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NetworkRail

Network Rail Fourth Adaptation Report

December 2024

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Acronyms and abbreviations

Acronym	Definition
ARP1, 2, 3, 4	Adaptation Reporting Power. ARP (1, 2, 3, 4) the first, second, third and fourth Adaptation Reports to Defra
CP5, 6, 7, 8	Control Period. CP5 (2014 – 2019), 6 (2019 – 2024), 7 (2024 – 2029), 8 (2029 – 2034) are our fifth, sixth, seventh and eighth five yearly funding and investment cycles
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EA	Environment Agency
HS1, 2	High Speed 1 and 2
FRM	Flood Risk Management
ICCRA	Network Rail's Integrated Climate Change Risk Assessment
LBTS	Land Based Transport Sector
NAP 1, 2, 3	National Adaptation Programme. 1 (2013 – 2018), 2 (2018 – 2023), 3 (2023 – 2028)
NIC	National Infrastructure Commission
ORR	Office of Rail and Road
PPM	ORR Public Performance Measure
RS	Route Services
RSSB	Rail Safety and Standards Board
S4	ORR Schedule 4 possessions regime
SO	System Operator
S8	ORR Schedule 8 performance regime
TA	Technical Authority
TCFD	Task Force on Climate-related Financial Disclosures
TfL	Transport for London
UKCCRA 1, 2, 3	United Kingdom Climate Change Risk Assessment 1 (2012), 2 (2017), 3 (2022)
WRTF	Weather Risk Task Force
WODMs	Weather Operations Delivery Managers
WRCCA	Weather Resilience and Climate Change Adaptation

Foreword

Our railway is the greenest way for millions of people and goods to make their way across Great Britain, and we want to keep it that way. We know it's a vital part of daily life for millions, whether they're commuting to work or heading out to explore. That's why planning for the extreme weather we're increasingly facing is so important to make sure our passengers have a safe and reliable journey.

Climate change is here to stay, and it's affecting our railways. We're committed to tackling this challenge head-on. Since our last report, we've made great strides by implementing key resilience projects, developing adaptation plans, and agreeing on climate change scenarios for the industry to help us to boost the resilience of the railway as we prepare for severe weather.

In this update, we'll build on our progress over the past few years and focus on how we plan to make our railway more resilient to climate change and severe weather. By doing this, we can keep everyone's journeys running smoothly and safely.

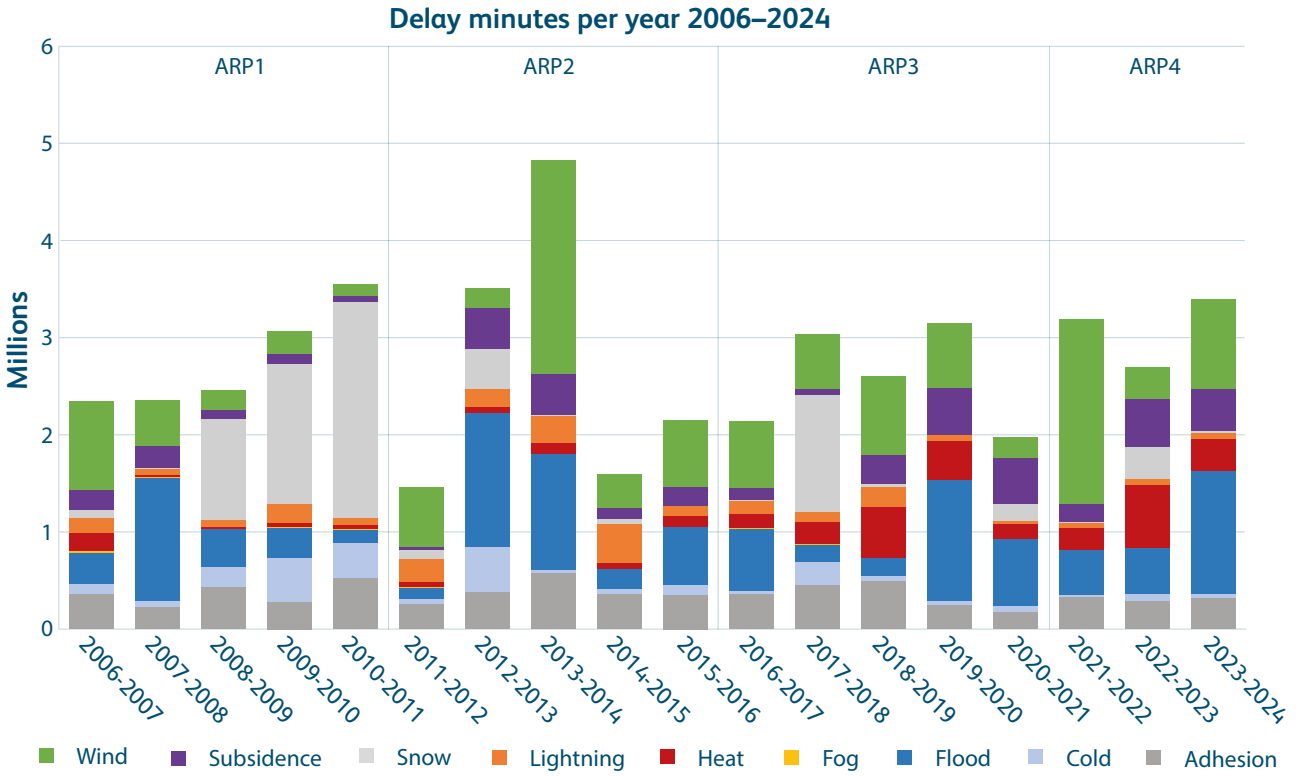
Andrew Haines
Chief Executive

Executive summary

The need for adaptation

Since our last report in 2021, we have continued to see and feel the effects of extreme weather events across the seasons, with some very severe storms, record breaking hot temperatures and the coldest winter since 2010. These challenges have delayed many of our freight and passengers' journeys; a further 9.3 million weather-related delay minutes have cost £370 million in compensation over the last three years.

We're seeing the trend move away from cold and snow-related railway impacts and towards flooding, heat, and subsidence impacts. This will be reflected in people's daily lives, with flooding and extreme heat impacting everyone and our ability to deliver their journeys smoothly and on-time.



We're constantly planning and responding to extreme weather events because they affect our ability to provide reliable journeys. However, climate change is bringing increased weather risks that our railway wasn't designed to handle. That's why we need to continuously learn and adapt to keep our railway moving. By continuing to invest in understanding these changes and developing the tools and actions needed, we can make the railway more resilient for our passengers and freight users.

This reporting round

The process of creating this report gives us an opportunity to review and update our work on understanding our climate change risks and the creation and use of our national climate change policies, strategies, and adaptation plans. It allows us to share our findings and experiences with others and to make improvements.

This document is our submission for this fourth round of adaptation reporting under the Climate Change Act 2008 covering the period from December 2021 to December 2024. Its content and layout is aligned with the Defra Transport Sector reporting guidance and can also be used to support our Task force on Climate-related Financial Disclosure (TCFD) response in our **Annual Report and Accounts**. As an adaptation report covering our physical climate change risks, it does not cover our greenhouse gas emissions reduction work.

The report covers our infrastructure assets, the activities to operate and maintain them and our interfaces with other organisations and communities across our five regions in Great Britain. It builds on our 2021 Adaptation Reporting Power (ARP3) submission by providing updates on developments in our weather resilience and climate change adaptation strategy and governance, our risk understanding and the actions we are taking to address these. It also lays out the actions that we plan to take between now and 2029.

Taking action

Since 2021, we've made significant strides to understand how climate change will affect our railway, so we can plan and prepare and help our freight and passengers to still get to where they need to go.

We've made good progress in delivering the priorities and actions that we set in our ARP3 Report. This includes:

- updating our weather and climate change strategy which is embedded within our **Greener Railway: Environment and Sustainability strategy**,
- developing a methodology for implementing **adaptation pathways strategies** across Network Rail,
- significantly improving our Integrated Climate Change Risk Assessment (ICCRA), which can be found on **our website**,
- continuing to deliver our Weather Risk Taskforce (WRTF) actions,
- continuing to research and work with experts across our industry.

We are also investing to support our railway to cope with the more extreme weather we're facing. Delivering our Control Period Six (CP6) **Route Weather Resilience and Climate Change Adaptation (WRCCA) Plans** has seen investment in drainage engineers, building or rebuilding drains, strengthening our embankments, installing smart movement sensors, CCTV, and innovative new technologies. We will continue this progress through our Control Period Seven (CP7)' **Region WRCCA Plans**. This is key to keeping our services running for our passengers in difficult conditions.

As our climate continues to evolve, so must our approach. We need to continuously learn and adapt to keep our railway moving so, as well as our ARP3 actions, we've also improved how we will adapt though:

- extending adaptation planning to our Route Services directorate,
- extension of the WRTF to incorporate the outputs of the Extreme Heat Taskforce,
- contributing to and using the rail industry Climate Change Adaptive Capacity Assessment tool,
- developing a way to measure the benefits of investing to make our railway more resilient.

While we are proud of the progress that we continue to make in our drive to deliver an appropriately adapted railway, we recognise that considerable work remains to be done. Based on our work and learning to date this report sets out our priorities and actions that we will work to deliver through our next five-year investment period. The action plan outlined follows the framework of our new Adapt to a Changing Climate strategy with the actions aligned to key themes.

Key priorities include:

- continued integration of climate change adaptation consideration into our policies, standards and asset modelling,
- development of long-term adaptation pathways strategies for high criticality locations,
- delivery of the CP7 Region WRCCA Plans and creation of CP8 plans,
- capability development and training tools,
- continued research and work with experts across industries, particularly around interdependencies, geospatial mapping of risks and identification of asset thresholds and adaptation measurements.

While it will take many years to adapt to our changing climate, this work is a significant step and all part of our journey to being ready to handle our climate change challenge.

Case study 1: Western route – Dawlish seawall

Following on from the CP5 project for section one of the Dawlish seawall, 360m of defences along Marine Parade, which opened in July 2020, work started on section two in November 2020. This £80 million pound Government-funded project is now finished, opening to the public on 25 May 2023, and completing the transformation of the seafront. This has created 415m of new high-level promenade providing fully accessible public areas from Boat Cove to Coastguards Footbridge.

The design was developed as part of the South-West Rail Resilience Programme as a result of years of detailed modelling, designing and collaboration between world-leading marine, coastal and railway experts. The defence is eight metres high, two and a half metres higher than the previous wall, to ensure greater protection of the railway and the community behind, improving the long-term resilience of the railway to the effects of sea level rise on erosion and storm impacts. This will lead to fewer line closures and a quicker recovery after large storm events and, improve the customer experience by reducing spray and beach debris that reach the platforms and providing better station and promenade access.

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1.1 The Adaptation Reporting Power

Under the Climate Change Act 2008, the Secretary of State for Environment, Food and Rural Affairs has the power to request that organisations that provide key functions in the economy and public services (reporting authorities) produce reports on what they are doing to adapt to climate change. As the organisation responsible for the management of the majority of Great Britain's railway infrastructure this includes us.

The Reporting Power is exercised every five years to allow the Government to gather information on what climate challenges the reporting authorities are exposed to and how they are responding to them. This helps the Government understand the level of risk to the UK and the action being taken by key organisations and sectors. The information gathered is then used to develop a UK Climate Change Risk Assessment (UKCCRA) and a National Adaptation Programme (NAP).

Previous reporting rounds have seen us issue reports in 2011, 2016 and 2021, but this reporting cycle meant that the reports were issued too late for the data to feed into the five yearly review cycle for the UKCCRA and NAP. The fourth Adaptation Reporting Round has been shortened to three years covering the period 2022 to 2024 to ensure that going forward the ARP, UKCCRA and NAP cycles are aligned with the reports issued at the end of 2024 feeding into the UKCCRA4.

1.2 Our reporting history

Network Rail has participated in all three of the past Adaptation Reporting rounds. Our first report (ARP1) was submitted in 2011 and used research from the Tomorrow's Railway and Climate Change Adaptation research to build a largely qualitative picture of our approach to managing climate impacts. Our second report in 2015 (ARP2) showed significant advances from our work in ARP1 including the step change we had made in how we assessed climate risks across our organisation and improvements in our governance of the issue. Our last report (**ARP3**) was our most comprehensive to date summarising all of our activity so far and showcasing our key advances including:

- our most comprehensive risk assessment,
- our Route Weather and Climate Change Adaptation (WRCCA) Plans,
- improved governance and reporting,
- physical adaptation actions.

1.3 Purpose, scope and structure of this report

To accompany this reporting round, Defra issued its Climate Adaptation Reporting Fourth round guidance. This gives tailored advice for reporting authorities with different levels of experience. We, Transport for London (TfL), National Highways, High Speed 1 (HS1) and High Speed 2 (HS2) and the Office of Rail and Road (ORR) have worked with Defra, to develop a common reporting and risk assessment framework that aligns with its guidance. This builds on the approach used in ARP3 and will allow Defra and the transport sector reporting authorities to draw comparisons and conclusions across our reports. To achieve best practice, this report has been created following the surface transport framework and the Defra guidance, specifically ANNEX G – Returning organisations.

We recognise the importance of adaptation reporting as a tool to support the process of understanding the climate change risks to the UK and the development of appropriate national climate change policies, strategies and adaptation planning. We view our participation as making a critical contribution to this work and this report meets the needs of our voluntary submission under the Adaptation Reporting Power. It also gives us an opportunity to review our progress, adjust our plans and share our findings and experiences with others.

This document is our submission for this fourth round of reporting in line with the Defra Transport Sector guidance. It covers all of our infrastructure assets, the associated activities to operate and maintain them, and our interfaces with other organisations and communities across our five regions in Great Britain. As an adaptation report covering our physical climate change risks, it does not cover our greenhouse gas emissions reduction work.

As it is only three years since ARP3 in 2021, this report does not revisit the detailed background and narrative on the weather impact analysis, governance, strategies, policies and risk assessment methodology behind our ARP3 Report. It is intended to be a briefer update covering the actions contained in the ARP3 Report, summaries of any additional work that we've delivered and our planned activities over the next five years and beyond. Highlights include:

- a refresh of our **Greener Railway: Environment and Sustainability strategy,**
- significant improvements in our Integrated Climate Change Risk Assessment (ICCRA), which can be found on **our website**,
- delivery against the **CP6 Route WRCCA Plans** and creation of the **CP7 Region WRCCA Plans**,
- development and implementation of an **adaptation pathways methodology**,
- agreement of **common climate change planning scenarios** for the rail sector,
- improvement in our weather and climate impacts knowledge and our planning and response,
- ARP3 action plan progress and our ARP4 action plan.

Details on the other actions we have delivered in the last three years can be found in **Section 5.1**.

1.4 Task Force on Climate-Related Financial Disclosure (TCFD) content

Our 2023/24 Annual Report and Accounts gives our response to the TCFD, so this report is not intended to meet the TCFD reporting needs. It does give detail related to some requirements, particularly physical climate risks and our approach to managing them.

Table 1 signposts TCFD content in this report and additional background content in our ARP3 Report. As the focus of this report is physical risks there is no content on financial disclosures, carbon and transition risks.

Table 1 – Signposts to TCFD related content[1]

Requirement	Recommended disclosures	ARP4 section	ARP3 section
Governance: Disclose the organisation's governance around climate-related risks and opportunities	Describe the Board's oversight of climate-related risks and opportunities	3	3
	Describe management's role in assessing and managing climate-related risks and opportunities	3 and 6	3 and 5
Strategy: Disclose the actual and potential impacts of climate-related risks and opportunities on the organisation's businesses, strategy and financial planning where such information is material	Describe the climate-related risks and opportunities the organisation has identified over the short, medium and long-term	4	6 and 7
	Describe the impact of climate-related risks and opportunities on the organisation's businesses, strategy and financial planning	3 and 5	4 and 7
	Describe the resilience of the organisation's strategy, taking into consideration different climate-related scenarios, including a 2˚C or lower scenario	3 and 5	4 and 8
Risk management: Disclose how the organisation identifies, assesses and manages climate-related risks	Describe the organisation's processes for identifying and assessing climate-related risks	4	5
	Describe the organisation's processes for managing climate-related risks	4	3 and 5
	Describe how processes for identifying, assessing and managing climate-related risks are integrated into the organisation's overall risk management	4	3 and 5
Metrics and targets: Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material	Describe the metrics used by the organisation to assess climate-related risks and opportunities in line with its strategy and risk management process	5 and 6	3
	Describe Scope 1, Scope 2, and, if appropriate Scope 3 greenhouse gas emissions, and the related risks	N/A	N/A
	Describe the targets used by the organisation to manage climate-related risks and opportunities and performance against targets	5	3 and 4

[1] The Requirements and Recommended disclosures column text in this table is extracted from the TCFD Proposed Guidance on Climate-related Metrics, Targets and Transition Plans available online at: **Final Report – Recommendations of the Task Force on Climate-related Financial Disclosures**

1.5 Definitions of resilience and adaptation

To meet the challenge of creating a weather and climate-resilient railway system, we must have a common understanding of what a resilient railway looks like. As core terms such as 'resilience' and 'adaptation' can have several definitions depending on the context, using shared definitions is essential.

