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TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

Transport Scotland's Approach to Climate Change Adaptation & Resilience

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List of Acronyms

ACCAR	Approach to Climate Change Adaptation and Resilience
ACF	Adaptation Capability Framework
CCPu	Climate Change Plan update
CCRA	Independent assessment of UK Climate Risk
CFL	CalMac Ferries Ltd
CMAL	Caledonian Maritime Assets Limited
DBFO	Design, Build, Finance, Operate
DC	Dynamic Coast
DMRB	Design Manual for Roads and Bridges
DRMP	Disruption Risk Management Plan
FRMA	Flooding Risk Management (Scotland) Act 2009
GHG	Greenhouse Gas
HIAL	Highland and Islands Airports Limited
HLOS	High Level Output Specification
HWS	High Wind Strategy and National Wind Management Guidelines
IPCC	Intergovernmental Panel on Climate Change
ITS	Intelligent Transport Systems
OC	Operating Companies
ORR	Office for Road and Rail
OTA	Objective Target Areas
NMC	Network Maintenance Contracts
NR	Network Rail
NTS2	National Transport Strategy
PAP	Pilot Adaptation Programme
PVA	Potentially Vulnerable Areas
RSSB	Rail Safety and Standards Board
SCCAP2	Climate Ready Scotland: Scottish Climate Change Adaptation Programme
SC	Scottish Canals
SCOTS	Society of Chief Officers of Transportation in Scotland
SEPA	Scottish Environmental Protection Agency
SG	Scottish Government
SRNLS	Scottish Road Network Landslide Study
SRWC	Scottish Road Works Commissioner
STPR2	Scottish Transport Projects Review 2
TS	Transport Scotland
UKCCRA3	United Kingdom Climate Change Risk Assessment 2022
UKCIP02	United Kingdom Climate Impacts Programme 2002
UKCP09	United Kingdom Climate Projections 2009
UKCP18	United Kingdom Climate Projections 2018
UKG	United Kingdom Government
COP26	UN Conference of the Parties
VLG	Vulnerable Locations Group
VLOG	Vulnerable Locations Operational Group

Ministerial Foreword

We are living in a global climate emergency. The impacts of climate change, caused by human influence, are already being felt in Scotland, with increased rainfall, hotter temperatures and rising average sea levels. These trends are expected to continue and intensify, with future impacts likely to be more severe than we have experienced so far.

Scotland's transport system is vulnerable to these increased, more intense weather events, which can contribute to the deterioration of assets, disruption to networks, and potentially hazardous incidents. This disruption often disproportionately impacts vulnerable communities with fewer and less resilient transport options; adapting the transport system to be resilient to these impacts, which are seen as inevitable, is vital as we work towards a Just Transition.

Transport is currently Scotland's largest sectoral emitter of greenhouse gases, responsible for 37% of Scotland's total emissions. The Scottish Government is committed to ending Scotland's contributions to the causes of global climate change through a commitment to a 75% cut in emissions by 2030 and Net Zero emissions by 2045. The transport sector will play a key role in achieving these targets and further, phasing in new types of infrastructure as we move to Net Zero provides us with an opportunity to build adaptive capacity and resilience.

Even with our commitment to Net Zero emissions by 2045, the concentration of greenhouse gases in the atmosphere will continue to increase for the coming decades, and average global temperatures will rise. Scotland must act now to adapt and increase resilience to the 'locked-in' impacts of climate change to avoid costly and disruptive consequences for our people, communities and economy as well as adverse effects on our natural environments and biodiversity.

A priority of our [National Transport Strategy](#) (NTS2) is to 'Take Climate Action', with outcomes of 'helping to deliver our net-zero targets'; 'promoting greener, cleaner choices'; and **'adapting to the effects of climate change'**.

Transport Scotland's Approach to Climate Change Adaptation and Resilience (ACCAR), outlines the key climate risks affecting Scotland's transport system and sets out our strategic outcomes for Road, Rail, Aviation and Maritime transport networks, whilst recognising our varying levels of influence.

Our vision is for Scotland's transport system to be **well adapted** and prepared for the current and future impacts of climate change. A transport system that is **safe** for all users, **reliable** for everyday journeys and **resilient** to weather related disruption.

Executive Summary

Responding to the climate emergency remains a top priority for the Scottish Government. This of course, includes action to reduce emissions but also adapting to the current and future impacts of climate change that have already occurred, or will occur. Even if we were able to stop all emission today, there would still be adverse impacts from climate change that are 'locked in' due to past emissions. Climate change is also one of the main drivers of biodiversity loss, with the destruction of ecosystems undermining nature's ability to regulate greenhouse gas emissions and protect against extreme weather, thus accelerating climate change and increasing vulnerability to it.

There are three main aspects of climate change that must be considered in responding to the climate emergency and the impacts of climate change:

- **Mitigation** relates to reducing and/or preventing GHG emissions, thereby reducing the scale of future impacts as far as possible;
- **Adaptation** is preparing for the impacts of climate change which are locked-in; and,
- **Resilience** is the ability to respond to the weather-related impacts of climate change and maintain normal operation of a system and its associated services.

Through their Independent Assessment of UK Climate Risk, the Climate Change Committee have set out 7 climate risks that relate to transport, including:

- Risks to infrastructure networks (water, energy, transport, ICT) from **cascading failures**
- Risks to infrastructure services from **river, surface water and groundwater flooding**
- Risks to infrastructure services from **coastal flooding and erosion**
- Risks to **bridges and pipelines from flooding and erosion**
- Risks to transport networks from **slope and embankment failure**
- Risks to **subterranean and surface infrastructure from subsidence**
- Risks to transport from **high and low temperatures, high winds, and lightning.**

This Approach to Climate Change Adaptation & Resilience sets out an ambitious vision for a well-adapted transport system in Scotland which is safe, reliable and resilient in relation to the current and future impacts of climate change.

This vision will be delivered through our Adaptation and Resilience Framework, which includes four high level Strategic Outcomes and various Sub Outcomes, which collectively will address the 7 transport related climate change risks outlined above.

Our Vision

A transport system which is well adapted and prepared for current and future impacts of climate change. It is safe for all users, reliable for everyday journeys and resilient to weather related disruption

Our Strategic Outcomes

Trunk Roads

Trunk Roads which are well adapted and resilient to the current, projected and unexpected impacts of climate change

Rail Network

Supporting the delivery of climate change adaptation and resilience for Scotland's Rail network

Aviation Network

Engaging with aviation stakeholders to support their decision making in relation to climate change adaptation and resilience

Maritime Network

Contributing to safeguarding lifeline ferry services, ports, harbours and canals in response to the threat of climate change

As well as the above Vision and Strategic Outcomes, this document sets out the following in relation to our Approach to Climate Change Adaptation & Resilience:

- **An Overarching Context** covering key policy documents, research, evidence and the latest climate science, such as the United Kingdom Climate Projections and Independent Assessment of UK Climate Risk;
- An **overview of the transport system** in Scotland including road, rail, aviation and maritime networks; and,
- **Consideration of adaptation and resilience** across the road, rail, aviation and maritime networks and our wider activity as an organisation.

Transport Scotland – Who we are and what we do

Transport Scotland (TS) is the national transport agency, delivering the Scottish Government's (SG) vision for transport. In Scotland we carry out a number of functions in relation to transport including:

- overseeing the inspection, maintenance, operation and improvement of Trunk Roads;
- overseeing aspects of the ferry, canal and railway networks;
- provision of rail and ferry services;
- we own Highlands and Islands Airports Limited and Glasgow Prestwick Airport;
- we help to secure international air routes for Scotland; and,
- deliver the national concessionary travel schemes and the provision of network traffic and travel information services.

TS currently has 9 Directorates. 5 of these specifically deal with different areas of the transport network in Scotland, such as road and rail, and another four cross cutting Directorates that cover transport strategy, policy, programmes and corporate services. These are shown in **Figure 1**.

Our directorates

Low Carbon Economy

Responsible for working across Government and with our partners and stakeholders, to create the conditions for Scotland to lead in and benefit from the shift to ultra-low emission vehicles.

Major Projects

Responsible for the design, development, procurement and construction of major trunk road improvement projects across Scotland, along with providing procurement advice across the organisation.

Roads

Responsible for the safe operation of the Trunk Road Network, roads policy, air quality and the environment, transport resilience and transport planning for major events.

Rail

Responsible for Scotland's rail policy, specification and development as well as the funding of Scotland's rail infrastructure, passenger and freight services through rail industry delivery partners.

Bus, Accessibility and Active Travel

Responsible for the Scottish Government's policy relating to bus, active travel, smart and integrated ticketing and accessible travel.

Transport Strategy and Analysis

Responsible for transport strategy and integration, transport futures, transport analysis and strategic transporting planning.

Aviation, Maritime, Freight and Canals

Promotes Scotland's international connectivity and transport links to our remote and island communities.

Finance and Corporate Services

Provides core services and advice in finance, human resources, learning and development, information technology, facilities, health and safety, chief executive support, communications and corporate governance.

Ferries

Promoting connectivity of our islands and remote communities through contract management, vessel and infrastructure replacement and the Islands Connectivity Plan.

Figure 1 - Transport Scotland's Directorates and functions.

This corporate structure delivers operational, strategic and policy-based actions across a number of transport areas including infrastructure, public transport, active travel and freight. TS works closely with a number of stakeholders and partners in this regard.

Introduction

Scotland's transport infrastructure and networks are fundamental to our nation's communities, businesses and visitors. They offer critical connections between people and places, and are vital in providing access to essential services, such as healthcare.

The importance of our transport systems cannot be overstated, particularly as they are susceptible to variations in Scotland's weather systems.

Our road, rail, maritime and aviation systems are all facing unprecedented vulnerability to the weather-related impacts of climate change, which can contribute to the deterioration of assets, disruption to networks, and potentially hazardous incidents that may cause fatalities or serious injuries. These impacts have serious knock-on consequences across sectors, places and wider infrastructure systems that depend on transport infrastructure for their normal functioning. By increasing the climate resilience and ability of transport infrastructure to adapt to climate change, we will have a significant influence on Scotland's overall ability to increase resilience and adapt.

Climate change is not a new concept. Scientific evidence has shown that the Earth's climate has always gone through periods of change, however, the UN Intergovernmental Panel on Climate Change (IPCC) have stated that it is now 'unequivocal' that the recent observed warming trends are attributable to human influence. **Figure 2** below illustrates the change in global surface temperatures, related to human activity, from the Industrial Revolution to 2020.
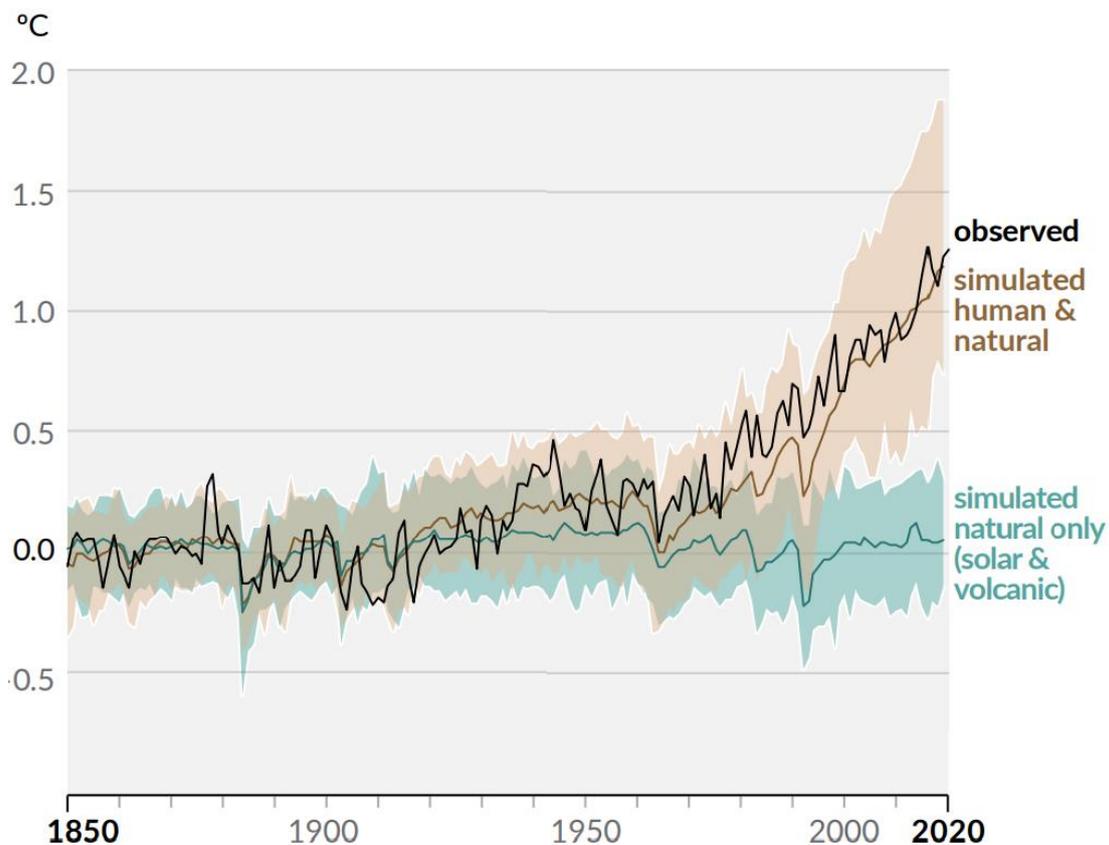

Figure 2 - Change in global surface temperature (annual average) as observed and simulated using human & natural and only natural factors (both 1850-2020). (Source: IPCC, 2021: Summary for Policymakers)

Further to this, the IPCC's recent report on Climate Change: Impacts, Adaptation and Vulnerability stated that 'human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability.'

The report also highlighted that even if the Paris Agreement's goal of limiting warming to 1.5°C can be achieved, this would still cause unavoidable increases in multiple climate hazards. Furthermore, current projections show that the trajectory of global emissions is closer to the **medium-high** emission scenario (within the scenarios set out in the UK Climate Change Projections 2018 (UKCP18) analysis), which would entail a much greater level of warming.

Across Scotland, these observed changes have already had a profound impact on our climate and weather patterns. We have seen temperatures rise, sea levels increase and variations in rainfall, with greater seasonality and more heavy downpours. For example, Scotland's 10 warmest years on record have all occurred since 1997 and average temperature in the last decade (2010-2019) was 0.69 °C warmer than the 1961-1990 average. Sea levels have risen by 16 cm since 1900 and the average rainfall in Scotland between 2010-19 was 9% wetter than the 1961-90 average (see also **Figure 3**).

Projected climate trends show that these variations are expected to continue and intensify, with future impacts likely to be more severe than we have experienced so far. Scotland must act now to adapt and increase resilience to these impacts to avoid costly and disruptive consequences for our people, communities and economy as well as adverse effects on our natural environments and biodiversity.

The adverse effects of human-induced changes associated with climate change links directly to the biodiversity crisis which we are witnessing across the world, with the extinction of species being more rapid in the past 50 years than at any time in human history. Whilst this document focuses on climate change, both the climate emergency and biodiversity crisis must be tackled together with holistic policies that address both issues simultaneously and not in isolation.

