National Engineering Policy Centre

Royal Academy of Engineering

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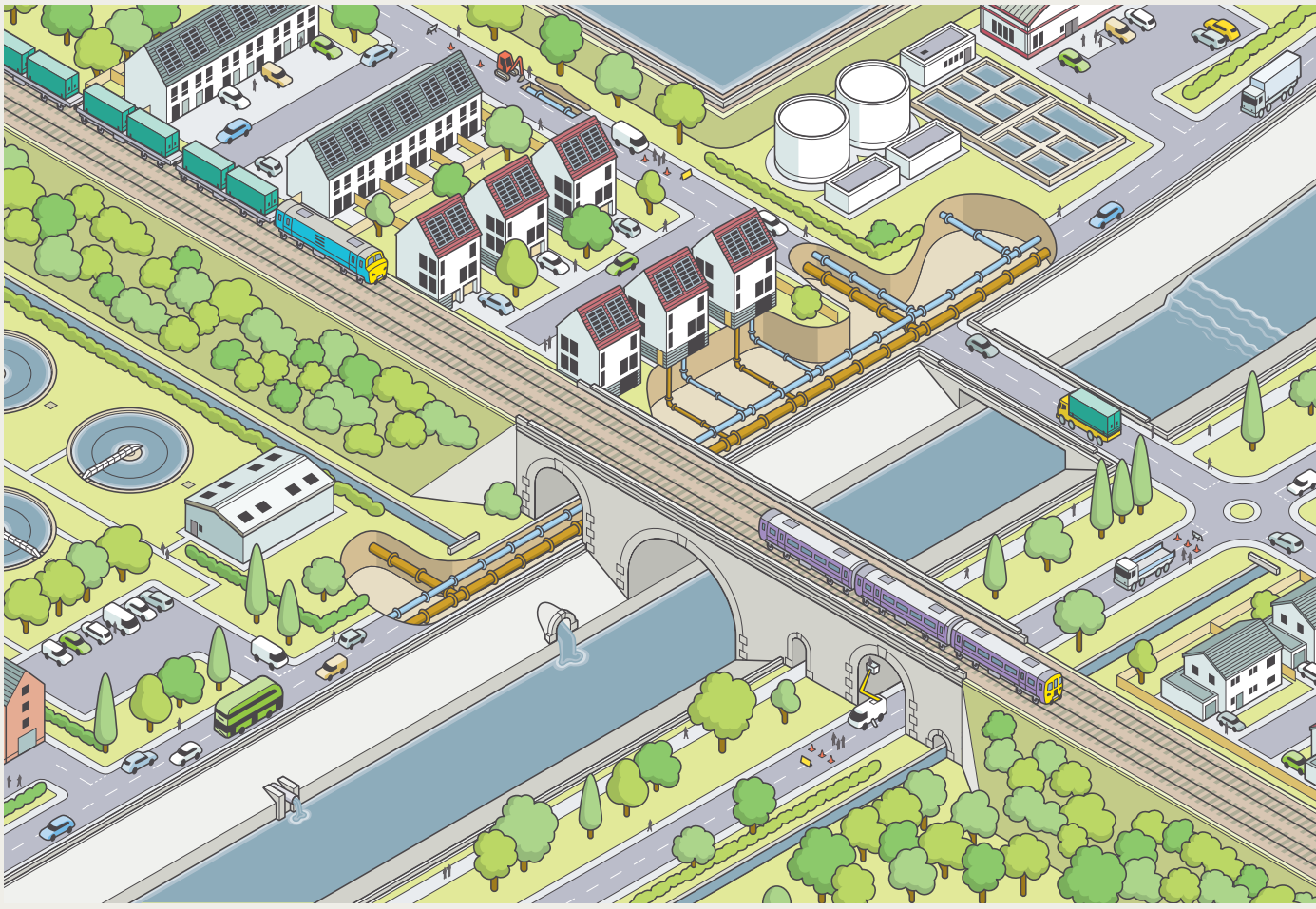
Reviving our ageing infrastructure



CIHT · ice · IHE Institute of Highway Engineers · Institution of Mechanical Engineers · Institute of Water · The Institution of Structural Engineers · THE PWI · IAM The Institute of Asset Management

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Foreword

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The UK's economic infrastructure is at a tipping point. We must confront the growing challenges presented by the ageing assets that our infrastructure systems rely upon. While these challenges have been widely documented, this report goes further, offering a cross-sectoral, actionable roadmap for change. Drawing on the expertise of engineers, asset managers, and policymakers, we set out not just the case for change, but a practical agenda for delivering it. Our aim is to outline the actions required to ensure the UK's infrastructure is safe, resilient, and fit for the future. Too often, we take the continued functioning of our infrastructure for granted in our day-to-day lives — we cannot afford for this to continue. Our approach to the management of ageing infrastructure must change now.

The UK saw major expansion of its infrastructure systems from the late 19th and throughout the 20th century, infrastructure that today continues to provide the essential foundations for the functioning of our society and economy. These infrastructure systems are ageing. Many are operating at capacity and approaching a critical state where their deterioration will accelerate and their future reliability risks being compromised.

At the same time, the pressures being placed on our infrastructure systems are increasing. For example, climate change is leading to more frequent and intensive rainfall events, heightening demands on drainage and flood defence systems, and making embankments and cuttings increasingly vulnerable to landslips.[1]

The combination of ageing asset stock, increasing pressures and growing demand is accompanied by heightened reliance and expectations of service performance. With many of our infrastructure systems operating at or close to capacity, even planned interventions disrupt people's lives. However, without planned maintenance, renewals and enhancements, far worse disruption is inevitable.

Disruptive and costly events such as the disruption of water supply from the Franklaw water treatment works, and the closures of the Clifton Bridge in Nottingham, the Hammersmith Bridge in London or the Nuneham Viaduct near Oxford, should not be seen as isolated incidents but rather as an early indicator of the challenges ahead. The case for change is not just an economic one — it will also reduce carbon emissions. Maximising the life of our existing assets is far less carbon intensive than demolishing and replacing them.

The complexities, uncertainties and risks that must be faced when balancing maintenance, renewal and enhancement decisions means that the understanding between policymakers, regulators and engineers must be enhanced. We must also address the growing technical skills gap, which will mean celebrating and raising the prestige of those who manage our infrastructure — skills that are currently underappreciated and undervalued.

A dilemma facing many asset managers today is that if they are vocal about the deteriorating condition of their assets, it can have negative consequences for them and their teams. If we are to move forward, we need to have frank conversations informed by a better understanding of asset condition and trends. Inadequacies in data must not be allowed to be an excuse for inaction.

Given that the need and urgency of change is clear, this report goes beyond the *why* to look at *how* we should change the way we manage our ageing infrastructure. We have brought together the views of expert engineers, asset managers and policy professionals to identify seven key enablers of change, and a series of urgent actions to put them into practice. Approached with a common understanding and commitment between professionals and policymakers, these actions will start us along a pathway towards the effective long-term stewardship of our infrastructure.

Executive summary

We are at a critical moment for the UK's infrastructure. Many of our essential assets, from roads and bridges to water pipes and flood defences, were built decades ago. Following many years of underinvestment in maintenance, they need immediate attention to extend their lives and ensure that they can continue to support the services on which our society and the economy depend.

Climate change is now accelerating deterioration, with wetter winters, hotter summers and more frequent storms placing new stresses on infrastructure that it was never designed to withstand. Meanwhile, demand has grown: more traffic on roads and greater population density are coupled with rising expectations for reliable services and growing economic dependence on well-functioning infrastructure. These converging factors mean that without timely intervention, emergency outages, unplanned repairs and disruption will become more frequent, impacting public safety, the economy and the environment.

This report, developed by the National Engineering Policy Centre (NEPC), looks at the state of our ageing economic infrastructure across the water and wastewater, flood defence and road and rail transport sectors that provide essential public services. These infrastructure systems were selected due to commonalities in the types of assets they are built from, the mixed age and condition profiles of these assets, and the challenges they face. The evidence, while limited in places, makes clear that past practices will not be enough. We must embed a new, proactive approach to managing our ageing infrastructure. It is no longer a question of whether we need change, but how to deliver it.

As the UK government's 10 Year Infrastructure Strategy[i] notes "Infrastructure design should be guided by a hierarchy. First, maintain and optimise existing assets." This report responds to this first critical step in the hierarchy. It sets out evidence-backed, cross-sectoral actions towards better stewardship of our ageing infrastructure systems.

By investing wisely now in our existing infrastructure the UK can safeguard essential services, support economic growth, and develop world-leading expertise in infrastructure stewardship. Proactive maintenance and renewal offer extremely high value for money: studies show each £1 spent on preventive maintenance can save £5–£10 in future costs or damages avoided.[2–4] Taking care of what we have is not a cost but an investment in resilience and prosperity.

This report identifies seven enablers of change. These are cross-cutting priorities of equal importance that emerged from consultations with a diversity of experts and stakeholders across water and wastewater, flood defence and road and rail transport systems.

For each enabler, the report sets out a desired outcome and identifies urgent actions that policymakers, asset owners and engineers need to take now. These urgent actions provide initial steps along a pathway to ensuring UK's infrastructure is reliable, climate-resilient, efficiently maintained and delivering long-term public value through proactive stewardship.

i UK Infrastructure: A 10 Year Strategy sets out the government's long-term plan for economic, housing and social infrastructure to drive growth. It was published in 2025.

Water and wastewater

The average replacement rate of **sewers and potable water mains** is **0.1%**, implying asset lives of up to **1000 years**

19% of **public water supply** in England is **lost to leaks**

Poorly maintained and outdated sewer systems have contributed to the growing number of **pollution events** and **lack capacity** to cope with **demand from new housing**

Flood defence

Annual damages from flooding are predicted to rise to **£3.6 billion** by 2050 without significant investment in flood prevention

Environment Agency assets are, on average, **60% of the way through their useful economic life**

In 2023, over **250,000 homes were at increased flood risk** due to flood defence assets being below their required condition

Transport

17% of the **local road network** in England and Wales is in **poor condition**

Congestion and deteriorating road surfaces are estimated to cost the UK economy **£30 billion** per year

25% of all rail delays are caused by **faults with infrastructure assets**, with a **50% increase in impacts on assets** from weather events recorded over the past five years

Enablers of change	Urgent Actions
Outcomes, regulation and standards We need a long-term vision for reliable and resilient infrastructure that meets future societal needs, underpinned by regulations and standards.	1. **Governments** should define the system-level outcomes it wants each infrastructure sector to achieve over the next 25 years, to guide investment and policy decisions. 2. **Governments** should use upcoming infrastructure investment strategies to explicitly prioritise the maintenance and renewal of existing assets. 3. **Asset owners**, **regulators** and **standard-setters** should collaborate to develop a set of meaningful metrics and standards to assess asset condition and infrastructure system health and how it is changing.
Financing for the long-term We need long-term financing with the flexibility to optimally balance proactive maintenance, renewal, and enhancement of infrastructure assets.	4. **HM Treasury** should lead a cross-government review of how current funding, financing and accounting models and guidance affect decisions on maintenance, renewal and enhancement. This should be conducted by the end of 2026, to inform the next update of the 10 Year Infrastructure Strategy.
Skills and capability We need a well-supported, respected and skilled workforce, equipped to develop and deploy new and established techniques, to steward the UK's ageing infrastructure systems.	5. Better data is needed to recognise the bespoke skills needs for asset management. **Asset owners**, working with **regulators** and government skills bodies, should conduct regular forecasts of skills needs for infrastructure maintenance, renewal and enhancement, considering asset portfolio, geography and demographics. 6. **Professional bodies**, supported by the Engineering Council, should champion infrastructure stewardship skills as part of purpose-driven careers. 7. **Regulators** and **asset owners** should assess whether their boards have sufficient technical engineering expertise to recognise and manage asset risk and appoint a chief engineer to address any gaps and align priorities as part of a collective responsibility for asset stewardship.
Data Accurate data and digital tools must be the backbone of proactive infrastructure management, turning status and trend information into actionable insight to optimise the nature and timing of maintenance and renewal interventions.	8. **National Infrastructure and Service Transformation Authority (NISTA)**, in consultation with counterparts in **Scotland**, **Wales** and **Northern Ireland**, should establish an infrastructure data framework to drive the secure sharing of asset condition and system performance data and trends. 9. **Sector industry bodies** should spotlight practical and standardised approaches to digital monitoring, modelling and data-driven decision-making that support proactive asset management. Highlighting innovation that addresses common challenges will reduce duplication in research and development efforts, support responsible adoption and maximise returns on investment.

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Innovation We need to actively encourage purpose-driven and collaborative innovation to extend the life of ageing infrastructure to minimise cost and disruption.	10. **Regulators**, **standards-setters** and **asset owners** should identify and remove regulatory, procedural and cultural barriers that hinder innovation at scale in asset maintenance, renewal and enhancement. 11. **Governments** should work with **sector trade bodies** and **asset owners** to develop contracting models that reduce the legal and commercial burdens on innovators and enable successful solutions to be scaled within and across sectors. 12. **UKRI**, **regulators**, **asset owners** and **other research funders** should establish innovation challenge funds for addressing our ageing infrastructure.
Societal awareness A new narrative needs to be fostered where maintenance, renewal, and enhancement of existing infrastructure are valued, and the trade-offs between them can be productively debated.	13. An interministerial group on maintenance should be established between **HM Treasury**, **Department for Environment**, **Food and Rural Affairs (Defra)**, **Department for Transport (DfT)**, **Ministry of Housing**, **Communities and Local Government (MHCLG)** and counterparts in **Wales**, **Scotland**, and **Northern Ireland** to develop a unified national strategy to improve resilience and build a culture of infrastructure stewardship. 14. **Governments**, **regulators** and **asset owners** should work together to develop a new narrative around maintenance that builds public trust at home and abroad and demonstrates global leadership in infrastructure stewardship.
System Coordination We need to enhance coordination across infrastructure systems through clear roles, aligned governance, and shared information, enabling effective stewardship of assets that span sectors, regions and authorities.	15. **NISTA** should pilot efforts to drive regional system coordination across ageing economic infrastructure and streamline the regulatory environment.

