Office, 2019), which complements the UKCP18 projections with data at a higher spatial and temporal resolution than previous climate projections, giving us greater detail on the

frequency and intensity of extreme weather. These projections are only available for a RCP8.5.

## **Risks**

The tables below show the results of the climate risk assessment and present the residual risks, for which our adaptation strategy sets out new actions to manage. Therefore, the scores take into account ongoing and planned actions as well as those completed or underway but not yet completed (see page 75-79 on completed or ongoing actions). The new actions associated with each residual risk will either directly manage the risk (including through others), or build our adaptive capacity in that they will build or share knowledge or understanding of the risk or develop capabilities relevant to managing it.

Residual risks to EA2025 Aim: By 2025 we will have created more climate resilient places and infrastructure, by ensuring the nation is prepared for flooding, coastal change and drought

**Table 2.2 Results of climate risk assessment to EA2025 aim 1: by 2025 we will be a stronger leader on climate adaptation and resilience, encouraging others to act now on the climate emergency and invest in adaptation**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>RP1</b>	Conventional asset led approaches face rising investment needs and/ or declining standards of service	Flood asset standards of protection are exceeded more frequently so that relying on conventional asset led approaches means either lower standards of service, with knock on effects on incident response and/ or more precautionary work (e.g. dredging), or rising investment needs for new and existing assets.	6	5	1.4; 1.6; 1.7; 1.12; 1.15; 1.16 2.1; 2.3 3.1; 3.3; 3.4; 3.5 4.1; 4.4 6.1; 6.2; 6.5; 6.6; 6.7 7.1; 7.2
<b>RP3</b>	New development that does not follow our flood risk advice	Challenges to securing flood risk and coastal change adaptation measures in new development mean our expectations are increasingly not met by Local Planning Authorities who allow development against our flood risk advice.	6	5	1.5;1.6; 1.7; 1.8; 1.9 2.1; 2.2 3.2; 3.3 6.1; 6.2; 6.5; 6.6; 6.7 7.2
<b>RP5</b>	New development that does not follow our water resource risk advice.	Challenges to securing water availability adaptation measures in new developments by Local Planning Authorities (Water resource pressures make it increasingly costly) means our advice is increasingly not followed.	5	5	1.1; 1.8; 1.9; 1.11 2.1; 2.2 3.2; 3.3; 3.4 6.1; 6.2; 6.3; 6.7 8.2; 8.7
<b>RP2</b>	Increased maintenance and refurbishment of assets	Increased 'maintenance for operations' and refurbishment of assets due to more frequent 'load' on asset protection increases investment need and energy use/ emissions.	5	4	1.6; 1.9; 1.10; 1.12 3.5

<b>RP8</b>	Community health and wellbeing deteriorates due to more frequent flood or drought incidents	Community health, wellbeing and resilience deteriorates due to combined effects of more frequent and severe environmental incidents such as flooding. Including due to temporary population displacement with associated strain on local services.	6	3	1.2; 1.4; 1.5; 1.6; 1.8; 1.9; 1.11; 1.12; 1.13; 1.14 2.1; 2.2; 2.3 3.1; 3.3; 3.5 5.1 6.1; 6.2; 6.3; 6.5; 6.6; 6.7 7.2 8.2; 8.7
<b>RP9</b>	Permanent population displacement due to flooding	Permanent population displacement due increased severity and or frequency of environmental incidents such as flooding leads to higher density living with impacts on mental health, risk of disease outbreak and strain on local services and infrastructure	6	3	1.5; 1.6; 1.8; 1.9 2.1; 2.2; 2.3 3.1; 3.5 5.1 6.5; 6.7;.6.8 7.2
<b>RP4</b>	Groundwater flooding and its effects on communities and critical infrastructure.	Lack of clarity on our strategic overview role leads to reputational damage as groundwater flooding risks increase. This could lead to additional demands for the EA to extend our services beyond what are currently resourced for under our strategic overview role. We are not resourced to deliver this, we need to clearly understand our operational remit and be mindful of reputational and legal problems that may arise.	4	4	1.4; 1.6; 1.7 2.1; 2.3 3.1; 3.2; 3.3; 3.4; 3.5 5.1 6.1; 6.2; 6.6; 6.7 7.2; 7.3; 7.5; 7.6

<b>RP6</b>	Morphological response causes rapid flooding	Morphological response during extreme events increases in magnitude with potential to increase flood hazard very rapidly and threaten critical infrastructure.	4	3	1.2; 1.4; 1.5; 1.7; 1.11; 1.12 1.13 2.1; 2.2; 2.4 3.1 4.1; 4.2 5.1 6.1; 6.2; 6.5; 6.6; 6.7 7.3; 7.5; 7.6 8.2
<b>RP7</b>	Waterside amenities inaccessible	Flooding and erosion makes waterside amenities inaccessible more frequently affecting use of our waterways	3	4	1.6; 1.9; 1.12; 1.13 2.1; 2.4 3.5; 3.6 6.7