Below are the definitions that should be applied when reading this report:

- **Resilience** – The ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from adverse and extreme weather conditions (e.g., storms), and gradual or erratic weather pattern changes caused by climate change (e.g., temperature, water availability),
- **Adaptation** – The process of adjusting to current or expected climate change and its effects. Adaptation seeks to reduce risks, moderate harm and exploit beneficial opportunities from today's changed climate conditions and to prepare for impacts from future changes.

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2.1 Network Rail

Network Rail is a public sector, arms-length body of the Department for Transport (DfT) responsible for managing the railway infrastructure across the whole of Great Britain, covering the three nations of Scotland, England and Wales. Our regulator is the Office of Rail and Road (ORR) who hold us to account on our health and safety, service and financial performance.

We get people and goods where they need to be and support our country's economic prosperity by delivering a simpler, better, greener railway. As the greenest form of transport, we aim to offer a safe, reliable and sustainable service by focusing on safety, train service delivery, efficiency, sustainable growth, customers and communities and our people.

Figure 1 – Our strategic priorities

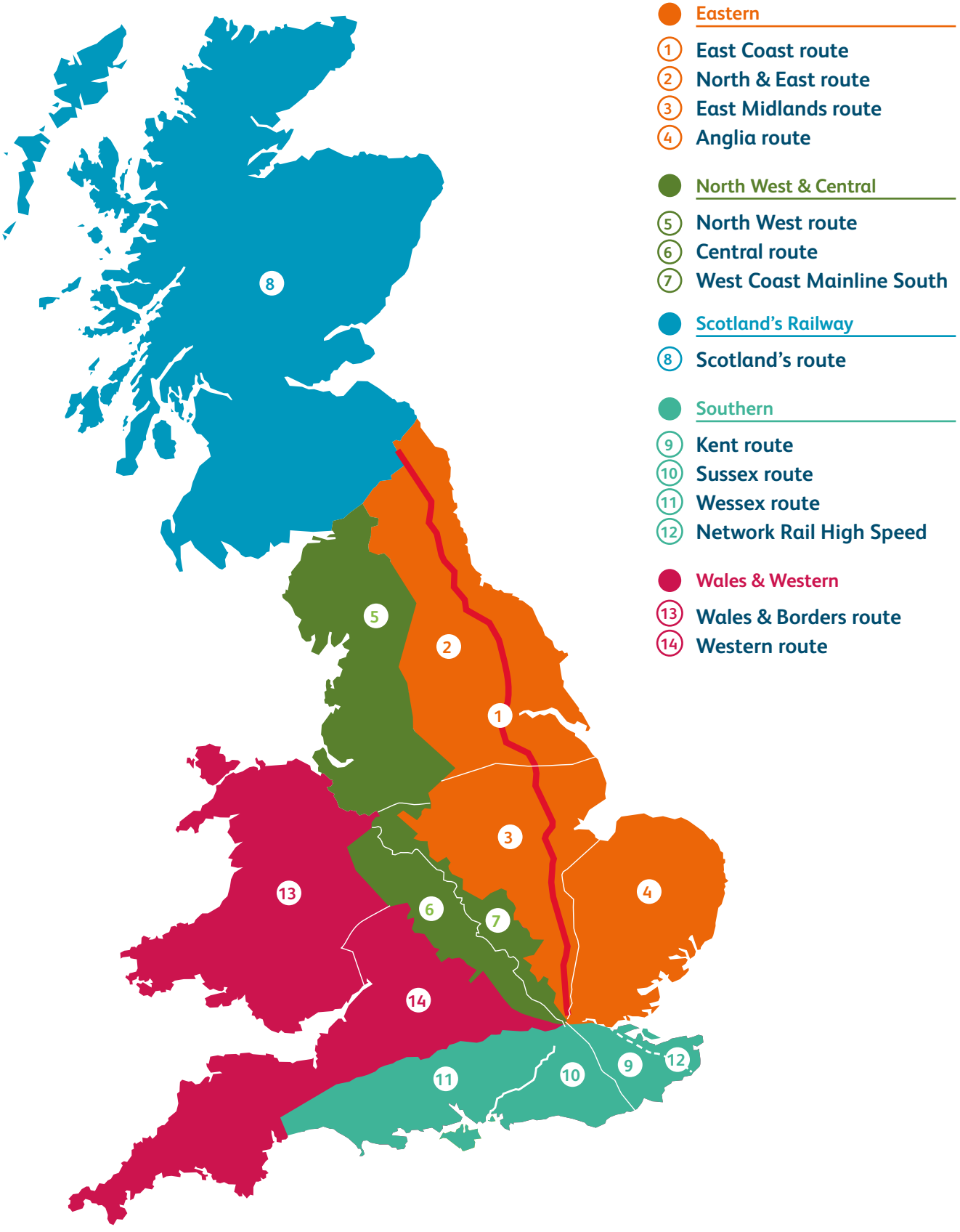
Safety | Train service delivery | Efficiency | Sustainable growth | Customers and communities | People

Our large and complex network includes roughly 20,000 miles of track, 30,000 bridges, tunnels and viaducts and thousands of signals, level crossings and operational buildings. We own all of the stations, managing 20 of the largest, with the rest, over 2,500, run by the train operating companies.

We are a devolved organisation with a tiered structure. Our national functions are responsible for providing the strategic direction and control framework for the business as well as operating the railway as a system, business services, long-term strategy, policy and planning and co-ordinated research. The five regions are responsible for responding to the needs of their local customers by developing appropriate plans and supporting their routes. The routes carry out the day-to-day maintenance and renewals necessary to deliver train performance. This means that we can be more responsive to our customer's needs and make key operational decisions at the front line. **Figure 2** shows the distribution of our regions and routes.

The future Great British Railways will change the way railway infrastructure and train operations are managed in Great Britain over the next reporting period, bringing track and train together to improve delivery for passengers and freight users. This plan sets out our intentions for key activities covering Network Rail's area of influence and our engagement and collaboration with the wider rail industry.

Figure 2 – Our regions and routes[2]



[2] Source: Our regions – Network Rail

2.2 Weather and climate impacts update

Our network runs through a wide variety of terrain, crosses rivers, passes through towns and cities, hugs the coast and operates in a wide range of weather conditions. It is exposed, on a daily basis, to the impacts of adverse and extreme weather including heatwaves, droughts, snow, intense or prolonged rainfall and flooding. These and other weather impacts are key challenges to the delivery of our services. Changes in their frequency and severity increasingly test the resilience of our assets and systems leading to significant disruption to our customers, staff and communities.

Since our first Adaptation Report, the climate has continued to show the sorts of changes projected by the Met Office's climate projections. Over the past 18 years, we've seen more intense and more frequent extreme weather events with increasing levels of impact affecting our ability to operate our services and infrastructure safely and efficiently. This continues to pose increasingly serious risks to our organisation, and the people and businesses who rely on us.

In our ARP3 Report we discussed how the weather affects us, how we monitor its impacts and how we analyse the data to understand the level of impact and we outlined key trends. Since then, we have collected another three years of weather-related performance data under the ORR Schedule Eight (S8) performance regime and the Schedule Four (S4) possessions (planned maintenance) regime. We now have 18 full years of data for the S8 data (2006/07 – 2023/24) and 11 years for the S4 data (2013/14 – 2023/24). For this report the analysis using the weather attribution categories in Figure 3 has been updated and the key findings are shown below.

Figure 3 – Attribution categories for weather impacts

Adhesion	Traction loss due to line contamination e.g. fallen leaves, moisture, oils
Cold	Low temperature impacts e.g. ice on conductor rails, frozen points, rail breaks
Flooding	Flowing or standing water e.g. river flooding, surface water flows, overwhelmed drainage
Fog	Reduced visibility e.g obscured signals
Heat	High temperature impacts e.g. rail buckles, temporary speed restrictions, sagging overhead lines
Lightning	Direct or indirect strike e.g. track circuit/signalling failure, building damage, power loss
Snow	Snowfall impacts e.g. blocked lines, points failures
Subsidence	Geotech failures e.g. landslips, desiccation, rockfalls
Wind	Damage due to high wind e.g. trees or other debris on the line or overhead lines

During the last three years, from 2021/22 – 2023/24, we experienced an additional 9.3 million weather-related delay minutes which cost us more than £370 million in delay compensation. As usual this has been due to a range of weather events and patterns with the key impacts being:

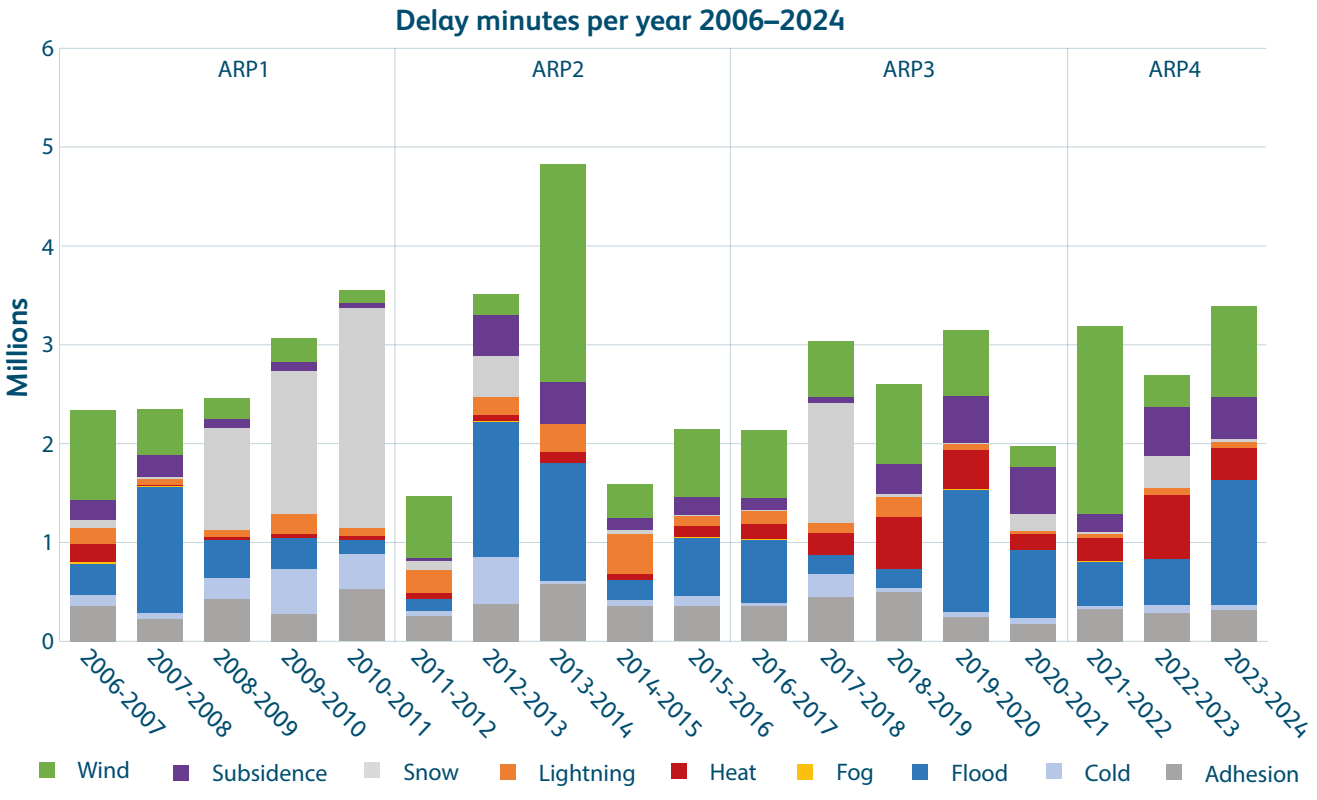
2021/22 – The storm season was active with seven named storms and an extremely wet October. Of particular note was Storm Arwen, which brought a Met Office red wind warning, and the grouping of Storms Dudley, Eunice and Franklin all in one week causing significant disruption to the network. This year saw the second highest impact from wind over the past 18 years with 1.9 million delay minutes. Flooding linked to these storms caused an additional 453,000 delay minutes.

2022/23 – Heatwaves and record hot temperatures saw a new annual record for heat impacts of 646,000 delay minutes. Subsidence also hit a record 498,000 delay minutes in part due to embankment shrinkage in summer followed by autumn rainfall. In contrast, December was the coldest since 2010 adding nearly 400,000 delay minutes.

2023/24 – The storm season was highly active with 12 named storms including Storm Babet whose exceptional rainfall triggered two Met Office red warnings. We saw nearly 1.3 million flooding delay minutes, our third highest ever, and a further 927,000 wind and 423,000 subsidence delay minutes.

Looking at the full 18-year dataset (Figure 4 and **Figure 5**) we can see that all weather impact categories continue to accumulate delay minutes and compensation costs. However, the trend continues to be away from cold and snow related impacts towards flooding, heat and subsidence. That said, the winter of 2022/23 illustrates why extreme winter planning should remain part of our weather resilience activities. Nationally, wind and flooding remain our biggest impacts to date causing just over 12.1 million and 11 million delay minutes respectively.

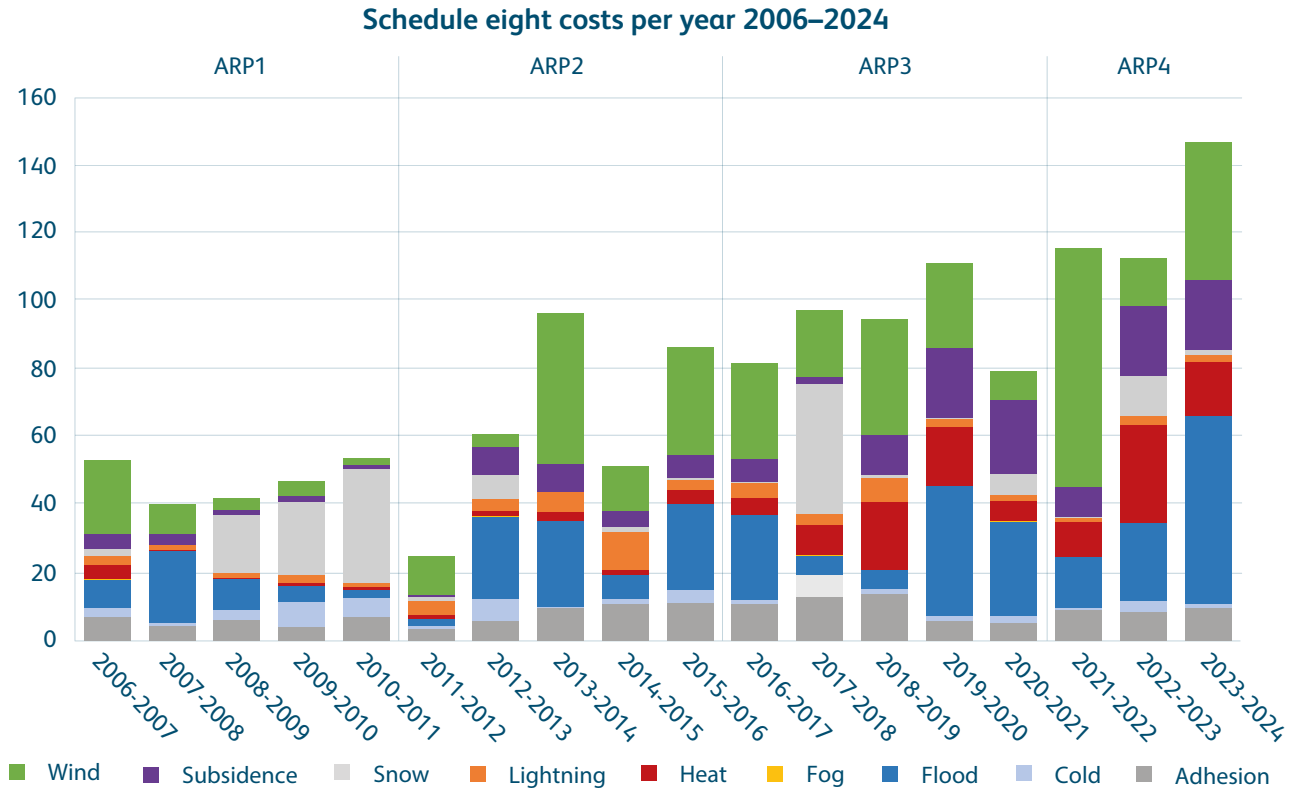
Figure 4 – Delay minutes per year



While 2021/22 and 2023/24 are in the top five years for weather-related delay minutes the general picture shown in **Figure 4** is of a roughly stable trend over the past decade. Adding the new data has actually reduced the average number of delay minutes per year by 3.5 % from an average of 1.73 million across 2006 – 2021 to 1.67 million from 2006 – 2024. This indicates that the weather and climate resilience work we are doing is helping to counteract the increasingly extreme weather that we are experiencing.