Next steps for the Academy

To build on this report, the Academy will work with partners in the NEPC to develop and foster a shared understanding of the UK's asset base and its management needs, thereby seeking to mature these seven enablers into comprehensive pathways for positive action and change.

Specifically, the Academy will work with partners in the NEPC to produce guidance to help bridge any gaps in technical understanding between policymakers, regulators and asset owners..

In addition, the Academy will explore opportunities to support the strategic shift required through the delivery of our flagship products, including through:

- **Responding to skills gaps in this field in our Skills Centre resources and programmes.**
- **Welcoming applications for innovations that extend the useful life of assets through our Research and Invention Fellowships.**
- **Spotlighting AI adoption for infrastructure management in our Practical AI programme.**

1.0 | Introduction

The UK's linear infrastructure provides the hardwiring that is essential to the flourishing of our society and growth of our economy — from the water that comes from our taps to the flood defences that protect us and the transport systems we rely on.

The UK was a pioneer in the early development of modern infrastructure, but as a consequence we now need to pioneer the management of a modern infrastructure system with a significant number of ageing vital assets.

The need to act is urgent. Many of our ageing assets are approaching a critical state where they risk compromising the reliability of the services they provide. These long-lived assets face mounting challenges from a backlog of underinvestment, limited funding for routine maintenance and an age profile that means deterioration will only accelerate. Climate change is expected to place growing pressure on infrastructure systems, with more frequent and severe weather events accelerating deterioration and increasing the risk of unpredictable failures.[1] At the same time, public, political and regulatory expectations for infrastructure performance are rising, putting operators under greater scrutiny and increasing the media attention on infrastructure management. As demand grows, failures have more significant economic, social and environmental consequences.

Without timely maintenance, renewal, or enhancement, infrastructure will continue to deteriorate, leading to poor service performance, increased safety risks, disruption, and rising costs of repair. Addressing these challenges will require a proactive approach to asset management, ensuring infrastructure remains safe, accessible, and resilient for future generations.

This report from the NEPC follows interviews and workshops with experts from industry, academia, regulators, civil society and policymakers. It focuses on three critical sectors of civil, linear, economic infrastructure[ii]: water and wastewater, flood defence, and transport (road and rail). By looking at these sectors together we can uncover the aggregate risk, explore the interdependencies and identify common opportunities so that these assets and the services they provide can be sustained for future generations.

In the following chapters this report aims to:

- Take a cross-sector approach, to look at the challenges and risks facing our civil linear infrastructure across water and wastewater, flood defence and transport sectors.
- Illustrate the conditions required to effectively manage our ageing assets.
- Identify enablers for better management of ageing infrastructure to support better informed, and long-term decision-making.

> The need to act is urgent. Many of our ageing assets are approaching a critical state where they risk compromising the reliability of the services they provide

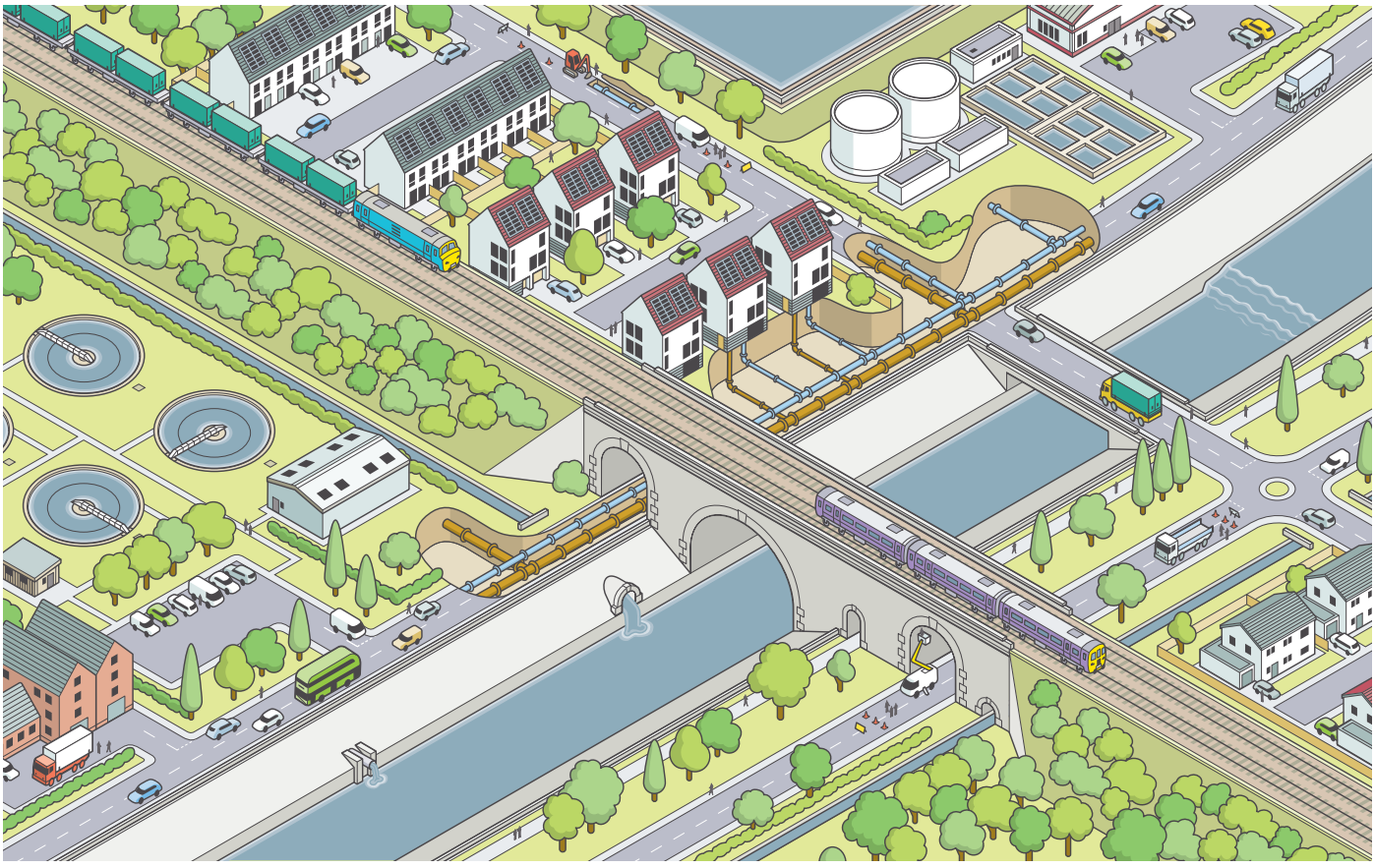
ii The 10 Year Infrastructure Strategy defines economic infrastructure as transport, energy, water and wastewater, waste, digital and flood risk management

2.0 | Our ageing infrastructure

This report focuses on three critical sectors of civil, linear, economic infrastructure: water and wastewater, flood defence, and transport (road and rail), each selected for its essential role in providing public services, its vulnerability to climate impacts, and the age of its assets. Assets across these sectors are essential to enabling economic activity, supporting productivity, and protecting communities from environmental risks, but many assets are significantly aged.[5]

These sectors are also deeply interconnected, which means that a failure in one sector can have far reaching impacts on service disruption in another. At the same time, the policy and regulatory landscape through which these assets are managed throughout the UK is complex and often siloed.

A burst watermain not only affects water supply but can also cause flooding[6] that damages property, blocks roads and disrupts public transport. Water mains typically run below roads, which need to be excavated for repairs, resulting in disruption to transport services and adversely affecting the durability of the road.[7]



> Our infrastructure assets are combined into systems to provide a functional service that supports our society and economy — such as providing clean water, protection against flooding or the ability to move people or products around the country

In this chapter, we set out the current state of our ageing infrastructure and describe how government policy is responding to it. First, we set this in context by providing an overview of some of the challenges confronting those responsible for managing ageing infrastructure.

Box 1 | **Definitions**

Ageing infrastructure – Assets that, without action, are approaching the end of their useful life.

Useful life – The period over which an asset is capable of fulfilling a useful purpose.

End of maintainable life – The point at which maintenance becomes ineffective or disproportionately expensive, meaning that without renewal, an asset will soon cease to fulfil a useful purpose.

Maintenance – Process of keeping an asset in a functional condition and/or extending its useful life.

Renewal – Process of replacing an asset or part of an asset.

Enhancement – Proactive process of making strategic improvements to an asset.

2.1 | Managing our ageing infrastructure

The core challenge confronting those responsible for managing ageing infrastructure can be broadly captured in three simple questions:

1. What is the optimal maintenance or renewal intervention for a specific asset?
2. When is the optimal time to undertake this intervention?
3. Can the funding to undertake this intervention be made available?

Whilst these questions are simple to ask, they are rarely easy to answers.

2.1.1 | Delivering level of service

Our infrastructure assets are combined into systems to provide a functional service that supports our society and economy — such as providing clean water, protection against flooding or the ability to move people or products around the country.

While maintenance or renewal interventions are typically performed on individual assets, it is the level of service provided by the systems that they are a part of that matters. For example, the impact of closing a bridge cannot be assessed in isolation. What matters is the extent to which the transport network it serves is compromised and for how long, and that in turn is affected by usage and the availability of diversion routes. System-level interdependencies can introduce significant complexity into asset management decision-making.

The nature and timing of optimal interventions and the justification of funding must therefore be viewed from the perspective of the avoided risk of disruption to the overall infrastructure system and the service that it provides. The risk of service disruption directly links to the risk of failure of the infrastructure assets that support that service, though some assets are more critical to service provision than others.

2.1.2 | The implications of age

Assets tend to deteriorate over time. However, the rate of deterioration is not linear and is affected by many factors including what the asset is made of, how intensively it is used and the environment to which it is exposed.

Although age is not therefore a unique determining factor for condition, there is undoubtedly a corelation between age and condition. Even when regular maintenance is undertaken, the breakdown of protective treatments or the gradual formation of cracks can allow contaminants to penetrate elements and accelerate deterioration.

In general, as assets age, the likelihood of asset failure increases, as do the costs of rectifying problems. For many assets, the probability of failure over time follows a similar pattern, which is described by the 'bathtub' curve (**Figure 1**).

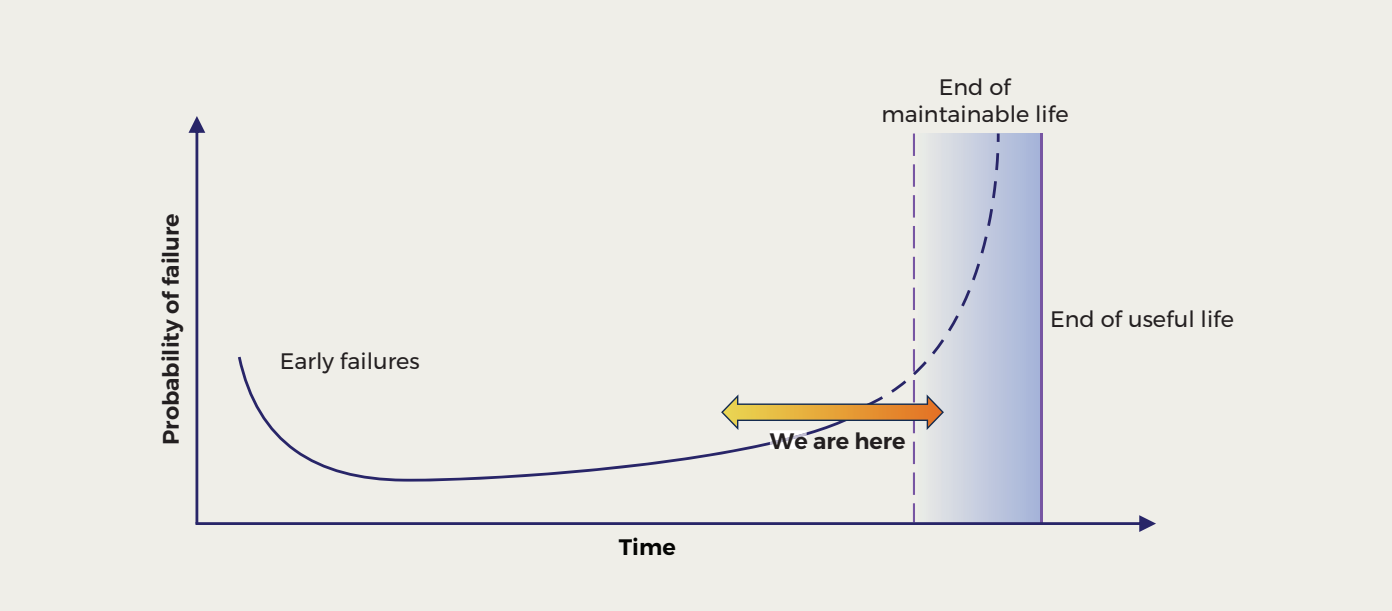


Figure 1 | **The 'bathtub' curve of failure probability over time. During construction and early use of an asset problems may present themselves, particularly during commissioning, but usually they can be remedied quickly and the likelihood of such early failures soon drops away. Subsequently, during most of an asset's 'useful life', the likelihood of failure stays fairly consistent and only increases slowly over time, particularly if effective maintenance is undertaken. At some point in the asset's life, however, the probability of failure starts to rise more steeply. Eventually, it reaches a point where maintenance alone is no longer effective – this is the 'end of maintainable life'. At this stage, renewal or enhancement are necessary. The bathtub curve does not capture the impact of failure, which will differ for different assets within an infrastructure system.**

During an asset's useful life, regular maintenance is an effective tool for reducing the probability of failures and extending the asset's useful life. However, over time, without suitable maintenance, assets will deteriorate to the point where additional maintenance alone may no longer be a feasible or cost-effective way to extend the asset's life – the 'end of maintainable life' – and enhancement or renewal will be needed.[8] This time-dependency is why determining *when* to undertake a maintenance or renewal intervention is so important, particularly because such interventions typically require considerable advanced planning. To determine when to intervene, it is necessary to understand both the condition of assets and the rate at which their condition is deteriorating.

