

Climate change and the strategic road network

Building resilience for a changing future

Climate change and the strategic road network

Building resilience for a changing future

Climate change is affecting society as a whole, and the transport sector is no exception. As we build and maintain our roads – the country’s vital transport arteries – we must help tackle the causes of climate change, and prepare for a changing climate.

Climate change is already happening and affecting us all. In one severe rainfall event alone, in October 2021, we saw significant flooding on the M25, A3 and M23. Together with wider government and businesses, we are making big steps to cut carbon. But we need to prepare for heavier rainfall, hotter summers and rising sea levels, and the consequences that may follow.

We are responding to climate change now by reducing emissions and adapting to future conditions

In 2021 we published our Net Zero Highways Plan to show how we will meet the target of net zero greenhouse gas emissions. Our work to prepare for a changing climate builds on this work.



CORPORATE EMISSIONS

Net zero by 2030



MAINTENANCE & CONSTRUCTION EMISSIONS

Net zero by 2040



ROAD USER EMISSIONS

Net zero by 2050

The effect of climate change on our network

The strategic road network, England's 4300 miles of motoways and major A-roads, includes assets of varying lifespan. Longer life assets such as bridges, tunnels, drainage and earthworks will endure for many decades, so we need to consider how the climate will affect them over a long period. It is critical that we take account of not just today's weather, but long-range climate change too.

We know that there are a range of risks from future climate change that we need to adapt to. **The latest climate projections for the 2070s tell us that the UK may experience:**



An increase in winter rainfall and more intense rainfall events in summer



An increase in summer temperatures that may be between 0.9 and 5.4 degrees C warmer in a high emission scenario



Rising sea levels which will vary depending on location with the south-east experiencing the highest rises



A potential increase in wind speed in the second half of the century

These changes could lead to changes to weather we experience from day to day, with more extreme weather happening more frequently. For example, we are likely to see more flooding, more storms and more heatwaves.

The government's advisor on climate change is the Climate Change Committee.

They have highlighted some of the key risks that the transport sector, including National Highways should prepare for, including:

- Risks from river, surface water and groundwater flooding
- Risks from coastal flooding and erosion
- Risks from slope and embankment failure
- Risks to bridges and pipelines from flooding and erosion
- Risks from high and low temperatures, high winds, lightning
- Risks to infrastructure networks from cascading failures, where effects on one organisation, for example power generation, could have knock on effects on another organisation

How climate change affects the strategic road network

This diagram illustrates some of the impacts of climate change and measures we are taking to address these

Heat waves can cause a wildfire risk which can cause smoke to blow across highways