**Table 2.3 Results of climate risk assessment to E1.6025 aim 2: By 2025 we will be a stronger leader on climate adaptation and resilience, encouraging others to act now on the climate emergency and invest in adaptation**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>CL1</b>	Reputational effects of adaptation shortfall (perceived or real)	The impacts of climate change could constrain our ability to meet objectives with available resources or the growing/ changing expectations of others. This will affect our reputation and ability to influence others.	5	6	1.1; 1.2; 1.4; 1.5; 1.6; 1.7; 1.8; 1.11; 1.12; 1.13; 1.14; 1.15; 1.16 2.1; 2.2; 2.3 3.1; 3.5; 3.6 4.1; 4.4 6.1; 6.2; 6.3; 6.5; 6.6; 6.7; 6.8 7.2; 7.5; 7.6 8.2; 8.3; 8.4; 8.5; 8.7; 8.8
<b>CL2</b>	Opportunity for green finance	Opportunity to lever 'green finance' for adaptation and resilience	6	5	1.1; 1.7; 1.11; 1.14 2.2 3.1; 3.2; 3.3; 3.4; 3.5 4.1; 4.2; 4.4 6.3; 6.6 7.1; 7.2; 7.6 8.2; 8.7



<b>CL3</b>	Opportunity to be credible advisor on adaptation	Opportunity for the Environment Agency to become England's credible advisor on adaptation	6	5	1.1; 1.2; 1.3; 1.4; 1.5; 1.6; 1.7; 1.11; 1.14 2.1; 2.2; 2.3; 2.4 3.1; 3.2; 3.3; 3.4; 3.5 4.1; 4.3; 4.4 5.1 6.2; 6.3; 6.5; 6.6; 6.7 7.1; 7.2; 7.3; 7.4 8.2
<b>CL6</b>	Unable to meet increasing demands for our data and advice	Climate change means more demands for our water and environmental data and advice while more incidents increases the volume of data being collected. These challenges, combined with ongoing data quality issues, affect our ability to advise and inform decision making.	5	5	1.1; 1.2; 1.3; 1.5; 1.6; 1.11; 1.14; 1.16 3.5; 7.4; 7.6
<b>CL4</b>	Additional demands due to surface water flooding and its effects on communities and critical infrastructure	Lack of clarity on our strategic overview role leads to reputational damage as surface water flooding risks increase. This could lead to additional demands for the EA to extend our services beyond what are currently resourced for under our strategic overview role. We are not resourced to deliver this, we need to clearly understand our operational remit and be mindful of reputational and legal problems that may arise.	5	5	1.2; 1.4; 1.6 2.1; 2.3 3.2; 3.3; 3.4; 3.5; 3.6 5.1 6.1; 6.2; 6.7; 3.6

<b>CL5</b>	Health effects of heat on the vulnerable	Health effects of heat on vulnerable people, especially where there is a heat island effect.	3	4	1.5 2.1; 2.2 3.3; 3.6 6.7; 6.8 8.5
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**Table 2.4 Results of the climate risk assessment to E1.6025 aim 3: By 2025 we will be ready for bigger, more frequent incidents and will support those at risk to be more resilient**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>IM1</b>	A 'new scale of incidents', which the current service will not be able to deal with	Climate change leads to a new scale of incidents with which our current Incident management service won't cope. This means we need to change the incident management service to deal with the new risks that we face	6	5	1.1; 1.2; 1.4; 1.5; 1.6; 1.8; 1.9; 1.10; 1.11; 1.12; 1.15 2.1; 2.2; 2.3 3.1; 3.2; 3.3; 3.5; 3.6 4.1; 4.2 6.1; 6.2; 6.5; 6.7; 6.8 7.1; 7.2; 7.3; 7.5 8.2; 8.5
<b>IM4</b>	Disruption to movement of staff/ equipment or power during incident response	Greater frequency and severity of environmental incidents leads to disruption to travel or power infrastructure which affects our ability to respond i.e. movement of staff and equipment and operations e.g. pumping stations.	6	5	1.4 6.1; 6.2; 6.7 8.3; 8.4; 8.5; 8.6; 8.8

<b>IM5</b>	Increased frequency and duration of incidents means stop and slow of other work	Increased incident response leads to increased demands and expectation on our staff to support response. Means less time for other work including long term planning, communications and engagement, strategy implementation or other EA roles e.g. responding to planning consultations, carrying out regulatory activities, promoting adaptation etc.	6	5	1.3; 1.4; 1.5; 1.8; 1.9; 1.10 1.15 2.2; 2.3 3.1; 3.2; 3.3; 3.5 4.1; 4.2 6.1; 6.2; 6.5 7.1; 7.2; 7.3; 7.5 8.2
<b>IM6</b>	Effects on staff health, safety and wellbeing of due to increased incident duty	Responding to increased incidents leads higher workloads, more pressure and a decrease in staff wellbeing. In turn this means we cannot rely on our people to volunteer now or in the future if incidents are more frequent and more severe and our incident management service becomes unsustainable. In addition more H&S incidents due to compressed planning and delivery.	6	5	1.3 1.4 1.5 1.8 1.9 1.10 2.2 2.3 3.1 3.2 3.3 3.5 4.1 4.2 6.1 6.2 6.5 7.1 7.2 7.3 7.5 8.2 8.5 8.6
<b>IM3</b>	Altered spatial pattern of incidents	Spatial pattern of environmental incidents may change e.g. flooding. Requiring additional funding, staff and resources to extend and develop our incident management service and response.	6	4	1.1; 1.2; 1.4; 1.5; 1.6; 1.8; 1.10; 1.11; 1.15 2.1; 2.2 3.5 6.1; 6.2; 6.8 7.2; 7.3; 7.5 8.2