There are other implications of age. Older assets were typically designed to be fit for the demands and expectations of their time, although fortunately, in some cases they were over designed, which has allowed their useful life to be extended. However today, even if they are still maintained in good condition, they may no longer meet current demands or standards. For example, over time vehicle usage has increased along with vehicle size and weight, and the introduction of legislation such as the Disability Discrimination Act has resulted in standards for footway widths that cannot be easily retrofitted to older assets.

2.1.3 | Asset data and uncertainty

In developing this report considerable effort has been invested in identifying available sources of data on our ageing infrastructure. This has proven challenging and has demonstrated a significant gap in our knowledge of asset condition and infrastructure system performance. The lack of reliable trend data for asset condition and performance is a particular problem given its importance in decision-making.

Even where good asset-condition data exists, uncertainties and gaps in understanding of how asset condition and performance affect the overall system performance can be scarce, adding further complexity to decision-making and compromising efforts to understand the health of infrastructure systems.

2.2 | The state of our ageing infrastructure

This section summarises the available evidence on asset age and condition across the three sectors of interest. It introduces a series of case studies that demonstrate the widespread disruption caused when assets must be closed for emergency repairs. These events should not be seen as isolated instances; instead, they must be seen as early indicators of the challenges that will increasingly be faced by the UK's ageing civil infrastructure assets.

2.2.1 | Water and wastewater

The provision of potable water and removal of wastewater from UK homes and businesses is critical for public health, environmental protection and the support of the wider economy, with the provision of sanitation recognised as one of the greatest advances in public health in the last 150 years.[9] However, the Independent Water Commission found that government and regulatory pressure to keep bills low between 2009 and 2024 contributed to what "can now be seen as underinvestment over this period".[10]

Water companies operate over 1,400 drinking water treatment works and nearly 6,000 reservoirs supply potable water to millions of homes through over 400,000 kilometres of mains pipes.[11] In England and Wales around 60% of mains infrastructure was built before 1981, and around 13% of mains are known to be over 100 years old.[10] However, for many older mains, exact age is not known, nor is there data on their condition. Currently, 19% of public water supply in England is lost to leaks, with poor condition of pipes a contributory factor.[12] In Scotland and Northern Ireland, leakage per capita is 60% higher leakage per capita than England and Wales.[11] When water supply infrastructure fails it can have severe and widespread consequences, including disrupting the delivery of safe drinking water[13] (**Case study one**).

The UK has over 500,000 kilometres of sewers, 100,000 kilometres of which are combined sewers carrying wastewater and rainfall run-off.[14] This is treated at over 17,000 wastewater treatment works and community septic tanks across the UK before being discharged to inland waters, estuaries or the sea.[15] There is no public data available on the condition of sewers and wastewater assets. Thames Water manages some of the oldest assets in the industry.[10] The company has estimated that a significant portion of its network has been fully exhausted, with assets that are in such poor condition that they are considered beyond their useful life.[16]

Case study one | Franklaw Water Treatment Works, North Lancashire

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In August 2015, Cryptosporidium (microscopic parasite that can cause hospitalisation and, in extreme cases, death[21]) was detected in water supplied from Franklaw treatment works.[22] As a precaution, United Utilities issued a boil water notice to 712,000 consumers resident in North Lancashire. It was found that contamination had entered the system from Barnacre Service Reservoir, which had structural faults that allowed contaminated water from the environment to seep in. During maintenance work, the company switched water supplies and accidentally used this contaminated reservoir water within the treatment process, allowing the parasite to bypass normal safety barriers. Lack of adequate risk assessment and maintenance were considered key factors of this incident.

Ageing and insufficiently maintained wastewater assets are struggling to meet growing demands from urbanisation and changing weather patterns. This is contributing to the growing number of pollution events from combined sewer overflows.[17] Outdated sewerage systems lack capacity to keep up with demand posed by new housing development,[18,19] a key objective for the UK government.[20]

2.2.2 | Flood defences

Flooding remains one of the most persistent and costly risks to communities and to infrastructure in the UK. On average, around 700 flood events are recorded in England each year,[23] causing widespread disruption and substantial damage to property, transport networks, public services, and even lives. Recent estimates suggest the direct cost of flooding

> In England, the Environment Agency (EA) manages around 6,500 kilometres of raised flood defences (including walls, embankment, bridge abutments, demountable defences) and 25,000 structures, and 13,500 earth embankments

to the UK economy already exceeds £2.4 billion annually,[23] with flood defences estimated to save households £1.15 billion in damages each year.[24]

In England, the Environment Agency (EA) manages around 6,500 kilometres of raised flood defences (including walls, embankment, bridge abutments, demountable defences) and 25,000 structures, and 13,500 earth embankments. Many of the earth embankments were constructed in the late 1940s and have since been 'topped up' or augmented to increase their height and standard of protection. However, the EA is seeing more of its assets showing signs of stress, increasing the risk of their failure during floods. The rate of deterioration has increased due to more frequent and severe weather extremes.[25]

To effectively balance the costs of maintenance, the EA has set a target for 98% of its 'high consequence' assets to be at their required condition. An asset being below required condition does not necessarily mean the asset has failed or that it will not perform its function, rather that the probability that it will not perform as intended is increased. According to the EA, a 100% target is not realistic or good value for money due to the time it takes to carry out repairs, and a target below 98% increases the cost of maintenance itself due to the increased deterioration of assets.[4]

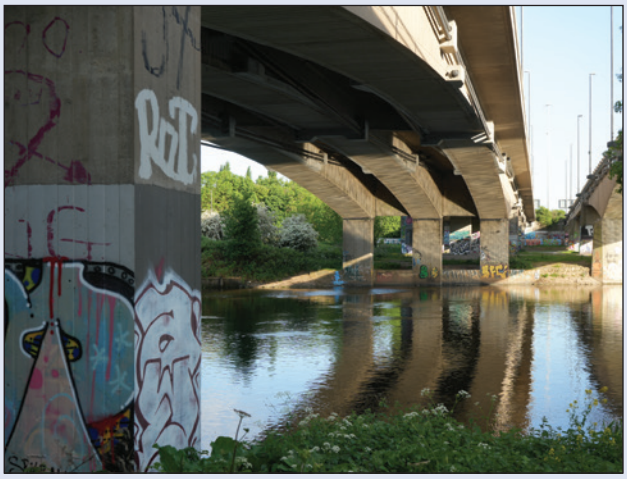
In 2021–22 the EA reported that its funding had been below that required to cope with climate change and ageing assets, and was a key reason for declining asset condition.[26] In 2022–2023, EA reported that a funding shortfall of £34 million would mean it could only keep 94% of high consequences assets at the required condition, short of its 98% target. This gap means that 203,000 properties were at increased flood risk due to deteriorating defences owned by EA.[27] A further 50,000 homes were estimated to be at risk due to assets owned by third parties being below required condition.[4] As of March 2025, the current percentage of EA assets at required condition has fallen to 92.8%.[28]

2.2.3 | **Transport**

Transport infrastructure is a critical enabler of economic development and social connectivity. Assets such as roads, bridges, and railways are essential for ensuring the movement of goods, services, and people. Well-functioning transport infrastructure adds significant value by reducing travel time, improving supply chain efficiency, and supporting regional competitiveness.

There are over 250,000 miles of roads in Great Britain, 97% of which are locally managed by councils.[34]

Case study two | **Clifton Bridge, Nottingham**



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Opened in 1958, Clifton Bridge serves the A52 road to the west of the city of Nottingham. The bridge carries around 60,000 cars every day.[29]

In 2018, a crack was discovered in the bridge and repair work was conducted.[30] This led to further investigations into the structural integrity of the bridge, and, in February 2020, severe corrosion of internal prestressing steel was identified.[31] As a precautionary measure, the bridge was temporarily closed.

Following the closure of the bridge, traffic turned Nottingham into one of the world's most congested cities.[32] Although the bridge closure initially caused severe congestion, the onset of the COVID-19 pandemic and the associated lockdown significantly reduced traffic volumes, reducing the impact of the closure.[29] The final traffic restrictions were lifted at the end of 2021 when repairs were completed. The overall repair scheme cost around £20 million.[33]

Most of the major road network was designed and built in the 1960s and 1970s,[8] and many of the structures in this network are reaching the end of their maintainable life.[35] The closure of bridges causes significant economic and social disruption, with a range of impacts on different groups, as shown in case studies three and four. Of the over 70,000 bridges managed by councils, 4.3% were reported as substandard in 2021.[36]

Case study three | **Hammersmith Bridge, London**

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In 2019, after the identification of micro-fractures in the bridge's weight-bearing pedestals, Hammersmith Bridge over the River Thames was closed to motor traffic. In 2020, as a further precautionary measure, it was fully closed to pedestrians, cyclists and river traffic below after a sudden increase in the size of the micro-fractures was observed, which was partially attributed to that year's heatwave.[39]

The bridge's closure caused widespread transport disruption for communities across multiple boroughs,[40] severely affecting public and private transport, and increasing traffic congestion and travel times for commuters, businesses and leisure.[41] The impacts of the closure also included harder access for emergency services and concerns about walking distance for disabled or older groups.[41]

After an initial phase of remedial work, the bridge was partially reopened to pedestrians, cyclists and river traffic in 2021, but remains closed to motor traffic. Options for the long-term future of the bridge are still being considered; however, the cost of a full repair programme is now estimated to be £250 million.[42]

The majority of the local road network evolved from historic cart tracks, which were never designed to carry the volume or size of today's vehicles. The huge expansion of estate roads post-war means that all those roads are deteriorating at the same time. About 17% of the local road network in England and Wales is in poor condition,[7] with people increasingly unsatisfied with the state of repair.[37] Deteriorating road-surface condition combined with congestion is estimated to cost the UK economy approximately £30 billion each year.[38] Estimates suggest that the one-time cost for local authorities in England and Wales to tackle the backlog in repairs would cost £16.8 billion and take 12 years.[7]

The railway network experienced rapid expansion in the 19th century. Today, Network Rail manages over 20,000 miles of track; 30,000 bridges, tunnels and

Case study four | **Nuneham Viaduct, Oxford**

© 2025 Network Rail

The closure of the Nuneham Viaduct between Didcot and Oxford in spring 2023 highlights the growing risk posed by ageing infrastructure under increasing environmental stress. This 160-year-old structure suffered a complex failure involving one of its supports sinking into the underlying clay soil.[47] Funding for the remedial works at the viaduct had been confirmed and the contractors were already on site, however, weather-related accelerated deterioration resulted in significant disruption. This led to emergency closure of a critical rail corridor for over two months. The disruption severed direct passenger services between Oxford and London and forced a diversion of around 40 freight trains per day,[48] including flows from the Port of Southampton to the Midlands.

> Today, Network Rail manages over 20,000 miles of track; 30,000 bridges, tunnels and viaducts; and 190,000 earthwork assets, comprising 70,000 soil cuttings, 20,000 rock cuttings and 100,000 embankments, many of which are over 150 years old. Together, these assets would cost around £600 billion to replace

viaducts; and 190,000 earthwork assets, comprising 70,000 soil cuttings, 20,000 rock cuttings and 100,000 embankments, many of which are over 150 years old.[43] Together, these assets would cost around £600 billion to replace.[44] Network rail discovers around 100 broken rails throughout the network that require repair each year.[45] Additionally, and like other ageing infrastructure, the rail network is affected by changing weather patterns, leading to more weather-related disruption.[46] Asset faults cause 25% of all rail delays, and Network Rail has reported a 50% increase in weather events impacting assets over the past five years.[44]

2.2.4 | System governance

The governance of infrastructure across the UK is complex and is devolved to different national and local levels across the UK. In the following tables we set out some of the key stakeholder groups and organisations that govern our infrastructure across water, transport and flood defence. The tables are not exhaustive of the complexities of devolved governance, nor do they capture the complexities of interdependencies between different infrastructure sectors. For example, many infrastructure assets such as roads rely on surface drainage to manage rainwater and prevent flooding. While maintenance of asset drainage generally remains with asset owners, these networks often interact, for example by draining into sewers, creating split governance across interconnected systems.

In Section 3.0, where we assign urgent actions to different stakeholder groups such as regulators and asset owners, we are assigning those to the specific organisations identified in the above tables.