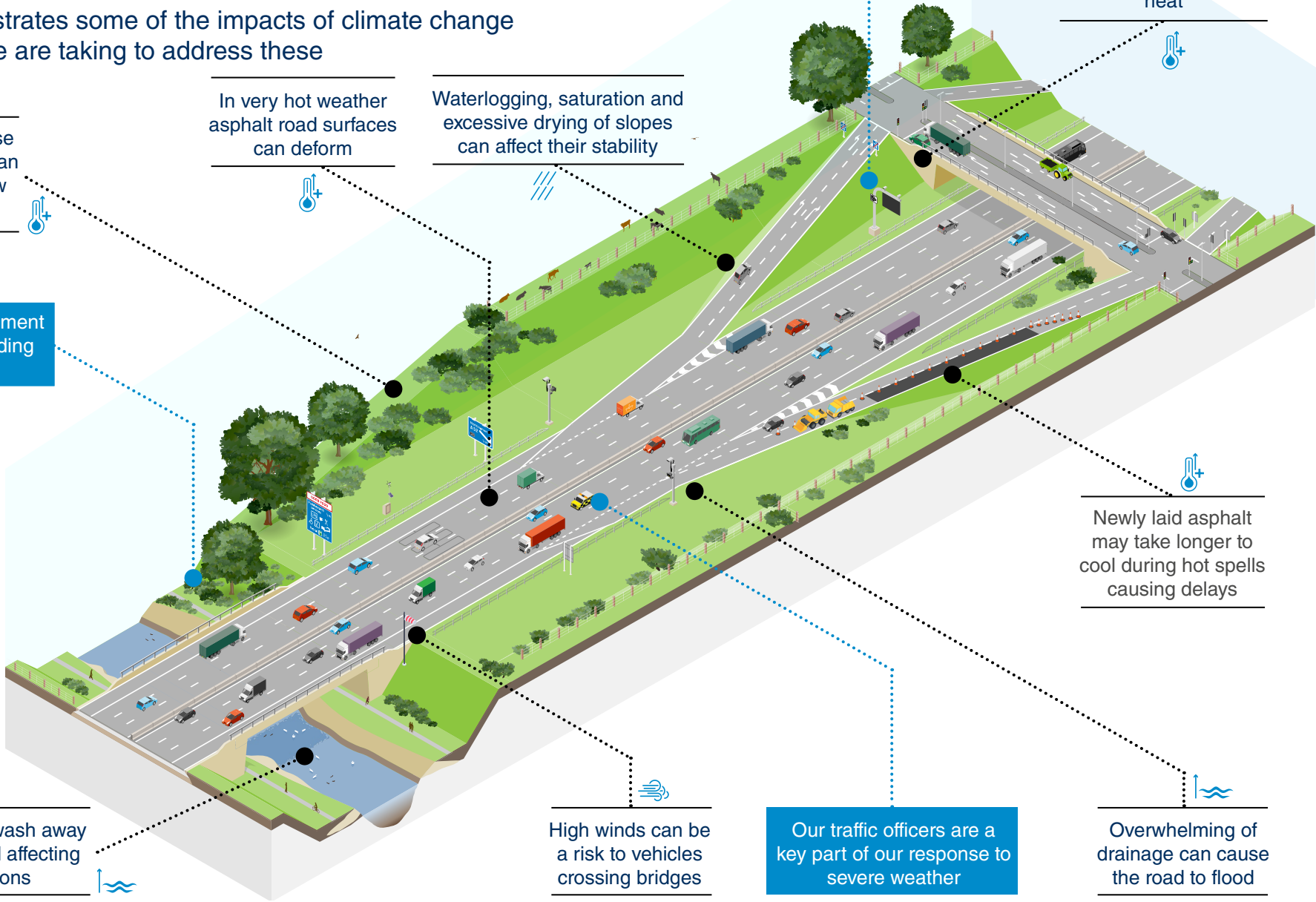
In very hot weather asphalt road surfaces can deform



Waterlogging, saturation and excessive drying of slopes can affect their stability



Natural flood management can help lessen flooding risks



Information can help inform road users of severe weather

Bridge expansion joints and bearings may be damaged by extreme heat



Newly laid asphalt may take longer to cool during hot spells causing delays



High river flows can wash away parts of the river bed affecting bridge foundations