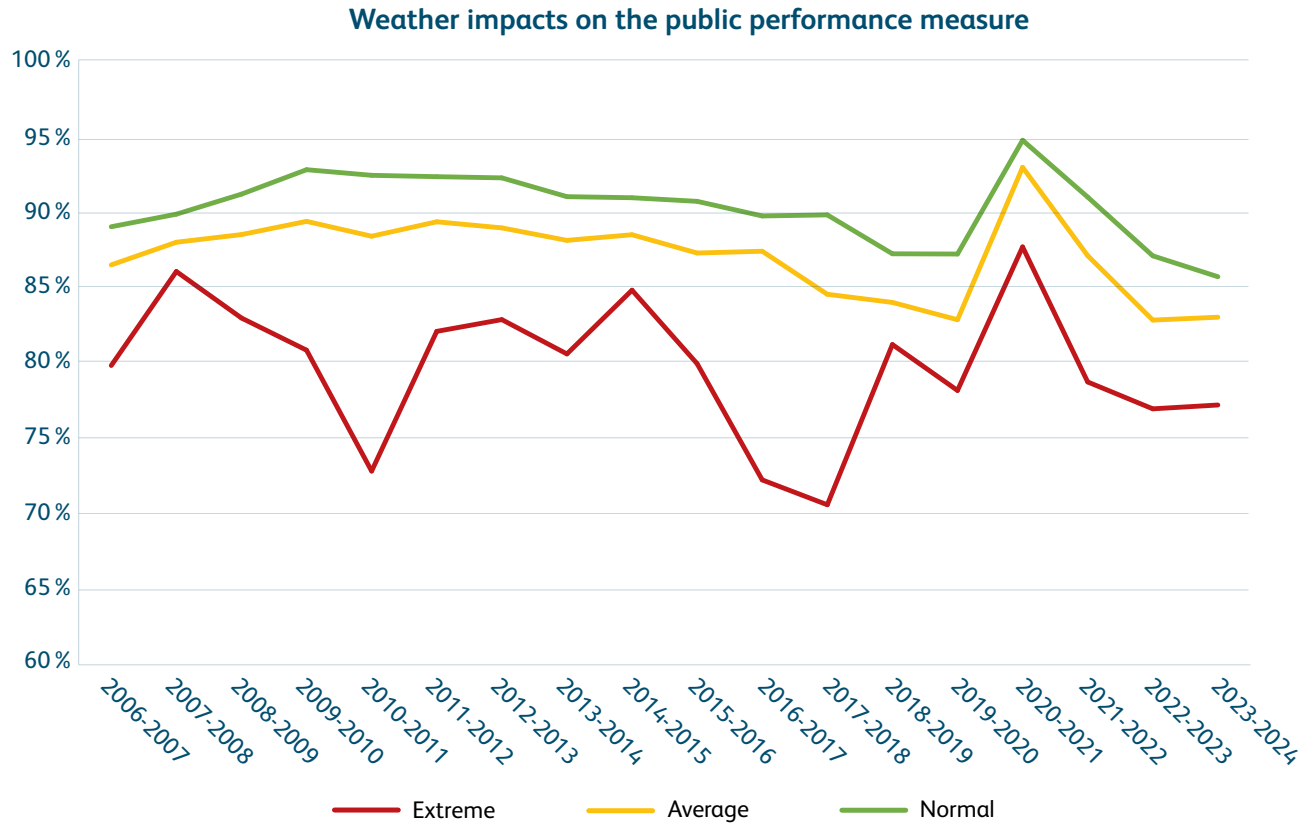
The cost of extreme weather continues to rise however due to increases in the S8 compensation rates over time (Figure 5). The average annual cost has risen by just under 17 % from £66.7 million in 2006/12 to £77.8 million across the whole 18 years.

Figure 5 – S8 delay costs per year



Extreme and adverse weather events impact train punctuality as illustrated in Figure 6. On adverse weather days we see a drop in the **Public Performance Measure (PPM)** of around 2–4 % from normal weather performance. Extreme weather day performance is more severely and variably impacted. The spike in performance around 2020/21 is not related to weather, it was influenced by the impacts of the Covid-19 outbreak and the extensive changes it made to train services.

Figure 6 – PPM monitoring 2006/07 to 2023/24



As weather challenges increase, the total cost to us and the impact on our assets, processes and people will make it increasingly difficult to deliver the service that our customers expect. This underlines the importance of our work to determine the impacts that changing weather patterns and events will have on us, and how we must adapt to maintain the continued safe, reliable and efficient operation of our network. The remainder of this report gives an update on the progress that we have made in the three years since our ARP3 Report.

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3.1 Our strategic vision, objectives and approach

Climate change adaptation is one of the key themes in our Greener Railway – Environment and Sustainability Strategy. The strategy supports our purpose by connecting people and goods with where they need to be for generations to come. It outlines how we can become a greener railway in line with our 'simpler, better, greener' vision and our strategic ambition is to 'create a railway fit for the future, that cares for the environment and that helps communities thrive'.

Adapting to climate change is one of the key priority areas for delivering a railway fit for the future and our objective is to have a **well-adapted railway system that is flexible, reliable, operates safely and is responsive to a changing climate**.

We need to consider weather and climate resilience in everything we do, from our day-to-day activities to our long-term planning. Keeping our passengers, workers and assets safe is our priority. In some instances getting passengers and freight to their destination might not necessarily be by train (i.e. in unsafe weather conditions we may need to use alternative mode of transport). We will achieve our objective by creating resilient assets and systems and a resilient operational response:

- **Resilient Operational Response:** Actions taken to safely operate the railway during adverse and extreme weather events. These include actions that enable a fast and effective response to, and recovery from, disruptive events through thorough planning, and exercises in advance of adverse weather events,
- **Resilient Assets and Systems:** Actions taken to increase the resilience of assets and systems in response to changes in our climate. This can be achieved through physical adaptation of assets (e.g., increased capacity of culverts to handle a greater volume of water). It is also achieved through administrative controls such as changes to how we respond, our operations and our investments in research and development among others.

By 2030 we will:

- deliver 90 % of regional WRCCA Plan milestones by March 2029,
- have established the first regional long-term adaptation pathways strategies based on assessment of high priority locations by end CP7,
- have Key Route Strategies for operating in extreme weather by the end of CP7,
- routes and train operators give integrated assurance of readiness against seasonal weather plans for infrastructure and operations by the end of CP7.

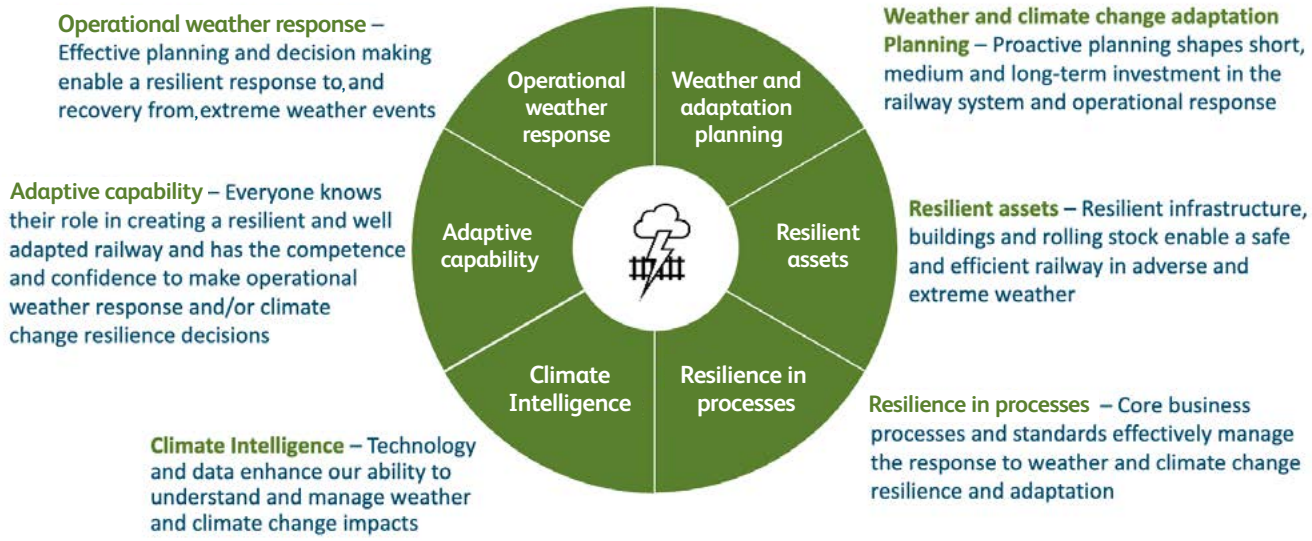
Beyond 2030 we have ambitions to:

- have 100 % of our network covered by adaptation pathway strategies to enable us to see continuous improvements in the reliability and safety of the network,
- improve customer satisfaction during adverse and extreme weather.

This will contribute to future safety, reliability and performance of the railway meaning that we can keep moving people and goods for generations to come thereby supporting economic growth in the UK.

Our strategy work falls into six key themes as illustrated in Figure 7.

Figure 7 – Themes for adapting to a changing climate



This strategy and approach build on the one we set out in our ARP3 Report and brings all activities on operational weather response, weather resilience and climate change adaptation under one overarching strategic vision. The initiatives and milestones outlined in this report relate only to delivery of the climate change adaptation elements. Delivery of the strategy is the responsibility of teams across the routes, regions and national functions as explained below.

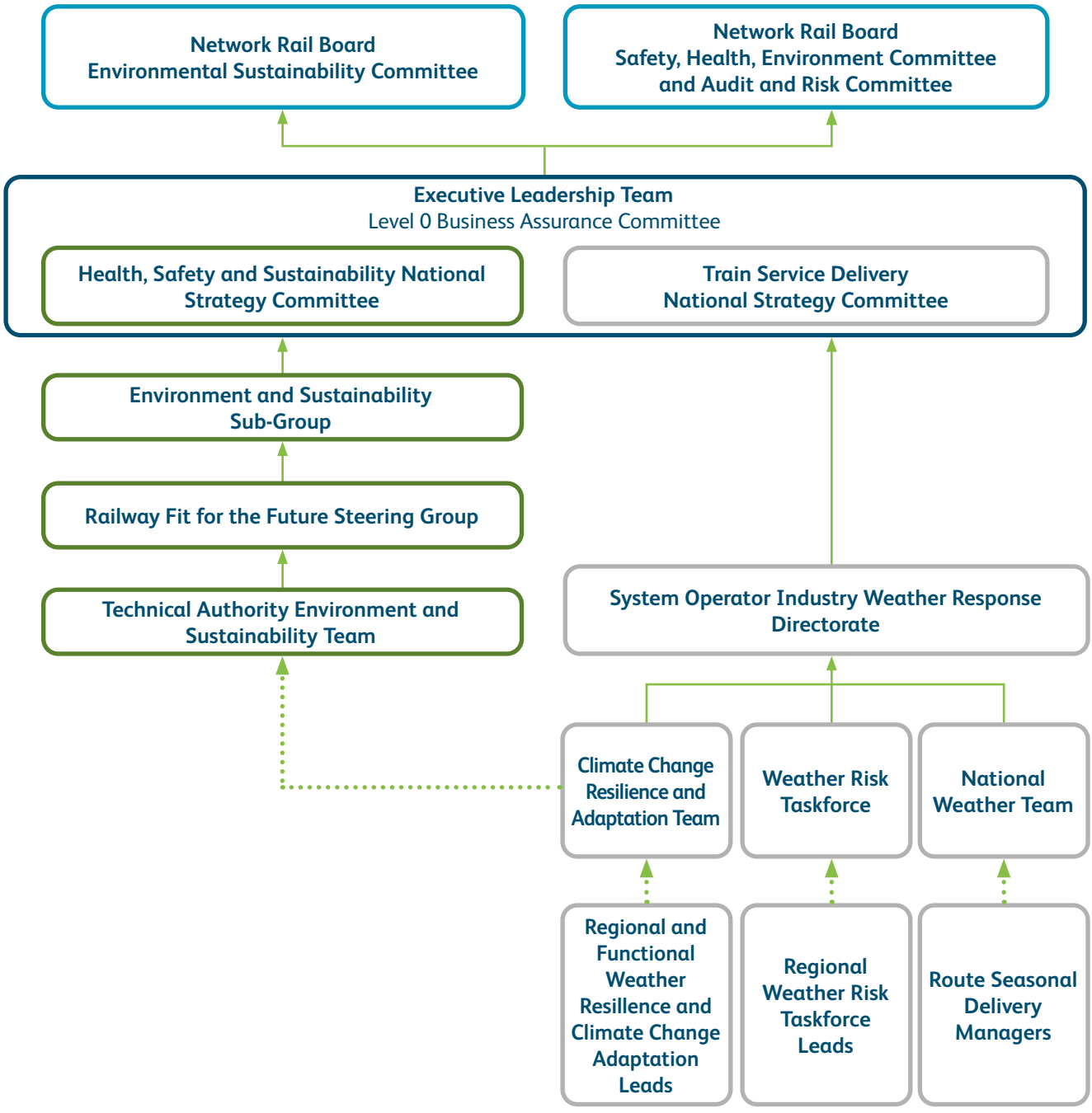
3.2 Governance

Our corporate governance structure is outlined in our ARP3 Report. Governance of weather and climate change has changed over the past three years due to an increased focus on managing the risks. The tragic derailment at Carmont, near Stonehaven, in August 2020 has triggered a fundamental shift in the way that Network Rail, and the industry, manage weather and climate change. These issues are top of the agenda for our Executive Leadership Team and Board. This has led to an increase in resources and investment in managing weather at a local level (e.g. drainage inspectors) and a restructure of the teams providing technical expertise and strategic support for the business.

Delivery of our objective of a well-adapted railway system that is flexible, reliable, operates safely and is responsive to a changing climate is the responsibility of multiple teams and business units across Network Rail and the wider rail industry.

The guiding mind supporting this activity is the Industry Weather Response Directorate within the System Operator (SO) national function. The Directorate was established in June 2023 to bring together the National Weather Team, which leads on operational and seasonal weather response, and the WRTF. The Climate Change Adaptation team transferred from the Technical Authority (TA) Environment and Sustainability Team in September 2024 to create one team that now leads on all aspects of weather and climate change to streamline activity and support the integration of climate change management within Network Rail. This move has retained the reporting line via the Health, Safety and Sustainability National Strategy Committee and has added an additional parallel reporting line through the Train Services Delivery National Committee (Figure 8).

Figure 8 – Network Rail weather and climate change adaptation resilience governance



Governance structures are likely to change in coming years with the establishment of Great British Railways. For now, climate change adaptation activity continues to be governed through the Environment and Sustainability strategy governance structure and operational weather response through the Train Services Delivery Strategy Committee.

Regions and national functions have weather resilience and climate change adaptation leads and/or teams leading implementation of the climate change adaptation strategy.

Managing weather and climate change falls into three policy areas/workstreams covering the short to medium-term **operational weather response**, medium to long-term **asset management and engineering** and longer-term **climate change resilience and adaptation** (Figure 9). Each policy area owns, develops and maintains policy, standards and processes for weather management and climate change resilience and adaptation. They update requirements based on legislation, external standards, funder and regulator requirements, produce incident reports, commission independent expert reviews, manage stakeholder expectations and promote research and evidence collection.