Table 1 | **Infrastructure asset owners, operators, and regulators in the UK by sector and country**

Water and wastewater

Country	Assets	Asset owners/operators	Regulators
England	Water assets including reservoirs, water treatment works, water mains Wastewater assets including sewers, pumping stations, wastewater treatment works	Water and sewerage companies (9) Water-only companies (9)	Ofwat Environment Agency Drinking Water Inspectorate
Wales		Water and sewerage companies (2)	Ofwat Natural Resources Wales Drinking Water Inspectorate
Scotland		Scottish Water	Water Industry Commission for Scotland Scottish Environment Protection Agency Drinking Water Quality Regulator for Scotland
Northern Ireland		Northern Ireland Water	Utility Regulator Northern Ireland Environment Agency Drinking Water Inspectorate, Northern Ireland

Flood defence and flood risk management

Country	Assets	Asset owners/operators	Regulators
England and Wales	Strategic flood defence infrastructure including major flood barriers, river embankments	Environment Agency (England), Natural Resources Wales (Wales)	
	Local flood defence infrastructure including embankments, culverts, sewers	Local authorities Private landowners Water and sewerage companies	
Scotland and Northern Ireland	All flood defence assets	Local authorities Scottish Water (Scotland), Northern Ireland Water (Northern Ireland) Private landowners	

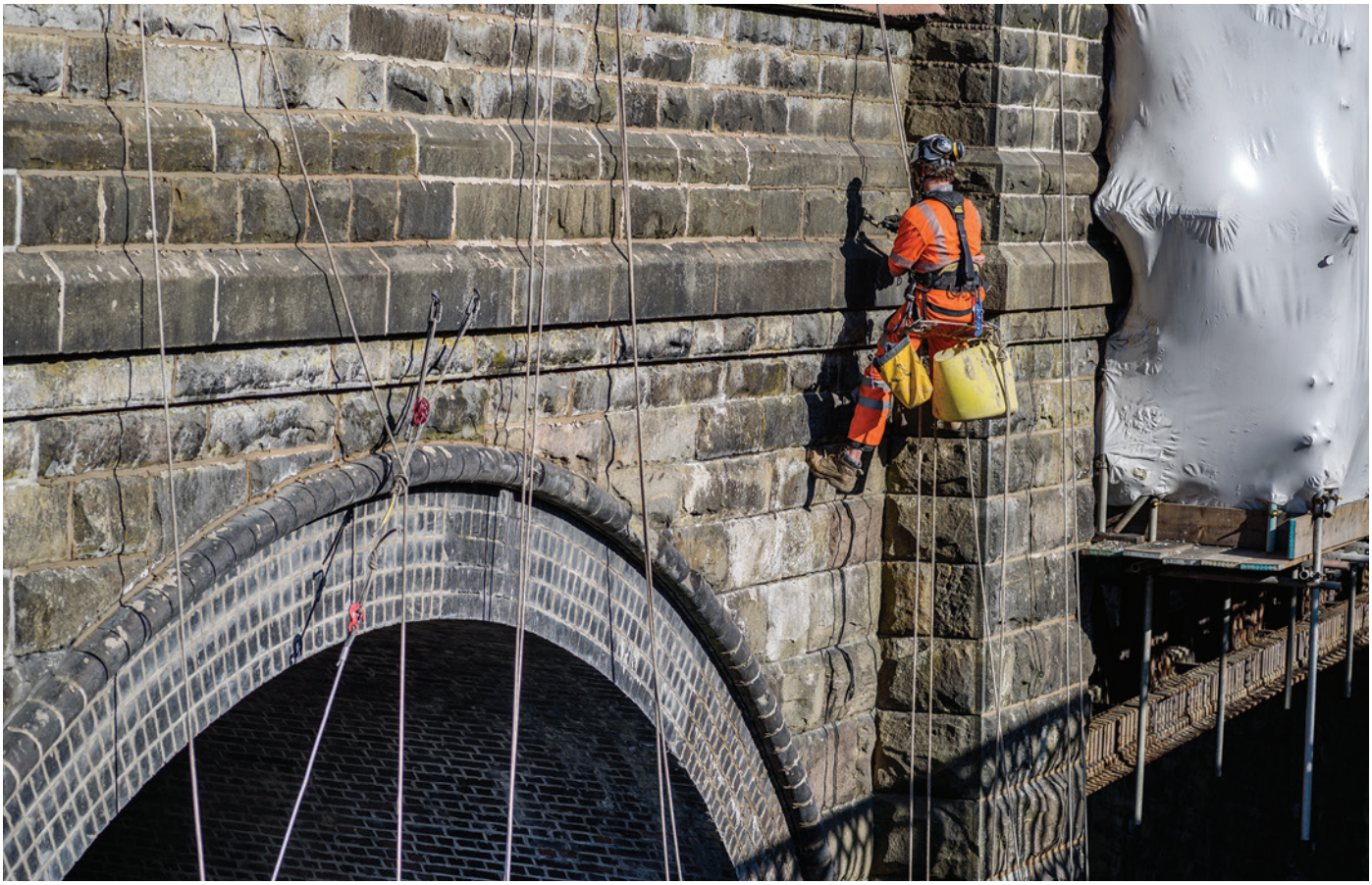
Transport – rail

Country	Assets	Asset owners/operators	Regulators
England Wales Scotland	Track, embankments, bridges, signals, some stations	Network Rail (public)	Office of Rail and Road
Northern Ireland		NI Railways (public)	Department for Infrastructure Office for Rail and Road

Transport – road

Country	Assets	Asset owners/operators	Regulators
England	Strategic Road Network Local roads London roads	National Highways Local Highway authorities Transport for London	Office for Rail and Road
Wales	Strategic Road Network Local roads	Trunk road agents (North Wales and South Wales) Local authorities	
Scotland	Trunk Road Network Local roads	Transport Scotland Local authorities	
Northern Ireland	All roads	Department for Infrastructure	

> A 2023 survey found that, in Great Britain, 68% of people agreed that the country is not doing enough to meet its infrastructure needs, and 70% agreed that the infrastructure in the country has not been sufficiently adapted to cope with future changes in the climate



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2.3 | **Future trends**

This section explores trends in asset condition across the three sectors covered by this report. A 2023 survey found that, in Great Britain, 68% of people agreed that the country is not doing enough to meet its infrastructure needs, and 70% agreed that the infrastructure in the country has not been sufficiently adapted to cope with future changes in the climate.[49]

There is limited public data available on the changing condition of infrastructure assets. However, replacement rates and funding commitments can give some clue as to whether the level of maintenance, renewal and enhancement is appropriate, given the accelerating decline of asset condition as they age.

Notwithstanding increased policy focus on the importance of maintenance, renewal and enhancement, the size of the backlogs in maintenance will still leave difficult decisions for asset managers.

With the publication of the 10 Year Infrastructure Strategy, the UK government has announced a new £1 billion Structures Fund to support the repair of transport infrastructure such as bridges, tunnels and flyovers.[50] The fund is intended to ensure our infrastructure is more resilient to extreme weather events and to make every day journeys safer, smoother and more dependable. However, the size of this fund is small compared to the scale of spending required.

2.3.1 | **Water and wastewater**

Ofwat has found that renewal rates have fallen to unsustainably low levels, with companies extending the life of assets far beyond the average expected asset life.[51]

Across Price Review 19, water companies forecast and were funded to renew water mains at an average of 0.4% per year. The National Infrastructure Commission found that, considering renewal rates since the 1990s, this rate would imply asset lives of up to 180 years,[52] with research showing that some modern polyethylene pipes may last up to 160 years.[53] However, this target replacement rate has not been met, and instead water companies have delivered an average rate of 0.1% per year across Price Review 19,[51] implying expected asset lives of up to 1,000 years.

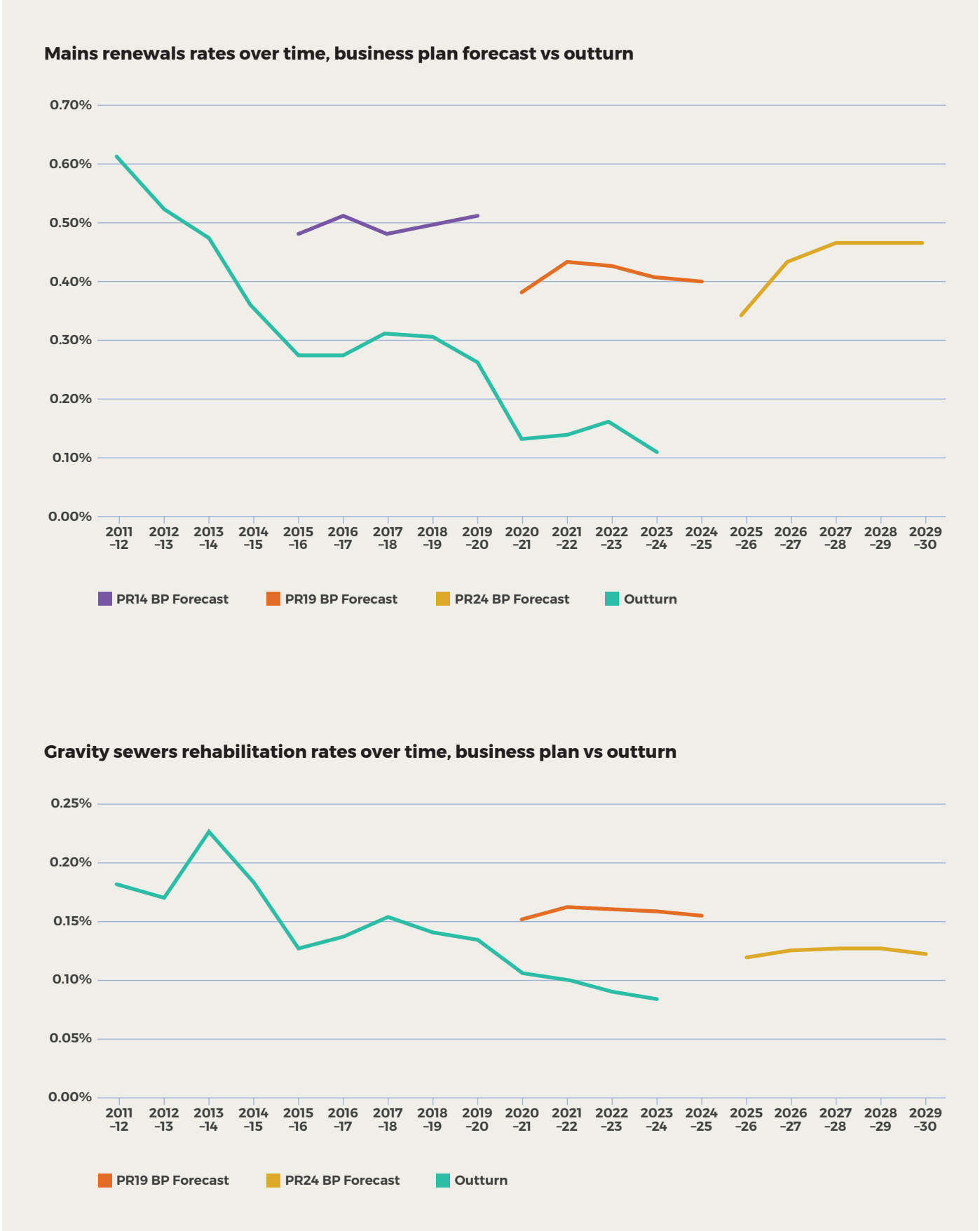

Figure 2 | **Rates of rehabilitation forecast and delivered for water mains and gravity sewers. Ofwat.**[51]

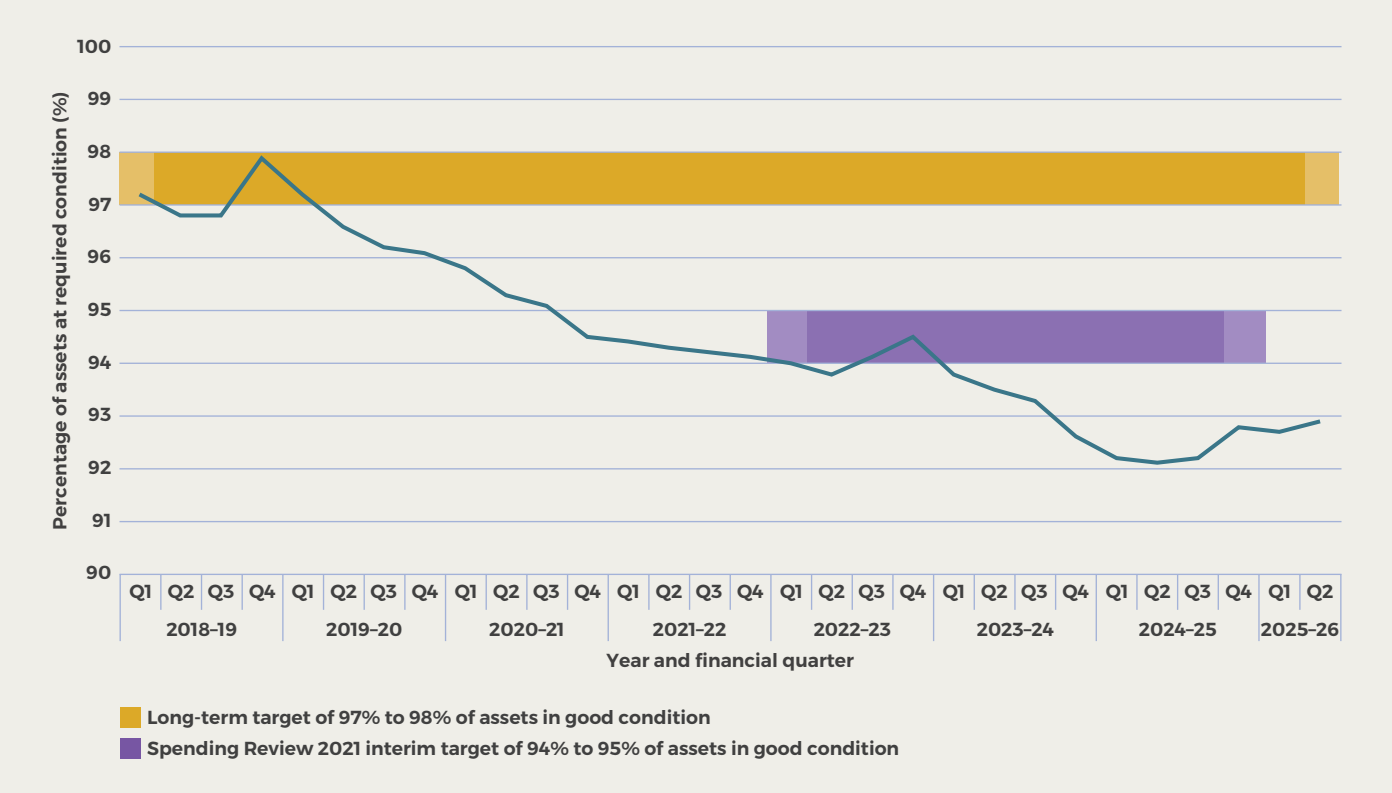

Figure 3 | **The graph shows a steady decline in asset condition at an average rate of 0.84% per year from Q4 2018/19 to Q2 2024/25. This was a result of below-required funding settlements over the period (SR15 was the last funding settlement meeting the required needs), the impacts of severe flooding during the autumn and winter of 2023/24 and the increased cost of infrastructure maintenance and repairs due to inflation over the period. Recent interventions including the repurposing of £108 million from capital, together with the good weather of 2025, has increased asset repair rates and stabilised condition above 92% for the last 18 months. Had additional funding not been provided, it is likely that asset condition would have continued to decline at 0.84% per year. In the longer term the EA will need to invest further funding into asset maintenance to reduce asset deterioration rate and increase condition above 92% to return assets to their optimum condition of 98%. Data provided by the Environment Agency.**

For wastewater, water companies forecast to rehabilitate gravity sewers at a rate of 0.16% per year (implying a 625-year asset life), however, they are only delivering an average rate of 0.09% per year (implying a 1,100-year asset life).

No age or condition data is understood to be gathered on other critical civil structures in the water sector such as service reservoirs or treatment works.