<b>IM8</b>	Reduced resilience of communities	Increased frequency and severity of environmental incidents affecting communities reduces their resilience and ability to recover adding extra expectation and pressures to our incident management service and delivery of local place-making objectives.	6	4	1.4; 1.6; 1.7; 1.11 2.1; 2.2 3.1 4.1 6.2; 6.5; 6.6; 6.7; 6.8
<b>IM2</b>	Wider variety of different types of incidents	Wider variety of different types of incident and likelihood of concurrent incidents (environmental, drought, fire, groundwater flood etc or increased scale/ geographic spread). Results in increasing expectations of our response for which we don't have capability/ resource. Leads to increased risk for communities and could cause partners and public to lose confidence in our service.	5	4	1.1; 1.2; 1.4; 1.11; 1.15; 2.1 6.1; 6.2; 6.7; 6.8 7.3; 7.5 8.5
<b>IM7</b>	Loss of public confidence in mapping, modelling and the frequency of incidents	Uncertainty in the scale of climate related change leads to loss of public confidence in our mapping, modelling and incident frequency estimation. In turn this will affect the willingness of the public to respond, increasing impacts of environmental incidents, risk to life and reputational damage.	4	4	1.1; 1.2; 1.5; 1.6; 1.8; 1.11; 1.12; 1.16 2.2; 2.4 6.2 7.2

**Table 2.5 Results of the climate risk assessment to E1.6025 aim 4: By 2025 air will be cleaner and healthier**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>A1</b>	Impacts on air pollution and its effects on health and ecosystems.	Impacts on air pollution and its effects (often exacerbated by higher temperatures) on health and ecosystems. Including from: changes to atmospheric chemistry; ammonia from agriculture and natural sources; wildfires	6	5	1.4; 1.11 2.1 4.1 6.1; 6.2; 6.3; 6.7; 6.8 7.3; 7.5
<b>A2</b>	Impacts of adaptation (and mitigation) on emissions to air.	Reactive or planned adaptation and mitigation activity of industry and others (including ourselves) leads to increased emissions e.g. from cooling technologies, pumping, behaviour change, construction or more frequent maintenance/ repair of structures.	5	5	1.11 6.8

**Table 2.6 Results of the climate risk assessment to E1.6025 aim 5: By 2025 rivers, lakes, groundwater and coasts will have better water quality and will be better places for people and wildlife**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>W15</b>	Damage to natural functioning of catchments exacerbates climate impacts	Modifications to rivers and coasts make them less resilient to droughts, storms, surface runoff and sea levels, exacerbating flood and coastal change risks and causing significant damage and further loss of ecosystem services.	6	6	1.5; 1.8; 1.11; 1.12; 1.13 1.15 2.2; 2.4 3.4 4.1; 4.4 8.2; 8.7

<b>W6</b>	Water pollution/ contamination due to flooding	Flooding or heavy rain causes pollution/ contamination of water bodies with consequences for human health and wildlife	6	6	1.3; 1.4; 1.5; 1.6; 1.7; 1.8 1.11; 1.12 2.1; 2.2 3.1; 3.5 4.1; 4.4 6.1; 6.2; 6.3; 6.6; 6.7; 6.8 7.3; 7.4; 7.5; 7.6 8.2
<b>W1</b>	Increasing tension from competing demands for water	Drier summers and more evapotranspiration as temperatures rise and growing season potentially lengthens, drive increasing tension from competing demands for water resources i.e. between public water supply, industry, biomass, development, recreation and the environment, especially for chalk streams.	5	6	1.4; 1.5; 1.8; 1.11 2.1; 2.2 4.1; 4.3 6.1; 6.2; 6.3; 6.7; 6.8 7.3; 7.5 8.2; 8.7
<b>W3</b>	Current water quality standards become redundant in 'a new ecology'	Climate change leads to 'a new ecology' for which current water quality standards are redundant	6	5	1.11, 1.15 2.1 3.4 4.1; 4.4 6.3; 6.7; 6.8 7.3; 7.5 8.2
<b>W4</b>	Decreased suitability of temperature sensitive species	Rising water temperatures and loss of cold water refuges (including from groundwater inflows) puts stress on instream ecology. Risk of funding temperature sensitive species projects, which may have a short lifespan if we reach thresholds that are no longer suitable.	6	5	1.11; 1.15 4.1 6.3 7.3; 7.5 8.2; 8.7

<b>W5</b>	Coastal squeeze	Sea level rise and coastal change outpace ability for coasts and estuaries to be managed or to naturally adapt, leading to coastal squeeze and huge loss of ecosystem services	6	5	1.7; 1.11; 1.12 3.1; 3.5 4.1; 4.2; 4.3; 4.4 6.3; 6.5; 6.6 8.2
<b>W7</b>	Decline in water quality due to reduced dilution	Reduced frequency of flushing flows, leading to reduced dilution and dispersion of pollutant contaminated sediments and heavy metals with consequences for wildlife and human health (including mental health impacts from visual impact of dried rivers and suffering wildlife)	5	6	1.3; 1.11; 1.15 2.1 3.4 4.1 6.3; 6.7; 6.8 7.3; 7.4; 7.5; 7.6 8.2; 8.7
<b>W8</b>	Increased eutrophication due to warmer water	Increased risk of eutrophication due to greater impact of nutrients in a warming climate	6	5	1.3; 1.4; 1.11; 1.15 3.4 4.1 6.1; 6.2; 6.3 7.3; 7.4; 7.5; 7.6 8.2; 8.7
<b>W10</b>	Saline intrusion	Sea level rise drives saline intrusion of coastal freshwater habitats and groundwater. This also impacts on surface water abstractions or GW abstractions located close to rivers. Over time, the water abstracted could become more saline and unable to be used for public water supply if they are impacted.	6	5	1.11 3.4 4.1; 4.2; 4.3; 4.4 8.2