Figure 9 – Core weather and climate resilience policy areas

Resilient assets and systems		Resilient operational response
Climate change resilience and adaptation	**Asset management and engineering**	**Operational weather response**
Lead climate change adaptation policy	Lead asset management policy and strategy in line with climate adaptation and operational weather response policies	Lead operational weather response policy in line with climate change adaptation policy

Each **region** follows a similar structure, and these teams are responsible for developing local plans and delivering on the ground resilience.

The **Weather Risk Taskforce** gives overarching programme support for delivering independent and regulatory review recommendations and enhances collaboration across the organisation.

Hundreds of people and teams across Network Rail support the management of weather and climate resilience and **Figure 10** illustrates how it all links together. Further detail on the role of each workstream and the key responsibilities of the teams delivering them are outlined in **Table 2**.

Figure 10 – Overview of the management of weather and climate resilience in Network Rail

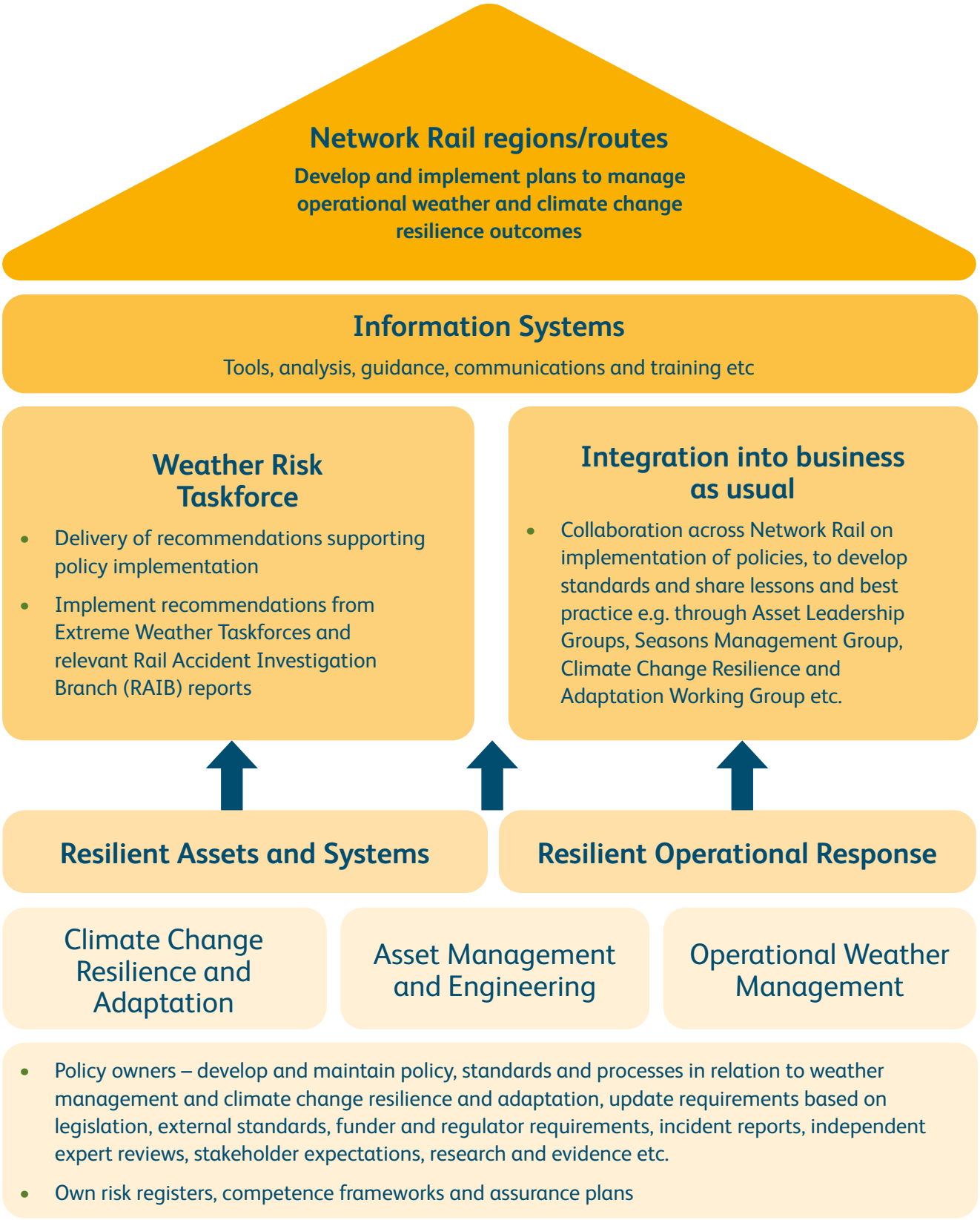


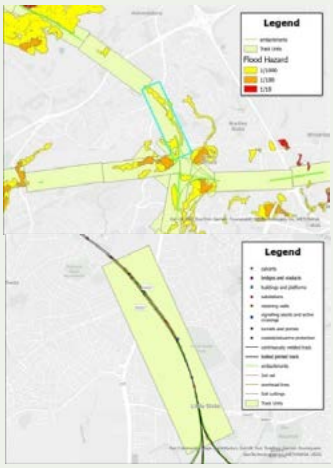
Table 2 – The role of weather and climate resilience workstreams

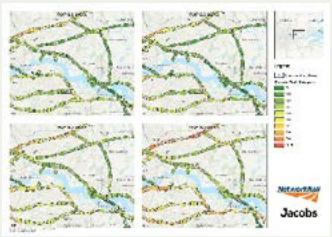
Workstream	Role
Climate Change Resilience and Adaptation	This workstream develops our network level strategic direction, policy and investment planning on weather and climate resilience. It is led by the ***Climate Change Resilience and Adaptation Team*** in ***SO's Industry Weather Response Directorate***. This team defines our vision, strategy and policy for the management of weather and climate resilience and is responsible for oversight and governance of the Adapt to a Changing Climate element of our Greener Railway Strategy. Delivery is through collaboration with the Region with close links to the TA's Environment and Sustainability team
Operational Weather Response	This entails developing network level standards, tools and programmes to support the smooth running of the railway in all seasons. It will be led by ***the National Weather Team*** in ***SO's Industry Weather Response Directorate***. This team is responsible for developing and assuring operational weather management standards and seasonal preparedness procedures and national management and reporting of weather-related incidents in line with national strategy and action plans. It works with the Emergency Planning and Business Continuity teams facilitating smooth incident preparedness and response
Asset Management and Engineering	This involves including weather and climate resilience in asset policies, standards and specifications, region and route asset management and capital delivery projects. This policy area is led by ***the TA's Chief Engineer's team***. The team define our asset strategies and policies for making our assets resilient to extreme weather and climate change. They set asset standards, component specifications and develop and implement plans to increase asset resilience delivering performance, safety, financial and reputational benefits considering the interdependencies between our assets and the wider railway system
Region and route delivery	The relevant weather and climate resilience-related functions across our regions and routes will use the key outputs resulting from the three core workstreams above to develop and implement plans to deliver weather and climate resilience outcomes at a local level. Long-term adaptation pathway strategies and investment plans will be developed for enhancing the resilience of their region and routes to identify key investment pathways and points of transformational change required
Weather Risk Taskforce	This programme delivery team leads transformational change delivering systems, tools, processes and training through implementation of the recommendations from the rainfall and heat Extreme Weather Taskforces and relevant RAIB reports (some actions are led by regional teams). The team is in the ***SO's Industry Weather Response Directorate***. Each region has a Single Point of Contact (SPoC) who is accountable for costing the programme, driving focus and delivery at a regional level and working with the WRTF

Case study 2: Adaptation pathways climate risk screening

In order to successfully design the adaptation pathways for their routes the regions need to be able to understand the risks associated with all of the assets along the whole of the operational railway that they manage. In 2024 the adaptation pathways climate risk screening tool was developed to start this process.

As a first step, a wide range of data sets was gathered to understand what the weather vulnerabilities of our assets are and what the nature of the current and future weather hazards are. This included our asset location data, weather data, climate change projections data, route criticality data, flood maps and our ICCRA.





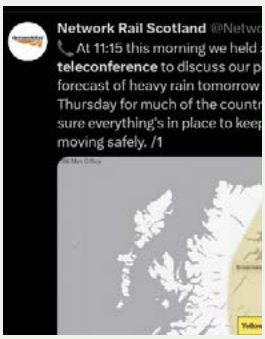
Using this data each of our 'point' assets (e.g. building, sub-station etc.) was given a risk score for each weather hazard and a combined risk score for all of its hazards, allowing them to be ranked. This data was then entered into a GIS tool and overlaid on a map of our network.

As our track is a continuous network, defining risk at a point location does not work, so the whole of our network was divided into sections 2km long and 500m wide, the method was then used to assign risk scores to each section.

As a last step these two risk datasets were combined so that regions could identify and prioritise both individual point asset risks, track risks for each section and the combined risk rating for all assets and risks associated with each track section.

The outputs are now being used by each region in their work to identify and prioritise route sections for adaptation pathways development.

Case study 3: Scotland's Railway – WODMs increasing adaptive capacity



Scotland's Railway was the first Network Rail region to recruit and deploy Weather Operations Delivery Managers (WODMs).

Based in the Weather Operations Team they are weather specialists who bring a background in meteorology to railway operations. They work 24 hours a day on rotating shifts every day of the year to ensure continuous coverage.

Their job is to monitor current and forecasts of weather conditions and give live weather analysis to key business communities across the region's operations, including control and engineering teams.

This bespoke up to the minute analysis is then integrated into the planning and delivery of their responses to extreme and adverse weather. For example, WODMs can advise on the location of emergency speed restrictions that can be triggered by forecast extreme weather events.

Purpose and definitions

Introduction

Managing weather and climate impacts update

Understanding risks and challenges

Our adaptation action plans

Monitoring and reporting

Concluding remarks

Appendices

4

Given the range and level of risks that a railway faces daily we have a robust corporate risk assessment and management system. Within this we have a specific Weather and Climate Change Enterprise Risk Register and a detailed Integrated Climate Change Risk Assessment (ICCRA) dedicated to understanding and managing current and future weather event risks that can impact our operations and the part that these play in the reliable and sustainable running of the railway.

Even with our past weather and climate resilience work, the risk of weather-related impacts is an ever-present challenge that continues to worsen with climate change as outlined in **Section 2.2**. To keep up with how the changes in our weather risks affect us, and to be best able to deal with them and plan for the future impacts, we need to continually develop our risk understanding and response. Improvement and update of our risk assessment is a continual process. The sections below outline the work done in this area since the last Adaptation Report.

4.1 Our Integrated Climate Change Risk Assessment

Our ICCRA is an asset-based risk assessment first created in 2018/19 with updates in 2020 and 2021 to increase its asset function and region coverage. The 2021 update saw its format aligned with the agreed transport sector template for publication alongside our ARP3 Report.

A notable difference between our ICCRA and the Defra ARP4 risk assessment guidance is between the climate scenarios we use and those recommended (Table 3). The rail industry has agreed to the standardised use of selected climate change scenarios to ensure consistency between organisations and facilitate information sharing. Further detail on these scenarios is available on the **RSSB website**. While they do not cover the lower level of changes that would be experienced under categories two and three of the ARP4 guidance they do exceed them and meet the fourth category, therefore delivering an equal or higher level of resilience for the railway.

Table 3 – ARP4 climate scenario guidance versus rail industry agreed scenarios

ARP4 scenario guidance	Network Rail scenarios[3]
1: Present-day (present to 2030) Historic trends, existing data and near-term projections to 2030	Historic trends, existing data
2: Mid-century by 2050 (2040 – 2060), a 2˚C rise 10th – 90th percentiles for chosen pathway e.g. RCP2.6	2050s RCP6.0 90th percentile, a 2.5˚C rise
3: End of century by 2100 (2080 – 2100), a 2˚C rise A 2˚C rise by 2100 or a pathway consistent with this – such as RCP2.6 or SSP1-2.6	N/A
4: End of century by 2100 (2080 – 2100), a 4˚C rise A 4˚C rise by 2100 or a pathway consistent with this such as RCP 6.0, RCP8.5 or SSP5-8.5 or SSP3-7.0	2080s RCP6.0 90th percentile, a 4˚C rise

Full details of our corporate risk management process and the creation and evolution of our risk assessment can be found in Section 5 of our **ARP3 Report**.

[3] Temperature Projections based on: **UK Climate Risk Independent Assessment (CCRA3) – Technical Report Chapter 1: Latest Scientific Evidence for Observed and Projected Climate Change**

4.1.1 ICCRA update for ARP4

Since our ARP3 Report we have identified further improvements to our ICCRA including the asset coverage, the risk scoring granularity, the standardisation of terminology and the analysis that we could carry out on the content. Work in 2023 and early 2024 improved the asset coverage and increased the risk scoring granularity through two parallel activities:

- new national level asset function risk assessments. A telecoms assessment is complete, with new risk lines added to the ICCRA and a buildings and structures assessment is ongoing,
- generation of region-specific scores for lines in the ARP3 ICCRA with a current or future score of eight or above. This balanced capturing value for high level risks with the effort of a full review, new columns accommodate the results. NOTE: with the exception of Scotland's Railway (see below) scores were not included for telecoms or buildings and structures.

The updated ICCRA was released in June 2024 and a second phase of work was started to address the increasing complexity and variation in content that these and the past incremental updates have introduced. The biggest issues include:

- increasing variation in the descriptions/names used to classify weather drivers,
- inconsistencies in the naming of assets and the hierarchy used,
- multiple risk assessment baselines,
- data and data entry formats hindering analysis,
- increasing number of columns and data duplication.

In August and September 2024 an ICCRA Review and Update Project addressed these issues. The first task streamlined and standardised the weather driver categories and the asset classifications.

For the weather drivers we have:

- moved from a combined climate driver/weather driver column, which used 48 categories, many of which overlapped or tried to capture combination events, which the original assessment was not designed to do e.g. 'long hot dry summer as a proxy for drought',
- to five risk categories (climatological, environmental, geophysical, hydrological and meteorological) which can be assigned a climate variable, a weather driver, and a hazard. The number of weather drivers has been reduced to 21. Definitions are given in **Table 4** below.

Table 4 – ICCRA risk category definitions

Risk category	Definition	Risk drivers covered
Climatological	Impacts from prolonged weather events	Droughts, heatwaves and wildfire
Environmental	Impacts from vegetation responses	Vegetation growth, tree fall, leaf fall
Geophysical	Impacts on natural ground or built geophysical assets	Coastal erosion, scour, solid mass movements (ground instability/ landslide), high/low soil moisture
Hydrological	Impacts from water masses	Sea level rise, storm surges, coastal and non-coastal flooding
Meteorological	Direct risks from day-to-day weather	High/low temperatures and ranges, snow, ice, high winds, lightning, fog, rainfall, humidity, lightning, sun glare

For the asset categories we have moved:

- from two columns assigning 32 fixed asset function selections from a dropdown menu and a free text asset description with 269 bespoke definitions to date, many of which were not aligned with the Network Rail Asset Accountability Matrix,
- to four columns mapped to the first four layers of the Asset Accountability Matrix using pre-defined dropdown menus. While this has increased the number of asset categories to 504, it ensures that they are all consistently used and comparable across entries.

Other actions have removed the multiple baselines, improved the risk definitions, removed duplicate data and unnecessary columns, added impact and likelihood columns and split the risk score and risk ratings (e.g. 6/Moderate) in the risk scoring sections to aid analysis.

While we have seen more use of the ICCRA across the business, as it has improved we were conscious that we had not updated our analysis of its content. We took this opportunity to add an analysis tab with various predefined reporting tables allowing users to extract analysed data.

The updated version of our ICCRA issued after this project (Issue 4 December 2024) was used to give the analysis results discussed below. A copy can be found **on our website**.

4.1.2 Updated risk analysis

For our ARP3 Report we used the version of our ICCRA available at the time to identify our key risks (current risk score of eight and above) and attribute them to four high-level weather categories. We then discussed how these impacted our assets and operations and the effects that we expect a changing climate to have. In this section, we have used the updates to our ICCRA as an opportunity to dig deeper into the data and better understand the distribution of the risks across the impact drivers and our asset functions.