To address this backlog, and address public concern about pollution, Price Review 24 has approved a quadrupling of new investment in capital projects over the next five years.[10]

In Scotland, Scottish Water is currently only investing at 40% of the necessary long-term replacement rate of water and wastewater assets given the reality of ageing assets and the impacts of climate change.[54]

2.3.2 | Flood defences

Without significant investment in flood prevention and resilience, annual damages to property and infrastructure from flooding is projected to rise sharply, potentially reaching £3.6 billion by 2050.[23]

There has been a recognition that the balance between new construction and maintenance needs to shift because it is important to maintain existing defences. For the EA, the 2025 Spending Review saw a shift of funding from capital to maintenance spend with "the most money that, again, has ever been put into maintenance". However, this funding is unlikely to be sufficient to bring the number of assets at required condition up to the 98% target.[55]

The EA analysis of the value of all of their assets relative to their modern equivalents show that their assets are on average around 60% through

their useful economic life,[56] which highlights the importance of investing in our existing assets to achieve the lowest cost of ownership. Some major defences in Lincolnshire, the Humber and London will, however, reach the end of their maintainable life this century, requiring replacement and enhancement.[55]

The government and the EA have announced that more than 1,000 flood defence projects will either be constructed or repaired, aiming to safeguard thousands of homes and businesses from flooding risks.[57]

2.3.3 | **Transport**

In England, prior to 2015, funding for the Strategic Road Network was on an annual cycle. This, combined with funding cuts during 2010–2015, led to a focus on short-term fixes, which means that more complex interventions are now needed to maintain the network's performance.[8] The funding mechanism changed in 2015, and National Highways now receives a multi-year funding settlement through the Road Investment Strategy. In the Road Investment Strategy 2: 2020–2025 (RIS2), 40% of the total funding (£10.8 billion) went into operations, maintenance, and renewal activities.[8] Road Investment Strategy 3: 2026–2031 (RIS3) is expected to have an even greater focus on the maintenance and renewal of the existing network,[58] and a number of projects from RIS2 are expected to overrun into the RIS3 period.[59] This suggests a growing challenge with maintenance and indicates that allocated funding in previous settlements was not sufficient.

For local roads, historic underinvestment has meant that the average resurfacing frequency across local roads is once in every 93 years.[7] In 2023, DfT announced £8.3 billion in additional long-term funding for local roads maintenance up to March 2034.[60]

Network Rail's rate of strengthening earthworks via renewal is typically between 0.5% and 1.0% of the asset base every five-year control period.[43] Through Control Period (CP) 7, between 2024–2029, Network Rail has planned for £19.3 billion on replacing old assets with new, and £12.6 billion on day-to-day upkeep of current assets, a 6% rise on CP6 maintenance spending.[61]

However, even with this funding, Network Rail has projected that its assets are ageing faster than it can afford to renew them in CP7, meaning a growing portion of core rail infrastructure assets will be nearing the end of their expected life during the control period.[44] To improve value for money and mitigate the

Box 2 | **A case study on trends in structural conditions of rail**

2025 marked the 200th anniversary of the modern railway. Today, Network Rail manages 20,000 miles of track and 30,000 bridges, tunnels and viaducts across Britain.[62] The majority of railway bridges were built over 100 years ago, and the oldest metal bridges are in the poorest condition.

Prior to Control Period 5 (2014–2019), Network Rail prioritised its capital investment on arresting actively failing assets or in the recovery of assets following failures.[43]

From 2012 onwards, Network Rail has placed a greater focus on maintenance of structures, signalling and track improvements. At first, the focus of this new approach was aimed at the assets at highest risk with the majority of resource targeted at addressing known defects. However, it was recognised that in addition to addressing those assets in the poorest condition there is also a need to commit sufficient resource to prevent other assets degrading into the poorest condition in the future. Recognising this, Network Rail has now evolved its approach in several ways:

- Inspection processes are more advanced, with more invasive processes providing higher quality information, which enables better understanding of degradation rates and foresight of challenges.
- Greater staff resource is allocated to asset management, with a custodian model based on better data, training and knowledge-sharing.
- The budget for minor works has increased.
- A supervisory approach from the Office for Rail and Road is an enabler of good stewardship practices, reaching a balance between heavy maintenance and renewal.

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This evolution of approach is based on the principles of good asset stewardship, reaching a balance between maintenance and renewal. This approach is further supported by the Office for Rail and Road through ongoing monitoring and regulation.

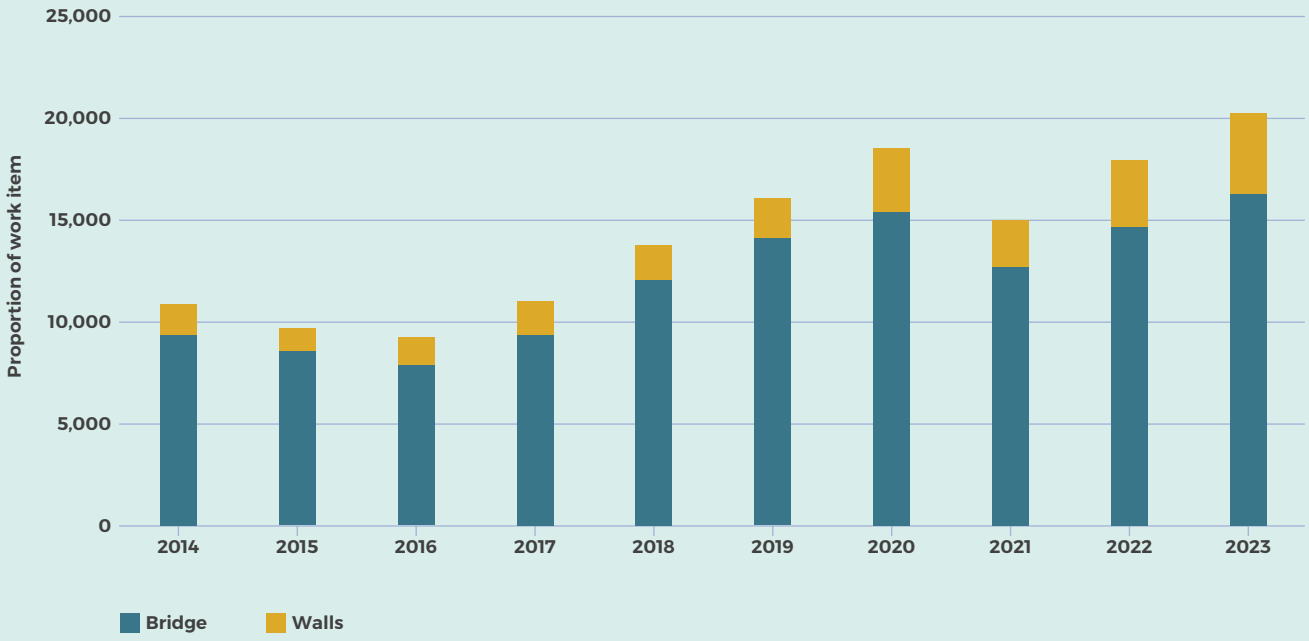

Figure 4 | **The total count of work items for bridges and retaining walls identified during routine inspections per year. The graph shows a growing volume of work items identified per year. Data provided by Network Rail.**

Over the course of Control Period 6, Network Rail spent £11.2 billion on maintenance, £10.6 billion on enhancement and £21.1 billion on renewals across all Network Rail assets.[63]

However, despite this focused approach and funding, the data indicates:

- The number of defects being found is increasing, a growing number of assets are in poor condition, and proportionally more of those assets are at higher risk (Figure 4 for bridges and retaining walls).
- Service performance is declining with an increase in temporary speed restrictions needed to manage defects (Figure 5).
- Demand for minor works is growing, taking priority over renewals, with the volume of renewals declining.
- Climate change is putting the system under additional strain and introducing new challenges.
- There is competition for resources as all asset classes are in need of simultaneous attention: signalling, track, embankments and structures.

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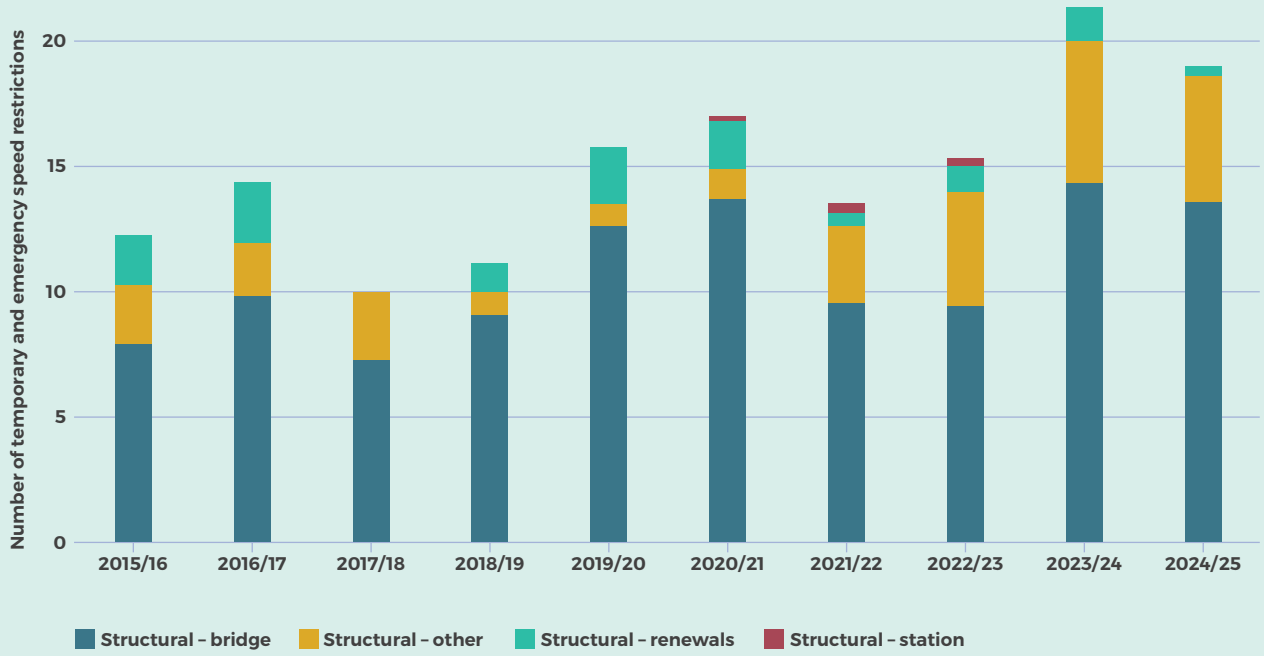

Figure 5 | **Annual count of temporary and emergency speed restrictions associated with structures lasting more than seven days. The graph shows an upward trend in restrictions over time. Data provided by Network Rail.**

- The trends in asset condition suggest that it will be increasingly challenging to maintain our ageing rail infrastructure to current service levels with the resources currently allocated. Network Rail are pursuing learning, continuous improvement, innovation and technology gains to enhance its management of its assets. These cannot fully substitute the need for renewals; however, they can extend the serviceable life of assets and reduce the number of assets that need immediate renewal. These actions include: Deploying technologies to capture asset state more accurately, replacing the subjectivity of human visual examination.
- Improved transparency and sharing of knowledge, drawing together data on asset condition, work done, and asset performance.
- Decision support tools that assist asset managers in prioritising work and enable better management oversight and assurance.
- Training and development programmes for asset stewards.

> The number of defects being found is increasing, a growing number of assets are in poor condition, and proportionally more of those assets are higher risk

affordability gap, Network Rail are pursuing several initiatives including improving implementation of learnings from incidents, deploying new technologies to capture asset condition more accurately, strengthening management of weather-sensitive assets, new systems to improve sharing of information, and tools that support operation of the network in extreme weather.

2.4 | Heightening pressures and demands

2.4.1 | Climate change

Climate change will have impacts across all infrastructure sectors, and its impacts are already being observed. Climate change is leading to hotter, drier summers; warmer, wetter winters; and more frequent and intense storms.[55] These place greater strain on existing assets, which were not designed with these extremes in mind.[64] The increased frequency and severity of extreme weather events coupled with the age of assets can be expected to result in accelerated deterioration of assets.[5]

The combined impacts of climate change and asset age are more acute where assets are less well maintained — and therefore more susceptible to extreme weather. For example, for roads, water can penetrate existing cracks or defects, leading to the formation of potholes and, in time, undermine the entire structure of the road.[5] Network Rail has found a clear link between intensity of rainfall and earthworks failures. It found that failures are further exacerbated when intense rainfall is combined with hotter, drier summers.[65]

One of the biggest impacts will be the increase in flooding. According to the EA, climate change is projected to increase the total number of properties vulnerable to flooding from rivers and the sea from 2.4 million to roughly 3.1 million over the period from 2036 to 2069,[66] assuming that no new flood defences are built.[55]

Climate change is also driving growth in surface-water flooding risk, with the number of properties located in areas at high risk of flooding from surface water projected to rise from 4.6 million to 6.1 million between 2040 and 2060.[66]

Infrastructure is at risk from flooding as well. Around a third of all roads and railways are in areas at risk from one or more sources of flooding. Climate change projections estimate that this will rise to 46% of all roads and 54% of all rail by the mid-century.[66] A third of water pumping stations and treatment plants are also at risk of flooding.

The EA will need to maintain and upgrade assets to cope with climate risk. Natural flood management will need to be considered to manage the threat from surface water.[55]

2.4.2 | Changing use and demands of assets

For water and wastewater assets, a steady growth in the UK's population over the last 20 years[67] has increased demand for potable water and wastewater provision. Some of the greatest percentage increases in population growth projected between 2025 and 2055 are in the south and east of England, which are the driest regions of the country.[68,69] Without action, in England, a five-billion-litre-a-day shortfall in public water supplies is projected by 2055, equivalent to approximately 36% of current daily public water supply,[70] with an additional one billion litres needed for other uses in industry, agriculture and power generation.[71] This shortfall reflects changing needs for drought resilience, environmental improvement, and changes in water availability due to climate change.