<b>W9</b>	Remobilisation of contaminants due to warmer water	Thermal pollution of rivers (from consented discharges in combination with climate change), can result in the remobilisation and bioavailability of contaminants.	5	5	1.3; 1.4; 1.11 3.4 4.1 6.1; 6.2; 6.3 7.3; 7.4; 7.5; 7.6 8.2
<b>W13</b>	Insufficient water for boats	Increased frequency, severity and duration of events where boaters (either commercial or recreational) are unable to navigate due to insufficient depth of water or insufficient upstream reserves to enable lock operation (combined with reduced funding from charged income).	4	6	1.11; 1.12; 1.13; 1.15 2.4 8.2; 8.7
<b>W2</b>	Crossing of ecological tipping points	Climate pressures in combination with industrial impacts mean ecological tipping points or thresholds are approached or passed, with implications for control requirements and species/ecosystem decline.	5	4	1.11 3.4 4.1; 4.3; 4.4 6.3 7.3; 7.5 8.2; 8.7
<b>W14</b>	Obstructed navigation due to deposition of eroded materials	Increase in bankside erosion can obstruct channels and compromise the safe navigation of commercial or recreational boats/ vessels.	4	4	1.12 2.4 8.2
<b>W11</b>	Reduced sediment availability increasing coastal flood risk	Sea level rise leads affects sediment dynamics, reducing sediment availability and leading to greater pressure on assets and increased flood risk, especially in large, well populated estuaries.	5	3	1.1; 1.11; 1.12 2.4 3.1 4.3; 4.4 6.1; 6.2 8.2



<b>W12</b>	Impact of increasing extreme weather on angling activity	More frequent severe weather has a negative impact on angling	4	3	1.6; 1.11; 1.12 2.4 4.1; 4.3
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**Table 2.7 Results of the climate risk assessment to E1.6025 aim 6: By 2025 nature and land is better protected and enhanced**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>NL1</b>	Loss of special habitats	Loss of special habitats, such as wetlands due to changing rainfall patterns, impacts on groundwater recharge or loss of key species. Leads to further loss of wildlife and may impact on the community's mental health to see the loss to these habitats.	5	6	1.11; 1.14; 1.15 2.1 3.4 4.1; 4.2; 4.3; 4.4 6.3; 6.7 8.2
<b>NL7</b>	Insect decline affects pollination of crops	Climate driven decline in pollinator species affects productivity and nutrition	5	6	1.11 2.1 3.5 4.1; 4.2; 4.3; 4.4 8.2
<b>NL2</b>	Land contamination due to mobilisation of contaminants	Flooding (including groundwater flooding) and heavy rainfall mobilise existing contaminants with impacts on land e.g. from cemeteries or septic tanks. Complicated by lack of clear responsibility for long term management of contaminated land.	5	5	1.2; 1.3; 1.4; 1.6; 1.11 1.14 2.1; 2.3 6.1; 6.2; 6.3; 6.7 7.3; 7.4; 7.5; 7.6 8.2

<b>NL8</b>	Invasive species or plant and animal disease	Increase in non-native invasive species and plant and animal disease spread affects direct work, use of vehicles and boats, surveys etc.	6	4	1.11 4.1
<b>NL3</b>	Reduced infiltration due to drier periods	Reduced land infiltration rates as a consequence of soil compaction during drier periods. Possible increased surface run-off and peaked hydrograph during subsequent rainfall event	5	5	1.3; 1.4; 1.14 2.3 3.4 6.1; 6.2; 6.3 8.2; 8.7
<b>NL4</b>	Altered geomorphological processes due to wetter periods	Wetter winters and more extreme rainfall events change rate and scale of geomorphological processes: soil erosion, sedimentation, waterlogging and capping of soils and aquifer saturation, affecting nutrient uptake, water quality, groundwater recharge and baseflows, surface runoff and landslide risk.	5	5	1.3; 1.4; 1.11 2.3 4.2; 4.3; 4.4 6.1; 6.2; 6.3 8.2; 8.7
<b>NL5</b>	Changes to suitability of crops	Increase in temperature and changes in rainfall patterns lead to new crops being grown in new geographical areas. Risk of inappropriate crops being grown in high risk locations with negative consequences for soil and water and nutrition.	5	5	1.11 4.1 6.3 8.2
<b>NL6</b>	Fewer slurry spreading days	Wetter winters and extreme rainfall events meaning fewer days available for spreading slurry (while livestock are also more often housed), leading to inappropriate applications or insufficient slurry storage capacity with knock on effects on industrial waste streams.	5	5	1.6; 1.11 1.14 6.3 8.2; 8.7

<b>NL12</b>	Protected area objectives become obsolete	Current measured objectives that define the condition of existing protected areas become obsolete / unachievable	4	5	1.6; 1.11; 1.12 3.5 4.1; 4.3; 4.4 8.2; 8.7
<b>NL11</b>	Species re-introductions become unsuitable	Species re-introductions with habitat may not be suitable in a changing climate; e.g. our white-clawed crayfish ARK sites may not be suitable in 10/20 years	4	5	1.11; 1.12 4.1; 4.2; 4.3 8.2
<b>NL9</b>	Landfill caps losing integrity during heatwaves	Hot, dry weather causes landfill caps to dry out and lose integrity with consequences for management and possible contamination.	3	3	1.3; 1.4; 1.11; 1.12 6.1 7.5; 7.6 8.2
<b>NL10</b>	Erosion makes land and landfill restoration difficult	Increased frequency of flooding events makes land and landfill restoration difficult due to increased soil erosion.	2	3	1.3 3.5 7.5; 7.6