High winds can be a risk to vehicles crossing bridges



Our traffic officers are a key part of our response to severe weather

Overwhelming of drainage can cause the road to flood

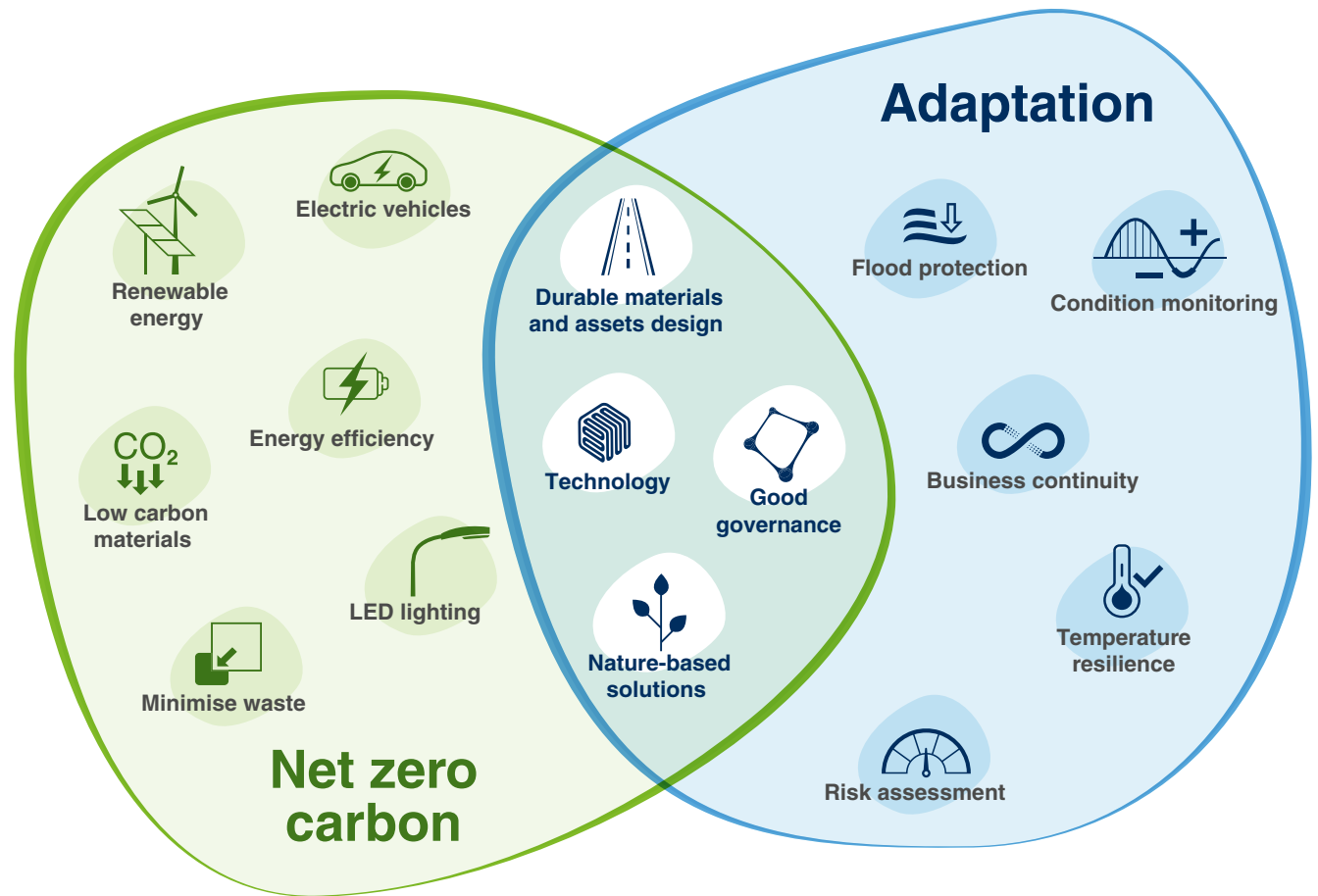


Future proofing our road network

There are many risks from climate change for infrastructure organisations. At National Highways we must be flexible when planning the long term development and improvement of the network. This includes looking at future trends in climate and weather conditions.

Our work to build and maintain our roads includes defining the standards for building, inspecting and maintaining roads and managing the work to deliver those standards. We also support our customers as they use our roads. For example, we have around 1200 uniformed traffic officers who patrol and control the network in all weathers. We commission research to help better achieve our priorities and understand how climate change may affect our operations.

To address climate change we have published our net zero highways plan to ensure we are able to reach net zero greenhouse gas emissions. However, we must also adapt to the climate change we will experience over the coming decades.



Managing the effects of climate change

The different elements of climate change present various risks and challenges for our network. Over the following pages, we examine the risks and the actions we are putting in place to address them.



Rainfall



Temperature



Combined risks



Other risks related to climate change



People and climate change



Nature based solutions



Rainfall

Climate projections show that in the UK, we can expect to have wetter winters and drier summers.