The SG's commitment to addressing the global climate emergency means both limiting Scotland's contributions to future climate change by reaching Net Zero greenhouse gas (GHG) emissions by 2045 and building resilience to the impacts which are locked in, meaning impacts that will occur regardless of our efforts to reduce emissions. Both "mitigation" and "adaptation" aspects are vital for a Just Transition and the transport system has a vital role to play in both.

Addressing the biodiversity crisis is a commitment which the SG has chosen to directly align with Scotland's Net Zero target. As noted in the consultation for the SG's Biodiversity strategy, whereby they are committing to "restoring nature and ending Scotland's contribution to climate change, our country is transformed for the better - helping to secure the wellbeing of our people and planet for generations to come," by 2045.

A priority of our National Transport Strategy (NTS2) is to 'Take climate action.' This includes adapting to the impacts of climate change, allowing our transport systems to remain resilient and reduce the harmful effects on future generations.

This document sets out TS's current approach to adaptation and resilience in relation to climate change, highlighting the key messages and urgency scores for infrastructure risks, derived from the Climate Change Committees (CCC)

Independent assessment of UK Climate Risk (CCRA3), which provides evidence to inform the UK Government's UK Climate Change Risk Assessment 2022 (UKCCRA3).

Our approach sets out four high level Strategic Outcomes and a number of Sub-Outcomes to deliver a well-adapted and resilient transport network for the future. Within the current decade we will address the 7 CCRA3 risks that relate to transport (see **Table 1**) and align our delivery with the current and subsequent Scottish Climate Change Adaptation Programme (SCCAP).

Increasing resilience and adapting to the impacts of climate change requires significant capacity building and change within organisations. The Adaptation Scotland programme has developed an award winning Adaptation Capability Framework (ACF) that major organisations in Scotland are using to develop their work to adapt.

TS played a crucial role in helping to develop this resource and is using the ACF to identify and further develop our adaptation maturity (see ANNEX A). This initial baselining exercise recognised the need to develop a wider understanding of our approach. It is envisaged that TS will continue to use the ACF to further develop our adaptation capability and increase our maturity level.

Overarching Context

Climate Change

Since the industrial revolution, atmospheric concentrations of GHG's have increased rapidly compared to their pre-industrial levels, which has led to changes in Earth's climate. As the rate of infrared radiation being absorbed into the Earth's atmosphere increases, the Earth's average surface temperature rises. These human-induced temperature increases are commonly referred to as global warming.

Absolute temperatures vary depending on your location in the world. Therefore, average global temperatures are assessed against a set baseline period of 30 years. Using surface temperature monitoring stations around the world to record changes in global temperature, variations in global temperature from this 30-year baseline can then be seen as a temperature anomaly.

Climate change is defined as large-scale, long-term shifts in the planet's weather patterns and average temperatures. The shift in global temperatures is already having a profound impact on Scotland. We have seen temperatures rise, sea levels increase and variations in rainfall, with extended seasonality.

Scientific analysis can also predict future changes. The magnitude of these changes carries uncertainties and vary according to different scenarios for global emissions pathways, but in any case, will be far greater than anything we have seen in the past.

United Kingdom Climate Projections (UKCP18)

The UKCP18 dataset is based on the latest developments in international climate science. They consist of:

- Updated probabilistic projections, giving estimates of different future climate outcomes;
- A new set of global climate model projections, comprising simulations from both the latest Met Office Hadley Centre climate model and global climate models from around the world; and,
- A set of regional climate model projections on a finer scale (12km) for the UK and Europe.

The UKCP18 aim to equip governments, businesses and other interested parties

with scientific information allowing them to assess the challenges and opportunities faced by our changing climate.

The key expected future climate change trends for Scotland, derived from the UKCP18 analysis, are identified in **Figure 3** below.

HOW HAS SCOTLAND'S CLIMATE CHANGED?

Over the last few decades Scotland has experienced a warming trend, shifting rainfall patterns and rising sea levels

Scotland's 10 warmest years in record have all occurred since 1997. The average temperature in the last decade 2010-2019 was 0.69°c warmer than the 1961-1990 average, and the warmest year on record was 2014

There has been an increase in rainfall over Scotland over the past few decades (with an increasing proportion of rainfall coming from heavy rainfall events). The annual average rainfall in the last decade (2010-2019) was 9% wetter than the 1961-1990 average, with winters 19% wetter

Mean sea level around the UK has risen by approximately 1.4mm/year from the start of the 20th century

HOW WILL SCOTLAND'S CLIMATE CHANGE IN THE FUTURE?

The changes in climate that we are already experiencing are projected to continue and intensify

SUMMER

SCOTLAND WILL EXPERIENCE WARMER WETTER WINTERS WITH MORE INTENSE RAINFALL EVENTS

Although temperatures are projected to increase in both the summer and winter, warming is expected to be greatest in the summer

Climate change has already increased the chance of seeing a summer as hot as the summer of 2018 to between 12 and 25%. With future warming, hot summers by mid-century could become even more common, near to 50%

Summer rainfall is projected to decrease, although extreme downpours will be heavier despite the overall drying trend

WINTER

SCOTLAND WILL EXPERIENCE WARMER WETTER WINTERS WITH MORE INTENSE RAINFALL EVENTS

Winter temperatures are projected to increase

These changes do not mean that cold snaps and/or severe snowstorms can't or won't occur in the future

Winters are projected to become wetter in terms of both the amount of rainfall and the number of wet days. The increase is expected to be larger in western Scotland compared to the east

Figure 3 - Scotland's changing climate, key trends and projections. (Source: Adapted from Adaptation Scotland, Climate Trends and Projections, 2021)

Scotland's Climate Risk

The UK Climate Change Act (2008) requires the UK Government (UKG) to conduct a UK-wide "Climate Change Risk Assessment" (CCRA) every five years. The latest suite of reports (CCRA3) identify and provide full analysis of 61 climate change risks and opportunities.

Four national summaries provide an overview of the CCC's underpinning evidence for each of the UK nations. A series of sector briefings are also produced, including transport.

The CCRA3 assigns each risk or opportunity with an urgency score (ANNEX B) which indicates the level of action required based on current and planned levels of activity. These are:

- More Action Needed;
- Further Investigation;
- Sustain Current Action; and,
- Watching Brief.

Key risks from the CCRA3 in relation to Scotland and transport that have a high future magnitude score, and where more action is required now to address them after considering any existing adaptation responses, include the following:

- The risk of climate change impacts, especially more frequent flooding and coastal erosion, causing damage to our infrastructure services, including energy, transport, water and Information and Communication Technologies (ICT);
- The impact of extreme temperatures, high winds and lightning on the transport network;
- Increased severity and frequency of flooding of homes, communities and businesses; and,
- The viability of coastal communities and the impact on coastal businesses due to sea level rise, coastal flooding and erosion.

The CCRA3 has established that there are 32 risks/opportunities for Scotland that are categorised as 'more action needed,' with 'sustain current action' only applicable to four. Urgency scores have increased for 25 risk/opportunities in Scotland since CCRA2 in 2017.

Alongside the 61 individual climate risks and opportunities, the CCC also set out 8 priority risk areas for further adaptation within the next 2 years, covering various policy areas, including transport infrastructure. These are shown in **Figure 4**. Although there are not any specific areas for transport infrastructure there are clear links to certain priority risks area such as:

- Risks to the supply of food, goods and vital services due to climate-related collapse of supply chains and distribution networks; and
- Risks to people and the economy from climate-related failure of the power system.

Figure 4 - Eight Priority Risk Area's, their magnitude of risk out to 2100 and associated key policy areas set out in the CCC Independent Climate Change Risk Assessment. (Source: Climate Change Committee, 2021)

Transport Climate Risks

The CCRA3 identifies 7 key climate risks that relate to transport infrastructure, shown in **Table 1** and in more detail in ANNEX C. The most significant weather-related risk facing Scotland is flooding and its impacts on people, communities, buildings and infrastructure. Although the CCC does not identify flooding as high priority risk area, the Scottish Government consider it as the most significant risk in Scotland and are therefore treating it as a priority.

The transport system and its networks regularly face challenges from weather related impacts (such as flooding, landslides and high winds), which as a result of climate change are projected to increase. There is a need for additional adaptation and resilience measures to avoid an increase in costly disruption and loss of service on transport networks.

Risks to infrastructure networks from cascading failures are an important aspect here that need to be managed due to the interdependencies between transport and other infrastructure networks, such as energy and water. For example, the loss of power supply may result in freight and travel delays across the transport network. Further, the CCC highlight that a "full understanding of the impacts of cascading failures is difficult to ascertain," therefore it will be important that TS seeks opportunities to build resilience across wider infrastructure networks.

The long lifespan of transport infrastructure assets in relation to these risks must be considered for new and existing infrastructure across the entire transport system. This will be important as Scotland also moves toward Net Zero emissions by 2045, presenting an opportunity to build adaptive capacity and resilience into future infrastructure.

Table 1 - CCRA3 risks and urgency scores relating to transport infrastructure.

CCRA3 Risk Identifier	CCRA3 Risk	CCRA3 Urgency Score
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures	More Action Needed
I2	Risks to infrastructure services from river, surface water and groundwater flooding	More Action Needed
I3	Risks to infrastructure services from coastal flooding and erosion	Further Investigation
I4	Risks to bridges and pipelines from flooding and erosion	Further Investigation
I5	Risks to transport networks from slope and embankment failure	More Action Needed
I7	Risks to subterranean and surface infrastructure from subsidence	Further Investigation
I12	Risks to transport from high and low temperatures, high winds, lightning	More Action Needed

Responding to the Global Climate Emergency

The Scottish Government is seeking to end Scotland's contributions to the causes of global climate change through its commitment to Net Zero GHG emissions by 2045. The Climate Change Plan Update (CCPu) outlines strategic actions that will be taken to achieve this over the period to 2032, including various actions for transport that align with NTS2.

Alongside this, the second Scottish Climate Change Adaptation Programme (SCCAP2) set out the strategic approach to climate adaptation and resilience across all sectors of the economy (in response to the 2017 CCRA). The next SCCAP, in response to the 2022 CCRA, is due for publication in 2024. A hierarchy of key documents that include climate change considerations (both adaptation and mitigation) in relation to the transport system is shown in **Figure 5**.

Figure 5 - Hierarchy of Scottish Government climate change Plans and Programmes and key Transport Scotland Strategies that relate to climate change adaptation.

As noted previously, further climatic changes are projected and seen as inevitable. Preparations for these changes through mitigation, adaptation and resilience measures are therefore required.

Mitigation relates to reducing and/or preventing GHG emissions, thereby reducing the scale of future impacts as far as possible.

Adaptation is preparing for the impacts of climate change which are locked-in.

Resilience is the ability to respond to the weather-related impacts of climate change and maintain normal operation of a system and its associated services.

Although climate science and projections deliver a level of confidence in the general trends for future climate, there is no way of predicting an exact level of change, or precisely what the impacts will be. As a result, there will be some uncertainty over the 'ideal' level of adaptation and resilience planning that is needed. However, recent advice from the CCC suggests we need to adapt for 2 degrees of warming globally and in the face of future uncertainties, plan for 4 degrees. We must therefore take a flexible approach in relation to decision-making and lessons learned.

The Strategic Outcomes and Sub-Outcomes identified in this document represent the best options for the level of influence TS has over the transport system, its networks and infrastructure. The aim of the Strategic and Sub-Outcomes is to build capacity, appropriate adaptation and levels of resilience around current and future climatic events.

SCCAP2: Climate Ready Scotland

The Scottish Government's second Climate Change Adaptation Programme (SCCAP2) is entitled Climate Ready Scotland. The programme runs until 2024 and sets out policies and proposals to increase the capacity of Scotland to adapt to climate change, based on the 2017 CCRA. SCCAP2 takes an outcomes-based approach (**Figure 6**) which is aligned with both the UN Sustainable Development Goals and Scotland's National Performance Framework. An outcomes-based approach seeks to focus on what a policy or policies should achieve (the outcome), rather than the specific inputs and outputs.

TS leads on 13 SCCAP2 policy objectives, which aim to assist delivery of the programme (ANNEX D). These objectives are spread across various areas of transport. There is a focus on the delivery of actions that improve transport resilience, particularly across Trunk Roads, which feed into delivering the high-level outcomes of the programme.

In March 2022, the CCC published their first independent assessment of progress against SCCAP2, finding that whilst the vision for a well-adapted Scotland set out in SCCAP2 is welcome, progress towards this has "stalled across most sectors." It was somewhat critical of transport areas, such as roads, ports and ferries, although acknowledged that this can be improved with the publication and delivery of this Strategy. The report did highlight good progress in adaptation planning in some areas, such as within the rail network and made a number of recommendations for driving forward adaptation which will be fully considered in delivery of our Strategic Outcomes outlined below.

Figure 6 - Outcomes of Climate Ready Scotland: Scotland's second climate change adaptation programme.

National Transport Strategy

TS's NTS2 sets out the ambitions for Scotland's transport system over the next 20 years. Through the priority **'Takes climate action,'** it is envisaged that people will be able to make travel choices that minimise the long-term impacts on our climate and the wellbeing of future generations. It states that Scotland's transport system will '**adapt to the effects of climate change'** and deliver policies which will focus on Scotland's transport networks to ensure they are managed effectively, well adapted and resilient.

The NTS2 Delivery Plan 2022-23 sets out a number of strategic policies including publishing Transport Scotland's Approach to Adaptation and Resilience (this document).

Following publication, we have continued to develop and enhance good adaptation practices across the agency, including the establishment of both a Vulnerable Locations Group (VLG) and Vulnerable Locations Operations Group (VLOG) for Trunk Roads.

Strategic Transport Projects Review

The second Strategic Transport Projects Review (STPR2) is a Scotland-wide review of the strategic transport system and networks, across all modes, and will inform transport investment in Scotland for the next 20 years. Options identified through STPR2 will focus on making the best use of existing capacity and assets.

STPR2 sets out a number of recommendations including several under the theme '**increasing safety and resilience on the strategic transport network**', and one specifically for **'Trunk Road and Motorway Network Climate Change Adaptation and Resilience.'**

Transport Scotland's Adaptation and Resilience Vision

Scotland's transport system is a critical resource for people, communities and businesses who are all facing an unprecedented threat from the impacts of climate change. It is imperative that the nation is prepared for these impacts. By supporting the vision of our National Transport Strategy (NTS2) and embedding the drivers (**Figure 7**) of TS's adaptation and resilience Vision, TS aims to deliver a well-adapted transport system which is safe, reliable and resilient for all users.

Our Vision
A transport system which is well adapted and prepared for current and future impacts of climate change. It is safe for all users, reliable for everyday journeys and resilient to weather related disruption.

SAFE
A transport system that is safe for all users across all modes, minimising serious injury or fatalities, despite the impacts of climate change

OUR VISION
Well Adapted

RELIABLE
A transport syetem that can be relied upon to support everyday journeys, communities, vital services and the movement of goods

RESILIENT
A transport system that is prepared for, and able to sufficiently repond to the impacts of climate change

Figure 7 - Transport Scotland's Adaptation and Resilience Vision.