Although we will not revisit most of the risk analysis work in our ARP3 Report, we have reanalysed the risk attribution work to account for the revisions to our approach to the classification of weather and climate risks.

As can be seen in Table 5 and **Figure 11** the majority of our risks are meteorological with high/low temperatures and precipitation events being the biggest individual contributors. The meteorological (other) category is a combination of fog, lightning, high winds/storms and sun glare.

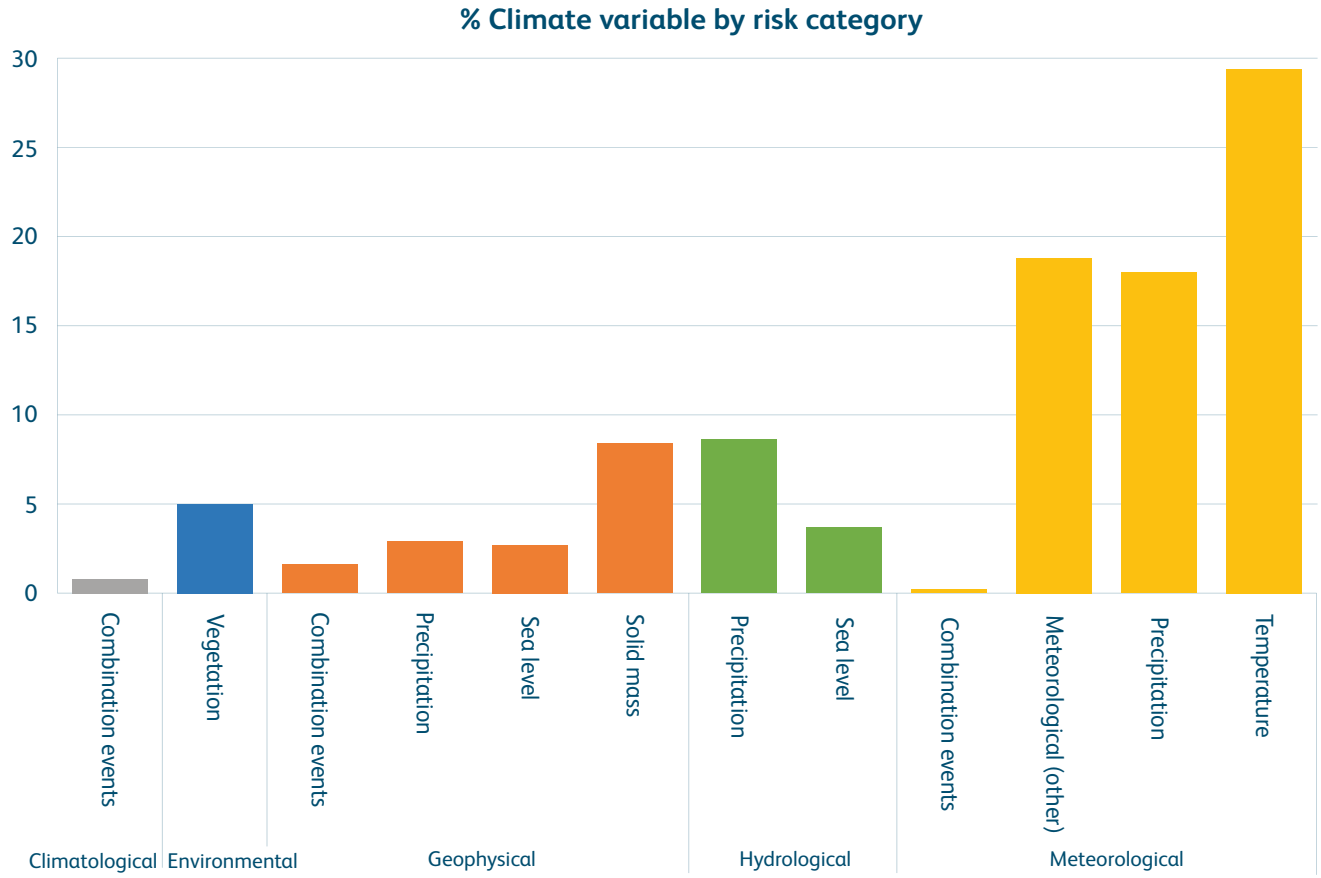
The geophysical and hydrological categories cover most of the remaining risks with the largest climate drivers being sea level rise and precipitation, either directly or through effects on earthworks (solid mass) for the geophysical risks.

Although the environmental category is only a minor percentage of the total risks its vegetation climate driver accounts for a higher number of risks than several other variables.

Table 5 – Spread of risk category and weather drivers

Risk category	Category %	Climate variable	Variable %
Climatological	0.8	Combination events	0.8
Environment	5.0	Vegetation	5.0
Geophysical	15.5	Combination events	1.6
		Precipitation	2.9
		Sea level	2.7
		Solid mass	8.4
Hydrological	12.3	Precipitation	8.6
		Sea level	3.7
Meteorological	66.4	Combination events	0.2
		Meteorological (other)	18.8
		Precipitation	18.0
		Temperature	29.4

Figure 11 – Number of risks by risk category and climate variable

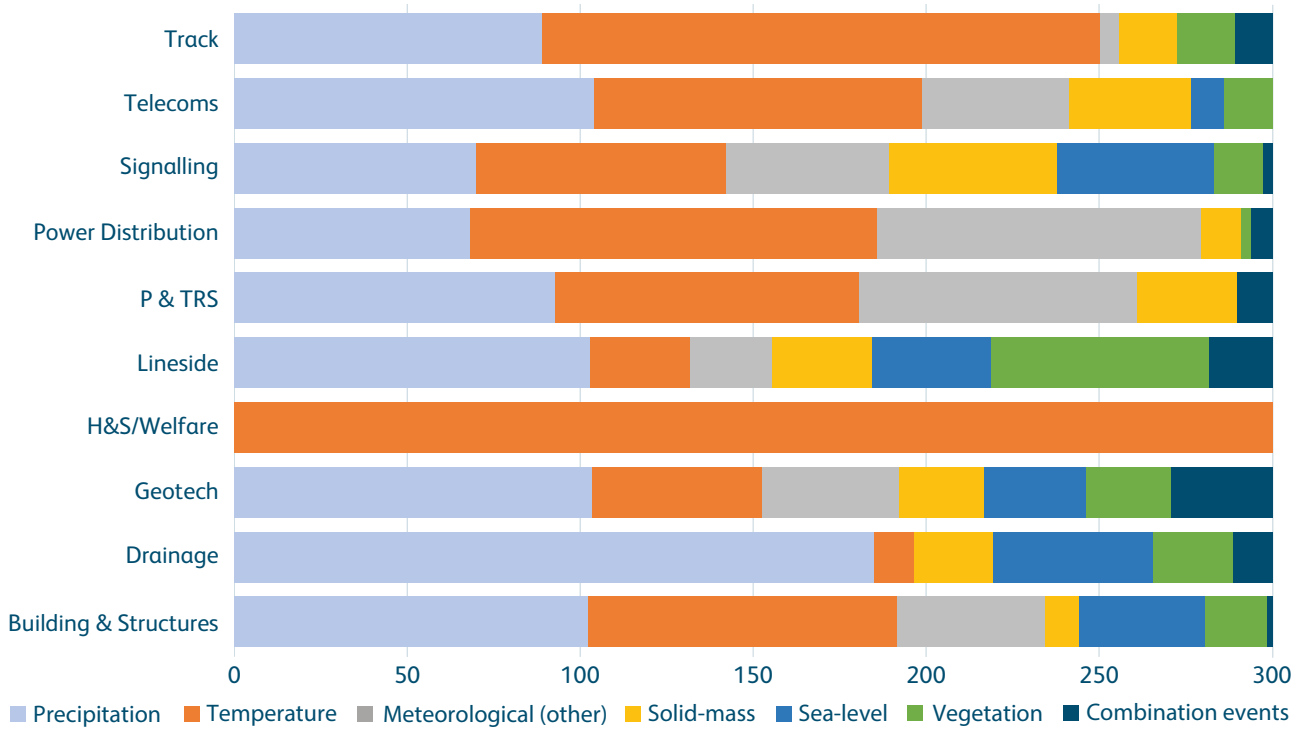


Examining how the climate drivers relate to the top asset classification level in the risk assessment we can see that for most asset functions the precipitation, temperature and meteorological (other) risk categories make up the lion's share of the risk profile (**Figure 12**). While this informs our wider understanding of the risk categories that we should use in developing our adaptation responses, there are key variations that need to be factored into detailed planning:

- track – while precipitation is important, temperature impacts are the dominant contributor. meteorological (other) makes little contribution,
- drainage – the reverse is true with sea level impacts also needing consideration,
- geotech and lineside show a more mixed pattern with all categories needing attention,
- lineside is the only function that sees a significant contribution from vegetation drivers,
- whilst not major individual contributors for many functions the other climate variables need to be taken into account on a function by function and location-specific basis.

Health and safety/welfare appears to be the largest departure from the general pattern of weather driver distribution with 100 % of its risks from temperature, but it is not yet formally included in our ICCRA and the data is only based on five risks. This category will not be considered further in this analysis, future updates will address this.

Figure 12 – Percentage of climate variable risks by asset function

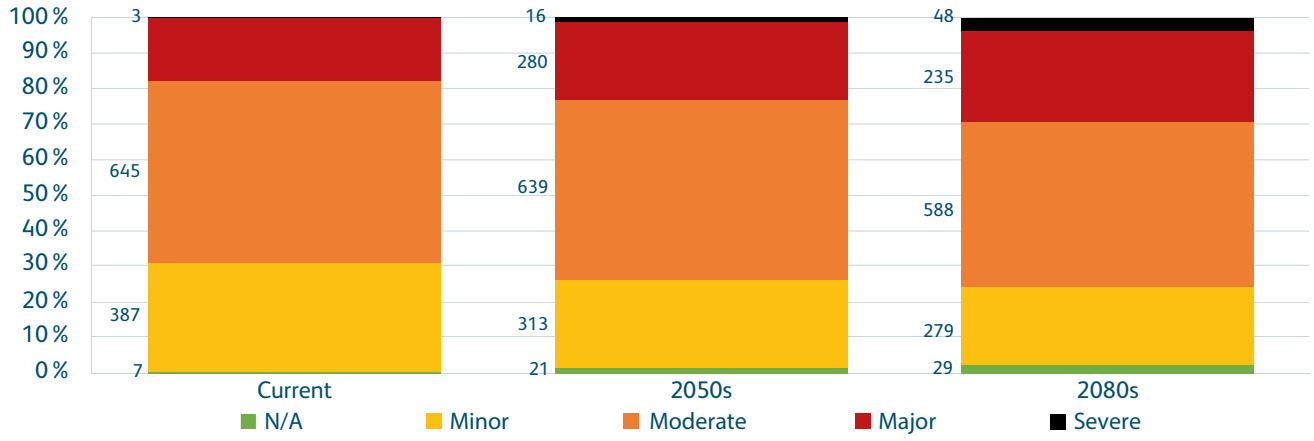


For all three time slices of our ICCRA the spread of risk covers all categories in our corporate risk matrix, ranging from minor to severe. There is a clear trend for risks to shift up the scale with the number of minor risks decreasing by nearly a third by the 2080s. Moderate risks also decrease, by nearly 10 % as the number of risks shifting to higher categories outweighs those moving up from the minor category. Significant increases are seen in major risks, over 40 %, and severe risks, which increase from three to 48.

A N/A category exists to include risks that have been identified and assessed, but which do not have enough impact to warrant a score because a) the asset resilience outweighs the weather impact in/up to that time period or b) existing asset management policies, strategies and plans will remove the risk. Further detail is in the asset function risk analysis below.

These general trends highlight the need behind our drive to incorporate climate change adaptation into our asset management processes. Showing not only the increasing urgency, but that the right strategies and actions can significantly reduce the risks that they target.

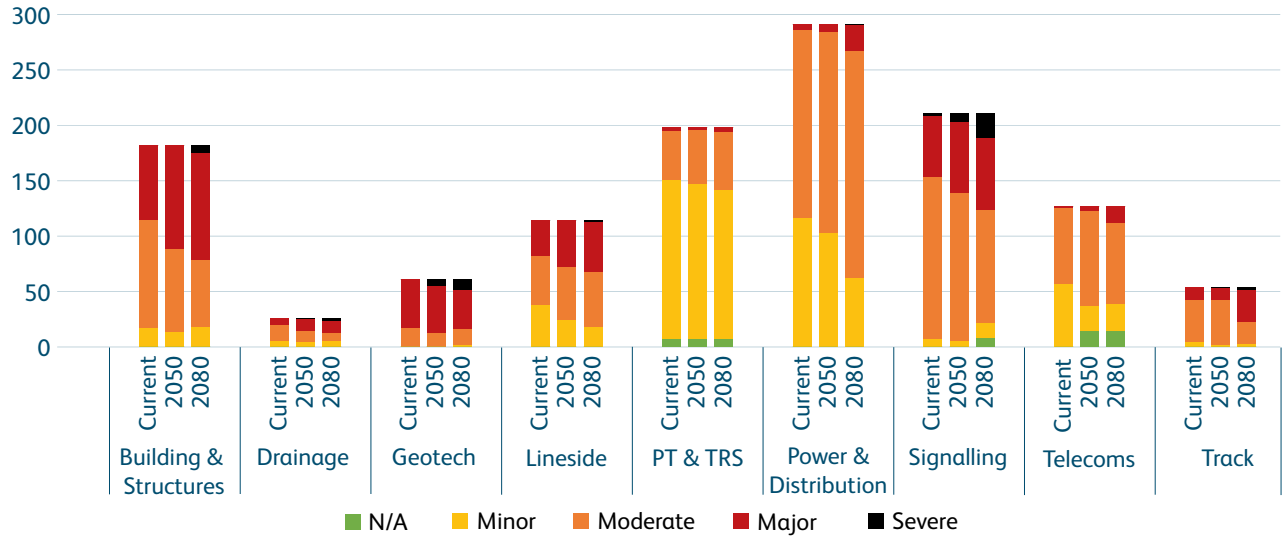
Figure 13 – Percentage of risk score categories over time



This information on the general scale of the risks we face, their attribution to climate drivers and the general trend in risk scores is helpful in informing our polices and high-level strategies. However, a deeper analysis of the data by asset function shows that the proportion of the risks affecting each function and the pattern of how their severity changes is not uniform (Figure 14).

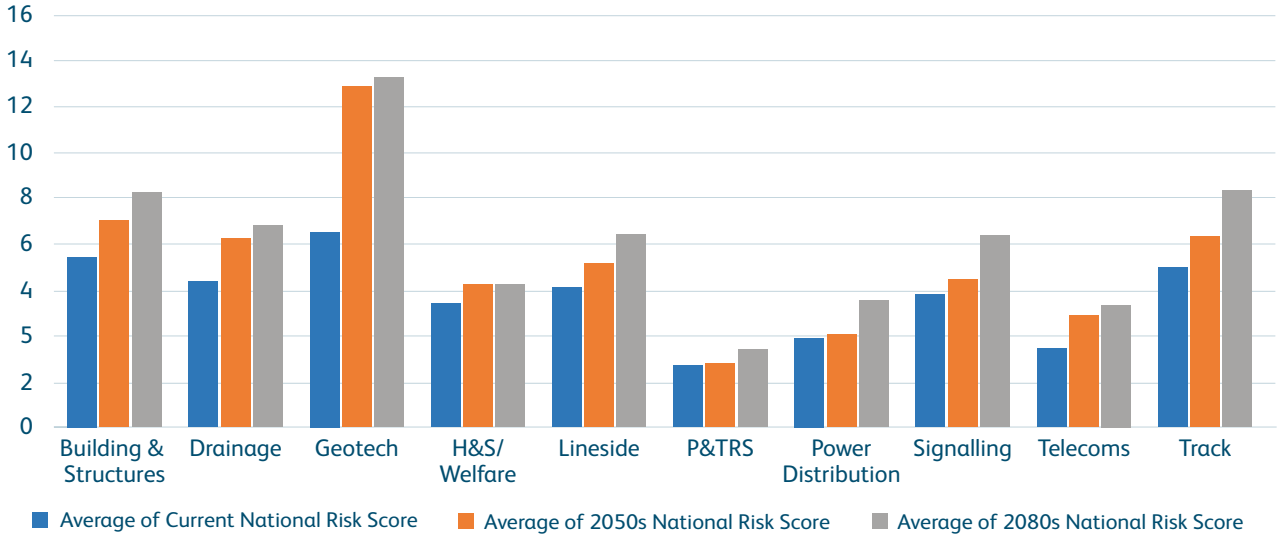
While the power and distribution and PT & RS asset functions have significant numbers of risks this is due to the size of their asset hierarchies and the granularity of their risk assessments compared to other asset functions. The major and severe risks are largely associated with the buildings and structures, signalling, geotech and lineside asset functions.