An increase in winter rainfall, which may be up to 35%, by 2070

What's the risk to our roads?

When rain falls on the road surface it is important that this water is drained away effectively. However, water that falls nearby may also affect the road, for example the road may cross a river or estuary.

Where drainage fails to operate effectively, this may cause the road to flood. And flooding may also affect other assets, such as earthworks or the foundations of structures.

Some of the key risks we have identified include:

- Overwhelming of drainage causing the road to flood
- High river flows washing away river beds surrounding the support structures for bridges
- Waterlogging and saturation of slopes and earthworks affecting their stability
- Excessive water soaking into the layers of a road



What actions are we taking?

We have already addressed many of these risks by updating our standards for road design. For example, we have updated our standards for drainage design to ensure we build bigger drains more able to cope with increased rainfall. Knowing the locations most likely to flood is also an important part of addressing issues, so we continue to identify high risk areas through our Drainage Data Management System.

Increases in rainfall causes different types of flooding

Flooding on the road surface

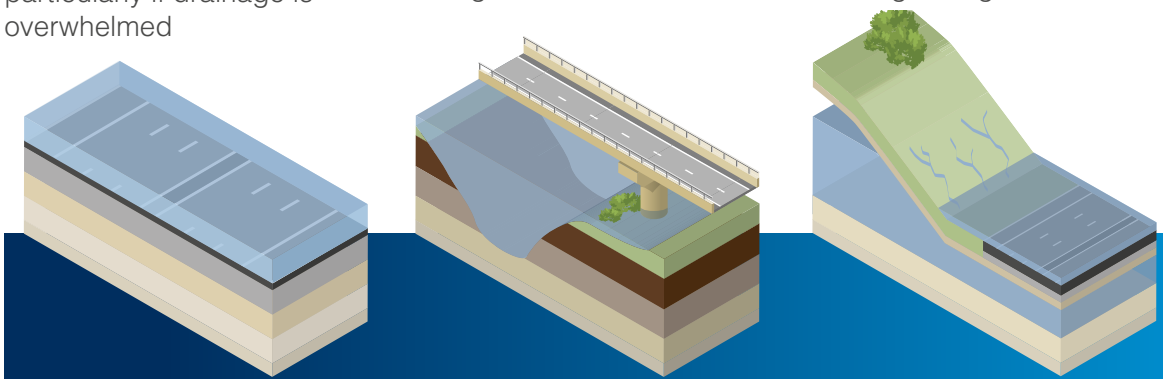
Surface water flooding can pool on the road surface, particularly if drainage is overwhelmed

Flooding from rivers

Fluvial flooding is where rivers flood. This can directly affect structures on or near water such as bridges, where rapid flowing water could cause damage

Groundwater flooding

Groundwater flooding is where the water table rises, this can start to pool at the surface causing roads to flood, erosion of earthworks, or can saturate assets below the surface causing a range of effects.



Many of these risk are addressed through the drainage system. While in some cases it may be important to increase drainage capacity or monitor drainage performance, in other cases it may be beneficial to think about the water cycle including how natural drainage processes can help reduce flooding.

A solution to flooding in Catterick

Repeated flooding at the A1 at Catterick was a risk to traffic, the economy, and the local community of Catterick village. We worked in partnership with others such as the Environment Agency and North Yorkshire County Council to design a solution, which included a flood storage reservoir, and adding meanders and hydro-brakes to slow and control the flow of water through Brough Beck. This solution delivered £2million of benefits to the regional economy and protected 149 properties from flooding.





Temperature

Climate projections for the UK show that all parts of the UK will be warmer in future, particularly during the summer. There will be an increase in the frequency of heatwaves and a reduction in the frequency of cold spells.

The top 10 warmest years the UK has experienced since 1884 have all occurred since 2002.

What's the risk to our roads?

Temperature has several effects on a road. Higher air temperatures and direct sunlight can cause issues such as cracking.

Construction materials as well as clay soils in earthworks can expand and contract in response to temperature changes. While we allow for this, climate change can mean we need to monitor and plan for greater changes.