Of new homes that were built in England between 2014 and 2024, 8% – that is almost 110,000 homes – were built in a flood zone.[72] Flood defences play a key protective role for many of these areas. As more homes are built in these flood zones, the potential impact of a failure in flood defences is in turn increased.

Demand on transport infrastructure continues to grow. Car ownership has been growing consistently. The proportion of households in Great Britain with access to one or more cars has steadily risen over the past 50 years,[73] with over 41 million vehicles on the road in 2024.[74] The Department for Transport's projections indicate a 22% increase in traffic between 2025 and 2060.[75]

The UK government has set a target to grow rail freight by 75% by 2050, which will require an additional 450 freight trains per day.[76] Passenger rail journeys almost doubled over the 20 years prior to the pandemic,[77] with passenger numbers having broadly recovered to pre-pandemic levels as of 2024–25.[78] Since the pandemic, demand has shifted from peak commute hours towards demand spread throughout the day, with leisure being the most common reason for people travelling by rail in 2025.[79] Demand for a seven-day-railway pushes maintenance work to happen overnight to minimise disruption to passengers.[80]

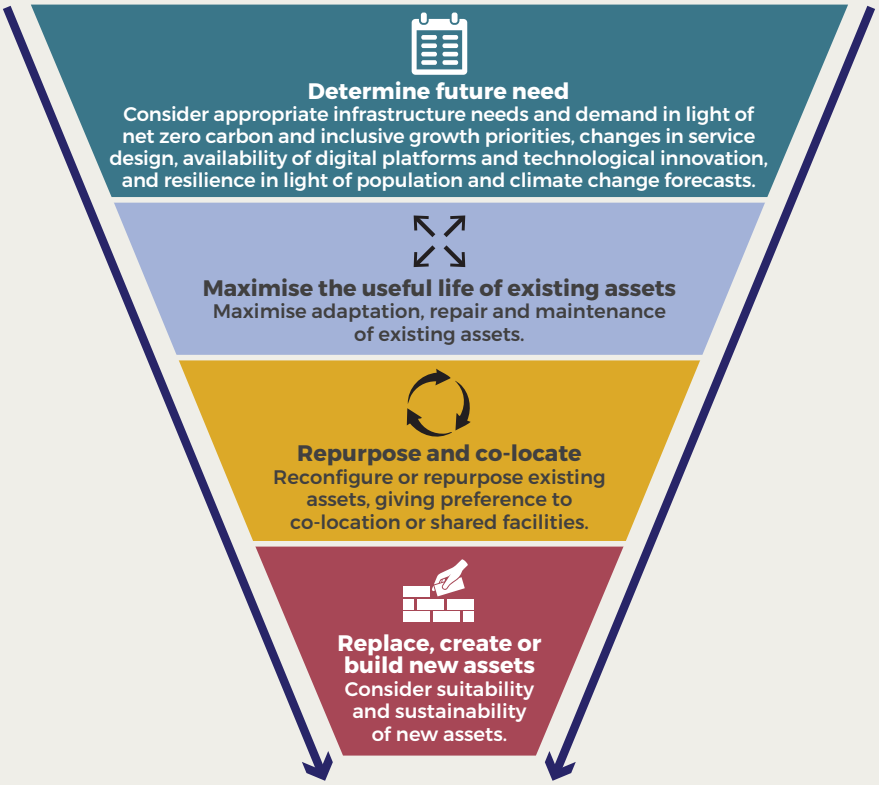

Figure 6 | **New Scottish Government investment hierarchy.**[82]

2.5 | The opportunity

There is growing recognition across government, regulators, and delivery agencies that maintaining and optimising existing infrastructure is vital to economic growth, public safety, and climate resilience.

The UK government's 10 Year Infrastructure Strategy acknowledges the poor condition of UK's economic and social infrastructure that, without action to prioritise the maintenance of existing assets, will constrain growth and climate resilience.[81] The Infrastructure Strategy places the maintenance and optimisation of existing assets at the top of its design hierarchy, resulting in more funding allocated to maintenance in recent settlements for water and wastewater, flood defence and transport.

In 2021, the Scottish government adopted a similar infrastructure investment hierarchy that prioritised maximising the life of existing assets over building new (**Figure 6**).[82] Since then, reduced capital budgets, rising project costs, and the increasing maintenance demand have created significant challenges for ministers, leading to difficult decisions around pausing or cancelling planned infrastructure projects.[83]

Prioritising maintenance makes sense on multiple fronts. Proactive maintenance is much less expensive than the cost of failure (**Box 3**); and maximising the life of assets avoids the embodied carbon required to replace assets. However, infrastructure cannot be repaired forever, so conscious, informed choices need to be made about what infrastructure outcomes we want to prioritise and how we best balance maintenance, renewal and enhancement to meet them.

Section 2.1 and 2.2 have highlighted the consequences of not effectively managing our ageing assets, and some of the factors that will put our infrastructure under additional pressure over coming

Box 3 | **The value of maintenance**

The overall cost of maintenance tends to be lower when maintenance is undertaken proactively and in a timely manner. This is because costs tend to rise non-linearly if assets cross certain thresholds of condition. Furthermore, as assets' condition degrades and service provision is impacted, the value of the asset declines.

While reactive maintenance is necessary to address immediate safety issues, it is not a sustainable solution and is significantly more expensive than investing in preventative maintenance and structural renewal schemes. These are significantly more cost-effective over time, preserving the life of infrastructure and reducing the need for repeated emergency repairs.

The estimated return on investment varies, however. In the case of local highways, maintenance provides good to very good return on investment. With every additional £1 invested, an absolute minimum return of £2.20, with further socio-economic benefits estimated to provide up to £5+ return.[2] Maintenance of flood defences is also very cost effective, with every £1 increase in maintenance spending resulting in almost £7 saved in capital spending.[3] Including the avoided damages, the EA suggests a return of £11 for every £1 invested in maintenance.[4]

A recent National Audit Office report on maintenance of public service facilities (buildings) found that funding constraints prevented government departments from focusing on preventative maintenance, which typically delivers the best long-term value for money, but that funding to support preventative maintenance is not seen as a priority.[84]

As managing ageing assets is a challenge all countries will face, there is a prize if we get this right, creating an opportunity for the UK to pioneer and export our expertise globally, and giving the UK a reputation of capability and competence

years. The additional funding that has been allocated to maintenance is important, but is not going to be enough to address existing backlogs while meeting current service expectations.

In a constrained fiscal environment, every maintenance, renewal or enhancement project must be delivered in the most joined-up, cost-effective way. This is challenging wherever the data on asset condition is poor, and where the policy landscape remains complex, with fragmented responsibilities across sectors and levels of government.

Delivering effective infrastructure stewardship will require ongoing coordination between national policy, regulatory incentives, engineering practice, and local delivery, in a way that crosses sectoral boundaries. This is reliant on good data, competent people and innovative delivery to ensure that the right intervention happens at the right time.

As managing ageing assets is a challenge all countries will face, there is a prize if we get this right, creating an opportunity for the UK to pioneer and export our expertise globally, and giving the UK a reputation of capability and competence. The compelling economic case for change is amplified by the carbon benefits. Extending the life of our existing assets is one of the key contributions that engineers can make to reducing the carbon intensity of our infrastructure systems.

The following section sets out seven key enablers for change to embed long-term asset stewardship into the management of our ageing infrastructure.

3.0 | Seven enablers of change

Figure 7 | **The seven enablers of change**

In recent years we have seen several prolonged infrastructure closures due to ageing assets, which have cost tens of millions to address. We must see these as a leading early indicator of what is to come. As continued deterioration, a changing climate and growth in public demand put our infrastructure under increasing strain, we risk consequences for public health and safety, service delivery and economic growth. To avoid these costs to society, the economy and the environment, we must embrace change that delivers efficient, long-term asset stewardship and ensures our ageing infrastructure remains resilient for future generations.

Through collaborative workshops with engineers, asset owners, operators and policymakers, we identified seven priority enablers for change where action is needed to ensure our infrastructure remains safe, accessible and resilient (**Figure 7**). For each of these areas we set out:

> Clear strategic direction from government about what outcomes and level of service our infrastructure should deliver is an essential foundation to successful regulations, and in turn, standards

- The context and policy landscape.
- What a good outcome would look like.
- The urgent actions needed to start to move us in that direction.
- Who should lead on each of the urgent actions. In doing so, we sometimes use general terms, such as 'regulators', because the recommendations are applicable across multiple sectors and the countries that make up the UK. Table 1 summarises infrastructure asset owners, operators, and regulators across the UK by sector and geography.

3.1 | Strategy, regulation and standards

Clear strategic direction from government about what outcomes and level of service our infrastructure should deliver is an essential foundation to successful regulations, and in turn, standards. The outcomes that governments choose to prioritise will significantly impact the balance that is placed across maintenance, renewal and enhancement.

Historically, governments have not always clearly stated their expected outcomes, which has resulted in a disjointed regulatory landscape, challenges with enforcement, and a lack of clarity for asset owners about priorities.[10] This gap has been recognised in recent policy, reviews and upcoming legislation, including the 10 Year Infrastructure Strategy and the recently introduced Railways Bill, which will give powers to the Secretary of State for Transport to set a long-term strategy that clearly articulates the government's vision and desired outcomes for the railway.[85]

Regulations and standards are needed to support strategy and ensure and enforce infrastructure performance over the long term. Regulations are statutory requirements set in law that set the overall requirements that infrastructure must meet. Standards are agreed ways of doing things that are authored by independent authorised bodies and may be met on both mandatory and voluntary bases. Standards can interpret and guide the implementation of regulations, providing agreed definitions and good practices.

There is a clear gap across many infrastructure sectors in standards that define the level of resilience we want our infrastructure systems to meet,[86] particularly when considering changing climate.[87,88]

A lack of standardised metrics for measuring the condition of infrastructure assets and the performance of the overall system limits our ability to monitor and predicts trends in asset condition and to track progress towards desired strategic outcomes.[89]

What does good look like?

In a good system, the outcomes we want our infrastructure systems to support are clearly articulated consistently across sectors, supported by shared governance arrangements. Systems-level outcomes drive how we manage existing infrastructure, instilling a culture of infrastructure stewardship for the long-term.

Systems-level outcomes are supported by meaningful targets and reporting mechanisms so that regulators can monitor progress and trends, and assure that asset operators are delivering against strategic outcomes.

- Regulation is focused on the system-level outcomes we want infrastructure to support, not on asset-level performance-based metrics, which can lead to unintended consequences. Flexible regulatory frameworks support long-term, whole-life valuations to encourage sustainable interventions over short-term fixes.
- Regulations and standards are underpinned by guidance and codes of practice to help asset managers to make the right decisions.
- Standards for the design, construction and maintenance of our infrastructure assets consider the whole life cycle of the asset and the evolving demands that they face. These standards:
  - Establish consistent definitions for asset condition, asset risk and resilience.
  - Establish forward-looking asset condition and system performance metrics that are used to measure and forecast a system's long-term health and resilience, thereby enabling better evaluation of progress and assurance that the right actions are being taken to achieve system level outcomes.

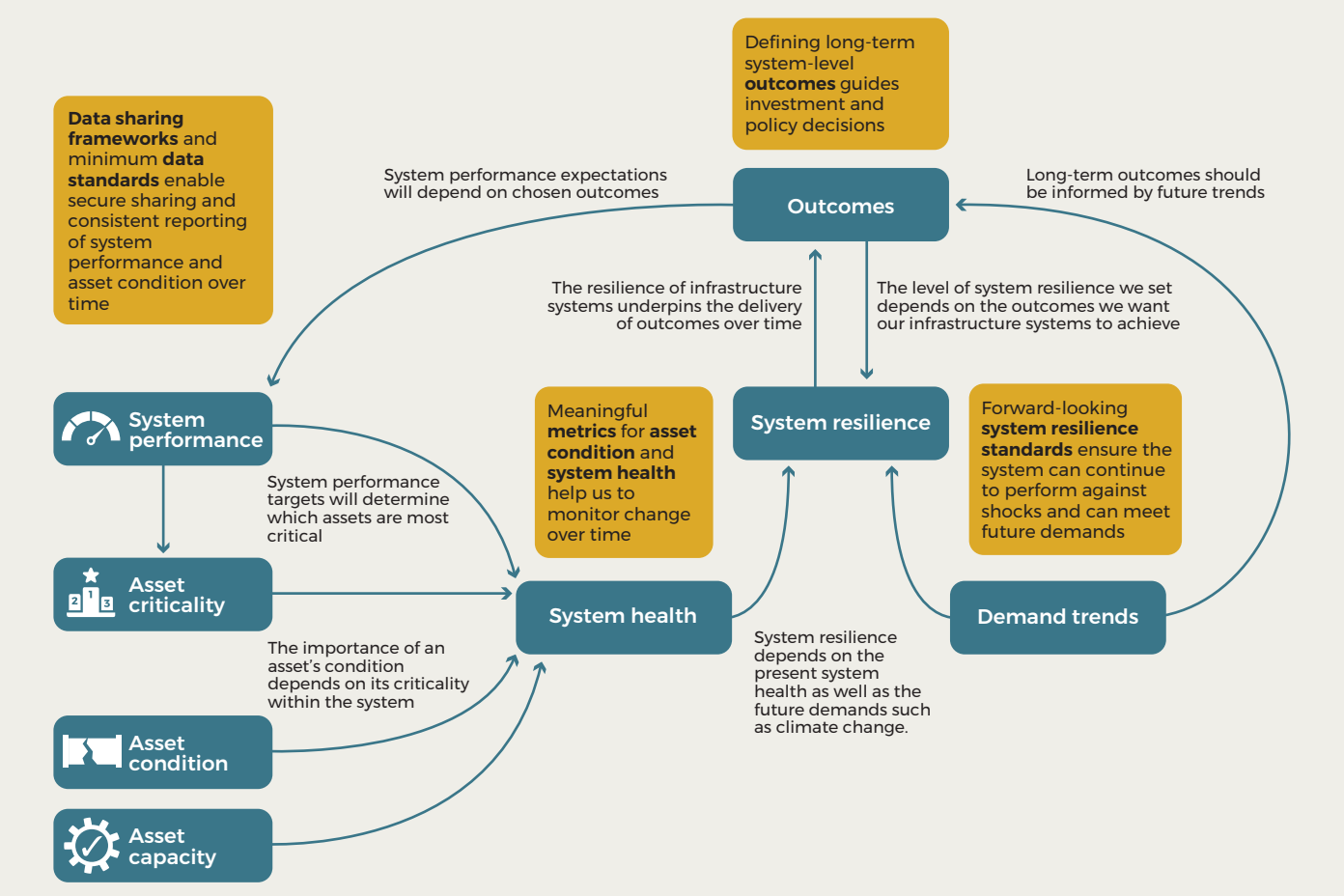

Figure 8 | **System resilience framework**

- Are supported by metrics and methodologies, agreed between regulators and asset owners, to allow comparison of infrastructure performance across sectors, enabling greater collaboration and balanced decision-making on maintenance, renewal, and enhancement.