Figure 14 – Change in risk score profile over time by asset function



The fact that this figure shows that the drainage and track asset functions appear to have relatively low numbers of risks and few severe and major risks seems at odds with our daily operational experience. Looking at the average risk score for each asset function (Figure 15) shows, however that although few in number, their risks are very significant, placing them in our top four most 'at risk' asset functions: 1) geotech, 2) track, 3) buildings and structures, 4) drainage and joint 5) lineside and signalling.

Figure 15 – Change in average risk score by asset function



A limitation to this analysis is that it doesn't currently consider the scale of the impact that each risk has on our assets across the operational network and the effects on our services (train performance etc.). As discussed in **Section 2.2** our weather-related delay minutes and S8 cost data analysis shows that our biggest impacts are currently from wind, flooding, snow, adhesion and subsidence, with increasing trends for flooding, heat and subsidence impacts. Taking this into account reinforces the message from our ARP3 Report that, whilst all asset functions face increasing challenges from all categories of risk, our current focus needs to be on:

precipitation impacts on drainage and buildings and structures with a secondary focus on track, lineside, signalling and telecoms,

precipitation/temperature impacts (subsidence, landslide, shrink/heave) on geotech with a secondary focus on assets on/in/near them, e.g. track, telecoms, signalling and power distribution,

temperature impacts on track, buildings and structures, power distribution and signalling with a secondary focus on lineside and telecoms,

wind impacts on vegetation and power distribution with a secondary focus on buildings and structures,

sea level impacts from flooding and erosion as this can be highly impactful at key locations.

The information from this analysis is used to inform the weather and climate change resilience strategies and action planning discussed in this report and we will keep refining our risk assessment and how we use its data with other data sets to gain more insight. Key improvements that we plan to explore are:

- improved inclusion of the buildings asset structures,
- inclusion of new risk assessments for additional business units such as health and safety,
- a method for accounting for combination weather events.

4.1.3 Using the risk assessment

Across CP6 and into this first year of CP7 we have seen increasing use of our ICCRA to help inform the development of weather and climate change related strategies and plans and activities designed to increase our adaptive capacity. Some key uses include:

CP7 Region WRCCA Plans – While creating these plans, the regions reviewed the ICCRA to identify region-specific risk scores as mentioned in **Section 4.1.1**. The review outputs were used to update the ICCRA creating the current version and this, along with their analysis of the findings, was used to inform the development of the plans and their actions.

WRCCA Vulnerability and Criticality Mapping Project – This ran from March 2022 to March 2024 developing a methodology for assessing and mapping our assets and network vulnerability to weather and climate change risks and impacts. It used the ICCRA to identify the relevant climate hazards and the 'current' risk scoring as a measure of asset vulnerability. It also informed the risk scoring matrix that was developed. Detail on the project outputs can be found in **Section 5.1**.

Climate change risk screening for adaptation pathways – Between November 2023 and August 2024 this project developed a prioritised assessment of the climate risks to every 2km length of our network for use in informing our adaptation pathways work. It used our ICCRA to identify the climate variables to include in the assessment, identify the asset vulnerabilities and to feed into the climate risk scoring. Further detail can be found in **Section 5.1**.

RS WRCCA plan and site risk assessments – In 2024, our national RS function began developing their weather and climate change adaptation plan and a methodology to assess weather and climate risks to their sites. The ICCRA is informing this process. Further detail is in **Section 5.1**.

Asset Management standards update – In 2024, we have started the process necessary to incorporate climate change consideration into our design standards. Key first steps are the identification of standards in need of update and their prioritisation. ICCRA issue 4 is being used to inform these steps. Further detail is in **Section 5.1**.

4.2 Interdependent and cascading risks

In our ARP3 Report we gave a high-level summary of our work to identify and prioritise our interdependencies (see ARP3 Section 6). We noted that there was still a lot to be done in this area and an action was set to extend our understanding by carrying out research and a risk assessment so that we could start to identify management actions.

Collaboration has continued in this area with TfL, National Highways, HS2, HS1 and Defra and, in 2023, TfL led a collaborative project – 'Climate Change and Interdependency Risks for London's Land-Based Transport Sector'. We were an active partner in developing the scope and the delivery of the project.

A systems mapping approach using a wide range of interdependent organisations was coupled with a climate risk assessment based on the rail sector climate change planning scenarios. This identified, mapped and prioritised the interdependencies that could affect the London land-based transport sector (LBTS) (impacts from the sector were not included in the scope). It identified 114 climate interdependency risks each with their bespoke impacts on the LBTS. Analysis showed that these come from 10 key organisational interdependencies illustrated in **Figure 16** and that:

- the key climate hazards were mostly associated with issues of increased high temperatures, sea level rise, winds and too much or too little water causing flooding, wildfires, ground movements and asset failures,
- the key dependencies are power, drainage and flood management, telecoms, structures assets (e.g. bridges), vegetation and banks and slopes.

The relationships between the hazards and the interdependencies, the risk trajectories that they follow and the organisations associated with them are summarised in **Figure 17**. The full report can be found on the **TfL website**.

Figure 16 – Key organisational interfaces

	Organisational interface	Description and assets included	Asset owners
	**Power grid resilience**	The capacity of the power grid as a whole and its resilience to changes in demand	National Grid
	**Power network – linear infrastructure**	The resilience of linear assets such as pylons and overhead power lines primarily within the transmission network	National Grid
	**Power network – substation assets and cables**	The resilience of substation assets and underground cables within both the distribution and transmission network	National Grid and UK Power Networks
	**Telecoms network**	The resilience of telecoms assets such as masts, cables, street cabinets, exchange centres and data centres	Multiple external providers, including; BT, Sky, Motorola, EE, Nokia, Vodafone
	**Civil structures**	The integrity of civil structures in close proximity to LBTS assets which are maintained by other landowners e.g. bridges, tunnels	Primarily Boroughs but also other private landowners
	**Pipe bursts**	The resilience of water company pipe assets which are in proximity to LBTS infrastructure	Thames Water and Affinity Water
	**Urban drainage system and combined network**	The capacity of the urban drainage system and the combined network maintained by other landowners	All owners of drainage assets including; Boroughs, Thames Water, private landowners
	**Vegetation and green infrastructure**	The management of lineside and roadside vegetation in close proximity to LBTS assets maintained by other landowners	Any landowners responsible for maintaining green infrastructure; Boroughs, GLA, private landowners, Environment Agency (EA)
	**Banksides and slopes**	The management of land maintained by other landowners near to rail or road infrastructure where there is potential for landslides	Private landowners, EA, Boroughs
	**FRM assets**	The resilience of flood risk management (FRM) assets such as the Thames Barrier and upstream flood defences	EA

- Infrastructure interfaces
- Environmental interfaces

Figure 17 – Summary of the project findings

		Present	2050s	2080s	
Surface water flooding	Caused by extreme rainfall/storm events and overwhelmed **urban drainage** systems. Impacting on rail and road assets as well as further cascading impacts as a result of damage to **telecoms assets, power substation assets** and **civil structures**.				
High temperatures and heatwaves	Placing strain on **power grid capacity** as well as on power sector assets such as **substations, linear assets** (e.g. overhead power lines) and **telecoms assets**. Cascading impacts to power supply for rail and road assets including disruption to comms.				
High winds and storms	As a result of increased storminess impacting directly on (**linear assets** – such as overhead power lines and pylons) within the power sector and **telecoms assets** (cables, masts etc). Exacerbated by indirect impacts from **vegetation growth**. Cascading impacts to power supply for rail and road assets and disruption to comms.				
Fluvial flooding	Caused by high rainfall and in some cases, overtopping of **FRM assets**. Impacting on road and rail assets as well as **civil structures**, **telecoms assets** and **power substation assets**.				
Tidal flooding	Caused by storm surges/extreme tides and sea level rise and overtopping of **FRM assets** such as the Thames Barrier. Impacting on rail and road assets as well as further cascading impacts as a result of damage to power **substation assets** and **civil structures**.				
Ground movement (e.g. subsidence)	Caused by temperature and soil moisture variation damaging **pipes** and **substation assets and cables**. Cascading impacts to water and power supply for rail and road assets.				
Landslides	Caused by heavy rainfall or drought impacting on **banksides and slopes** managed by other landowners. Cascading impacts to rail and road assets.				
Drought and wildfires	Drought leading to vegetation die-off and increased wildfire risk. Direct impacts to **vegetation and green infrastructure** and indirect impacts to **urban drainage systems** and **substation assets**.				

- Infrastructure interfaces
- Environmental interfaces

Number of Risks rated major or severe

0	1-4	5-8	9-12	13+

Several of the issues and their risks above are noted as co-dependencies, notably:

- vegetation management is carried out by land-based transport organisations and other stakeholders in close proximity e.g., removal of vegetation for track safety may expose a power sector asset or tree trimming for overhead lines may expose track to higher solar gain,
- management of/damage to civil infrastructure such as bridges, pipes and cables. A pipe break may damage a transport system embankment, or an embankment slip may damage a pipe,
- drainage management. LBTS and other people's drainage systems are often connected. Both systems need to be properly sized and maintained.

The findings were used to co-create a prioritised action plan with the stakeholders, which contains 52 actions to reduce the risk from the key organisation interfaces. It aims to deliver actions that reduce the impacts of interdependencies and reduce duplication of stakeholder effort. The actions are categorised as high priority/short-term (in one year), medium-term (two to four years) and longer-term (five or more years). Cost-benefit analysis has not been done and they are not in the funded business plan. One action attributed to Network Rail for delivery by the end of May 2025 is:

- short-term – Ensure the outputs of Network Rail research into landslide and embankment failure are shared with other asset owners to inform their own risk and adaptation measures.

As London's transport system includes rail, we were heavily involved, the risk assessment process is aligned with ours, and many of the findings and actions will be applicable to our network and operations. However the viewpoint from which the interdependencies were identified and scored is specific to TfL for the London LBTS. As there may be differences in our organisational experiences and needs we need to review the project method and outputs to identify and remedy these before we can confidently apply the conclusions to our organisation.

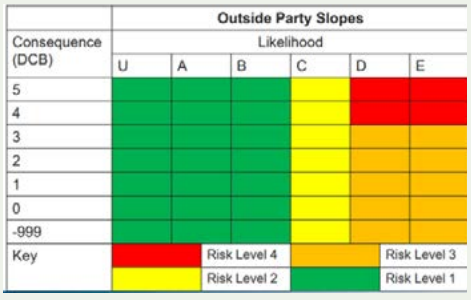
Case study 4: Wessex route – Outside party slope hazard assessments

This route and the South East route have significant areas of third-party earthworks and natural slopes alongside their lines including steep coastal slopes. These combined with soft cohesive soils mean that the railway could be at risk from their failure.

Since 2022 a project has been run to review outside party natural slopes and coastal cliffs adjacent to the Network Rail boundary, where failure could pose a risk to the safe operation or performance of the railway infrastructure. This desk-based process used data from a 2017 British Geological Survey project, which quantified hazard susceptibility from natural slopes starting within 50m of the Network Rail boundary. This included a Classification of Hazards on Outside Party Slopes' (CHOPS) consisting of seven developed failure models: 1. debris flow hazard; 2. earth flow hazard; 3. rock fall hazard; 4. Geosure Slope Instability (landslides); 5. National Landslide Database; 6. Network Rail CIV185 data using Network Rail's database for earthwork; 7. DiGMap50 showing locations where geologically mapped mass movement deposits are.

2490 slope hazards have been assessed over the last two years and a review focused on CHOPS D and E rated sites has led to 299 of the sites identified for a site visit in CP7.

This work will continue into CP7 with all sites with a review score of 100 or over being progressed to site based assessment.



Case study 5: South East route – Tonbridge to Hastings Undrained Earthwork and Modernisation Programme and Engineering Research (THUMPER)

The Tonbridge to Hastings line began construction in 1844, so its earthworks are now 180 years old and well past their design lives. In the last 20 years 57 of the 437 earthworks failures in the region occurred on this line, six times the regional average.

To better understand the failures and to improve prediction and response they have carried out a forensic analysis of the earthworks on the line. They captured historical datasets, maintenance records, ground investigation data and LiDAR to increase their knowledge of the earthworks. The high-quality LiDAR on its own identified 441 previously un-recorded earthwork failures or past remedial works.

A geodatabase was established to record key data for each failure including adjacent slope aspect, drainage, slope angle and other attributes to characterise each earthwork and failure, and slope stability models were also created in GeoStudio Slope/W. The data was analysed by date of record, location, geology, geometry, age of construction and condition and a GIS based digital twin was built. This analysis informs the risk categorisation of earthworks and identifies hot spots of potential failure.

In tandem a wide variety of novel instrumentation and non-intrusive techniques have been trialled on cuttings at the Bluebell Railway (a preserved railway line in Sussex). Through 2024/25 these will give data not normally collected for rail earthworks and decisions will be made over whether they could replace, or supplement existing approaches.

The THUMPER approach will inform the Southern region earthworks assessment methodology, aligned to the processes described in Network Rail Assessment Standard (NR/CIV/086 Mod 2). Further details can be found in a paper presented to the XVIII European Conference on Soil Mechanics and Geotechnical Engineering 2024.

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The impact of climate change on our operations is becoming increasingly evident and adaptation planning and delivery continues to gain importance in our business planning process. This has enabled us to deliver considerable progress against our ARP3 Report actions and in the planning of CP7 actions as outlined below.

5.1 ARP3 Report action plan delivery

In our ARP3 Report we set out a programme of actions that we intended to deliver between 2021 and 2030 to create a framework for sustainable and appropriate adaptation action. This was a blend of asset interventions to improve resilience and enabling actions to build adaptive capacity, improve knowledge and improve processes and decision making.

The last three years have greatly increased our climate change knowledge and seen good progress in embedding climate change consideration into key processes. This has led to the successful delivery of many of the actions that we set out in our ARP3 Report and good progress against others, bearing in mind the reduced timescale of this report. It has also seen refocussing of some of our priorities leading to some actions being removed or delayed and the creation and delivery of new actions not included in our ARP3 Report. **Table 6** below summarises the progress made against our ARP3 Report actions and provides delivery highlights.

Case study 6: Anglian route – Bacton toe drainage

Flow from this culvert in extreme weather events has caused flooding at the toe of our embankment for several years. This also affects the adjacent playing field with local residents and the council becoming involved.

The Maintenance Delivery Unit team began work to address this in late 2021, but the risk of slope failures on the steep embankment meant that a full drainage design and mitigation plan became necessary.

A £125,000 scheme was designed to give flood protection for our embankment and the playing field with work being carried out from December 2021 to January 2022. This renewed the toe drainage run connecting the culvert to an existing drainage system with toe support being factored into the design to stabilise the earthwork. Work was also required by the local authority to clear a section of water course on the playing field, which serves as the outfall.

Since delivery the installation has been regularly inspected and maintained as per the standard and no further issues have been reported.

Catchpit and pipe runs and final re-instatement

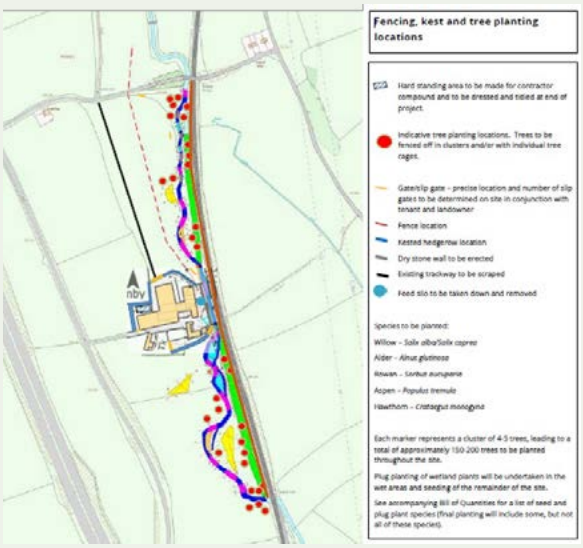
After photo August 2022

Case study 7: North West & Central – River Leith scour

Near Thrimby in Cumbria a section of the busy West Coast main line had been identified as at high risk of scour from a section of the River Leith that ran directly alongside it. Historical straightening and rerouting of the river meant that high flows due to heavy rainfall threatened to erode the railway and cause flooding in the surrounding area.