Warm conditions may also affect the people, such as road workers and road users, that work and travel on our roads. They may find the conditions uncomfortable or may need to plan work differently.

Some of the key potential effects we have identified include:

- Expansion of concrete pavements at joints leading to deformation of overlying road surfaces
- Softening and deformation of asphalt surfaces, and difficulties laying asphalt where it does not have sufficient time to cool
- Expansion of the expansion joints and bearings in bridges

Newly laid warm mix asphalt can cool more quickly and reduce carbon footprint



What actions are we taking?

We have already updated some standards to address these risks. For example, we have updated our standard to include warm mix asphalt. This allows lower temperature asphalt to be laid, meaning that it is able to cool more quickly. This prevents delays in maintenance and construction work during warm conditions. Warm mix asphalt is also manufactured at lower temperatures, which means it has a lower carbon footprint to traditional asphalts manufactured and applied at higher temperatures.

While our standards generally take account of the impacts of temperature, we also have research completed or underway to look at temperature impacts on bridges and the climate resilience of asphalt pavements.

There is more work to do here though. For example, more research is needed to further understand the effects of heat on bridge expansion joints, and what solutions we should implement where our current asphalt surfacing may be at high risk of being impacted by heat.

A move to more resilient road surfaces

The asphalt surfacing on our roads was previously made up of hot rolled asphalt. However, in recent years there has been a shift to Thin Surface Course Systems (TSCS). As well as having benefits such as being quicker to install and reducing the noise associated with traffic, TSCS is considered to be more resilient to adverse weather and climate change. In addition to reducing spray in wet conditions, it also has improved resistance to rutting (which is where asphalt can soften and expand, developing depressions, such as a wheel path engraved into the road). We test all asphalt surface materials to be resistant to surface temperatures of 60 degrees C. We also carry out routine inspections of the entire network using dedicated survey vehicles to ensure any problems are quickly spotted.





Combined risks

Considering climate change isn't simply about addressing the direct impacts of wetter or hotter future weather. Often weather conditions can combine to have an impact on our roads.



Sinkholes, like this one at the M2 in Kent, may occur in heavy rain in some places

What's the risk to our roads?

In terms of combined rainfall and temperature changes, the key risks occur where repeated cycles of wetting and drying affect the ground underneath and surrounding the road.

Key risks include:

- Shrinking and swelling of soils can make features such as slopes less stable
- Damage to underground features such as drains or pipes from soil drying and shrinkage, amplified by sudden rainfall events
- Ground water level changes causing impacts on the foundations of some structures which could lead to a need for repair

What actions are we taking?

While modern standards of design minimise these risks, we have already developed hazard identification tools and commissioned further research in this area to further increase resilience. For example, we have developed 'shrink – swell' soils ground related hazard guidance to better inform our work. We're now looking to conduct further research and integrate climate change data into our processes and future planning.



Other risks related to climate change

We know that sea level rise is one of the key risks to coastal areas in the UK, however most of our road network is inland. It may still be a local risk in some locations, for example to bridges that cross tidal estuaries.

Wind speeds can also affect structures and road users. Climate projections show potential increases in wind speed in the second half of the century. Where wind speed and higher seas combine we may see increases in wave height.



What are the risks to our roads?

- Wind action causing damage to structures such as bridges, signs and electronics
- Storm surges and associated washed away debris causing damage to bridges or changes to the river bed around bridge piers
- Freeze-thaw damage caused by more water on road surfaces which can damage the road, for instance by causing potholes
- Wildfire risk to surrounding land and causing smoke to blow across the highway
- Trees or branches blowing on to the road



What actions are we taking?

We have engaged with a range of standards and research forums to consider these and other risks. For example, we have, and continue to collaborate in research in climate change with other road administrations across Europe. This allows us to see best practice in adapting to climate change across different climatic zones, giving an insight into how best to prepare for future climate changes in the UK. We have also changed our standards to minimise the risk of trees falling on the carriageway in high winds.