**Table 2.8 Results of the climate risk assessment to E1.6025 aim 7: By 2025 we will achieve cleaner, greener growth by supporting businesses and communities to make good choices, through our roles as a regulator, adviser and operator**

<b>Risk ID</b>	<b>Risk Descriptor</b>	<b>Narrative</b>	<b>Severity</b>	<b>Urgency</b>	<b>New actions to tackle (see tables 5.11-5.18)</b>
<b>GG1</b>	Our regulation fails to support adaptation	Our current regulatory approaches struggle to cope with the speed, breadth, severity and frequency of climate driven hazards and impacts.	6	6	1.2; 1.3; 1.6; 1.11 5.1 7.3; 7.4; 7.5; 7.6 8.2

<b>GG2</b>	More pollution incidents from regulated sites	More pollution incidents from permitted sites due to flooding, extreme rainfall/ wet weather, coastal inundation, wind damage, low flows, waste fires or reduced efficiencies (e.g anaerobic digesters). Also indirectly due to runoff from firewater/ fire prevention measures or failure of pollution control systems due to weather or flooding impacts. Increases demand on incident response with associated staff time and costs.	5	5	1.3; 1.4; 1.6; 3.1; 3.5 6.1; 6.2 7.3; 7.4; 7.5; 7.6 8.2
<b>GG8</b>	Increased diffuse pollution from agriculture	Combined effects of wetter winters and non-compliance with the requirements of silage, slurry and agricultural fuel oil regs (SSAFO) () or Nitrate Vulnerable Zones (NVZs) leads to increased diffuse pollution and consequences for habitats. With knock-on effects for development e.g. need for nitrate neutrality.	5	5	1.3; 1.4; 1.11; 1.15 6.1; 6.3 8.2; 8.7
<b>GG6</b>	Increased energy use due to industry responses to weather or climate change.	Increased energy use as an unintended consequence of industry mitigation or adaptation (whether planned or reactive) e.g. due to increase in energy for cooling (operators could fail to meet permit conditions or targets under CCAs).	5	5	2.1 6.7; 6.8
<b>GG3</b>	Escalation in number and consequences of industrial accidents.	Severe weather events make industrial accidents more likely, with significant consequences for people and the environment.	5	5	1.3; 1.4; 1.6 3.1; 3.5 6.1; 6.2 7.3; 7.4; 7.5; 7.6 8.2

<b>GG4</b>	Increase in other environmental concerns at industrial sites	Environmental concerns other than pollution incidents at industrial sites, such as fugitive emissions, pest infestation (e.g. flies), odour, litter and dust at industrial sites due to high temperatures, dry weather or wind.	5	5	1.3 7.3 7.4 7.5 7.6
<b>GG5</b>	Risks to water abstraction for industry	Dry weather and competition for resources creates pressures on availability of water for industries to abstract.	5	5	1.3; 1.11 3.4 5.1 6.3 7.6 8.2
<b>GG7</b>	Disruption to energy generation	Disruption to energy generation due to flooding, lack of water available for abstraction, extreme high flows or severe weather affects our ability to support sustainable growth through shifts to new technologies (which can exacerbate water issues), energy security and sustainable resource use.	4	5	1.3; 1.6; 1.7; 1.11 3.5 5.1 6.6 7.6
<b>GG9</b>	Opportunity to achieve multiple benefits from land use change as part of wider net zero	The ambitious net zero target will drive rapid change thus presenting an opportunity to use land to maximise resilient multiple benefits.	5	4	1.2 1.3; 1.6 2.1; 3.1; 3.4; 3.5 4.2; 4.4 5.1 6.6; 6.7; 6.8 8.2
<b>GG12</b>	Business disruption in industries we regulate	Weather and climate change driven disruption to industries that we regulate (that may or may not have knock on environmental concerns) e.g. sea level rise threats to waste disposal; supply chain disruption (including of e.g. essential medicines); disruption to utilities; water resource constraints.	5	4	1.3; 1.6; 1.7; 1.11; 1.12 3.1; 3.5 5.1 6.6 7.6 8.2

<b>GG11</b>	Renewable technologies suffer damage or loss of efficiency	High temps and low flows effects the efficiency/ profitability of water source heat pumps if less water available for process or cooling less effective. High flows and low flows can affect the efficiency of hydropower. Higher temperatures can affect biological material, such microorganisms, macrophytes and mussels that could clog and foul industrial pipes (e.g.hydropower and heat pumps). Increased frequency of rain causing scouring of tidal power technologies	4	4	5.1; 8.2
<b>GG10</b>	Hydropower opportunity due to higher flows		2	2	5.1 8.2

**Table 2.9 Results of the climate risk assessment to E1.6025 aim 8: By 2025 we will have cut waste crime and helped develop a circular economy**