Urgent actions

1. **Governments** should define the system-level outcomes it wants each infrastructure sectors to achieve over the next 25 years, to guide investment and policy decisions.
   - **Regulators** and **standard-setters** should develop forward-looking systems resilience standards to ensure that our infrastructure systems continue to deliver the desired outcomes under future demand and climactic conditions.
   - These resilience standards should be supported by **regulator** mandated 10-year asset management plans to encourage prioritisation over the longer term.
   - Long-term system-level outcomes should be stated, or the path to setting them defined, in upcoming strategies such as the Long-Term Rail Strategy and Water White Paper.
2. **Governments** should use upcoming infrastructure investment strategies to explicitly prioritise the maintenance and renewal of existing assets.
   - This includes the Infrastructure Investment Plan in Scotland, Infrastructure Finance Plans in Wales, the Investment Strategy Northern Ireland and sector specific strategies such as the third Road Investment Strategy (RIS3), Control Period 8 (CP8) and Price Review 29 (PR29), and the Structures Fund in England.
3. **Asset owners**, **regulators** and **standard-setters** should collaborate to develop a set of meaningful metrics and standards to assess asset condition and infrastructure system health and how it is changing.
   - This must be supported by regulators holding asset owners to account through an effective supervisory approach.

> Evidence shows that preventative work offers greater value for money. This knowledge and associated practices need to become better embedded in project appraisal processes

- The assessment of infrastructure system health must incorporate asset condition, function and change over time, accounting for assets' roles within the system.
- In England, **NISTA** and in Scotland, the **Scottish Futures Trust**, should support coordination efforts across sectors to develop a common framework for the consistent comparison of system health and risk.
- Regulators should require **asset owners** to report system health and asset condition data and trends to regulators on an annual cycle, so that greater scrutiny can be provided and long-term trends can be tracked.

3.2 | Financing

Decades of underinvestment in infrastructure maintenance is resulting in higher one-off spending requirements to replace and renew assets that have reached the end of their maintainable life.

Evidence shows that emergency repairs are more expensive and less effective than proactive, preventive maintenance (see **Box 3**).[90] We therefore know that maintenance is cost effective, however it can be challenging to use this evidence to make a compelling case for an individual maintenance project, balanced against competing short-term demands for capital budgets, renewals and enhancements.

For example, short-term funding cycles and multiple funding schemes for local road maintenance have resulted in local authorities having limited flexibility to balance more cost-effective preventative maintenance against short-term reactive work.[37] This contrasts with the five-year cycle associated with funding for the strategic road networks and that used by the water industry. However, any cyclical funding period can suffer from 'boom and bust' without rigorous long-term strategic oversight.[91]

The separation of capital and operational expenditure, particularly in the public sector, prevents asset owners from being able to optimise spend between maintenance, renewals and enhancements. Operational budgets are subject to lots of competing demands, making it challenging to make strategic investments in maintenance and renewal. Capital budgets tend to drive a focus on new or time-limited activity. In Price Review 14, Ofwat introduced a total-expenditure (totex) approach to allow water companies more flexibility.[92] A totex approach that is supported by rigorous technical oversight and a culture of infrastructure stewardship offers the potential to allow asset owners to balance demand and to take a better whole-life approach to asset management.

In the 10 Year Infrastructure Strategy the government committed to providing greater long-term-funding certainty. Capital budgets were set at the Spending Review 2025 for the next five years. Some projects may receive funding settlements of up to 10 years. These will be extended every two years at regular spending reviews to avoid 'cliff edge' budgets.[81] For sectors such as flooding and coastal erosion infrastructure, the government has committed to a 10-year capital investment programme.

What does good look like?

Evidence shows that preventative work offers greater value for money (See **Box 3**). This knowledge and associated practices need to become better embedded in project appraisal processes.

- Financing models offer asset owners predictability, enabling improved planning and resource sharing across sectors and supply chains.
- Financing settlements give asset owners the flexibility to balance spending across maintenance, renewal and enhancements, supported by appropriate oversight.
- Funding settlements and investment frameworks are informed by good engineering practice, and designed to reflect whole-life value, including the cost of inaction. They support sustained investment in preventative maintenance, renewal and enhancement.
- Operating models recognise the whole-life value of infrastructure assets so that investment decisions can be made that balance the needs of current users, future generations, and both public and private sector actors.
- Private and public financing mechanisms are underpinned by clear risk-sharing arrangements and accountability structures, with built-in incentives to invest in maintenance.[93,94]

As infrastructure systems age and grow more complex, a skilled workforce is essential to sustain safety, resilience, and innovation. Yet across sectors, organisations are facing acute recruitment and retention challenges, especially in technically specialised roles

- Financial assessors are appropriately skilled to understand whole-life needs of assets and have access to appropriate technical expertise.

Urgent actions

4. **HM Treasury** should lead a cross-government review of how current funding, financing and accounting models and guidance affect decisions on maintenance, renewal and enhancement. This should be conducted by the end of 2026, to inform the next update of the 10 Year infrastructure strategy. As part of this, HM Treasury should:
   - Assess whether current evaluation approaches and thresholds for benefit-cost ratios are appropriate for maintenance, enhancement and renewal.
   - Review whether the separation of capital versus operational budgets and associated spending restrictions are appropriate for asset owners so that they can achieve long-term efficient and balanced investment in existing infrastructure.
   - Review the standard 60-year appraisal period for civil linear infrastructure projects. Many of our civil, linear assets are much older than 60 years, and it may be more cost efficient to appraise them as though they will exist in perpetuity through proper maintenance, renewal and enhancement.
   - Review how discount rates are applied in practice to the assessment of infrastructure maintenance, renewal and enhancement schemes.
   - Consider the need for additional guidance for place-based business cases, explicitly addressing the maintenance requirements of retained legacy assets that underpin and serve that place as well as new assets.
   - Review the maintenance issues facing the UK's major assets, supported by external expertise, and publish an estimate of the value of the national maintenance backlog.

3.3 | Skills and capabilities

As infrastructure systems age and grow more complex, a skilled workforce is essential to sustain safety, resilience, and innovation. Yet across sectors, organisations are facing acute recruitment and retention challenges, especially in technically specialised roles.

- The rail sector is facing a critical loss of knowledge and experience, with up to 90,000 workers expected to leave through retirement or attrition by 2030.[83]
- In the water sector, 66% of surveyed engineers said they were planning on leaving the industry in the next three years, and 23% are set to retire in the next five years.[95]
- The EA experienced a 33% drop in the number of registered civil engineers working in flood and coastal erosion between 2013 and 2018.[96]
- Audit Wales found that National Resources Wales and local authorities found it particularly challenging to recruit professionals with the right technical skills.[97]

For the water sector, the gaps in asset owner capability[98] are also mirrored by skill gaps within the regulators, with the Independent Water Commission finding that Ofwat did not appear to have adequate in-house understanding of the assets that water companies are responsible for.[10]

The skills shortage is exacerbated by the lack of training on offer,[99] and the sometimes negative and unexciting reputation asset management gets. Investors and employers in regulated infrastructure sectors need a credible, long-term strategy from government to give suppliers the confidence to invest in skills. Initiatives such as the Institute for Asset Management's apprenticeships offer important routes into a career in asset management.[100]

Without targeted investment in workforce, skills, and clearer career pathways into asset management, the UK risks falling short in maintaining safe, sustainable, and resilient infrastructure systems.

Government has committed to reforming public procurement, to drive greater investment in skills and supply chains through public contracts and investing over £100 million over three years to support engineering skills in England to support industrial strategy delivery.[101]

What does good look like?

An interdisciplinary workforce, spanning strategic decision-making, operational delivery, technical specialists and frontline operatives, is in place to effectively manage our ageing assets in all corners of the UK. A productive workforce spans foundational skills through to high-level competencies, retaining established skills while evolving to leverage the opportunities for innovation.

- Asset management is recognised not as a niche discipline, but as a purpose-driven career covering all facets and skills required for infrastructure stewardship, from artisanal and technical through to board-level roles.
- Infrastructure stewardship attracts and retains talent through clear career pathways, social values, and opportunities for innovation.
- Education and skills providers offer multiple entry points into gaining asset management expertise, including within wider engineering courses and careers. Infrastructure operators support a pipeline of skills through apprenticeships, degree apprenticeships and vocational training. These are developed in partnership with government and education providers and are supported by long-term funding.

Case study five | **@one Alliance**

The @one Alliance is a joint venture between Anglian Water and several partner firms.[102] The @one Alliance delivery model fosters close collaboration and open knowledge sharing among Anglian Water, its partners and the supply chain.

It runs structured apprenticeship and graduate programmes, including degree apprenticeships in engineering. Through partnerships with education providers such as the College of West Anglia and the Milton Keynes College, the alliance supports and ensures a steady flow of skilled talent into the industry. By investing heavily in apprenticeships and early-career development, @one Alliance has built a resilient pipeline of skilled professionals ready to tackle the challenges of a changing water industry.

- Long-term visibility of governments' infrastructure strategies gives investors and the supply chain confidence to invest in skills, technology and delivery capabilities.
- Asset management professionals are supported in career development and mobility through cross-industry collaboration and alignment of CPD schemes from apprentice through to chartered roles. Greater mobility encourages learning and improvements to be embedded more quickly.
- Asset management expertise is embedded into strategic decision-making on infrastructure investment to meet the long-term needs of asset.

Urgent actions

5. Better data is needed to recognise the bespoke skills needs for asset management. **Asset owners**, working with **regulators** and government skills bodies, should conduct regular forecasts of skills needs for infrastructure maintenance, renewal and enhancement, considering asset portfolio, geography and demographics.
   - This data should feed into NISTA's Infrastructure Pipeline dashboard to give the supply chain confidence in long-term workforce needs.
   - **Government** should facilitate **asset owners** and **supply chain** to partner with **education providers** to develop new training routes into asset management. Government should support specialist qualifications that build capacity and expert capability throughout the supply chain.
6. **Professional bodies**, supported by the Engineering Council, should champion infrastructure stewardship skills as part of purpose-driven careers, by:
   - Reviewing, through the Engineering Council's ongoing work on the Accreditation of Higher Education Programmes, the requirements for course accreditation to ensure a sufficient supply of core technical capabilities for maintenance, renewal and enhancement — including both traditional engineering skills, asset management practices and new technology competencies.
   - Develop and drive flexible CPD schemes that align with modern demands, skill gaps and career pathways.
   - Offer prizes to celebrate maintenance and renewal projects alongside other major projects.
7. **Regulators** and **asset owners** should assess whether their boards have sufficient technical engineering expertise to recognise and manage asset risk and appoint a chief engineer to address any gaps and align priorities as part of a collective responsibility for asset stewardship.

> Significant opportunities exist to bring data from multiple technologies together to examine assets in near-real time. Analytical tools including AI can help uncover trends in data, quantifying how the condition of individual assets and performance of the system is changing over time

3.4 | Data

Cost-reductions and advancements in technologies including drones, satellite imagery and LiDAR have increased the use of sensors and digital monitoring techniques across our linear civil infrastructure. This evolution in digital technology offers great potential for asset managers to understand the condition of their assets and how it is changing better than ever before. Alongside new data streams, frontline expertise remains essential to understanding asset behaviour, history and to capture 'near misses'.

However, the availability, comprehensiveness and quality of data is not uniform across sectors or geographies, and a concerted effort is needed to collect and report on it consistently. For example, Ofwat is actively working with the water sector to gather robust, comparable data on priority assets to improve the collective understanding of asset condition.[103] Without clear reporting requirements, data blind-spots risk being a source of inaction with potentially catastrophic consequences.

Data alone does not give a comprehensive understanding of asset condition or what it means for current and future system performance. Work is needed to enable the data to be collected, translated and interpreted alongside frontline expertise to build a full picture of asset condition trends, and in turn to determine optimal maintenance, enhancement and renewal interventions.

Significant opportunities exist to bring data from multiple technologies together to examine assets in near-real time. Analytical tools including AI can help uncover trends in data, quantifying how the condition of individual assets and performance of the system is changing over time. Aggregating datasets and applying machine-learning techniques across asset classes can build system-level understanding and insight into system health, helping ensure interventions deliver best value for money and long-term system performance and resilience. For example, the concept of digital custodianship brings purposeful integration of monitoring, data and modelling together to support long-term asset stewardship, system health and sustainability.[104]

What does good look like?

- Data is treated as a strategic asset, with organisations incentivised to maintain, analyse, and share it to improve outcomes.
- Asset-imaging and low-power monitoring technologies are deployed at scale, providing structured, high-quality, trustworthy data suitable for analysis to establish asset condition and trends.
- Open, standardised, and interoperable data enables within- and cross-sector collaboration, shared insights, identification of interdependencies, and improved system-level resilience.
- Digital tools are integrated throughout the decision-making process as part of a practice of digital infrastructure stewardship, offering predictive analytical insights that enable preventative action.

Urgent actions

8. **NISTA**, in consultation with counterparts in **Scotland**, **Wales** and **Northern Ireland**, should establish an infrastructure data framework to drive the secure sharing of asset condition and system performance data and trends. This should:
   - be based on minimum data standards for asset condition and system performance.
   - align with efforts and learning from the National Digital Twin programme and feed into the National Data Library to enable research and innovation to better understand infrastructure performance over the long-term.
9. **Sector industry bodies** should spotlight practical and standardised approaches to digital monitoring, modelling and data-driven decision-making that support proactive asset management. Highlighting innovation that addresses common challenges will reduce duplication in research and development efforts, support responsible adoption and maximise returns on investment.
   - **Sector industry bodies** and **standards-setters** should formalise data and survey standards to unlock the potential for the aggregation of datasets and application of AI that enables

asset managers to translate quality asset data into effective long-term infrastructure stewardship.