On exposed bridges such as the Dartford and Second Severn Crossings we have parapets and barriers which provide a level of shielding against high winds, to assist the safe passage of high sided vehicles.

Elsewhere, on the Orwell Bridge in Suffolk, we now reduce the speed limits when wind speeds reach 50mph, where possible enabling us to keep the bridge open rather than closing it to traffic and all the disruption and inconvenience to drivers this can cause.

We'll continue to collaborate with other organisations and commission research. For example, we are reviewing our maintenance standards for pothole repairs to ensure they are more resilient to changes in climate.



Climate change and the strategic road network

Managing the effects of climate change



People and climate change

As our climate changes, we can expect more extreme weather events. Heavier rain or higher winds can cause difficult driving conditions for our customers and unsafe working conditions for those who work on our roads.

Risks on our roads

We have identified several direct future risks to our customers and workforce from climate change, including:

- Uncomfortable driving and working conditions during heatwave events
- Excess surface water and decreased visibility during extreme rainfall events may result in less safe driving conditions
- Risks to vehicles, particularly high sided vehicles, overturning in higher winds
- Some winter risks that may lessen, but still occur, such as the risk of falling ice from structures like bridges occurring due to wetter conditions coinciding with freezing conditions

What actions are we taking?

Many of these risks are dealt with through our processes for managing health and safety or for dealing with weather-related events. For example, we have established processes that our traffic officers follow to respond to incidents, and have regional severe weather plans in place. We also issue severe weather alerts and provide seasonal driving advice on our website. We keep our procedures under review to ensure they remain effective and responsive to changing circumstances.

← Thread



National Highways
@NationalHways



In conjunction with [@metoffice](#) a severe weather warning has been issued for snow in the South East & East of England on Sunday (07/02) between 03:00 and 21:00. Please check the weather forecast and road conditions if you're planning to travel. Info here: highwaysengland.co.uk/travel-updates...



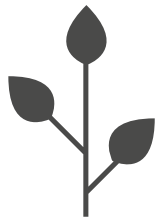
5:36 pm · 5 Feb 2021 · Hootsuite Inc.

36 Retweets 2 Quote Tweets 38 Likes



Tweet your reply

Reply



Nature based solutions

Some of the actions we are taking to adapt to climate change involve changes to road construction to improve performance in a changing climate, or put new processes in place to deal with adverse weather conditions. However, we also recognise the important role that the natural environment can play in reducing risks.



Slowing the flow

In a heavy rainfall event water will drain off the wider landscape into streams and rivers or may percolate into aquifers. This can cause flooding many miles away, and can be a risk to our roads. Simple measures, such as changes to the management of land, can slow the flow of water. This can reduce the risk of flooding where water runs off the land into rivers very rapidly. Working together with others, if we think carefully about how we achieve this, we can also deliver wider environmental benefits, such as creating new habitats for wildlife, or reducing the carbon in the atmosphere.

A move to more resilient road surfaces

National Highways awarded more than £420,000 to 13 Natural Flood Management projects in the north-west of England. These partnership projects with the Don Catchment Rivers Trust and Mersey Rivers Trust used an emerging approach called Natural Flood Management to help protect the M60, M62, A58, A616, A628 and B6194 from flooding.

The pilot projects have involved planting woodlands and hedgerows, building ponds, soil aeration and creating natural barriers to water flow called 'leaky dams'. By creating new niches for nature not only will the project develop new habitats for species, creating gains for biodiversity, water flowing through the catchment will be slowed, reducing flood risk throughout the landscape.

A second phase of the project will allow further natural flood measures to be implemented.

Working together

Responding to climate change is not something that we can do on our own. Many of the risks we see emerging from climate change do not just affect our roads, but may occur across a larger area. For example, heavy rain may affect a wider river catchment, and the flooding that follows may also affect farmland landowners, settlements and business.

We also know that an impact on our roads may affect other elements of infrastructure networks and vice versa. These types of impacts are called cascade failures. For example, the government has recently highlighted the risk of power failure due to an extreme weather event affecting the wider economy, including infrastructure networks.