Adaptation and Resilience Framework

Our Vision is underpinned by our four Strategic Outcomes supported by a series of Sub-Outcomes. The Framework (**Figure 8**) provides a foundation which will enable us to protect against extreme weather conditions caused by climate change and secure the well adapted future of our transport system. These Strategic Outcomes and Sub-Outcomes will be delivered through an appropriate governance structure, adaptation plans, stakeholder engagement and communication activity and will directly contribute to delivery of our adaptation and resilience Vision.

Through delivery of these Strategic and Sub-Outcomes we will address all 7 CCRA3 risks relating to transport (see **Table 1**) to 2030. This timeframe aligns with the current timeframe for SCCAP2 and the next iteration of SCCAP, due to be published in 2024, which will cover the period up to 2029. Following publication of SCCAP3 in 2024, a review and update of our approach will be undertaken to ensure it remains appropriate in this regard and continues to contribute to wider adaptation efforts in Scotland.

Our Vision

A transport system which is well adapted and prepared for the current and future impacts of climate change. It is **safe** for all users, **reliable** for everyday journeys and **resilient** to weather related disruption
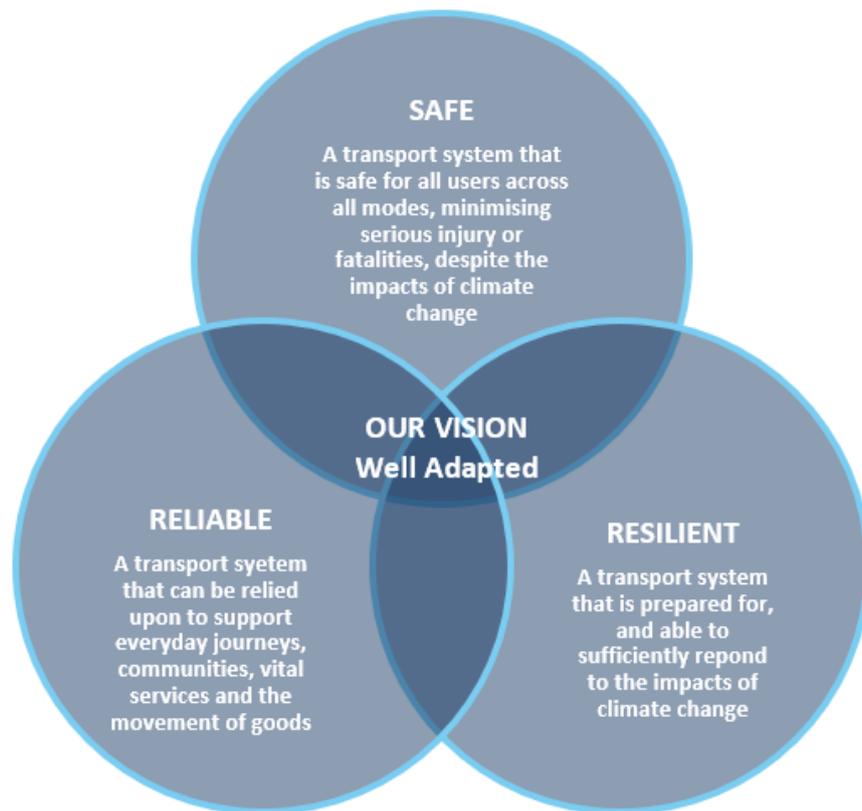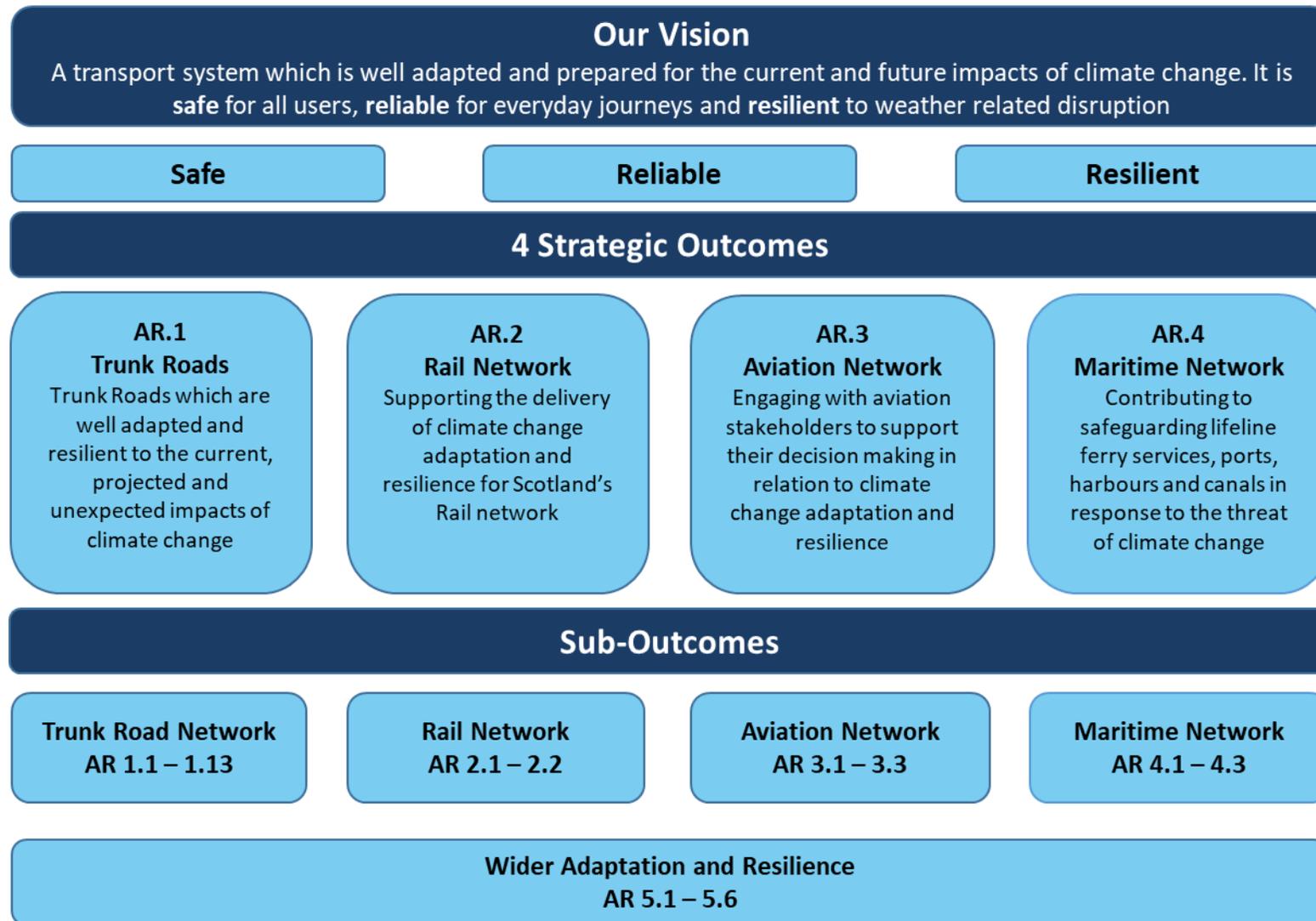
Safe	Reliable	Resilient

4 Strategic Outcomes

AR.1 Trunk Roads	AR.2 Rail Network	AR.3 Aviation Network	AR.4 Maritime Network
Trunk Roads which are well adapted and resilient to the current, projected and unexpected impacts of climate change	Supporting the delivery of climate change adaptation and resilience for Scotland's Rail network	Engaging with aviation stakeholders to support their decision making in relation to climate change adaptation and resilience	Contributing to safeguarding lifeline ferry services, ports, harbours and canals in response to the threat of climate change

Sub-Outcomes

Trunk Road Network AR 1.1 – 1.13	Rail Network AR 2.1 – 2.2	Aviation Network AR 3.1 – 3.3	Maritime Network AR 4.1 – 4.3

Wider Adaptation and Resilience
AR 5.1 – 5.6

Figure 8 - Transport Scotland Adaptation and Resilience Framework.

Scotland's Transport System

An infrastructure system can be defined as a distinct class of assets, such as for transport, energy or water supply. They can also include assets for emergency services, healthcare, risk reduction (e.g. flood defences), social infrastructure (e.g. schools) and green infrastructure (e.g. trees). The transport system is a distributed infrastructure system as assets are located across the country, connected through networks on which services are provided, such as public transport on road or rail.

Trunk Roads

Scottish Trunk Roads, shown in

Figure 9, is Scottish Ministers' single biggest asset. It is 3,739 km (2,323 miles) long; a diverse network, which includes a considerable number of bridges and other structures, for example over 2,000 bridges and over 1,800 culverts, footbridges and retaining walls. It has a gross asset value of £23 billion and represents 6% of the total Scottish road network. It carries 35% of all traffic and 60% of heavy goods

vehicles.

Figure 9 - Map of Scotland's Trunk Roads, depicting Operating Company (OC) areas and DBFO Concessions.

TS inspects, manages, maintains, operates and improves the trunk road and motorway network. TS has contracts in place with private sector Operating

25

Companies and Design Build Finance & Operate (DBFO) Concessionaires to ensure our roads are safe, efficient and well managed.

Rail Network

Scotland's railway network extends 2,819 km (1,752 miles) across the country. There are 709 km of the network currently electrified and 362 stations. The rail network infrastructure (e.g. tracks) is managed by Network Rail (NR), who are also responsible for the management of Glasgow Central Station and Edinburgh Waverley Station. Operational services, remaining passenger infrastructure (e.g. stations) and rolling stock (e.g. trains) services are managed and delivered through the Scottish Rail Holdings Framework Agreement.

TS are responsible for Scotland's rail policy and delivery, as well as providing input on matters reserved to the United Kingdom Government (UKG).

Aviation Network

Scotland's airports are part of a global network of routes which connect communities within Scotland and connect Scotland with the rest of the world. Three airports are owned in the private sector: Edinburgh, Glasgow and Aberdeen. Highlands and Islands Airports Limited (HIAL), a company owned by the Scottish Ministers, operate 11 airports mainly serving remote and rural communities from Campbeltown in the south to Sumburgh in the north. HIAL is subsidised by the Scottish Government. Glasgow Prestwick Airport is also owned by the Scottish Ministers but operates on a commercial basis. There are also a number of smaller airports and airstrips owned and operated by local authorities.

Maritime Networks

Ports and Harbours

TS manages all devolved policy matters covering commercial, publicly owned and trust ports, on behalf of Scottish Ministers. TS administers provisions outlined in the Harbours (1964), Pilotage (1987) and Ports (1991) Acts and related local legislation. TS are also responsible for applications for Harbour Empowerment and Revision Orders.

Canals

Scotland's canal network consists of a 137 mile of canals comprising the Caledonian, Crinan, Forth & Clyde, Union and Monkland canals with associated infrastructure including 19 reservoirs. These are managed, on behalf of the SG, by Scottish Canals (SC). TS is responsible for the management of four canal swing bridges on Trunk Roads, two watered, but non-navigable, sections on the Monkland Canal, and one section of the 19 km long Monkland Pipelines which supply water via the Monkland Canal to the Forth & Clyde Canal in Glasgow.

Our Approach to Adaptation and Resilience

The following sections identify TS's current approach to adaptation and resilience, and the impacts of climate change, across our portfolio, whilst highlighting the key messages and urgency scores for infrastructure risks, derived from the CCRA3.

A number of Sub-Outcomes have been identified against our Strategic Outcomes as a means to deliver a well-adapted and resilient transport system for the future.

Roads

Transport Scotland's Role and Context

Trunk Roads are a fundamental part of the transport system in Scotland which supports a number of transport modes on its network. It supports the SG's purpose 'to create a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth.' TS is responsible for the safe and effective management and maintenance of Trunk Roads and delivery of Scottish road policy. Our asset management process relating to Trunk Roads is delivered through a series of contracts including the Network Maintenance Contracts (NMC), DBFO contracts and services contracts.

The four regional NMCs are managed by TS who oversee the OCs programmes of inspection, maintenance and improvement work and their delivery routine and cyclic maintenance, including winter service.

TS is also responsible for promoting and delivering improvements to Trunk Roads through our operations and maintenance schemes, alongside new infrastructure projects, which are all required to meet a range of standards set out in the Design Manual for Roads and Bridges (DMRB) – LA 114 Climate – including adaptation measures which will improve the safety and resilience of the network.

Identified Risks

All 7 of the climate risks associated with transport, derived from CCRA3, apply to Trunk Roads and will be considered in delivery of our Strategic Outcomes. These specific risks are shown in **Table 2**.

Table 2 - CCRA3 risk identifiers associated with Trunk Roads.

CCRA3 Risk Identifier	CCRA3 Risk
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures
I2	Risks to infrastructure services from river, surface water and groundwater flooding
I3	Risks to infrastructure services from coastal flooding and erosion
I4	Risks to bridges and pipelines from flooding and erosion
I5	Risks to transport networks from slope and embankment failure
I7	Risks to subterranean and surface infrastructure from subsidence
I12	Risks to transport from high and low temperatures, high winds, lightning

Assessment of Climate Risk on Trunk Roads

Following the release of UKCP09 in 2009, TS sought to update the findings of the *Scottish Road Network – Climate Change Study 2005,* including its recommendations to minimise future climate change impacts. TS commissioned Jacobs to update their earlier work, based on United Kingdom Climate Impacts Programme (UKCIP02) which produced the 2005 study.

The key objectives of this study were to:

- Use the UKCP09 data to update the understanding of how climate change is likely to affect each of the climatic variables considered in the earlier Scottish Road Network – Climate Change study.

- To emphasise where departures from the previous understanding arise and to identify any implications to the earlier study's recommended adaptive strategies and relative priority.

Overall, the assessment found that the trends in the projected changes in climatic variables remain generally consistent with the findings of the earlier study. It concluded that the understanding of the general picture of climate change and its likely effects on the design, operation and maintenance of Trunk Roads had not significantly altered.

In 2017, an assessment of Trunk Roads identified those sections most vulnerable to the impacts of severe weather, and how this vulnerability will change over time in light of climate change. The study found TS is committed to embedding proactive climate change adaptation within its policies and procedures to strengthen governance, inform current and future maintenance requirements, and reduce the cost and disruption associated with response and repair activities.

The assessment found that approximately 2% of all Trunk Road sections were classed as having 'Extreme Exposure' to flooding. When UKCP09 was applied, this level of exposure increased significantly. UKCP09 also indicated the network exposure levels to landslides and high winds would also increase.

Climate change projections are complex in nature and associated with the vast number of variables, uncertainties and assumptions upon which they are based. Whilst the results of the assessment provide a reliable exposure picture of the network to adverse weather conditions for now and selected future timeframes, it is important to acknowledge the limitations associated with the climate change projections and incident data used for the assessment.