Risk ID	Risk Descriptor	Narrative	Severity	Urgency	New actions to tackle (see tables 5.11-5.18)
CE1	Stockpiling of waste due to bad weather	Stockpiling of waste due to bad weather conditions such as cold wet winters and hot weather including illegal waste storage and abandonment.	5	5	1.3 7.3; 7.4; 7.5; 7.6
CE2	More waste generated by flooding	More waste generated from increased frequency of flood events on our river banks and from houses and businesses	3	2	1.3; 1.6; 1.12 3.1; 3.5 6.6 7.3; 7.4; 7.5; 7.6

**Table 3.0 Results of the climate risk assessment to E1.6025 aim 9: By 2025 we will be on track to deliver our sustainable business commitments, including to be net zero by 2030**

Risk ID	Risk Descriptor	Narrative	Severity	Urgency	New actions to tackle (see tables 5.11-5.18)
SB3	Flooding of our own operations	Office, depot or other business critical resource becomes unusable or inaccessible due to flooding or other climate related incident or flooding of waste storage leads to pollution. Disruption to availability and access to resources to aid recovery.	6	4	1.6; 1.12 8.3; 8.5; 8.6

<b>SB1</b>	Increased energy use and emissions affects our ability to achieve net zero by 2030.	Weather related disruption and incidents increases our energy use or emissions due to e.g. business disruption, an increase in incident response or climate change adaptation activity, sustainability risks not being managed during incident response and recovery or unintended consequences of adaptation/ mitigation actions.	5	4	1.4; 1.6 6.1; 6.2 7.6
<b>SB2</b>	Disruption to our own supply chain	Weather related transport disruption affects delivery of equipment/ material. Disruption to access to and availability of resources due to disruption (both UK and global). Increase in prices of goods/works/services due to market volatility.	5	4	1.12 8.4; 8.8
<b>SB4</b>	Reduced capacity of carbon sinks contributing to EA Net Zero	Reduced capacity of carbon sinks to function effectively, adds cost so that more projects may be needed to cover the same amount of carbon. These may not be available to the high offsetting standards we require.	4	4	1.15 8.3
<b>SB5</b>	Negative effects on staff health and wellbeing	Effects on health and wellbeing of staff other than related to incident duty e.g. effects of heat/ water shortages or flooding indirectly through disruption to transport, access to services.	3	3	1.1; 1.2 8.3; 8.5; 8.6



## Interdependencies and interacting risks

Due to the interconnected nature of natural, societal (in particular infrastructure) and organisational systems, there are a multitude of interactions between our climate risks. For example, risks from climate change to water quality and quantity interact with each other and affect wildlife, risks to land can exacerbate flood risk or drought risk and climate change exacerbates pollution risks through an interaction of impacts on industry and an increasingly sensitive receiving environment

There are also interactions between our actions and the actions of others that will affect the residual risks or how best to tackle them (interdependencies). Activities where these interdependencies have a significant influence include:

- **Managing the likelihood and effects of climate driven environmental incidents:** Interdependency between our roles as advisor and operator in relation to flooding, drought and coastal change and our incident management service. The effectiveness and success of adaptation actions taken under each of these roles is dependent on all of the others. Moreover, they will be influenced by the resilience and contribution of communities and businesses to manage their own risks as well as the actions of other risk management authorities.
- **Taking a lead role where there are multiple other actors:** Our own risks, including those we manage on behalf of the country, depend on the actions of numerous other actors and interact with risks which are outside our traditional remit. There is a risk that in striving to work with others to play our full part in tackling the climate emergency, including making the most of our knowledge, reach and data, we increasingly work beyond the roles for which we are resourced.
- **Regulating industry where adaptation is largely voluntary:** Our adaptation plans include actions aimed at making sure the industries we regulate are prepared for the full extent of climate change. The success of these actions is highly dependent on action taken voluntarily by industry and the organisations that determine their institutional environment (including government, other regulators, industrial trade bodies, national and international standards bodies and environmental regulators within the devolved administrations in Wales, Scotland and Northern Ireland).

We are tackling issues arising from interacting risks and interdependencies by:

- Framing our risk assessment for this report around the cross-cutting aims of our corporate plan, taking into account the actions of others and making use of the interactive online tool developed as part of the CCRA3 research project on interacting risks (WSP, 2020)
- Using systems thinking to stress test our systems and assets

- Continuing the conversations on our five cross-cutting and interacting 'Reality Checks'
- Developing and embedding 'cross-business' ways of working, in particular collaboration and engagement, that support adaptation and resilience
- Continuing to work closely with customers and partners on relevant areas of interdependency, including in support of government policy
- Exploring the potential for place based adaptation through local pilots that engage with local partners and communities

## Adaptation action plan 2021-2026

Table 3.1 Breakdown of new actions under theme 1: Thinking differently

Action ID	Action	Intended outcome
1.1	Identify and build relevant knowledge and skills for adaptation	People are competent and capable of playing their part in responding to the effects of climate change
1.2	Develop and embed 'cross-business' ways of working, in particular collaboration and engagement, that support adaptation and resilience actions in all our work	Good practice on adaptation and resilience is spread across the business and we avoid conflicting or duplicated effort
1.3	Enhance our capability & capacity to transform our approach to regulating industry in a changing climate through people and processes by improving knowledge and securing more support for both	Agile people and processes that are capable of delivering transformational change
1.4	Increase our understanding of the risks and challenges to the Incident Management Service from climate change.	We are able to clearly define the remit and standard of the service that we offer with respect to climate related hazards. We know enough to design the service to take account of climate change.