This is why we must work together with others. We have already seen good examples where co-operation can bring benefits that go beyond our roads. For example, through our Designated Funds we have co-funded flood management measures and 'nature-based solutions' to flooding that have enabled road users and wider communities to benefit.

Andrew Barron, Senior Advisor, Flood and Coastal Risk Management, Environment Agency (left) and Michael Whitehead, Principal Environment Advisor, National Highways (right) at the Catterick flood defences



Climate change and the strategic road network

Working together

We work with partners at different levels: for instance, at a local level we participate in Local Resilience Forums. At a national level we participate in the Infrastructure Organisations Adaptation Forum to share information on climate risks, and we also work closely with the Environment Agency in relation to managing flood risk. Beyond the UK we collaborate on climate resilience with other road administrations, for example through the Conference of European Directors of Roads.

We'll need to work even more closely with our supply chain to minimise climate risk. We already ensure that our schemes carry out a climate change impact assessment using the latest climate projections.

We'll need to build on these strong partnerships going forward to ensure we effectively respond to climate change.

Partnership working to prevent flooding in Hull

Working with the Environment Agency, we've helped fund a project which will better protect more than 110,000 homes and businesses in Hull from flooding, as well the A63 where it runs through the city.

The city was hit by flooding in 2007 and 2013 with hundreds of homes and businesses affected on both occasions. A new £42 million flood barrier now runs for more than four miles from St Andrew's Quay to Victoria Dock Village.

The project was funded by a £39m Defra grant and a £3m contribution from National Highways, and will help to ensure Hull is more resilient to the effects of climate change.

The Environment Agency has predicted water levels on the Humber could rise by more than one metre in the next 100 years.



The road ahead

There are a number of future climate risks to our work and we are already actively addressing many of these risks.

It's important that as we manage our response to climate risk, we consider wider sustainable development. It would make no sense to adapt to a changing climate in ways that make climate change worse. This means we'll need to consider the wider economic, social and environmental benefits that adapting to climate change can deliver.

Climate Action is a United Nations Sustainable Development Goal. Adapting to climate change requires us to think about addressing the risk, as well as how we can deliver wider sustainable development outcomes, such as reduced greenhouse gases. So when we adapt to climate change, it is important that we do so in a way that doesn't cause problems for the environment, society or the wider economy.





Balancing ponds, such as this one on the A45, can be an important part of a more sustainable approach to drainage

Cover photo: Great Ouse Bridge, M62 – North East & Yorkshire

If you need help accessing this or any other National Highways information, please call **0300 123 5000** and we will help you.

© Crown copyright 2022.

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence

visit www.nationalarchives.gov.uk/doc/open-government-licence/

write to the **Information Policy Team, The National Archives, Kew, London TW9 4DU**, or email psi@nationalarchives.gsi.gov.uk.

Mapping (where present): © Crown copyright and database rights 2020 OS 100030649. You are permitted to use this data solely to enable you to respond to, or interact with, the organisation that provided you with the data. You are not permitted to copy, sub-licence, distribute or sell any of this data to third parties in any form.

This document is also available on our website at www.nationalhighways.co.uk

For an accessible version of this publication please call **0300 123 5000** and we will help you.

If you have any enquiries about this publication email info@nationalhighways.co.uk or call **0300 123 5000***. Please quote the National Highways publications code **PR123/22**.

National Highways creative job number GFD22_043.

*Calls to 03 numbers cost no more than a national rate call to an 01 or 02 number and must count towards any inclusive minutes in the same way as 01 and 02 calls.

These rules apply to calls from any type of line including mobile, BT, other fixed line or payphone. Calls may be recorded or monitored.

Printed on paper from well-managed forests and other controlled sources when issued directly by National Highways.

Registered office: Bridge House, 1 Walnut Tree Close, Guildford, GU1 4LZ.

National Highways Company Limited registered in England and Wales number 09346363.