> **Sub-Outcome AR 1.1: The Trunk Roads Adaptation Plan for the Trunk Roads is based on the most up to date climate change projections (UKCP18) and risk assessments, building on previous studies undertaken.**

Climate impacts on Trunk Roads

There are various weather-related climate impacts that affect Trunk Roads such as flooding, landslides and high winds. How these impact Trunk Roads and work that we undertake in relation to these is detailed below.

Flooding

Flooding remains the most acute and prominent climate risk facing Scotland at present and therefore one of the greatest risks to the effective operation of Trunk Roads. Flooding impacts can pose a major issue for the functionality of Trunk Roads, potentially causing disruption, increasing journey times and maintenance costs. Managing the impacts associated with flooding requires ongoing engagement with colleagues across the SG, Scottish Environment Protection Agency (SEPA) and the wider public sector to deliver the obligations set out in the Flooding Risk Management (Scotland) Act 2009 (FRMA).

Under the FRMA, we support the development and delivery of the Local Flood Risk Management Plans in relation to Trunk Roads. Where appropriate, we collaborate and share data regarding our assets impact on the Potentially Vulnerable Areas (PVAs) and Objective Target Areas (OTAs) defined in the FRMA.

> **Sub-Outcome AR 1.2: The delivery of Scotland's Flood Risk Management Strategies, Plans and associated actions will be supported by the development of flood risk maps produced in conjunction with SEPA.**

Landslides

The Scottish Road Network and Landslide Study (SRNLS) was commissioned in 2005 in response to heavy and prolonged rainfall that occurred in August 2004, which caused a number of landslides affecting Trunk Roads. The SRNLS collated and set out background information and presented the proposed means of debris flow management on Trunk Roads, the latter known as the 'Implementation Report.'

The Implementation Report provided several recommendations in relation to landslide management in Scotland. TS has recently carried out a review of these recommendations to inform our future approach to the management of landslides on Trunk Roads.

We continue to undertake a programme of research, through funding from the Scottish Road Research Board (SRRB), a partnership between TS, the Society of Chief Officers of Transportation in Scotland (SCOTS) and the Scottish Road Works Commissioner (SRWC). The programme focuses on slope monitoring and landslide management.

> **Sub-Outcome AR 1.3: Our management of geo-hazards on Trunk Roads is well-informed, supported by a database recording the condition of geo-technical assets, their ability to withstand current and future climate change and ranking them to inform adaptation and resilience interventions.**

Scour

Bridge scour is the process where sediment supporting or from around bridge abutments or piers is removed by fast moving water, reducing its load carrying capacity. Increased rainfall and potential flooding are likely to exacerbate the frequency and extent of scouring to our structures.

TS is responsible for the management of a number of structural assets which are potentially at risk from scour. A *Scour Management Strategy and Flood Emergency Plan* is in place for our OCs to ensure a consistent approach to inspecting, monitoring, assessing and recording scour and bed-level changes at these structures. This consistent approach improves the recording of changes at structures, which improves timing of interventions and prioritisation of mitigation measures. TS is currently contributing to a review of the DMRB scour standard, BD 97, which will see it replaced with an updated standard (CS 469) that includes the effects of scour on structures in flood plains.

As part of the work to produce the updated standard (CS 469) we are incorporating SEPA's updated allowances for climate change regarding river flows at structures. These allowances have increased from a blanket 20% for all of Scotland, to up to 56% depending on the location and catchment area.

This updated standard and our proactive approach in relation to scour will help TS to address the potential damage and risk of failure which future impacts of climate change may cause to our structural assets and increase their resilience.

> **Sub-Outcome AR 1.4: We are well prepared for the increased risk of scour through an updated Scour Management Strategy and Flood Emergency Plan following publication of the Design Manual for Roads and Bridges BD97 and updated CS 469 standards.**
>
> **Sub-Outcome AR 1.5: We are proactive in our approach to the analysis of scour and are continuously developing a programme of proactive scour schemes across the network.**

High Winds

High winds, particularly on exposed sections on Trunk Roads (e.g. bridges and elevated routes), can cause significant disruption and dangerous conditions for road users. High winds can have consequences for congestion, public safety and journey times across the network and therefore it is important that plans are in place to manage the occurrence of high winds on the road network. As a consequence of climate change, the frequency and severity of high winds are likely to increase. Currently wind speed and direction are measured at all estuarial crossings and exposed routes to inform safe passage.

TS's High Wind Strategy and National Wind Management Guidelines (HWS) is a guidance document which sets out robust and proportionate wind management procedures for the management of high winds throughout the Scottish road network. It is applicable to all road authorities, stakeholders and our OCs.

> **Sub-Outcome AR 1.6: We are well prepared for increased frequency and severity of high winds with an updated High Wind Strategy and National Wind Management Guidelines based on latest scientific data via the Met Office and UKCP18.**

High Temperatures

Intense weather events, such as heatwaves and droughts, are projected to increase as a result of climate change. This includes the potential for prolonged periods of intense high temperatures, which can deteriorate the integrity of a road's surface.

Within the UK, there have been reports of road surfacing excessively deteriorating and becoming liquefied at surface temperatures over 50°C. Scotland's Trunk Road surfaces have an approximate design lifespan of 20 years, however, this may be influenced by new variations in our weather system. In high temperatures, swing bridges are also known to overheat and become unable to open to canal traffic or close to allow road traffic.

TS worked closely with the industry supply chain to research the impact of weather on road surfacing materials, including high temperatures, and consequently developed a bespoke material specification.

TS2010 uses a highly-polymer-modified binder, which is much more resistant to temperature changes than conventional binders and can withstand surface temperatures up to 75°C, however, we continue to review relevant road material research.

> **Sub-Outcome AR 1.7: We are well informed on the impact of high temperatures on road surfacing, using a database of current road surface materials on Trunk Roads, and have established the likely impact for each road surface specification and its ability to withstand higher temperatures and prolonged periods of hot weather.**

Coastal Erosion

Coastal erosion is influenced by many factors: sea level, currents, winds, and waves. It is recognised internationally that climate change will increase both sea levels and the vulnerability of our coastal systems, low lying areas and shorelines.

The risk to Scotland's Trunk Roads from coastal erosion varies depending on its proximity to the coast. For example, there are many miles of sea walls adjoined to Trunk Roads which often require repairs due to wave action, likely to increase with climate change, and ongoing deterioration. This, alongside interdependencies with other transport infrastructure and communities which rely on our assets in these locations, means consideration must be given to minimising the impacts.
TS aims to reduce and monitor the impact of coastal erosion on the areas of Trunk Roads which may be affected, and our Trunk Roads Adaptation Plan will include an assessment of the climate impacts on Trunk Roads, including coastal erosion.

The Dynamic Coast (DC) project provides an evidence base for past and anticipated coastal changes in Scotland. The second DC was published in 2021 and contains data which should be used to inform our approach to addressing coastal erosion and its effect on our infrastructure assets.

> **Sub-Outcome AR 1.8: We are aware of the extent and locations on Trunk Roads at risk from coastal erosion and utilise Dynamic Coast data to inform any necessary interventions, such as improved sea walls, managed realignment or effective communication of impacts.**

Managing Impacts

Asset Management

In 2018, we published our Scottish Trunk Road Asset Management Strategy which sets out how our Trunk Road Network Asset Management Policy will be delivered through enhancements to our procedures and practices. Within the strategy it was emphasised that the focus of our resilience planning is more than the 'day-to-day' resilience of our network.

Our climate change adaptation and resilience processes seek to minimise future disruption and ensure that Trunk Roads are resilient to the potential impacts of a changing climate.

TS's Road Asset Management Plan reflects our Strategy and describes in detail how we deliver asset management at an operational level including detail on 'Risk Management and Network Resilience,' climate change risks and associated safety, climate change adaptation and climate change resilience.

Consideration of climate change adaptation and resilience is also embedded and considered as part of major infrastructure projects through the use of the DMRB. The procurement process of our major projects can vary in terms of timescales; therefore the latest climate change predictions are considered at each stage and re-evaluated if new climate predictions for the UK are released. This is an important aspect due to the long life span of transport infrastructure and provides a key opportunity to 'build in' resilience and avoid 'locking in' climate risks in the future.

> **Sub-Outcome AR 1.9: Current adaptation and resilience asset management processes are further embedded and improved. We are proactive in seeking opportunities for new processes that support adaptation and resilience of the Trunk Roads.**

Disruption Risk Management

Severe weather incidents can cause unplanned disruption across Scotland's transport system, including Trunk Roads. Our internal *Manual for the Management of the Risk of Unplanned Network Disruption* provides requirements for our OCs, including the preparation and administration of a Disruption Risk Management Plan (DRMP). The DRMP process requires our OCs to produce a number of primary and supporting plans, including for the management of high winds, landslides and flooding.

As a result of alterations in our weather system and projected climate change, we may be required to augment our disruption risk management process with a proactive approach to address future impacts.

Changes in our weather patterns may also impact the structural integrity of Trunk Roads with more frequent and intense rainfall, high winds, sudden cold snap events and rising temperatures.

> **Sub-Outcome AR 1.10: We are fully aware of the potential impacts climate change poses to the asset through a review of the latest UK climate change projections (UKCP18) and a scoping assessment of Trunk Roads.**

Future Intelligent Transport Systems Strategy

Published in 2017, Transport Scotland's Future Intelligent Transport Systems Strategy aims to provide clarity on our priorities for the provision of Intelligent Transport Systems (ITS) to contribute to the safe and efficient operation of Scotland's trunk roads and motorways and meet the needs of customers.

The Strategy aims to develop our ITS to contribute to improved air quality, lower noise levels and reduce the adverse effects of heavy traffic and consider how best to support a low carbon economy through the selection and use of ITS technology and greener travel choices, including low carbon and electric vehicles and supporting Active Travel.

Scotland's Road Safety Framework

TS's Scotland's Road Safety Framework to 2030 (RSF), sets out a long term vision for road safety. 'Vision Zero' sets the target of zero fatalities and injuries on Scotland's roads by 2030. The RSF sets out a Climate Strategic Action to 'deliver road safety initiatives that positively impact the climate emergency and mitigate the negative impacts climate change may have on road safety'.

Adapting Trunk Roads to the impacts of climate change can assist in making the network safer for all road users and contribute to the delivery of the RSF. In relation to climate change adaptation, road users will need to gain the knowledge, skills and experience required under extreme weather conditions, projected to increase with climate change, to become safe and responsible.

> **Sub-Outcome AR 1.11: The relationship between the weather-related impacts of climate change and road safety incidents on Trunk Roads is well understood and supports the strategic outcomes of the Road Safety Framework to 2030.**

Vulnerable Locations Group

TS Roads Directorate established a Vulnerable Locations Group (VLG) in 2020 with a mandate to support the identification of vulnerable locations on Trunk Roads and provide strategic direction related to weather impacts, including those as a result of climate change. The initial focus of the group has been to deliver cost effective actions in the short term whilst developing a move to a long-term proactive approach, including a dedicated budget for climate change adaptation.

Subsequently, a Vulnerable Locations Operational Group (VLOG) was established leading on schemes that enable delivery of well-adapted, safe, reliable and resilient Trunk Roads to the effects of climate change. The VLOG is currently undertaking a multi-phased Pilot Adaptation Programme (PAP) which aims to deliver best practice to support the mandate and the key aims of the VLG.

> **Sub-Outcome AR 1.12: We have a proactive Climate Change Adaptation Programme for Trunk Roads which goes beyond maintenance, informed by the Pilot Adaptation Programme.**
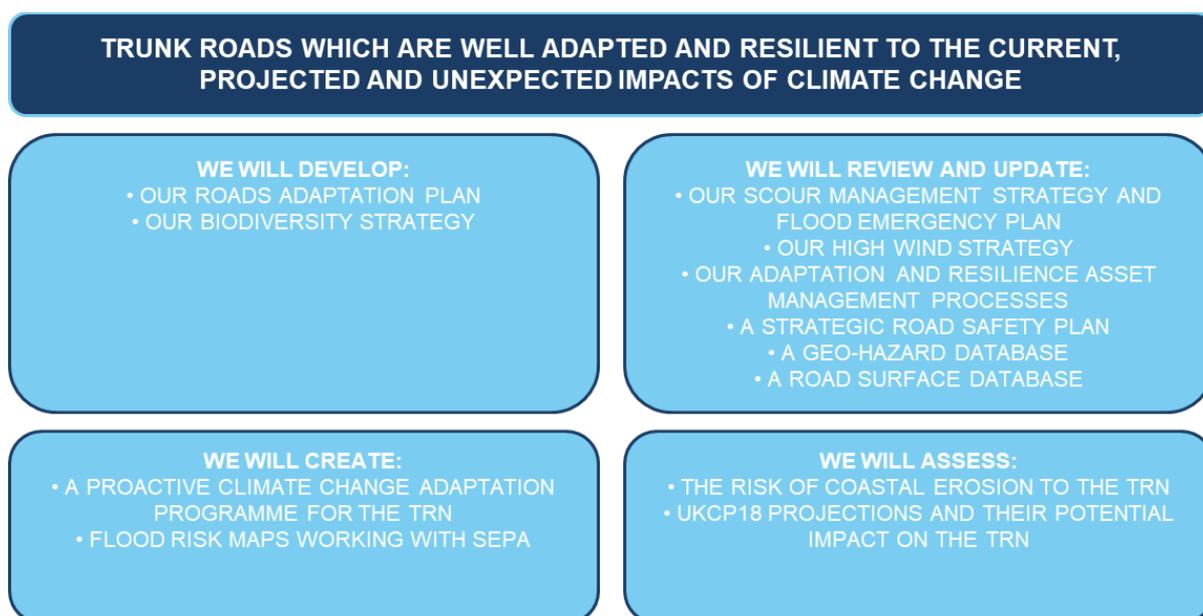
Biodiversity and Landscape

Landscape design and management can play a key role in combatting climate change, supporting adaptation, mitigation and resilience. Tree planting schemes on Trunk Roads can reduce surface water runoff during heavy rainfall events and improve ground stability, reducing disruption caused by impacts such as flooding and landslips, whilst also sequestering carbon from the atmosphere.

Our approach to landscape management also supports action in addressing the challenges facing Scotland's biodiversity, for example, through habitat creation or preservation which has the potential to enhance our natural ecosystems across our network. To support this, as part of NTS2, we have committed to "build on the requirements of national planning policy and strengthen our commitment to securing positive effects for biodiversity in all our works by applying our Fitting Landscapes policy."

> **Sub-Outcome AR 1.13: Our Biodiversity Strategy for Transport Scotland outlines the important role of landscape design and management in adapting Trunk Roads to the impacts of climate change.**

Embedding Adaptation & Resilience

TS will continue to further embed proactive climate change adaptation and resilience measures within our policies and procedures. We will continue to work closely with our OCs to deliver well-adapted Trunk Roads that are safe, reliable and resilient to the current, projected and unexpected impacts of climate change. A summary of how we will achieve our Strategic Outcome for Trunk Roads is shown in **Figure 10**.