<b>1.5</b>	Build internal capacity for area teams engaged in spatial planning so they can promote the EA's latest adaptation advice to inform local planning policy and developments.	Local Planning and Policy Developments is informed by EA adaptation advice
<b>1.6</b>	New national assessment of flood risk (FCERM strategy measure A.2)	People, communities and partners are better able to plan and adapt to future risks from flooding.
<b>1.7</b>	Work with partners to develop adaptive pathways in selected places (FCERM strategy measures 1.2.2)	People, communities and partners use adaptive pathways to plan for future flood and coastal change and adapt to future climate hazards; People, communities and partners benefit from learning that is generated.
<b>1.8</b>	Provide external climate change guidance and seek improvements to government planning guidance to help ensure plans and developments are resilient to a 4°C increase by 2100	Plans and developments are resilient to future flood risk under a climate change scenario of 4°C increase by 2100
<b>1.9</b>	FF2025 will create Technical Authority to ensure we have improved asset technical standards, aligned to change in risk	Our flood assets are fit for purpose in a changing climate
<b>1.10</b>	Move towards a more holistic "asset health" approach to asset management to better inspect and maintain assets throughout their lifetime.	Assets are effectively maintained throughout their lifetime

1.11	Work with the academic community to understand of the effects of climate change on environmental processes and to undertake applied analysis to create robust data-sets and tools that can be used to adapt to climate change.	<p>We play our part in the continuing development of robust scientific understanding to facilitate good decision-making.</p> <p>Our data provides a robust evidence base for us and our partners and other data users/providers to access and apply in support of climate change adaptation.</p>
1.12	Develop a more quantitative understanding of predicted climate change impacts on waterways, navigation and associated activities.	We are better able to prepare for the effects of climate change on navigation and associated activities while protecting the water environment
1.13	Support Area teams to explore and develop cross-functional inclusion of adaptation measures for navigation.	Water-way specific navigation outcomes are considered as part of wider catchment actions to deliver adaptation
1.14	Generate (including through research and the development of new methods and tools) and improve the use of, evidence on climate change impacts for water	We develop greater insights and information about who and what is vulnerable to flooding, water availability and water quality impacts as a result of expected change; we can visualise what the river of the future will look and feel like.
1.15	Stress test EA with respect to climate change	We understand the points, with respect to climate change, at which our systems and assets fail; we contribute to the knowledge base on climate stress testing methods; we are better able shape and prioritise adaptation evidence needs.

1.16	Map strategic adaptation evidence needs	We are generating evidence that is accessible and capable of supporting the decisions and investments of ourselves and others in the long term (100yrs and beyond) and move adaptation from a series of tasks into facing hard decisions.
1.17	Develop an approach to monitoring and evaluating our adaptation actions	We have a better understanding of how well our adaptation actions are managing our risks

**Table 3.2 Breakdown of new actions under theme 2: Collaborating**

Action ID	Action	Intended outcome
2.1	Expand work with partners for a holistic approach to reducing poor health and wellbeing and reducing inequalities resulting from climate change.	Our activities contribute to protecting health and wellbeing and reducing inequalities in a changing climate
2.2	Help external bodies operating in the planning system understand what they need to do to be resilient to climate change by providing key messages and supporting external initiatives with key partners.	External bodies operating in the planning system understand what they need to do to be resilient to climate change; External initiatives on planning and adaptation make use of our advice.

2.3	Share learning and best practice with other risk management authorities  (FCERM strategy measures 3.1.3)	Other risk management authorities benefit from our learning on working with communities; Best practice on working with communities spreads throughout the risk management community; communities are better able to cope and adapt to future flooding and coastal change.
2.4	Explore a strategic role working with other Navigation Authorities to develop climate change adaptation advice.	Consistent approaches to adaptation across navigation authorities to increase overall preparedness of navigation activities for the effects of climate change

**Table 3.3 Breakdown of new actions under theme 3: Investing for change**

Action ID	Action	Intended outcome
3.1	Enhanced appraisal guidance for flooding and coastal change projects  (FCERM strategy measures 1.1.1)	Investment decisions reflect a wide range of resilience actions and climate change scenarios.
3.2	Work with others in the investment community to take account of physical risks	Reduced physical risks from climate change to investments
3.3	Develop and promote approaches to green finance for adaptation and resilience	There is sufficient investment (both public and private) into the infrastructure the nation needs to be climate resilient and that all infrastructure is built greener and is adapted to tomorrow's climate.

<b>3.4</b>	Include resilience measures within the water industry national environment programme as part of the next price review (PR24)	Resilience and adaptation thinking is built into water company business plans and investments.
<b>3.5</b>	New long-term investment scenarios (FCERM strategy measure 3.5)	Flood policy and investment decisions are based on robust climate evidence.
<b>3.6</b>	Support the implementation of the TCFD through the provision of our data and engaging on the nature related financial disclosures framework (TNFD)	

**Table 3.4 Breakdown of new actions under theme 4: Working with nature**

<b>Action ID</b>	<b>Action</b>	<b>Intended outcome</b>
<b>4.1</b>	Improve and develop more effective ways of working collaboratively with partners on climate change adaptation and the nature crisis.	We see more and faster action tackling the climate and the nature crises.
<b>4.2</b>	Enhance resilience to sea-level rise and increase carbon sequestration through our collaborative restoration initiative: Restoring Meadow, Marsh and Reef (ReMeMaRe)	Habitats become more resilient to climate change including sea-level rise and function well, including sequestration of carbon.