The River Leith is in the Eden Special Area of Conservation, protected due to its important habitats, birds and species such as the otter, so any work to remove the scour risk needed to be carried out sensitively. The solution was to recreate the river's original natural meandering course.

In 2020, a £200,000 scheme was co-funded by Network Rail and the EA and developed and delivered in partnership with the Eden Rivers Trust (part of the Cumbria River Restoration Strategy partnership). This has improved the resilience of our railway by moving the scour threat away from the line and it has delivered flood resilience by reconnecting six hectares of floodplain and creating an additional 0.2 hectares of floodplain storage as wetland scrapes.



This section of river is now 33 % longer and has a more natural course with variations in flow speeds and habitats that will protect downstream communities and will boost the biodiversity. This was the first long bedrock channel creation project in the UK.

All images courtesy of and © the Eden Rivers Trust

The images below were retrieved by the Eden Rivers Trust from BING satellite imagery.

Table 6 – ARP3 actions progress summary

Action	Owner	Target date	Status
Strategies and programmes			
Update WRCCA Strategic Framework	TA WRCCA Strategy Manager	2022	**Complete –** The past three years has seen a significant shift in the way Network Rail manages weather and climate change (see **Section 3**). The Strategic Framework has morphed into the 'Adapt to a Changing Climate' theme within Network Rail's Greener Strategy, which was published in Autumn 2024
Update WRCCA Policy	TA Chief Environment & Sustainability Officer	2022 Reforecast 2026	**Outstanding –** The WRCCA policy sits within the wider Environment and Sustainability policy, the update of which has been delayed due to organisational changes. This will now be updated in 2025 after a refresh of the Environment and Sustainability strategy. We are now considering the need for a standalone weather and climate change standard, which may take the form of a policy and will give the business the best solution to support their work going forward – this will be developed in consultation with internal stakeholders
Publish CP7 Business Plans	Chief Executive	2024	**Complete –** Our business planning round for CP7 (2024 – 2029) saw weather and climate resilience thinking woven into the requirements of the process with two key advances being: • the development of a methodology for assessing, tracking and reporting the level of resilience benefit from asset investments, • CP7 Region WRCCA Plans were part of the Delivery Plan submitted to ORR and published alongside it, raising their importance. Published on 3 April 2024 and delivery has started. See **Our CP7 delivery plans – Network Rail**
Develop regional adaptation pathway strategies and investment plans	Regional Directors for Engineering and Asset Management	2029	**In progress –** Developing long-term adaptation pathways strategies in our regions is one of our flagship projects over the next five years. Funding has been secured for strategy development during CP7. This will be based on the **Adaptation Pathways Methodology guidance note** issued in August 2024, and the results of a pilot by our Southern region to test the approach and applicability for the railway. A working group has been established and each region has begun project delivery. The first adaptation pathways strategies based on high priority locations are due by the end of CP7 in March 2029

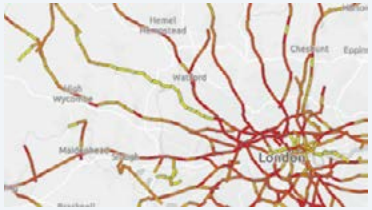
Action	Owner	Target date	Status
Implement Weather Risk Taskforce programme	Weather Risk Taskforce Programme Manager	2024 and beyond	**In progress –** The WRTF action plan has continued apace with 75 % of the actions now delivered. We have enhanced our operational weather response and planning by: • improving our weather forecasting, • developing and embedding 'best in class' decision making tools like the Convective Alerting Tool convective rainfall event forecast response and PRIMA and GUSTO enabling more proportionate operational responses to extreme rainfall and wind forecasts (see case study 10 for more detail), • increasing the number of people we have working on drainage inspection and maintenance in all of our regions, • the creation of the Weather Academy, which has so far given weather and climate change related training to over 400 colleagues. Further training is also available for the drainage and lineside community on managing water risk
Deliver Seasonal Weather Management Strategy	Seasonal Challenge Steering Group	2030	Through the Seasonal Weather Management Strategy we have developed and implemented GB Rail Industry Approach Documents for managing adhesion, hot weather and cold weather seasonal preparedness. These offer assurance against mandatory control measures outlined in standards. Assessment of our weather resilience management through the ORR Risk Management Maturity process has shown that we have good support from senior leadership, which is helping to improve maturity. We have used innovative technologies to improve our processes and we keep delivering on the recommendations from the Carmont and Salisbury reviews
Develop leading resilience metric	TA WRCCA Strategy Manager	2022 and beyond Reforecast 2029	**Outstanding –** This is a complex task that has been delayed due to resource constraints. Work is planned over the course of CP7

Action	Owner	Target date	Status
Risk management and action plans			
Deliver Asset Management WRCCA Plan	Chief Engineer	2024 and beyond	The actions around delivery of the Asset Management WRCCA Plan and development of Asset Function Resilience Strategies have changed focus over the past few years due to the emphasis on delivery of the recommendations from Carmont through the WRTF and updates to asset standards. Work is now focussed on updating asset standards (see below) and delivery of work through the WRTF
Develop and deliver Asset Function Resilience Strategies	Chief Engineer through asset leadership teams	2024 (develop) Delivery ongoing	
Deliver Route CP6 WRCCA Plans	Regional Directors for Engineering and Asset Management	2024	**Complete –** Due to the timing of the third Adaptation Reporting round our ARP3 Report covered the first two years of these plans. In their five years of delivery a total of 240 actions were undertaken covering investment in: • asset interventions to address rainfall and flooding, high and low temperatures, wind and desiccation, • asset monitoring though Remote Condition Monitoring installation and enhanced asset inspections, • knowledge generation through asset inventory improvements, risk assessment, site investigation, research projects and placements, • adaptive capacity including improving processes and polices and developing resources by recruitment and competency development. At the end of CP6 77 % of the actions had been completed and a further 11 % were partially completed. The remaining difference is accounted for by schemes that have been deferred to CP7. This was achieved alongside delivering additional actions arising after the publication of the plans, particularly those associated with the WRTF in response to Carmont and the independent weather resilience reviews. Additional detail can be found in the case studies throughout this report and in the CP6 review sections of the new **CP7 Region WRCCA Plans**

Action	Owner	Target date	Status
Develop and deliver Region CP7 WRCCA Plans	Regional Directors for Engineering and Asset Management	2024 (develop) 2029 (deliver)	**Development complete –** These were developed as part of our CP7 business planning process and published as part of our Business Plan in April 2024. They focus on improving our resilience to extreme weather and minimising its impact on performance and safety and the delivery of a sustainable railway by improving our resilience planning and delivery. The plans, and a national summary, are available from our website at **Climate change adaptation – Network Rail.** **Delivery is ongoing** and additional detail can be found in **Section 5.2**
Review and update Integrated ARP3 Climate Risk Assessment	TA WRCCA Strategy Manager	2026 and beyond	**In progress – Section 4.1.1** gives detail on the updates since our ARP3 Report and the current Issue 4 of the ICCRA is published alongside this report. Further improvements will be made continuously
Additional Action **Develop a RS Weather and Climate Change Plan**	Health Safety & Environment Director, RS	2029	In 2024 RS adopted targets to identify high risk sites vulnerable to extreme weather and are in the process of developing vulnerability assessments. A draft template for assessment is being produced for operational sites and a rapid climate change risk and opportunity assessment has been carried out for business units using ISO14090. A climate change adaptation delivery plan is in development for CP7 with the intention of publishing a RS WRCCA Plan in CP8

Action	Owner	Target date	Status
Standards and guidance			
Improving guidance and tools	TA WRCCA Strategy Manager	Ongoing	**Ongoing –** Examples include the provision of guidance for regions to produce their adaptation pathways and for our Chief Engineers to review and update their asset standards
Asset management standards review and update	TA network technical heads of assets	2024	**Ongoing –** Climate change projections have been integrated into our Product Acceptance process and some of our telecoms, signalling and points operating equipment standards. The WRTF has also been involved in reviewing several standards to increase the level of input that the regions are able to have into the management of our assets. Guidance for a comprehensive review of our asset standards that manage weather impacts in asset design, operation and maintenance has been given to our Chief Engineers. Work has been delayed due to the complexity of the task and resources focussing on delivery of WRTF activities but the review and prioritisation of documents is underway and a delivery programme will be created in early 2025
Water Management Strategy 	TA Network Technical Head of Drainage and Lineside	March 2023	**Complete –** Delivery of our Water Management Strategy in 2023 was a key step in creating an environment that enables our drainage community to make more sustainable decisions for water management. It has reset our relationship with water, shifting our thinking from 'how do we remove water from our assets' to a more holistic catchment-based way of thinking. It focusses on managing water as a system in partnership with other catchment communities and in more sustainable ways, such as Natural Flood Management techniques

Action	Owner	Target date	Status
Collaboration and engagement			
Continued collaboration with internal and external stakeholders	TA WRCCA Strategy Manager	Ongoing	**Ongoing –** The wide range of collaborations detailed in our ARP3 Report continue, with our core relationships being: • regulators – Policy development, resilience and service metrics and levels, business planning, data provision and scenario planning, climate risk assessment and adaptation reporting, • Rail Industry Climate Change Adaptation Working Group – The whole rail industry developing industry-wide solutions for long-term resilience, • Infrastructure Operators Adaptation Forum and Transport Adaptation Steering Group – Informing adaptation policy and action, sharing best practice and co-ordinating research, • the Committee on Climate Change to support national climate change risk assessment and planning, • the water and coastal erosion management community – Contributing to national strategies and identifying partnership opportunities for resilience investments. Examples of collaborative successes we have driven include: • the Great British Railways Transition Team (GBRTT) climate change resilience and adaptation chapter of the draft Long-Term Strategy for Rail, • the Rail Safety and Standards Board's (RSSB) Sustainable Rail Blueprint 'Prepared for a changing climate' content, • supporting RSSB to develop a rail industry climate change adaptive capacity maturity matrix. The first assessment round led to the development of a sector road map to support improved adaptive capacity, • rail sector agreement on common climate change scenarios for rail, an initiative that DFT support

Action	Owner	Target date	Status
Research and analysis			
WRCCA Vulnerability and Criticality Mapping R&D project  Figure 18 Number of days above 29°C 2070s RCP8.5 90th percentile	TA WRCCA Strategy Manager	2024	**Complete –** This created a consistent methodology for assessing current weather and future climate risk to our assets, developed a specification for a geospatial mapping system to display the outputs and produced several geospatial hazard layers for temperature and rainfall projections at a 5km resolution
Real Cost of WRCCA R&D project	TA WRCCA strategy manager	2024	**Complete –** This improved our understanding of the current and future costs of weather impacts through the identification of key cost data and development of a method of analysis and projection under climate change. A prototype weather costs analysis and climate costs projection tool was created. This is being further developed by our Economic Analysis team
Interdependencies research and risk assessment	TA WRCCA strategy manager	Ongoing	**Ongoing –** We were an active participant in the TfL London LBTS Interdependencies project as detailed in **Section 4.2** and work will continue to build on its outputs
Asset vulnerability research  Figure 19 Adaptation pathways climate risk screening output	TA WRCCA strategy manager	Ongoing	**Ongoing –** A high level climate change impact and risk screening was completed for every 2km section of our network to support the prioritisation of locations for adaptation pathways assessments. This used geospatial asset data and our climate planning scenarios for the 2050s and 2070s. Further detail can be seen in case study 2. Our WRTF also carried out a forensic analysis of the relationship between rainfall and asset failure as part of a collaboration with the Met Office. We have begun work to incorporate our climate change planning scenarios into our models for predicting asset deterioration, condition and failure rates. This will enable us to better determine our investment needs for future control periods and improve our asset management and business planning

Action	Owner	Target date	Status
Development and delivery of WRCCA Analysis Framework	TA WRCCA strategy manager	2022 (develop), ongoing delivery	**On hold pending review/abandonment** – Establishment of the WRTF and the outputs of the extreme rainfall and heat taskforces mean that the framework put forward is now out of date and requires review. This has been placed on hold due to resource constraints
Additional Action **Quantifying the benefit of our resilience spend**	TA WRCCA strategy manager	2024	Our asset workbanks are built on key cost and volume measures e.g. plain line track replacement, culvert refurbishment etc. A team from across regions and functions reviewed key volume lines and assigned a percentage of expenditure that would deliver resilience benefit, e.g. a drainage investment to address heavy rainfall and flooding risk was given a high percentage whereas upgrading lighting to LED was given a low one. This work was used to inform our CP7 Business Plan and the CP7 Region WRCCA Plans
Additional Action **Extreme Heat Taskforce**	Weather Risk Taskforce Programme Manager	Ongoing	Independent reviews were commissioned to improve our understanding of the risks from extreme heat following the record-breaking temperatures in July 2022. • Engineering – Sir Douglas Oakervee • Operations – Simon Lane • Weather forecasting and longer-term climate trends – Dame Julia Slingo • Customer Experience and Communications – Anthony Smith The recommendations from these studies are being implemented by the WRTF alongside those from the Carmont and Haddiscoe RAIB reports
Additional Action **Climate Change Adaptive Capacity Assessment**	TA WRCCA Strategy Manager and Regional Directors for Engineering and Asset Management		After supporting development of the rail industry adaptive capacity assessment, we used it to assess our national climate change adaptation team and regions. Overall, our national centre of excellence has a high level of adaptive capacity with scores well above the rail industry average. Our regions scored around average in 2023 but all made improvements in 2024 following approval of CP7 WRCCA Plans (see **table 7**)

Table 7 – Our climate change adaptive capacity assessment scores

Region/Function	2023	2024	Change
	Response level		
Eastern	2	2/3	0.5
North West & Central	2/3	2/3	–
Route Services	–	2	
Scotland's Railway	2/3	¾	1
Southern	2	2/3	0.5
Technical Authority	3	4	1
Wales & Western	2	¾	1.5

5.2 Our ARP4 action plan

As this report and the improvement in our climate change adaptation maturity assessment score show the last three years have seen us continue to make significant progress in building our adaptative capacity and the delivery of resilience investment. We recognise, that we still have a long way to go, and this section sets out the actions identified for delivery throughout the CP7 period.

Our action plan follows the framework of our new Adapt to a Changing Climate strategy and the actions have been aligned to five of the six key themes. Actions relating to operational weather response and detailed implementation of recommendations under the WRTF have not been included here. **Table 8** summarises the actions by theme.