3.5 | **Innovation**

Successful and impactful change requires innovation at scale. Innovation covers new technologies but also new ways of using existing technologies. While innovations in digital, material and process technologies and practices offer significant potential, their potential will only be realised if they are developed and deployed at scale in an environment with reduced barriers and greater incentivisation.

New technologies can transform how our infrastructure is inspected, monitored, maintained and renewed. The UK is not alone in confronting the challenges of ageing infrastructure, so globally leading innovations present significant export opportunities for services and products in the future. Promising technologies include drones and autonomous robots for visual inspections, and advanced sensors and artificial intelligence incorporated into decision-support tools.

Case study six | **Pipeline rehabilitation**

Between 1990 and 2010 approximately 10% of the water main network in England and Wales was in-situ resin lined and a further 16% was replaced.[108] This large programme resulted in world-leading innovations in techniques and the materials used. When looking back at the work done between 1990 and 2010, it should be noted that:

- The main driver for the work undertaken was to improve water quality. The linings were largely applied to "unlined" cast iron pipes and non-structural liner was used.
- New pipe-lining techniques such as slip-lining and in-situ resin lining were all developed in the UK and have found an international market.

One of the keys to this success was having a continuous, consistent workload which lasted for 20 years enabling private and public sector to work together and invest in new technologies. In addition, the gas sector and water sector worked in parallel to develop solutions which had mutual benefits as ideas and research was shared. This programme resulted in the UK becoming a world leader in pipe rehabilitation and the programme being delivered for a fraction of the cost with far less disruption to customers

Governments are recognising the opportunity to be more innovative – for example Northern Ireland's Minister for Infrastructure committed funding, collaboration, and innovative solutions to tackle Northern Ireland's ageing wastewater infrastructure.[105] Partnership between asset owners and research funders, such as the First of a Kind Rail Competition,[106] and regulatory innovation challenges such as Ofwat's Innovation Fund, are important mechanisms for driving innovation.[107]

What does good look like?

- Research and innovation are purpose-driven and practical, focused on effective asset stewardship, thereby improving efficiency, sustainability, and resilience. Collaboration, knowledge sharing, and best practices are embedded between academia, industry, and asset owners, ensuring real-world adoption and learning support.
- Procurement rules, technical standards, and legal frameworks are kept up-to-date and barriers to innovation at scale are removed.
- The infrastructure sector is better incentivised to embrace innovation, with the capability and confidence to adopt new tools, materials, and practices to deliver strategic goals like carbon reduction and service improvement.
- The rest of the world looks to the UK as an innovator in the end-to-end management of ageing infrastructure, creating significant export opportunities.

Urgent actions

10. **Regulators**, **standards-setters** and **asset owners** should identify and remove regulatory, procedural and cultural barriers that hinder innovation at scale in asset maintenance, renewal and enhancement.
11. **Governments** should work with **sector trade bodies** and **asset owners** to develop contracting models that reduce the legal and commercial burdens on innovators and enable successful solutions to be scaled within and across sectors.
12. **UKRI**, **regulators**, **asset owners** and **other research funders** should establish innovation challenge funds for addressing our ageing infrastructure.
    - Research consortia such as UK Collaboratorium for Research on Infrastructure and Cities should establish an ageing infrastructure community of practice to facilitate cross-sectoral learning.
    - Ongoing but disparate asset management innovation activities should be consolidated so that gaps in adoption and opportunities for deployment can be identified.

3.6 | Societal awareness

Public satisfaction with infrastructure is low. When asked which sectors have declined in quality over the last 10 years, 51% of UK adults surveyed said main roads and motorways, 39% said drainage and sewage systems, 38% said railways, and 32% said flood defences.[23] It's not just the national picture that matters: based on the quality of its infrastructure, the UK was ranked 22nd out of 67 countries in 2024.[109] The perception that the UK is a country with resilient, reliable infrastructure is vital to building the confidence of international investors.

Prioritising maintenance is politically challenging and often unpopular — most maintenance issues, when caught appropriately early, are largely invisible, may not have immediate impending consequences if unaddressed, and addressing them may mean some disruption to services. However, when poorly maintained assets fail or cross safety thresholds and must be closed, the results are highly visible and long-lasting, as shown in the case studies in Section 2.2. Moreover, when systems fail and cause disruption, public trust in infrastructure operators is eroded, as has been observed in the water sector.[110]

One of the most significant challenges is the tension between visible and hidden defects. Potholes and surface deterioration are highly visible to the public and therefore attract the most attention and funding. In contrast, less visible but equally critical issues – such as the condition of bridges, culverts, and retaining walls – often go unnoticed until they lead to failure, restricted services or closure for safety reasons.

Maintenance is essential for the safe and resilient operation of critical national infrastructure. During consultation for the third Road Investment Strategy, the Department for Transport found support for a greater focus on maintaining and renewing the existing network rather than making large-scale enhancements.[111] A 2020 survey showed that 56% of respondents were more inclined to prioritise maintaining and repairing existing infrastructure in Britain before spending on new infrastructure, whereas only 16% preferred the opposite view.[112] However, a separate survey found that less than half of road users who pass through roadworks report being satisfied with their management.[113] This situation can translate into abuse toward roadworkers, with 60% experiencing daily abuse,[114] which has a significant impact on their mental health and contributes to the workforce challenges the sector faces.

The reality is that the maintenance activities necessary for the long-term health of our assets often cause short-term service disruption, and there is clearly a communication gap. We cannot continue to expect our infrastructure to perform in its degraded state without some disruption for maintenance activity. In the same way that temporary speed restrictions help reduce dynamic loads on railways until maintenance or renewals are carried out, longer-term demand reductions may be needed to maintain long-term infrastructure performance.

What does good look like?

- Infrastructure is recognised as essential to delivering the outcomes that people care about, and the benefits of long-term resilience and consequences of underinvestment in maintenance are clearly understood. We cease to take our ageing infrastructure for granted.
- There is a shared culture of infrastructure stewardship among decision-makers in governments, regulators, asset owners and asset managers.
- There is an ongoing dialogue between government, industry, local authorities, and publics across the UK to review appropriate levels of service.
- Prioritisation decisions are more strongly grounded in the evidence with a better awareness of the trade-offs.

Urgent actions

13. An interministerial group on maintenance should be established between **HM Treasury**, **Defra**, **DfT**, **MHCLG** and counterparts in **Wales**, **Scotland**, and **Northern Ireland** to develop a unified national strategy to improve resilience and build a culture of infrastructure stewardship.

14. **Governments**, **regulators** and **asset owners** should work together to develop a new narrative around maintenance that builds public trust at home and abroad and demonstrates global leadership in infrastructure stewardship. To support this:

- **Regulators** and **asset owners** should improve communication about the scale of their asset portfolios, explaining their maintenance needs, and develop accessible public information pages on planned and emergency maintenance works, and the resulting service restrictions.
- **Asset owners** should support media campaigns showing the benefits of maintenance for social outcomes, highlighting good news about maintenance interventions. They should articulate what actions they are taking and explain the choices and trade-offs in a language the public will understand.

3.7 | System coordination

A clear delineation of roles and responsibilities at various levels of government leads to better project execution, ensuring that local governments aren't burdened by national mandates that aren't representative of local needs.[115] However, reviews have shown there is a lack of clarity about asset condition, inconsistent responsibilities, and insufficient funding to adequately address asset maintenance and replacement, particularly in the water industry.[116]

Local authority engagement with infrastructure providers can be ad-hoc and fragmented.[117] For example, resurfacing and reconstruction works are often disrupted by subsequent utility interventions, leading to premature asset damage and unnecessary inefficiencies. Data sharing is part of the solution, however, while the National Underground Asset Register helps address some of these challenges by bringing together data from over 300 asset owners, there remain opportunities for better coordination between organisations, particularly through longer-term planning.

Our ageing infrastructure underpins the delivery of Nationally Significant Infrastructure Projects, which are critical to economic growth and delivering clean power. Through earlier engagement, there are opportunities to ensure upgrades and reinforcements are prioritised in key supporting areas.

Some infrastructure maintenance schemes require consents and licences from bodies like the EA, particularly when works affect watercourses, flood defences, or protected habitats. These processes can be lengthy, disjointed and create seasonal bottlenecks. Streamlined regulatory processes and early engagement with environmental bodies could accelerate delivery, reduce delays, and improve flexibility in responding to asset failures or service restrictions. In October, Defra announced changes in the environmental permitting system for "low risk activities" as part of an update to the government's Regulatory Action Plan.[118]

Government structures are evolving to address some of these coordination challenges. In 2025, NISTA was formed. One of NISTA's objectives is to identify and coordinate infrastructure needs, including a more spatial approach to infrastructure planning.[81] The Independent Water Commission recommended the creation of an independent system planner responsible for taking a cross-sector view and supporting joined-up planning.[10]

What does good look like?

There is a practice of active stewardship of infrastructure assets.

- There are clearly defined roles and accountabilities for management and maintenance of infrastructure systems.
- These roles sit within nested and aligned governance structures, allowing coordination across sectors and for regional authorities to work effectively with national bodies and within national mandates to address their distinctive local needs.
- A multi-objective decision-making framework that balances economic, environmental, social, and regional goals is used to achieve systems level outcomes, underpinned by flexibility in funding rules and a broader definition of value.
- Systems coordination roles serve to join up policy development across infrastructure types and sectors. These roles act to identify where service level targets and policies are incompatible and understand the engineering implications of the connections between policy and outcomes.
- A common language around infrastructure system risk and performance supports the articulation of infrastructure needs and performance expectations to non-technical stakeholders.
- A shared understanding of the asset base, its condition and the health of the system exists between regulators, asset owners and asset managers. The links between economic regulation, engineering activities, system performance and customer outcomes are understood so that informed investment decisions and trade-offs can be made when constrained by limited funding.

Urgent actions

15. **NISTA** should pilot efforts to drive regional system coordination across ageing economic infrastructure and streamline the regulatory environment. Specifically, this should include:
    - Piloting a new regional systems coordinator function to facilitate cross-sectoral connection and better coordination of maintenance, renewals and enhancements at a regional level, addressing both short-term and long-term plans.
    - Undertake a review of the barriers that regulators, asset owners and local authorities face when trying to coordinate and align maintenance, renewal and enhancement activities across sectors, regulatory frameworks and funding timelines. The review should identify opportunities to streamline regulatory compliance, recognising the cost that this adds to maintenance activities.

Conclusions

The UK's civil infrastructure is ageing. From water and wastewater to flood defence and transport, our infrastructure systems are facing increasing pressures from changes in demographics and the climate. The evidence is clear that our infrastructure can no longer rely on reactive approaches to maintenance, renewal, and enhancement.

Our research and engagement have demonstrated that we need to change our approach to prioritise infrastructure stewardship. This will not depend on any single reform, but on coordinated progress across all seven enablers for change, so that we are able to ensure the UK's infrastructure is reliable, climate-resilient, efficiently maintained, and capable of delivering long-term public value and supporting economic growth.

Fragmented governance structures and short-term funding cycles hinder effective infrastructure planning. We need a long-term vision with government-led definition of outcomes that guide regulation and standards across sectors, as well as financing with the flexibility to balance maintenance, renewal, and enhancement.

Infrastructure sectors face a growing skill shortage and lack of competencies required to address emerging and future challenges, including the maintenance and management of infrastructure assets as well as the demands of a changing climate. We need a well-supported, respected and skilled professional and artisanal workforce, equipped to apply traditional techniques and develop and deploy new technologies to the UK's ageing infrastructure systems.

Without effective use and sharing of data, and with inflexible frameworks for innovation, the UK risks falling behind in its ability to maintain and adapt its infrastructure. Accurate data and digital tools must be the backbone of proactive infrastructure management, turning status and trend information into actionable insights to optimise the nature and timing of maintenance and renewal interventions. Flexibility and purpose-driven innovation to extend the life of ageing infrastructure should be encouraged, with collaboration and sharing between industry, academia, and regulators the norm. With a focused approach we can improve the system performance and long-term resilience, as well as minimising cost and disruption and creating export opportunities.

Infrastructure affects everyone, whether members of the public or policymakers, yet understanding of its value, the trade-offs involved in its upkeep, and the importance of timely maintenance remains limited. A clearer, more honest

It is time to take a more preventative approach so our assets continue to deliver value for future generations

narrative, where maintenance, renewal, and enhancement of existing infrastructure is valued, is required for a resilient future. Furthermore, it is essential to enhance coordination across infrastructure systems through clear roles, aligned governance, and shared information, enabling effective collaboration across sectors and regions.

Strengthening the social foundations of infrastructure stewardship is as vital as the much-needed technical reforms. The principles of transparency, accountability, and long-term care for infrastructure assets are not only transferable across water and wastewater, flood defence, and transport, but also to other sectors such as the energy system, telecoms and the wider built environment. It is time to take a more preventative approach so our assets continue to deliver value for future generations.

Next steps

To mature our seven enablers into more comprehensive pathways for positive action and change, the Academy will continue to work with partners in the NEPC to develop and foster a shared understanding between asset owners and policymakers of our national asset base and its management needs. Specifically, the Academy will work with partners in the NEPC to produce guidance to help bridge gaps in technical understanding.

In addition, the Academy will explore opportunities to support the strategic shift required through the delivery of our flagship products, including through:

- Responding to skills gaps in this field in our Skills Centre resources and programmes.
- Welcoming applications for innovations that extend the useful life of assets through our Research and Invention Fellowships.
- Spotlighting AI adoption for infrastructure management in our Practical AI programme.

The UK is well-placed to pioneer best practices in managing ageing infrastructure as we own some of the oldest infrastructure assets that are still in use in a rapidly changing world. Together, by valuing and caring for what we have, we can build on and strengthen great foundations that will lead us to a more resilient future for generations to come.

Annex A | **Acknowledgements**

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