4.3	Support the Marine Management Organisation and Natural England in ensuring that the regulations around the Marine and Coastal Access Act and Habitats Regulations enable habitat restoration.	Habitats become more resilient to climate change including sea-level rise and function well, including sequestration of carbon.
4.4	Work with Natural England to develop approaches to conservation that enable adaptation to sea level rise  (FCERM strategy measures 1.4.1)	The conservation of protected sites, species and natural landscapes takes account of future sea level and flooding.

**Table 3.5 Breakdown of new actions under theme 5: Designing a low carbon future**

<b>Action ID</b>	<b>Action</b>	<b>Intended outcome</b>
5.1	Support BEIS policy to make sure that the rapid transformation of energy infrastructure considers the impacts of climate change and implications of these for environmental regulation	The impacts of climate change on new technologies is minimised. Energy infrastructure is fit for a changing climate, including its design, operation and regulation

**Table 3.6 Breakdown of new actions under theme 6: Strengthening community resilience**

Action ID	Action	Intended outcome
6.1	Design our Incident Management Service to deal effectively with bigger, more frequent & complex incidents.	We have in place a guaranteed and scalable incident response, with an agile command and control framework, staffed by professionally accredited personal. We have our own strong Business Continuity measures in place to ensure we can provide an uninterrupted service.
6.2	Develop consistent incident response messaging with respect to climate change that is underpinned by accurate and timely situational intelligence	During incidents we will tell one incident story with respect to climate change across all partners and the media
6.3	We will support others to prepare for climate change, Particular focus on encouraging behaviour change in relation to incidents where it's people that reduce the effects	People value and respect their natural environment, they take action to reduce the chance of causing harm. People understand their part in building resilience from natural hazards and protecting the environment from serious and lasting damage.
6.4	Help others take action during incidents.	We provide services that help the public and our professional partners take action to reduce the impact of incidents.
6.5	Support coastal communities to transition and adapt  (FCERM strategy measures 1.3.1)	The livelihood and wellbeing of coastal communities facing significant scale and pace of risks from future flooding and coastal change is protected

<b>6.6</b>	Lead the delivery of place based resilience programme supporting 25 local places  (FCERM strategy measures 1.1.2)	Partners in 25 local places take innovative actions on resilience to flooding and coastal change; Other people, communities and partners benefit from the learning that is generated.
<b>6.7</b>	Develop an understanding of the health and wellbeing effects of climate change for a range of scenarios using an evidence based and collaborative people focussed approach and promote this to staff	We are better able to ensure our activities align with protecting health and wellbeing in a changing climate
<b>6.8</b>	Proactively promote a people centred approach to climate change and public health and air quality	Our activities relating to climate change and public health and air quality contribute to positive outcomes for people

**Table 3.7 Breakdown of new actions under theme 7: Helping businesses prepare**

<b>Action ID</b>	<b>Action</b>	<b>Intended outcome</b>
<b>7.1</b>	Work with and support water companies with Drainage and Wastewater Management Plans	Surface water flood and contamination risks reduced and energy saved.

7.2	Update guidance to planners and developers on flood risk assessment  (FCERM strategy measures 2.1.1)	Planners and developers take account of 2018 UK Climate Projections in their flood risk assessments.
7.3	Design our approach to working with regulated industries around impacts associated with a mean global temperature rise of +4°C by 2100 including a corresponding rise by 2050.	EA and operators are planning for 4 degrees
7.4	Seek support from government, industry, stakeholders & partners for a more innovative approach to adaptation and the step change required	Government, industry and partners explicitly commit to a more innovative approach and step change
7.5	Ensure all regulatory permissions and activities support & deliver embedding of climate change adaptation based on a mean global temperature rise of +4°C by 2100 including a corresponding rise by 2050.	Industries we regulate are embedding climate change adaptation into permitted processes and activities
7.6	Review and evaluate our own and other regulatory approaches to build the case for industry to do more to plan for climate change in all they do, with case studies and analysis of the impact.	We are able to make for regulatory change as appropriate.

**Table 3.8 Breakdown of new actions under theme 8: Stepping up to level up**

Action ID	Action	Intended outcome
8.1	Support the development of a national resilience strategy	A national resilience strategy that recognises climate change as a significant driver of material risks and prioritises climate resilience measures
8.2	Work with others to ensure that a strategic approach guides action to tackle pressures on England's water environment, focusing on protecting and improving catchments and making them more resilient to climate change.	Clean and plentiful water is available in an increasing number of river catchments in England. The pace of improvement increases as we implement a wider range of actions including a number of ambitious and long-term transformative measures.
8.3	Adapt our land and buildings to a +4°C degrees world.	Plans are in place to adapt all new property and acquisitions in high risk locations.
8.4	Build adaptation into supply chain risk management	Transparency on the high-risk areas of our supply chain and how we are managing these risks; Reduced likelihood or effects of supply chain disruption
8.5	Identify any potential contribution from weather events to H&S incidents and update our operational instructions and training accordingly.	A safe and healthy working environment

8.6	Proactively identify any psychological impacts of climate events and trends on the mental health and wellbeing of our staff, and revise our support to staff accordingly.	Increased personal resilience of our workforce
8.7	Work with government to ensure that England's environmental policy and legislation facilitates adaptation to climate change.	The combined environmental impact of climate change and newly permitted activities is reduced.
8.8	Better understanding of risks and challenges from climate change to our supply chain	Clients/commercial leads involved in letting contracts understand the impacts of extreme weather and climate change on our business critical supply chains and are able to consider adaptation at the earliest opportunity.

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