TRUNK ROADS WHICH ARE WELL ADAPTED AND RESILIENT TO THE CURRENT, PROJECTED AND UNEXPECTED IMPACTS OF CLIMATE CHANGE

WE WILL DEVELOP:
- OUR ROADS ADAPTATION PLAN
- OUR BIODIVERSITY STRATEGY

WE WILL REVIEW AND UPDATE:
- OUR SCOUR MANAGEMENT STRATEGY AND FLOOD EMERGENCY PLAN
- OUR HIGH WIND STRATEGY
- OUR ADAPTATION AND RESILIENCE ASSET MANAGEMENT PROCESSES
- A STRATEGIC ROAD SAFETY PLAN
- A GEO-HAZARD DATABASE
- A ROAD SURFACE DATABASE

WE WILL CREATE:
- A PROACTIVE CLIMATE CHANGE ADAPTATION PROGRAMME FOR THE TRN
- FLOOD RISK MAPS WORKING WITH SEPA

WE WILL ASSESS:
- THE RISK OF COASTAL EROSION TO THE TRN
- UKCP18 PROJECTIONS AND THEIR POTENTIAL IMPACT ON THE TRN

Figure 10 - Strategic Outcome for Trunk Roads and summary of Sub-Outcomes.

Rail

Transport Scotland's Role and Context

Scotland's railway infrastructure is managed by Network Rail (NR), including the delivery of major infrastructure projects and general maintenance. In response to climate change and to support weather resilience, NR manage various Route Weather Resilience and Climate Change Adaptation strategies and plans. These documents closely align with the High Level Output Specification (HLOS).

Scotland's Railway is a dynamic collaboration of Government and rail industry partners working together to deliver a safe, timely and high-quality railway across Scotland.

TS is responsible for Scotland's rail policy and delivery, which includes:

- developing rail policy and strategic planning;
- delivering major projects alongside industry partners;
- promoting and investing in the development of sustainable rail freight; and,
- managing economic regulation of the railways, and monitoring and advising on the affordability of the rail programme.

On the 1st of April 2022, the ScotRail Franchise transferred to ScotRail Trains Ltd, reporting to Scottish Rail Holdings Ltd, a company wholly owned by the Scottish Ministers. Rolling stock (trains) and services are currently managed and delivered through the Scottish Rail Holdings Framework Agreement.

TS also provide input from a Scottish perspective on matters reserved to the UKG such as railway safety and standards.

Identified Risks

All 7 of the climate risks associated with transport, derived from CCRA3, apply to the rail network in Scotland and will be considered in delivery of our Strategic Outcomes. These specific risks are shown in **Table 3**.

Table 3 - CCRA3 risk identifiers associated with the Rail Network.

CCRA3 Risk Identifier	CCRA3 Risk
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures
I2	Risks to infrastructure services from river, surface water and groundwater flooding
I3	Risks to infrastructure services from coastal flooding and erosion
I4	Risks to bridges and pipelines from flooding and erosion
I5	Risks to transport networks from slope and embankment failure
I7	Risks to subterranean and surface infrastructure from subsidence
I12	Risks to transport from high and low temperatures, high winds, lightning

High Level Output Specification

The HLOS is developed by TS for each Control Period of 5 years with input from NR and the Office of Road and Rail (ORR) and is a statement from the Scottish ministers. HLOS acts as the SG's commitment to improving railway performance, reducing journey times, and increasing the capacity and capability of the Scottish rail network.

The [HLOS for Control Period 6 (2019 – 2024)](#) (CP6) refers to '**A greener Scotland'** and sets relevant requirements regarding climate change, detailed in **Table 4**. Performance against these requirements is reported via a quarterly dashboard that NR provides to TS.

Table 4 - Climate change requirements in High Level Output Specification for Control Period 6.

HLOS CP6 Reference	Detail
6.27	Emissions reductions are a priority for a sustainable Scottish economy. Our climate change plans include proposals for new and more testing emissions reduction targets for 2020. Whilst rail is already a low contributor of total transport emissions, investment strategies must become more sustainable to provide a contribution to overall emissions reductions and to **ensure enhanced network resilience from adaptation interventions.**
6.29	The Scottish Ministers also require Network Rail to work with the rail industry to develop and apply suitable KPIs for monitoring the impact and mitigation of climate change upon network disruption and **the means of measuring the benefits of adaptation interventions.**
6.30	With the aim of monitoring and reducing the overall environmental impact of rail, the Scottish Ministers require the rail industry to report and build on the existing measures for the overall reduction in environmental impact.

HLOS Control Period 7 (CP7) will cover the period 2024-29 and will be published later in 2022 with climate change adaptation and resilience featuring prominently. The ORR will review NR's CP7 plans on a regular basis and advise TS on their performance.

> **Sub-Outcome AR 2.1: The next High Level Output Specification for Control Period 7 contains up-to-date requirements relating to climate change, including adaptation and resilience.**

Network Rail & ScotRail Adaptation Strategies

Network Rail's [Weather Resilience and Climate Change Adaptation Strategy](#) (WRCCA) was developed to give an understanding of how current and future weather events could impact on NR's infrastructure assets. This strategy will help embed the consideration of these impacts into daily activities, making weather resilience and climate change adaptation considerations business as usual. The strategy details the actions that NR will take to combat the impacts of weather and climate change on Scotland's Railway, between 2019 and 2024.

ScotRail announced their [Climate Change Adaptation Strategy](#) in 2021 with the strategic objective to build resilience to climate change into their business processes and establish a weather event plan to ensure normal service recovers as soon as possible following weather related disruption.

Following the fatal derailment at Carmont in August 2020, caused by a landslip following intense rainfall, NR commissioned two reports to assess its ability to withstand extreme weather:

- Weather Advisory Task Force, "To review Network Rail's capability to understand and manage adverse weather, particularly with regard to earthwork failures, with the aim of equipping Network Rail with the knowledge base and competencies, so that it becomes better prepared and more resilient in the future."
- Earthworks Management Task Force, "To review Network Rail's capability to understand and manage adverse weather, particularly with regard to earthwork failures, with the aim of equipping Network Rail with the knowledge base and competencies, so that it becomes better prepared and more resilient in the future."

Published in March 2021, the reports contained 58 recommendations to increase the resilience of the rail network to extreme weather. Work to deliver this is well underway.

> **Sub-Outcome AR 2.2: We are engaged and supportive of the development of future specifications and policies relating to climate change adaptation and resilience across the Scottish rail network.**

Tomorrows Railway and Climate Change Adaptation

In 2016, the Rail Safety and Standards Board (RSSB) published the research document Tomorrow's Railway and Climate Change Adaptation. This report acknowledges that investment in adaptation measures can improve current railway systems resilience and reliability. Climate change and adaptation modelling is an enabler for prioritised, targeted investment that ultimately leads to better value for money.
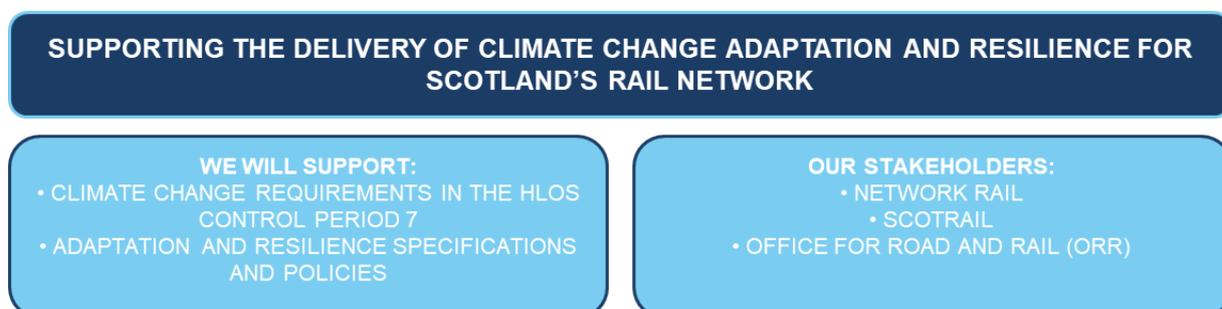
The publication highlighted gaps in the railway system and provided some recommendations for adaptation. The following recommendations were put forward:

- Conduct detailed vulnerability mapping of rail assets and locations;
- Enhance weather incident reporting and asset condition monitoring;
- Develop GIS-based alert systems and weather susceptibility maps;
- Make standards and rail assets "climate change-proof"; and

  Develop a multi-agency cooperation model.

Supporting Adaptation and Resilience

Climate change adaptation and resilience is essential for the future of Scotland's Rail network. Potential climate change impacts such as flooding, subsidence and erosion threaten the current and future effective operation of the network. We will support delivery of a well-adapted rail network which is safe, reliable and resilient by continuing to work closely with our stakeholders. A summary of how we will achieve our Strategic Outcome and our key stakeholders for the rail network is shown in **Figure 11**.

SUPPORTING THE DELIVERY OF CLIMATE CHANGE ADAPTATION AND RESILIENCE FOR SCOTLAND'S RAIL NETWORK

WE WILL SUPPORT:	OUR STAKEHOLDERS:
• CLIMATE CHANGE REQUIREMENTS IN THE HLOS CONTROL PERIOD 7 • ADAPTATION AND RESILIENCE SPECIFICATIONS AND POLICIES	• NETWORK RAIL • SCOTRAIL • OFFICE FOR ROAD AND RAIL (ORR)

Figure 11 - Strategic Outcome for the Rail Network, summary of Sub-Outcomes and our key stakeholders.

Aviation

Transport Scotland's Role and Context

Aviation is a reserved matter for the UK Government and is regulated by the Civil Aviation Authority (CAA) and the Department for Transport (DfT).

There are four major airports in Scotland: Aberdeen International Airport, Edinburgh Airport, Glasgow Airport and Inverness Airport. These operate on an independent commercial basis apart from Inverness, which is operated by Highland and Islands Airports Limited (HIAL) on behalf of the Scottish Ministers.

HIAL manages and operates 11 regional airports in total, which serve some of Scotland's remote and island communities. HIAL is wholly owned and subsidised by the Scottish Government in accordance with section 34 of the Civil Aviation Act 1982 and is sponsored by Transport Scotland. These subsidies enable HIAL to maintain the safe operation of its airports, as shown in **Figure 12**.
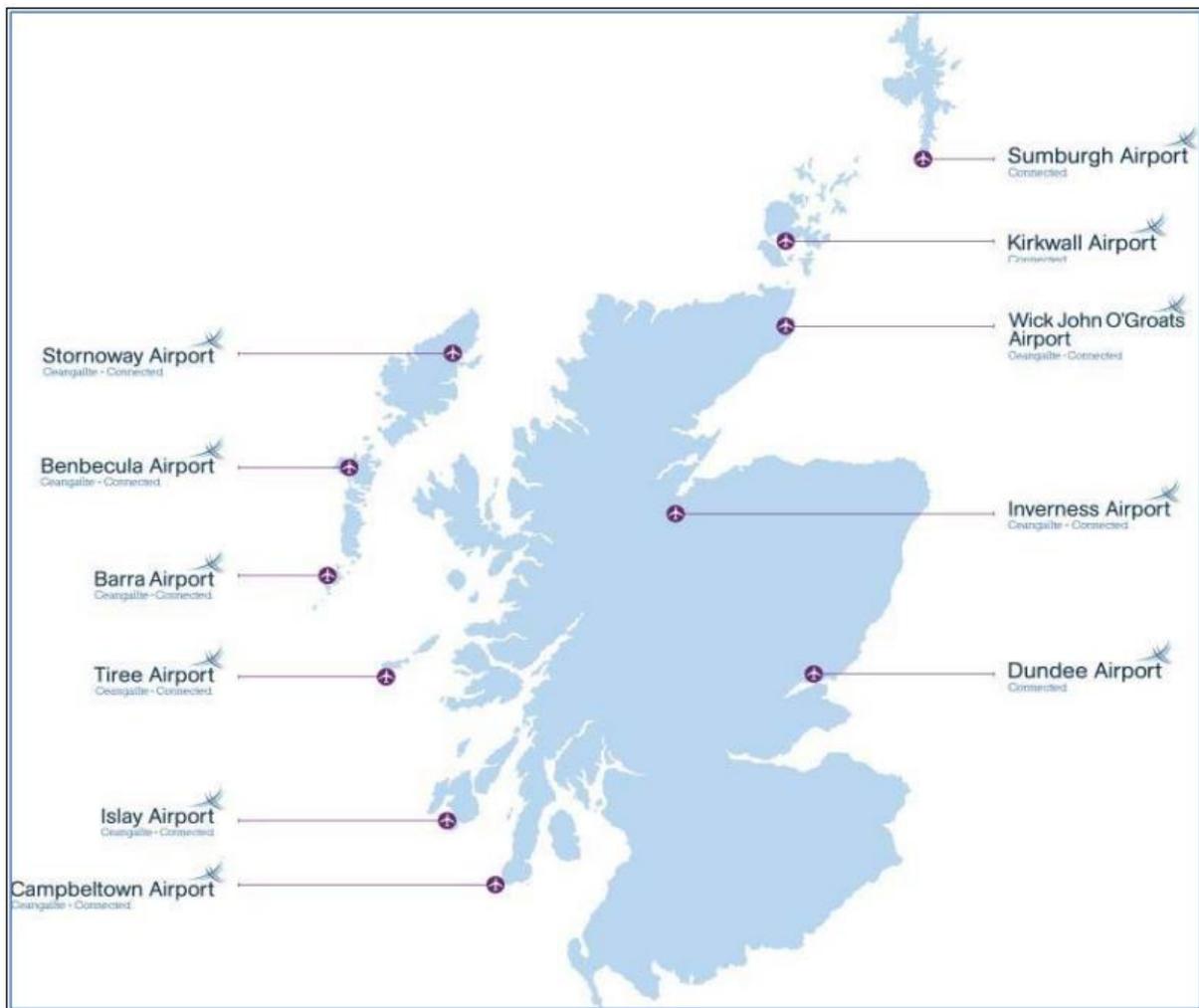

Figure 12 – Map of Scotland showing location of HIAL airports. (Source: HIAL, 2015)

Glasgow Prestwick, a specialist airport providing a range of aviation services, is also owned by the Scottish Ministers but, unlike HIAL, is operated on a commercial basis.

Scotland's main airports are commercial businesses and have their own governance arrangements. Coupled with the fact that aviation is reserved, this means that TS has limited influence over climate change adaptation and resilience activities at the airports. However, there are climate actions we can take in working with HIAL.

Identified Risks

Four of the climate risks associated with transport, derived from CCRA3, apply to the aviation network in Scotland and will be considered in delivery of our Strategic Outcomes. These specific risks are shown in

.

Table 5 - CCRA3 risk identifiers associated with the aviation network.

CCRA3 Risk Identifier	CCRA3 Risk
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures
I2	Risks to infrastructure services from river, surface water and groundwater flooding
I3	Risks to infrastructure services from coastal flooding and erosion
I12	Risks to transport from high and low temperatures, high winds, lightning

Climate impacts on aviation

Weather related climate impacts that affect aviation include flooding, high temperatures and severe weather. How these impact the airports operated by HIAL is detailed below.

Flooding

Flood protection and sea defence schemes are in place at several HIAL airports, with monitoring schemes at certain locations to inform future interventions. It is important that consideration be given to both current and future climate risks at HIAL airports. Monitoring is essential to ensure that appropriate, timely and effective adaptation and resilience interventions can be implemented. As with all climate risks, consideration should be given to whether a physical intervention is necessary, or a certain level of disruption can be tolerated.