Table 8 – ARP4 weather and climate resilience action plan

Action	Target date	Owner	Activities
Resilience in process			
Policies, standards and processes across Network Rail reflect future climate conditions and manage climate change risk where relevant	31 March 2029 and reviewed every five years	Standard/process owners	We will identify the owners of the polices, standards and processes responsible for managing our planning adaptation response. By the end of CP7 we aim to have reviewed and updated key standards and processes
Asset management standards and processes reflect future climate conditions and manage climate change risk where relevant	30 June 2027 and reviewed every five years	TA Chief Engineer	Our asset management standards review will continue. Next steps will be agreeing a prioritised list of standards for update and delivery of the review through our standards update process. It is likely that the selection of appropriate design ranges and/or solution specifications will require additional cost/benefit analysis
Non-asset-related national policies, standards and processes requiring updates to reflect climate change identified and timetabled for revision	31 December 2025	Head of Climate Change Resilience and Adaptation[4] and standard/ process owners	Fully embedding the management of climate change into business as usual will require us to identify, review and update policies standards and process beyond those in the asset management standards review. We will identify the owners and their relevant documents and agree a review programme
Adaptation planning			
First regional long-term adaptation pathways strategy delivered based on assessment of high priority locations	31 March 2029	Regions	Our regions are developing adaptation pathways strategies based on the methodology published in August 2024. The initial findings are due in 2027 to feed into CP8 business plans with regional strategies due at the end of CP7
National overview of regional adaptation pathways delivered	31 December 2029	Head of Climate Change Resilience and Adaptation	Once regional adaptation pathways strategies are finalised, a national overview will be developed

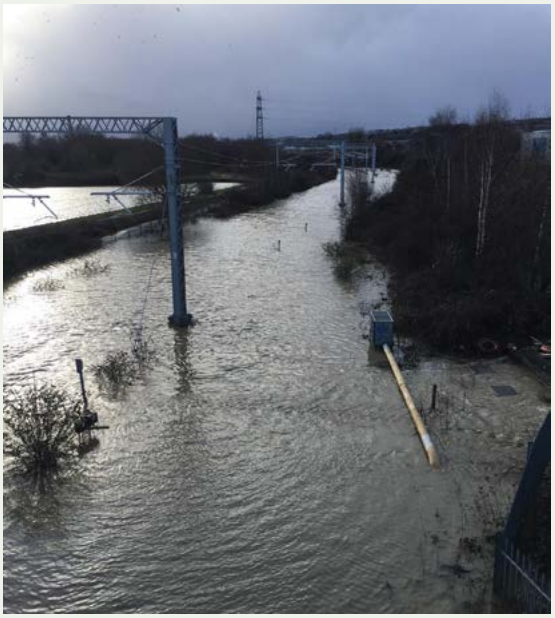
[4] The role of TA WRCCA Strategy Manager has changed title to Head of Climate Change Resilience and Adaptation as the climate change adaptation team transferred from the TA to the SO as discussed in **Section 3**

Action	Target date	Owner	Activities
Detailed methodology and tools for delivery of adaptation pathways complete	31 December 2025	Head of Climate Change Resilience and Adaptation	The delivery framework for adaptation pathways includes the methodology guidance, a climate risk screening and a tool to support data collation and options analysis. These will be developed based on learnings from the pilot project running in Southern Region and input from the working group
Level of service in extreme weather conditions agreed with Government and regulators	31 December 2027	Industry Weather Response Director	We will work with the Government and the National Infrastructure Commission (NIC) to agree the expected level of service from the railway in adverse and extreme weather conditions now and in the future. This will align with the approach set out in the NIC report on resilience standards
Adaptive capability			
All regions, routes and national functions complete climate change adaptation maturity assessment	31 May 2026 and then annually	Regions, routes, TA, SO, RS	We plan to expand use of the climate adaptation maturity assessment to other functions within our business and use the findings to guide our work on adaptation and enhancing adaptive capacity across the railway
SO, TA and regions collaborate to enhance adaptive capacity across the railway	31 March 2029	SO, regions, TA	Delivery of the actions set out in this report will be overseen by the Climate Change Resilience and Adaptation Working Group composed of representatives from each business unit and other stakeholders. This working group will identify areas of risk or opportunity and share best practice to support implementation of the Climate Change Adaptation Strategy
Training to support understanding of adaptation available to all staff	31 December 2027	Head of Climate Change Resilience and Adaptation	We want to increase the availability of training on climate change adaptation across our organisation. We will undertake a learning needs assessment and develop a route to competency and training plan including elearnings and courses in collaboration with (and hopefully under the umbrella of) the Weather Academy
Scope of Weather Academy expanded to incorporate climate change capabilities	31 December 2026	Weather Risk Taskforce Programme Manager/ Head of Climate Change Resilience and Adaptation	

Action	Target date	Owner	Activities
Resilient assets			
Regional CP7 WRCCA Plans implemented	31 March 2029	Regional Directors of Engineering and Asset Management	Over CP7 our regions will deliver the actions in their CP7 WRCCA Plans. Delivery will be tracked and reported to ORR every six months though our regulatory reporting processes. For further detail a summary document and each regional plan can be found on our **climate change adaptation page**
Regional CP8 WRCCA Plans aligned with adaptation pathways and asset work banks published	30 April 2029	Regional Directors of Engineering and Asset Management	Our CP8 Strategic Business Plan (2029 – 2034) will be developed towards the end of this reporting period. We will further integrate weather and climate resilience into our strategies and the CP8 WRCCA Plans will reflect this and the strategic decisions made through the adaptation pathways programme
RS CP8 WRCCA Plan published	30 April 2029	Route Services Director	RS has already started this process as noted in **Table 6**. We aim to start work with Property and seek to expand the development of WRCCA Plans to additional Network Rail functions
Climate intelligence			
Bespoke climate change hazard and vulnerability geospatial mapping tool delivered	31 March 2029	Head of Climate Change Resilience and Adaptation	We will scope and carry out phase two of our Vulnerability and Criticality Mapping Tool project building on the work undertaken in CP6
Flood and coastal risk management plan delivered	30 June 2026	Industry Weather Response Director	We will carry out an assessment of our vulnerability to flooding, review current management processes and develop plans to improve our approach to flood and coastal management
Leading metric that tracks the resilience benefits of investment delivered	31 March 2029	Head of Climate Change Resilience and Adaptation	We will undertake development of a metric or metrics that can give an indication of the impact that our adaptation actions and investment is having on the resilience of the railway system
Interdependencies across the transport sector and other infrastructure operators mapped	31 March 2029	Head of Climate Change Resilience and Adaptation	Building on the TfL Climate Change and Interdependency Risks for London's LBTS project we aim to extend its coverage to our network and tailor the outputs to our organisation
Asset damage thresholds from climate change defined	31 December 2027	Head of Climate Change Resilience and Adaptation	We plan to identify and define weather event thresholds at which our assets are damaged or their service is impaired

Action	Target date	Owner	Activities
Asset analytical models updated to reflect future climate conditions and give intelligence on climate change risk	30 June 2027	Head of Advanced Analytics	This will continue our work to integrate future climate projections into our asset models. Further development of the projects will improve the prediction of the condition of our assets and their deterioration and failure rates. Application of the outputs will improve the prediction of investment needs in a changing climate helping better inform future business plans
Data, information and tools created to better understand the costs and impacts of climate change and support decision making	31 March 2029	Head of Climate Change Resilience and Adaptation	We will seek opportunities to achieve this including the continuation of: • a project with the University of Birmingham to identify the current and future wildfire impacts on the railway corridor, • the work with our Economic Analysis team to finalise the development of the prototype weather costs analysis and climate costs projection tool.

Case study 8: North & East route – Rotherham flooding



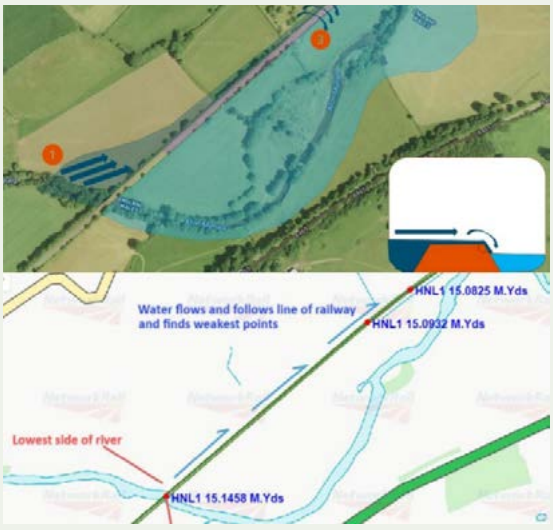
Over many years, heavy rainfall causing extremely high levels in the River Don and its tributaries in the Rotherham area has led to flooding of the railway and Rotherham Central Station. The volume of water entering the railway corridor means the floods can take several days to dissipate, with neither trains nor trams able to run. This happens roughly every three years causing considerable performance, safety and reputation impacts. Repeated recovery is resource hungry and comes at significant cost.

During CP6 we installed non-return valves on some of our drainage pipes and reprofiled a number of our retention chambers. This improved the performance of our drainage system, particularly the interface between our track drainage and the adjacent watercourses. We also made a significant funding contribution to an EA/Local Authority scheme to install a flood barrier on the adjacent Rotherham Canal as this was a more cost-effective solution for all parties. This has raised our flood protection at the station from a 1:3 year return period to 1:100 year return period. Further interventions are planned in the next five years to slow down the flows in the catchment above the urban area. North & East route will work closely with the local flood agencies to find common solutions.

Case study 9: Wales route – River Monnow rock armour flood resilience

The line between Newport and Shrewsbury is essential to connecting freight and passenger services between North and South Wales and to Manchester. However in many years it has suffered winter closures due to flood damage, a problem that has been increasing as rainfall patterns have been changing. In the 2019 – 2020 winter it suffered two washout events in four months.

This damage is caused when the River Monnow bursts its banks after heavy rain and the flood water flowing across the flood plain is trapped against the steep railway embankment which splits the flood plain in two. As the water rises the pressure against the embankment increases with the weight of the water until it is high enough to force its way through the embankment structure causing the washouts.



Extensive modelling was carried out to understand the current and future risk and numerous solutions were considered. Balancing the competing priorities of performance, safety, cost and sustainability does not always mean that resisting an impact is the right solution. In this case a solution that allowed the water to flow over the track in controlled way without damaging the track formation was chosen. The placing of rock armour along the embankment along with enhanced monitoring means that the region are able to proactively close the line in advance of flooding events and make informed decisions on re-opening the line much more quickly.

Previous examples have seen reduced interruptions, delays and repair costs as well as an increased reputation and usage of the services. A more resilient and reliable railway can only be a benefit to the local and national economy.

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The actions set out in this report will be included in the delivery plan for our Adapt to a Changing Climate strategy. Progress is monitored and reported through the SO Industry Weather Response Directorate and the Railway Fit for the Future Steering Group. Updates are also given to the Executive Leadership Team and Board Environment and Sustainability Committee.

On a day-to-day basis, delivery of weather and climate change resilience work is co-ordinated and disseminated through the Climate Change Resilience and Adaptation Working Group. This is chaired chaired by the Head of Climate Change Resilience and Adaptation with designated representatives from key stakeholders including regions, asset management, economic analysis and RS. Further detail on our governance structure highlighting key changes since our ARP3 Report is in **Section 3**.

In addition to this, progress against the CP7 Region WRCCA Plan actions is reported directly to the ORR. These reports are produced three times a year (October, March (draft) and May (full year)) as a requirement under our CP7 Delivery Plan reporting. They provide a national overview and region-specific reporting. Our regulated target is for 90 % completion of the actions published in the plans. Progress against investment actions within the Region Business Plans will be tracked through business-as-usual reporting on the delivery of key costs and volumes by our capital investment programme. Within each region, responsibility for implementation, monitoring and reporting of their plans sits with the Director of Engineering and Asset Management.

The Industry Weather Response Director has oversight of the work on operational weather response and the WRTF, which has governance processes set up to report to the Executive Leadership Team, ORR and Government.

All of the monitoring and reporting streams above allow us to evidence the delivery of our weather and climate change resilience actions, which we know improve our adaptation status, but they do not give us a mechanism for quantitively measuring and reporting it. Through a number of the actions in this plan we will be working towards the development and agreement of appropriate metrics and levels of service for measuring and tracking resilience with the aim of improving this position for the fifth round of Adaptation Reporting.

Case study 10: Proportionate Risk response when Implementing Mitigating speeds to Assets tool (PRIMA)

During extreme rainfall events we use speed restrictions to mitigate the safety risks associated with potential earthworks failures. Historic use of national weather event thresholds to trigger large scale (blanket) restrictions has been very safe, but often disproportionate to the risks we are mitigating. We need to better balance the appropriate primary safety benefits against knock-on, secondary risks caused by the level and scale of the speed restriction imposed (e.g. increased risk of Signals Passed At Danger – SPAD).

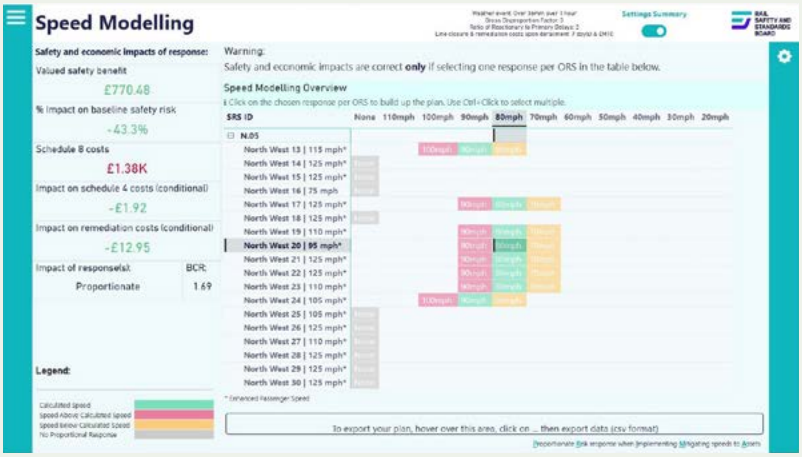
Building on their previous SPAD risk work we and the RSSB have developed the data led PRIMA tool which:

- considers the economic impact of our risk mitigations,
- values the overall safety benefit of the mitigations (accounting for the secondary risks),
- gives operations and engineering decision makers a balanced, modelled view of how proportionate blanket speed restriction use is relative to the risk for operational route sections.

Network Rail operations and engineering people consider the results in consultation with Train Operations Companies. Speed plans are then prepared for adverse/extreme rainfall scenarios that are implemented when rainfall safety thresholds are triggered. These plans also consider:

- the actual conditions on the ground (for example, infrastructure risks that are not considered by the model),
- the driveability of the resultant speed profile,
- the previous conditions (for example, prolonged periods of rainfall in advance of events that may increase the risk of an earthworks failure).

The tool is on trial on the North West route and Scotland's Railway. First use of PRIMA by North West in September 2024 when responding to forecast convective rainfall events showed these benefits:



- pre-prepared responses allow quicker response to convective rainfall event alerts, reduce control team workload, mitigate risk quicker and see less passenger disruption,
- it helps us better balance risks and safely run trains at higher line speeds significantly reducing disruption for our passengers,
- reduced disruption compensation costs and increased future revenue due to improved customer confidence.

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Weather events can pose significant challenges to the resilience of the railway and our services. The cost, safety and reliability impacts of these are felt by our customers, neighbours and the wider economy.

Our forecasting capability, event planning and management plans, processes and tools have been key to our ability to manage the current impacts in real time. In the last three years the National Weather Team and the WRTF have put significant effort into improving our planning and responses. Particular areas of focus have been improving standards and operational plans, upgrading forecasting capability and use, developing decision support tools and increasing staff capability through our new Weather Academy.

As we keep seeing the effects of climate change on the frequency and severity of weather events, the importance of our work to adapt to the future projected changes increases.

The period covered by this report has seen significant progress in improving our governance and strategies with a key step being the integration of our weather planning and response and climate change adaptation teams into one coordinated Industry Weather Response Directorate. We have also continued to develop our risk and impacts understanding, and to better integrate climate change consideration into our asset management and business planning activities.

Much work remains to be done and in the next five years our priorities will be:

- driving integration of climate change adaptation knowledge and principles into policies, standards and processes across our business,
- improving adaptation capability through the development of training and improved knowledge from research,
- delivering adaptation actions through the CP7 Region WRCCA Plans,
- developing CP8 WRCCA plans for the regions and exploring wider use in other business units,
- developing methods for better calibrating adaptation actions and measuring their benefit.

Given the complexity of our business, the scale of the climate challenges and our interconnected place in Great Britian's infrastructure system, it is obvious that we cannot adapt successfully on our own. Our work will require active collaboration with multiple stakeholders across sectors to ensure that we make fully informed decisions to deliver efficient and effective adaptation for all parties. We will continue our current collaborations and actively seek opportunities for partnerships working on research and adaptation actions.

This report has summarised our progress and lays out the next challenging and exciting programme of actions. We look forward to working on delivering it with you and on reporting our progress in the next Adaptation Reporting round.

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Appendix A Integrated Climate Change Risk Assessment

The most up-to-date version of the Network Rail Integrated Climate Change Risk Assessment can be found here.

Appendix B Links

For your convenience all links listed in this report are included below:

Document
Adaptation Pathways methodology
Annual Report and Accounts
Common climate change planning scenarios for the Rail sector
CP6 Route Weather Resilience and Climate Change Adaptation Plans
CP7 Region Weather Resilience and Climate Change Adaptation Plans
Department for Transport
Final Report – Recommendations of the Task Force on Climate-related Financial Disclosures
Greener Railway: Environment and Sustainability strategy
Integrated Climate Change Risk Assessment
Network Rail Third Adaptation Report (ARP3)
Office of Rail and Road
Our Control Period 7 (CP7) delivery plans – Network Rail
Our regions – Network Rail
Public Performance Measure (PPM)
UK Climate Risk Independent Assessment (CCRA3) – Technical Report Chapter 1: Latest Scientific Evidence for Observed and Projected Climate Change

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