> **Sub-Outcome AR 3.1: HIAL monitors flooding risks to its infrastructure and takes appropriate action at those airports most at risk from coastal erosion, flooding and sea level rise, to ensure there is no significant disruption to services.**

High Temperatures

Runways and operations managed by HIAL should be able to continue as normal as temperatures increase due to climate change. However, there is the potential for prolonged periods of intense high temperatures to deteriorate the integrity of a runway's surface over time. In terms of benefits, higher temperatures could also lead to a reduction in the use of 'de-icer' and runway treatments during the winter.

> **Sub-Outcome AR 3.2: HIAL monitors the effects of high temperatures at its airports and the impact these could have on vehicles, runways and infrastructure, and takes appropriate action to ensure there is no significant disruption to services.**

Severe Weather

The Scottish Government's Programme for Government 2019-20 committed to decarbonising domestic flights within Scotland by 2040, which will require a shift to low emission alternative aircraft. Current aircraft fleets perform well against cross winds, with visual impacts such as fog currently causing the greatest disruption to services. New low emission aircraft fleets must be capable of performing to the same standard and handling potential increases in severe and extreme weather events as a result of climate change.

> **Sub-Outcome AR 3.3: HIAL as the lead partner in the Sustainable Aviation Test Environment in Orkney, monitors the testing of new types of low emission aircraft, including their performance in severe weather conditions.**

Effective Engagement on Adaptation and Resilience

Working with our partners and stakeholders, we aim to be well-informed on the risks that climate change pose to aviation in Scotland, including flooding, high temperatures and severe weather. Further, we will work with HIAL to ensure that climate change adaptation and resilience are embedded in its decision making. A summary of how we will achieve our Strategic Outcome is shown in **Figure 13**.

EFFECTIVELY ENGAGING AVIATION STAKEHOLDERS, ENSURING THAT CLIMATE CHANGE ADAPTATION AND RESILIENCE ARE EMBEDDED IN DECISION MAKING

WE WILL ENGAGE ON:
• ESTABLISHING A CLIMATE WORKING GROUP
• ENCOURAGING A HIGH TEMPERATURE REVIEW
• COLLABORATING ON LOW EMISSION AIRCRAFT PERFORMANCE RESEARCH

OUR STAKEHOLDERS:
• HIGHLAND AND ISLANDS AIRPORTS LIMITED (HIAL)

Figure 13 - Strategic Outcome for the aviation network, summary of Sub-Outcomes.

Maritime

Transport Scotland's Role and Context

TS's maritime responsibility covers legislation, policy, guidance and services relating to Scotland's ferries. TS also acts as the sponsoring body for Scottish Canals, a public body who are responsible for managing Scotland's canal network.

We regularly collaborate with the Department for Transport on shipping and port policy, including reserved matters. We collaborate with Marine Scotland to ensure a joined-up approach when consenting for ports projects.

Identified Risks

Five of the climate risks associated with transport, derived from CCRA3, apply to the maritime network in Scotland and will be considered in delivery of our Strategic Outcomes. These specific risks are shown in **Table 6**.

Table 6 - CCRA3 risk identifiers associated with the maritime network.

CCRA3 Risk Identifier	CCRA3 Risk
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures
I2	Risks to infrastructure services from river, surface water and groundwater flooding
I3	Risks to infrastructure services from coastal flooding and erosion
I7	Risks to subterranean and surface infrastructure from subsidence
I12	Risks to transport from high and low temperatures, high winds, lightning

Ferries

Caledonian Maritime Assets Ltd (CMAL) are wholly owned by the SG with Scottish Ministers acting as sole shareholders. The company has ownership of the ferry fleet and infrastructure necessary for vital services across Scotland. The fleet consists of 36 ferries: 31 of which are leased to CalMac Ferries Ltd (CFL), and the remaining 5 to Serco Northlink. These services provide key connectivity for remote communities and businesses.

Climate change is likely to increase the intensity and frequency of severe and extreme weather events which could disrupt ferry services. In relation to climate change adaptation, CMAL, CFL and Serco Northlink give consideration to current and future climate risks through a programme of upgrades and modernisation.

TS actively engages with operators, providing information and guidance where appropriate, on services and infrastructure projects through a variety of working and advisory groups.

> **Sub-Outcome AR 4.1: We are proactive in our collaboration with CMAL and ferry operators, through existing working groups, providing a vital understanding of climate science to ensure it is considered when developing appropriate future interventions and policy.**

Ports and Harbours

As a result of climatic changes, we are already seeing sea rise around Scotland's coast with further rises predicted in the future. These rises, coupled with an increase in the intensity and frequency of severe and extreme weather events, have the potential to damage infrastructure associated with Scotland's ports and harbours, disrupting lifeline ferry services.

TS has limited levers to directly implement shipping adaptation and resilience interventions, as shipping is a reserved matter. However, we continue to engage closely with ports to ensure port infrastructure is equipped for the future. We aim to build on this work in relation to adaptation and resilience, working closely with the wider shipping and maritime sectors.

> **Sub-Outcome AR 4.2: There is an increased awareness regarding climate change adaptation and resilience with UKG and Scottish Ports. We influence policy and encourage proactive interventions by building on existing engagement.**

Canals

TS acts as the sponsoring body for Scottish Canals (SC), who are responsible for the canal network in Scotland. Through their Environment Strategy 2015-2025, SC is seeking to address the risk and impacts of climate change on the canal network.

This strategy addresses climate change adaptation, specifically around flood alleviation, through its 'Water Resource Management and Flood Control' theme. It indicates that the historical flood risk from the canals is low, however, there is potential for their use in flood mitigation and alleviation on a wider catchment scale. A successful example of this is Glasgow's Smart Canal which uses the 250-year-old Forth & Clyde Canal and smart technology to provide flood risk mitigation to reduce the impacts of climate change across North Glasgow.

The historic canal structures are vulnerable to the land use change which has occurred since they were built, and this is now being exacerbated by climate change and wider catchment management. A recent example of this impact is the 2020 breach of the Union Canal embankment near Linlithgow which resulted in damage to the Edinburgh to Glasgow railway line.
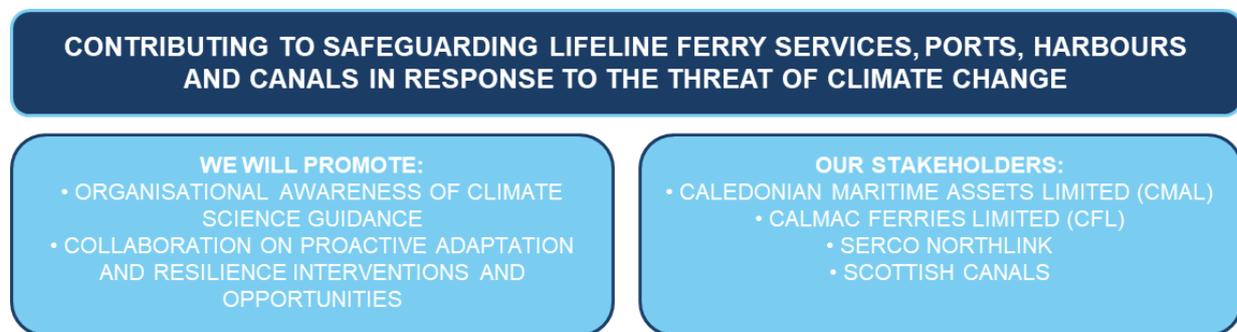
SC's Asset Management Strategy 2018-2030 notes that improving resilience depends as much on monitoring asset condition and predicting failure as it does on regular maintenance. This is relatively simple in regard to modern structures, however, managing historic assets can be labour intensive and expensive due to the complexity associated with these structures.

As a sponsoring body, TS regularly engages with SC on a variety of issues including climate change.

> **Sub-Outcome AR 4.3: We proactively collaborate with SC to identify climate change adaptation and resilience interventions and opportunities.**

Promoting Adaptation and Resilience

TS is committed to promoting the importance of adaptation and resilience to safeguard lifeline ferry services, ports and harbours and canals in response to the threat of climate change. Risks to the maritime network include flooding, coastal erosion and increased severe weather events. We, along with our partners, will ensure the maritime system in Scotland is safe, well-adapted and resilient. A summary of how we will achieve our Strategic Outcome and our key stakeholders for the maritime network is shown in **Figure 14**.

CONTRIBUTING TO SAFEGUARDING LIFELINE FERRY SERVICES, PORTS, HARBOURS AND CANALS IN RESPONSE TO THE THREAT OF CLIMATE CHANGE

WE WILL PROMOTE:
• ORGANISATIONAL AWARENESS OF CLIMATE SCIENCE GUIDANCE
• COLLABORATION ON PROACTIVE ADAPTATION AND RESILIENCE INTERVENTIONS AND OPPORTUNITIES

OUR STAKEHOLDERS:
• CALEDONIAN MARITIME ASSETS LIMITED (CMAL)
• CALMAC FERRIES LIMITED (CFL)
• SERCO NORTHLINK
• SCOTTISH CANALS

Figure 14 - Strategic Outcome for the maritime network, summary of Sub-Outcomes and our key stakeholders.

Wider Adaptation and Resilience Activity

Adaptation and Resilience Communications

TS's website provides an essential interface with an overview of our activities, legislation, plans, policy, projects and research. Traveline is a public-private partnership between TS, public transport operators and local authorities and acts as Scotland's national public transport information service - the 'one-stop' for all bus, rail, coach, air and ferry times in Scotland. TS's social media channels provide information regarding both our and our stakeholders key activities across the transport system

The Traffic Scotland Service supports the safe, efficient and resilient operation of Trunk Roads using an extensive array of Intelligent Transport Systems (ITS) and roadside infrastructure such as motorway gantry signals, variable message signs (VMS) and CCTV, which are co-ordinated from the Traffic Scotland National Control Centre at South Queensferry. It monitors Trunk Roads 24 hours a day, 365 days a year, responding to planned and unplanned incidents and events, setting dynamic signing, speed limits and providing real-time information to drivers through the VMS.

The Traffic Scotland ITS automatically detect the formation of queues in real-time, setting temporary speed limits and lane restrictions where necessary to reduce collisions and ease congestion. The service also uses a wide range of data sources to provide accurate and reliable traffic and transport information to the public to help people plan journeys through the Traffic Scotland websites and Social Media platforms.

The Traffic Scotland website is a well-used source of accurate traffic and travel information, receiving around 4.5 million visitors annually. At times of major disruption, such as severe weather, daily use of the website can rise significantly confirming its status as a trusted source. Further to this, individual transport operators, including that of our OCs on Trunk Roads, and across various modes have their own websites with up-to-date information and guidance.

The aim of these platforms is to provide up to date, accurate and understandable information on all public transport services within Scotland, and from Scotland to major destinations in other parts of the UK. These services collate data relating to roadworks, road traffic collisions, congestion and weather events allowing the provision of information to enable the operational efficiency of Scotland's transport system.

Effective communication regarding the risks and impacts associated with climate change on our transport system and its networks is a key element to ensuring they are well adapted, safe, reliable and resilient. Moreover, it enables users to make informed choices regarding their travel behaviour.

> **Sub-Outcome AR 5.1: Transport Scotland website users are well-informed on the latest climate science, policies and programmes through regular updates of website content.**
>
> **Sub-Outcome AR 5.2: All stakeholders, including the public, are informed of key developments and information regarding climate change adaptation and resilience through our existing platforms and social media channels. We maintain awareness of emerging platforms to reach the greatest audience.**

Cross Sector Engagement and Best Practice

Cross sector engagement and best practice on adaptation and resilience is important to build capacity to understand and respond to the CCRA3 risks set out above. This is particularly true for CCRA3 'I1' risks relating to cascading failures across infrastructure networks, such as transport, energy and water.

Adaptation Scotland (AS) is a SG funded programme which aims to support adaptation capacity building within the public sector and is delivered by sustainability charity Sniffer. TS currently sits as a member of the AS Programme Board and is an active participant on their Benchmarking Working Group, which meets regularly to share knowledge, latest activity and best practice amongst peers. This work will continue to seek opportunities to work together across the transport sector and beyond.

TS's collaboration with AS has aided in the development of the Adaptation Capability Framework (ACF) for a Climate Ready Public Sector. TS has utilised the ACF to understand its current adaptation maturity level, setting a benchmark for the agency (ANNEX A).

In October 2021, as part of preparations and engagement for the UN Conference of the Parties (COP26) in Glasgow, TS played a leading role in an SG led Climate Resilience Summit. TS committed to the *Ambition Statement* set out at this summit which outlined the following:

- Support enhanced understanding and action on climate risk and look forward to collaborating across sectors;
- Will further embed climate adaptation in our culture, corporate governance and organisational priorities as an immediate priority and throughout 2022 and beyond; and
- Express our support for an ambitious global deal at COP26 which addresses adaptation and resilience needs in a fair and just way.

Development of this engagement approach to adaptation and resilience has also been supplemented by a series of peer engagement activities, including interviews with international transport peers in Norway, Sweden and North America. Research, knowledge exchange, adaptation approaches and case studies were captured through best practice discussions.

Going forward, TS will continue to seek meaningful engagement with peers on climate adaptation and resilience to ensure best practice and facilitate ongoing knowledge exchange.

> **Sub-Outcome AR 5.3: We have an up-to-date evaluation of our adaptation maturity level through an annual baselining exercise using Adaptation Scotland's Capability Framework.**
>
> **Sub-Outcome AR 5.4: There is widespread engagement and knowledge sharing on climate change adaptation and resilience with transport peers and across sectors at a local, national and international scale.**

Behavioural Change and Organisational Influence

Scotland's response to the global climate emergency will require action across society and sectors. The SG is working to ensure Scotland is informed, resilient and well-adapted to the changing climate. Behavioural change is recognised as a key driver to achieve this. SCCAP2 includes detail of how behavioural change (e.g. checking weather forecasts regularly) can help individuals, communities, businesses and organisations to become well-adapted to climate change.

Across TS's portfolio, there is a need to understand climate change to enable informed decisions, ensuring sufficient mitigation, adaptation and resilience interventions. The ability to influence and embed an instinctive understanding of the subject can assist staff in the overall delivery of the Outcomes within this document. Further to this, climate literacy can influence wider behavioural change.

Systemic behaviour change cannot happen in isolation and requires a cultural shift starting with leadership. An effective governance structure can promote a common understanding of climate change. This enables staff to apply a consistent and appropriate approach in relation to mitigation, adaptation and resilience within their role, while still considering specific business needs and priorities.

> **Sub-Outcome AR 5.5: All staff and stakeholders are informed by bespoke climate literacy training and knowledge is shared between TS other relevant bodies within the sector.**
>
> **Sub-Outcome AR 5.6: Adaptation and resilience is embedded across the Transport Scotland functions through an internal governance structure for the ACCAR and an appropriate leadership board, with at least one individual from each directorate overseeing the implementation of the ACCAR outcomes.**

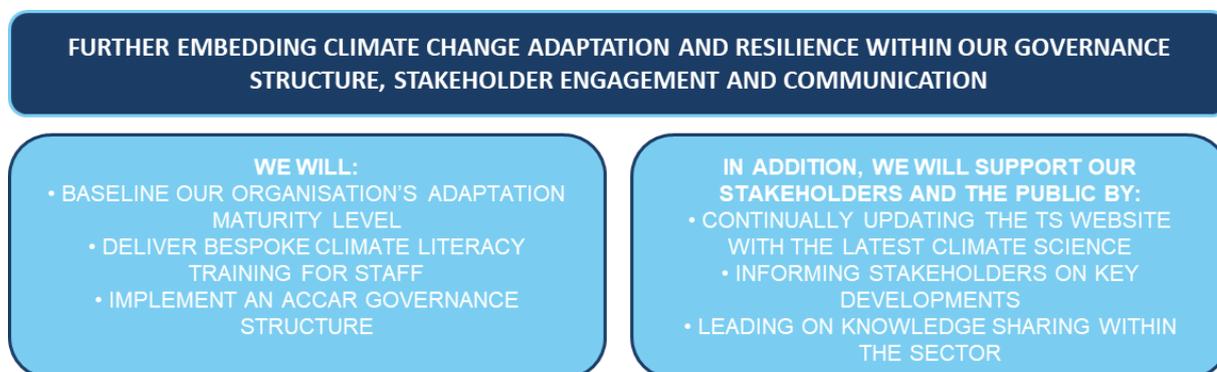## *Governance of Adaptation and Resilience*

Further embedding climate change adaptation and resilience within our governance structure, stakeholder engagement and communication activity is essential to delivery of our adaptation and resilience vision.

Our CEO is also an active member of the SG's Global Climate Emergency Board, who are responsible for the CCPu across all sectors and have recently taken forward a specific climate change adaptation work stream to further progress action in Scotland and response to the CCRA3 and the recent CCC review of SCCAP2. TS is also a designated risk owner within SG's response to the CCRA3 risks and these risks will be addressed by this approach.

Through the development and implementation of our internal governance structure (see AR 5.6) for the ACCAR, target setting, monitoring and evaluation in relation to our Strategic and Sub-Outcomes will be reported through current climate change reporting mechanisms. Actions associated with these outcomes will be set out in our subsequent plans, such as the Trunk Roads Adaptation Plan.

We will also draw on our various other strategies and plans in this regard to develop an effective monitoring and evaluation process that helps us achieve our outcomes and contribute to other strategies, such as the NTS2 or RSF.

We will ensure our organisation is capable of delivering well adapted transport system that is safe, reliable and resilient. A summary of our Sub-Outcomes regarding governance, engagement and communication is provided in **Figure 15**.

Figure 15 - Summary of our Sub-Outcomes for governance, engagement and communication.

Summary

TS is committed to delivering our vision for a well-adapted transport system in Scotland and will continue to take steps to embed adaptation and resilience within each of our transport networks and their modes, as well as our wider activity as an organisation. A summary of the Purpose, Vision, Risks and Strategic Outcomes of our ACCAR is provided in **Figure 16**.

Through our ACCAR we have set out:

- Our Vision and Framework for a well-adapted transport system that is safe, reliable and resilient;
- Key climate risks affecting each transport network, based on up-to-date climate science;
- TS's role and key approaches for each transport network; and,
- Our four Strategic Outcomes and various Sub-Outcomes to delivering a well-adapted transport system.

It covers a timeframe of 2022-30 in which we will address the 7 CCRA3 risks that relate to transport (see **Table 1**) and aligns with the timescales for the current and subsequent Scottish Climate Change Adaptation Programme (SCCAP). SCCAP3 is due to be published in 2024, which will cover the period up to 2029. Following publication of SCCAP3 in 2024, a review and update of our approach will be undertaken to ensure it remains appropriate in this regard and continues to contribute to wider adaptation efforts in Scotland.

We will continue to deliver against our current transport related outcomes within SCCAP2, play an active role in developing the next iteration of SCCAP and seek to realise our Strategic Outcomes through various Sub-Outcomes set out in our approach.

There will be a focus on infrastructure that is currently under direct TS control, such as Trunk Roads. For other infrastructure we will engage and collaborate with our stakeholders to further embed, enhance and encourage adaptation and resilience interventions across all transport modes in Scotland.

To ensure that Our Vision is delivered, a TS governance structure will be implemented to provide ownership of the Strategic Outcomes and Sub-Outcomes across each transport network. Delivery of the Sub-Outcomes and associated actions will be captured as part of our statutory Public Bodies Climate Change Duties Report and will inform our contributions to the SG annual progress report on SCCAP2. This will allow for progress to be tracked year on year.

Further to this reporting, it will also be important, as subsequent plans and actions are set out and progressed, that we develop relevant and appropriate targets and indicators of success. To aid this process, we will draw upon our various other strategies and plans to develop an effective monitoring and evaluation process to measure success, overseen by the governance structure.

PURPOSE

This document sets out TS's current approach to adaptation and resilience in relation to climate change, highlighting the key risks identified in the UKCCRA3 and provides an adaptation and resilience framework for Scotland's transport system

VISION

A transport system which is **well adapted** and prepared for the current and future impacts of climate change. It is **safe** for all users, **reliable** for everyday journeys and **resilient** to weather related disruption

RISKS

The CCRA3 identifies 7 key climate risks that relate to transport infrastructure, including the impacts of flooding, erosion, slope and embankment failure, subsidence, high and low temperatures, high winds and lightning. By delivering our Strategic Outcomes, we will manage these 7 risks across the Scottish transport network

STRATEGIC OUTCOMES

AR.1 Trunk Road Network

A TRN which is well-adapted and resilient to the current, projected and unexpected impacts of climate change

AR.2 Rail Network

Supporting the delivery of climate change and resilience for Scotland's Rail network

AR.3 Aviation Network

Engage with our stakeholders to support their decision making in relation to climate change adaptation and resilience

AR.4 Maritime Network

Contributing to safeguarding lifeline ferry services, ports and harbours and canals in response to the threat of climate change

Figure 16 - Transport Scotland Approach to Climate Change Adaptation and Resilience - Purpose, Vision, Risks and Strategic Outcomes.

Strategic Outcomes and Sub-Outcomes Summary Table

Table 7 - Strategic Outcomes, Sub-Outcomes, Sub-Outcomes detail and associated CCRA3 risks.

Strategic Outcome	Sub-Outcome Reference	Sub-Outcome Detail	Associated CCRA3 Risks
AR.1 Trunk Roads which are well adapted and resilient to the current, projected and unexpected impacts of climate change	AR 1.1	The Trunk Roads Adaptation Plan for the Trunk Roads is based on the most up to date climate change projections (UKCP18) and risk assessments, building on previous studies undertaken.	I1, I2, I3, I4, I5, I7, I12
	AR 1.2	The delivery of Scotland's Flood Risk Management Strategies, Plans and associated actions will be supported by the development of flood risk maps produced in conjunction with SEPA.	I1, I2, I3, I4
	AR 1.3	Our management of geo-hazards on Trunk Roads is well-informed, supported by a database recording the condition of geo-technical assets, their ability to withstand current and future climate change and ranking them to inform adaptation and resilience interventions.	I1, I5, I7
	AR 1.4	We are well prepared for the increased risk of scour through an updated Scour Management Strategy and Flood Emergency Plan following publication of the Design Manual for Roads and Bridges BD97 and updated CS 469 standards.	I1, I4
	AR 1.5	We are proactive in our approach to the analysis of scour and are continuously developing a programme of proactive scour schemes across the network.	I1, I4

Strategic Outcome	Sub-Outcome Reference	Sub-Outcome Detail	Associated CCRA3 Risks
	AR 1.6	We are well prepared for increased frequency and severity of high winds with an updated High Wind Strategy and National Wind Management Guidelines based on latest scientific data via the Met Office and UKCP18.	I1, I12
	AR 1.7	We are well informed on the impact of high temperatures on road surfacing, using a database of current road surface materials on Trunk Roads, and have established the likely impact for each road surface specification and its ability to withstand higher temperatures and prolonged periods of hot weather.	I1, I12
	AR 1.8	We are aware of the extent and locations on Trunk Roads at risk from coastal erosion and utilise Dynamic Coast data to inform any necessary interventions, such as improved sea walls, managed realignment or effective communication of impacts.	I1, I3
	AR 1.9	Current adaptation and resilience asset management processes are further embedded and improved. We are proactive in seeking opportunities for new processes that support adaptation and resilience of the Trunk Roads.	I1, I2, I3, I4, I5, I7, I12
	AR 1.10	We are fully aware of the potential impacts climate change poses to the asset through a review of the latest UK climate change projections (UKCP18) and a scoping assessment of Trunk Roads.	I1, I2, I3, I4, I5, I7, I12

Strategic Outcome	Sub-Outcome Reference	Sub-Outcome Detail	Associated CCRA3 Risks
	AR 1.11	The relationship between the weather-related impacts of climate change and road safety incidents on Trunk Roads is well understood and supports the strategic outcomes of the Road Safety Framework to 2030.	I1, I2, I3, I4, I5, I7, I12
	AR 1.12	We have a proactive Climate Change Adaptation Programme for Trunk Roads which goes beyond maintenance, informed by the Pilot Adaptation Programme.	I1, I2, I3, I4, I5, I7, I12
	AR 1.13	Our Biodiversity Strategy for Transport Scotland outlines the important role of landscape design and management in adapting Trunk Roads to the impacts of climate change.	I1, I2, I3, I5, I7, I12
AR.2 Supporting the delivery of climate change adaptation and resilience for Scotland's Rail network	AR 2.1	The next High Level Output Specification for Control Period 7 contains up-to-date requirements relating to climate change, including adaptation and resilience.	I1, I2, I3, I4, I5, I7, I12
	AR 2.2	We are engaged and supportive of the development of future specifications and policies relating to climate change adaptation and resilience across the Scottish rail network.	I1, I2, I3, I4, I5, I7, I12
AR.3 Engaging with aviation stakeholders to support their decision making in relation to climate change adaptation and resilience.	AR 3.1	HIAL monitors flooding risks to its infrastructure and takes appropriate action at those airports most at risk from coastal erosion, flooding and sea level rise, to ensure there is no significant disruption to services.	I1, I2, I3, I7
	AR 3.2	HIAL monitors the effects of high temperatures at its airports and the impact these could have on vehicles, runways and infrastructure, and takes appropriate action to ensure there is no significant disruption to services.	I12

Strategic Outcome	Sub-Outcome Reference	Sub-Outcome Detail	Associated CCRA3 Risks
	AR 3.3	HIAL as the lead partner in the Sustainable Aviation Test Environment in Orkney, monitors the testing of new types of low emission aircraft, including their performance in severe weather conditions.	I12
AR.4 Contributing to safeguarding lifeline ferry services, ports, harbours and canals in response to the threat of climate change	AR 4.1	We are proactive in our collaboration with CMAL and ferry operators, through existing working groups, providing a vital understanding of climate science to ensure it is considered when developing appropriate future interventions and policy.	I1, I3, I12
	AR 4.2	There is an increased awareness regarding climate change adaptation and resilience with UKG and Scottish Ports. We influence policy and encourage proactive interventions by building on existing engagement.	I1, I3, I12
	AR 4.3	We proactively collaborate with SC to identify climate change adaptation and resilience interventions and opportunities.	I1, I2. I3, I5, I7
AR.5 Wider Adaptation & Resilience	AR 5.1	Transport Scotland website users are well-informed on the latest climate science, policies and programmes through regular updates of website content.	I1, I2, I3, I4, I5, I7, I12
	AR 5.2	All stakeholders, including the public, are informed of key developments and information regarding climate change adaptation and resilience through our existing platforms and social media channels. We maintain awareness of emerging platforms to reach the greatest audience.	I1, I2, I3, I4, I5, I7, I12

Strategic Outcome	Sub-Outcome Reference	Sub-Outcome Detail	Associated CCRA3 Risks
	AR 5.3	We have an up-to-date evaluation of our adaptation maturity level through an annual baselining exercise using Adaptation Scotland's Capability Framework.	I1, I2, I3, I4, I5, I7, I12
	AR 5.4	There is widespread engagement and knowledge sharing on climate change adaptation and resilience with transport peers and across sectors at a local, national and international scale.	I1, I2, I3, I4, I5, I7, I12
	AR 5.5	All staff and stakeholders are informed by bespoke climate literacy training and knowledge is shared between TS other relevant bodies within the sector.	I1, I2, I3, I4, I5, I7, I12
	AR 5.6	Adaptation and resilience are embedded across the Transport Scotland functions through an internal governance structure for the ACCAR and an appropriate leadership board, with at least one individual from each directorate overseeing the implementation of the ACCAR outcomes.	I1, I2, I3, I4, I5, I7, I12

Annexes

ANNEX A - TS Adaptation Benchmark – Adaptation Scotland Capability Framework

	1. Starting	2. Intermediate	3. Advanced	4. Mature
Organisational Culture & Assets Progress Level…	OC1A Examine the Structure & Priorities of your Organisation	OC2A Secure resources to plan and deliver adaptation	OC3A Identify opportunities to include adaptation in plans, policies and procedures	OC4A Mainstream adaptation into your organisation's plans, policies and procedures
	OC1B Identify resources available for adaptation	OC2B Engage with colleagues to identify adaptation opportunities and potential 'champions'	OC3B Motivate 'champions' and actively promote adaptation across the organisation	OC4B Develop a network of recognised adaptation 'champions'
		OC2C Establish governance arrangements for adaptation	OC3C Put governance arrangements for adaptation into operation	OC4C Review and update governance arrangements for adaptation

Legend: Not Applicable; Relevant - Ongoing; Relevant - Complete; Relevant - Not Started

	1. Starting	2. Intermediate	3. Advanced	4. Mature
Understanding the Challenge Progress Level…	UC1A Learn about climate trends and projections	UC2A Develop understanding of climate risk and vulnerability	UC3A Develop (scenarios, storylines, narratives) for future climate change impacts and vulnerabilities	UC4A Mainstreaming of climate change risk assessment
	UC1B Learn about climate impacts affecting Scotland	UC2B Consider how your organisation's (decisions / functions) might be affected by climate change	UC3B Undertake strategic climate change risk assessment	UC4B Accessible climate adaptation knowledge that is integrated into internal systems and procedures
		UC2C Explore the impact of recent weather events on your organisation	UC3C Undertake project-level risk assessment	UC4C Actively engaged in sharing, learning, research and innovation
			UC3D Identify knowledge gaps, seek expertise and foster links with research and innovation	

Legend: Not Applicable; Relevant - Ongoing; Relevant - Complete; Relevant - Not Started

Planning & Implementation

Progress Level…

PI1A Identify existing adaptation work within your organisation.	PI2A Define strategic adaptation goals, outcomes and/or vision	PI3A Explore adaptation pathways / theory of change	PI4A Adopt an ongoing adaptive management cycle for adaptation planning
PI1B Demonstrate how your organisation contributes to Scotland's work to adapt	PI2B Identify a range of potential adaptation (measures, options, actions)	PI3B Appraisal of adaptation options	PI4B Taking action on adaptation is mainstreamed into your organisation's (functions / services)
PI1C Identify key internal stakeholders for adaptation	PI2C Develop an initial adaptation (strategy and) action plan	PI3C Develop a comprehensive adaptation strategy and action plan	PI4C Implement pathways for adaptation / transformational change
	PI2D Take action to deliver initial adaptation (measures, options, actions	PI3D Implement a programme of adaptation (measures, options and actions	

Not Applicable
Relevant – Ongoing
Relevant – Complete
Relevant – Not Started

Working Together

Progress Level…

WT1A Join and participate in relevant professional and/or adaptation networks	WT2A Make connections with external partners	WT3A Begin to formalise partnership working	WT4A Further develop and maintain partnership working
WT1B Identify and research relevant external organisations and partnerships	WT2B Coordinate with partners to deliver initial actions	WT3B Engage a wide range of stakeholders	WT4B Sustain engagement with partners and stakeholders
	WT2C Develop communication and engagement activities with partners	WT3C Implement further joint actions	WT4C Expand a programme of joint actions
		WT3D Join networks and link with peer organisations.	WT4D Take a lead in networks and peer organisations

Not Applicable
Relevant – Ongoing
Relevant – Complete
Relevant – Not Started

ANNEX B – CCRA3 Urgency Score Ratings

Category	Description
More Action Needed	New, stronger, or different Government action, whether policies, implementation activities or enabling environment for adaptation – over and above those already planned – are beneficial in the next five years to reduce climate risks or take advantage of opportunities. This will include different responses according to the nature of the risks and the type of adaptation: • Addressing current and near-term risks or opportunities with low and no-regret options (implementing activities or building capacity). • Integrating climate change in near-term decisions with a long life-time or lock-in. • Early adaptation for decisions with long lead-times or where early planning is needed as part of adaptive management.
Further Investigation	On the basis of available information, it is not known if more action is needed or not. More evidence is urgently needed to fill significant gaps or reduce the uncertainty in the current level of understanding in order to assess the need for additional action. Note the category of 'Research Priority' in CCRA2 has been replaced with 'Further investigation' in CCRA3. This is because of some confusion following CCRA2 that 'research priority' only denoted that more research was needed, when in fact the urgency is to establish the extent to which further adaptation is required.
Sustain Current Action	Current or planned levels of activity are appropriate, but continued implementation of these policies or plans is needed to ensure that the risk or opportunity continues to be managed in the future.
Watching Brief	The evidence in these areas should be kept under review, with continuous monitoring of risk levels and adaptation activity (or the potential for opportunities and adaptation) so that further action can be taken if necessary.

ANNEX C – CCRA3 risks for transport and beneficial actions.

CCRA3 Risk Identifier	CCRA3 Risk	CCRA3 Urgency Score	CCRA3 Description of Risk	CCRA3 Beneficial Actions
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures.	More Action needed	Vulnerabilities on one infrastructure network can cause problems on others, and transport infrastructure represents a significant part of this system.	Implement actions which support adaptation at a network level as well as for individual assets. Using common formalised standards of resilience, such as the new ISO 14091 standard. Improve arrangements for sharing data and information between transport and other sectors.
I2	Risks to infrastructure services from river, surface water and groundwater flooding.	More Action Needed	Extreme rainfall events cause flooding of transport infrastructure and hubs, resulting in travel and freight delays, accidents and impacts on emergency services.	Develop consistent indicators of flood risk resilience for transport networks to create the right institutional conditions for adaptation. Enhance or develop adaptation strategies to identify areas of the road network most vulnerable to flooding, Integrate green infrastructure solutions into transport developments.
I3	Risks to infrastructure services from coastal flooding and erosion	Further Investigation	Sea levels are currently rising and the rate of rise is accelerating, including around the UK. Coastal flooding and erosion risk to infrastructure services, including those associated with the transport sector, will therefore grow.	The use of adaptation pathways for the long term planning of flood risk management. Given the uncertainties around sea level rise, 'what if' planning for high coastal risk scenarios can help with understanding what could be done in the event of very high rates of change.
I4	Risks to bridges and pipelines from flooding and erosion.	Further Investigation	Bridges are critical transport assets. Flooding and erosion or scour (the eroding of soil around bridge foundations) due to increased rainfall can lead to travel disruption, significant repair costs and the potential isolation of remote communities.	Further research is needed to produce future estimates of the risks to bridges and pipelines from flooding, erosion and high temperatures. Modifications can be made to bridges to reduce their vulnerability to damage from flooding. Ongoing monitoring and maintenance of both types of assets will remain crucial to spot problems in enough time to act.

CCRA3 Risk Identifier	CCRA3 Risk	CCRA3 Urgency Score	CCRA3 Description of Risk	CCRA3 Beneficial Actions
I5	Risks to transport networks from slope and embankment failure.	More Action Needed	There are around 20,000 km of slopes and embankments supporting the UK's transport infrastructure. Deterioration and failure of these assets have significant negative impacts on transport networks through damage, travel delays and accidents.	Factor in updated projected increases in heavy rainfall events into long-term renewal programmes for all transport networks. Improve numerical tools, instrumentation and monitoring systems to increase understanding of slope failure processes in relation to weather and climate. Continue to use slope inspection programs and employ greater use of soft engineering techniques, such as vegetation management, to reinforce vulnerable slopes. Enhance maintenance of drainage systems for roads and railways and increased drainage capacity in new road infrastructure. Enhance maintenance of drainage systems for roads and railways and increased drainage capacity in new road infrastructure.
I7	Risks to subterranean and surface infrastructure from subsidence.	Further Investigation	Ground subsidence is often due to shrinkage and swelling of clay soils, with damage to infrastructure occurring because of interaction with vegetation and associated water content changes. This form of subsidence is regarded as the most damaging geological hazard in Britain today.	Production of more accurate and consistent data for understanding the linkages between subterranean and other types of infrastructure, and understanding potential adaptation strategies. Quantifying the uncertainty in soil properties. Increased ground and weather monitoring and the use of real-time decision support tools as a potential method to mitigate the risks of shrink-swell subsidence.

CCRA3 Risk Identifier	CCRA3 Risk	CCRA3 Urgency Score	CCRA3 Description of Risk	CCRA3 Beneficial Actions
I12	Risks to transport from high and low temperatures, high winds, lightning	More Action Needed	Evidence that demonstrates the impacts of extreme temperatures, high winds and lightning strikes on rail, road, air and water transport networks is plentiful.	Develop improved indicators of climate resilience for road, rail, ports and airports. Mainstream climate change adaptation into planning and design of new infrastructure. Improve weather and climate services, including early warning systems, through use of digital platforms, remote sensing and real time network management. Revise standards for railways to align with future climate projections.

ANNEX D - Transport Scotland's SCCAP2 Objectives (Published 2019)

Outcome	Sub-Outcome – Policy Objective	SCCAP2 Detail
Outcome 1: Our communities are inclusive, empowered, resilient and safe in response to the changing climate	1.2.1.1 Community Planning – Active Travel	The Active Travel vision is for walking and cycling to be the most popular mode of travel for short, everyday journeys. We want to make Scotland's towns and cities friendlier, safer and more accessible. Active Travel is fundamental to the development of a sustainable travel network and a key priority for the Programme for Government. The budget was doubled in 2018-19, with that funding sustained for 2019-20. This funding will be used to improve Scotland's active travel infrastructure and as a result its ability to adapt to the changing climate.
Outcome 2: The people in Scotland who are most vulnerable to climate change are able to adapt and climate justice is embedded in climate change adaptation policy – policies and research	2.2.2.5 Air Quality - Cleaner Air for Scotland Strategy	A review of the Cleaner Air for Scotland Strategy is due for completion at the end of 2019. Low Emission Zones will set an environmental limit on certain road spaces, allowing access to only the cleanest vehicles. We will work in partnership with local authorities and regional transport partnerships to deliver Low Emission Zones that are well designed to consistent national standards. The National Low Emissions Framework document will set the framework within which Low Emissions Zones are introduced and will be published in line with the commitments of the Cleaner Air for Scotland strategy.
	2.2.2.5 Air Quality - Electric Vehicle Charging Network through ChargePlace Scotland	Electric vehicles will not only help reduce greenhouse gas emissions and tackle climate change, but also help improve local air quality and therefore public health and wellbeing. Transport Scotland is supporting increased uptake of electric vehicles by: • providing support for home charge points for consumers, • providing support for workplace charge points, • working with each of our delivery partners to create Scotland's 'Electric A9', including charging points along the route and demonstrating that electric vehicles offer important advantages to motorists in rural and urban Scotland, • providing funding for towns and cities to become 'Switched On' – working with partners, local authorities will get funding to meet local EV transition needs such as supporting charging initiatives for tenements and EV incentives, • providing funding to support the ongoing expansion of the EV charging network, • supporting the installation of domestic and workplace charge points, and working with partners to identify solutions for households without off street charging. Delivery of this policy will be supported by changes to the Scottish planning system, such as no longer needing planning permission for on-street charging points.

Outcome	Sub-Outcome – Policy Objective	SCCAP2 Detail
Outcome 4: Our society's supporting systems are resilient to climate change	4.1.4 Transport - The National Transport Strategy 2	Transport Scotland will publish the new National Transport Strategy (NTS) in 2019, setting out policy for transport in Scotland over the next 20 years. This Strategy takes into account targets for decarbonisation of transport, accessibility, and elimination of poverty. The new NTS will seek to ensure that Scotland adapts to the effects of climate change, takes steps to mitigate further climate change and promotes greener, cleaner choices. The Strategy states that: "Adaptation of the strategic transport network to cope with effects of climate change is also vital to ensure the continued health of the Scottish economy." It emphasises the importance of a Sustainable Travel Hierarchy which promotes walking, cycling, public transport, and bike, car or ride sharing in preference to single occupancy car use. The Strategy will align with the emerging policy and legislative landscape in Scotland including the outcomes from the independent planning review, Climate Change Plan, local government review, Enterprise and Skills review, City and Region Growth Deals and the Transport Bill.
	4.2.3 Transport - Strategic Transport Projects Review 2	Following the publication of the second National Transport Strategy, Transport Scotland will seek to publish the Second Strategic Transport Projects Review (STPR2). STPR2 will examine the strategic transport infrastructure interventions required to support Scotland's Economic Strategy, including inclusive growth objectives, reflecting outcomes and priorities to be set out in the National Transport Strategy. The Strategic Transport Projects Review, published in December 2008, sets out the Scottish Government's 29 transport investment priorities over the period to 2032.
	4.2.3 Transport - Scottish Road Network Landslides Study and Implementation Report	Climate change will impact on slope stability due to changes in soil moisture. Parts of Scotland may see a seasonal increase or decrease in the amount of rainfall experienced which can lead to an increase in the frequency of landslides. Adapting to landslides and flooding will form a key area of work for the Transport Sector. In 2005, Transport Scotland published the Scottish Road Network Landslides Study, following road closures after landslides the previous year. In 2009, we published an Implementation Report. This report identifies areas of current high hazard in Scotland and makes recommendations as to how to assess the Scottish road network and management approaches which could be adopted to mitigate the effects of landslides.

Outcome	Sub-Outcome – Policy Objective	SCCAP2 Detail
	4.2.3 Transport - Integrated Roads Information System and Disruption Risk Assessment Tool	Collecting and analysing data to determine areas of the transport network that are susceptible to flooding, inundation and subsidence is vital to improve our knowledge about the capability of assets to respond to climate change. The use of the Integrated Roads Information System tool to record incidents such as flooding will allow identification of vulnerable locations in the trunk road network and prioritise sites that require engineering interventions or continued monitoring.
	4.2.3 Transport - Scour Management Strategy and Flood Risk Emergency Plan	Bridge scour is the process where sediment from around bridge abutments or piers is removed by fast moving water. An increase in rainfall and flooding as a result of the changing climate could cause an increase in the frequency of scour, potentially causing structural damage. A Scour Management Strategy and Flood Risk Emergency Plan has been developed and implemented across Transport Scotland's Operating Companies and Design-Build-Finance-Operate providers. The aim is to ensure a consistent approach to inspecting, monitoring, assessing and recording scour and erosion at structures and to improve interventions and mitigation measures. The strategy includes the monitoring of trunk road bridges and other structures, and enhanced monitoring of those structures which are known to be at risk. The strategy also includes installation of flood level marker plates next to high risk structures so that, during high rainfall events, inspectors can identify when flows approach or exceed critical flood assessment levels and recommend closure or restrictions of the structure until water levels recede and scour inspections can be undertaken.
	4.2.3 Transport - Landscape Management	Within the work of the Trunk Road divisions, the potential impact of climate change on our natural resources is managed via our Landscape Policy document, Fitting Landscapes. Through application of this mandatory policy, all works undertaken on the network must take account of the impact on the environment and local landscape character, whilst seeking opportunities to enhance the resource. The policy also requires designers and managers to consider the longer-term impacts of their works and build-in sustainability objectives.
	4.2.3 Transport - Preparing for Severe Weather Events	The UKCP18 projections note that there is likely be an increase in extreme weather events. Winter service operations allow safe use of the trunk road network and minimize disruption to users caused by snow or ice. Transport Scotland continues to develop and improve high wind management plans. All weather related incidents (including wind) are routinely reviewed to determine any necessary improvement actions. Our Met Office advisor based in the Traffic Scotland National Control Centre provides high wind forecasting for major

Outcome	Sub-Outcome – Policy Objective	SCCAP2 Detail
		bridges on the trunk road network to monitor, manage and disseminate information on restrictions and closures to operational partners, the public and the freight/haulage industry.
	4.2.3 Transport - Scottish Road Network: Climate Change Study and Implementation Plan	The Scottish Road Network: Climate Change Study (2005) and Implementation Plan (2008) gives direct recommendations to adapt the Scottish road network to cope with climate change. This study and implementation plan was updated following UK Climate Projections 2009 and consideration is being given to a further update following the UK Climate Projections 2018.
	4.2.3 Transport - Scottish Ministers' High Level Output Specification, Control Period 6	The most recent High Level Output Specification sets out how investment strategies must become more sustainable and ensure enhanced network resilience from adaptation interventions. Scottish Ministers also require Network Rail to work with the rail industry to develop and apply suitable Key Performance Indicators to monitor the impact and mitigation of climate change on network disruption and provide the means to measure the benefits of adaptation interventions.
Outcome 5: Our natural environment is valued, enjoyed, protected and enhanced and has increased resilience to climate change	5.2.2 Cultural Ecosystem Services - Walking and Cycling Networks	This network will close key gaps, upgrade connecting routes, link to public transport and promote shared use of paths to encourage active travel and enjoyment of Scotland's natural landscapes. Stronger walking and cycling networks diversify the transport system, providing additional options for travel in the event of weather related disruption. Changes to Scotland's climate may support this programme as leisure and other outdoor activities may be taken up by people as the climate warms, and active travel and recreation become more accessible. The Strategic Transport Projects Review will include the National Walking and Cycling Network, the National Cycle Network, and other strategic walking and cycling networks on local and trunk roads.