



STRATEGIC TRANSPORT PROJECTS REVIEW

PROTECTING OUR CLIMATE
AND IMPROVING LIVES



Appendix I: Recommendation Appraisal Summary Tables

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1. Detailed Appraisal Summary

An 'Appendix I: Recommendation Appraisal Summary Tables (ASTs) Explanatory Note' accompanies this AST.

1.1. Recommendation 31 - Trunk road and motorway climate change adaptation and resilience

Recommendation Description

The overall purpose of this recommendation is to adapt the trunk road and motorway network to the impacts of climate change to maintain resilience in the face of changing climatic conditions.

[In 2019 the Scottish Government declared a Climate Emergency and committed to a target of net zero emissions by 2045.](#) In parallel to policies and interventions to address Scotland's emissions and limit its contributions to climate change, there is also a requirement to adapt to the consequences of climate change that are already happening, which is underpinned by the [Climate Change \(Scotland\) Act 2009](#). Adapting to the impacts of climate change is necessary, regardless of how much carbon emissions are cut by, as many impacts of past emissions are already locked in. This will lead to further changes in the weather system for decades to come as set out in [Climate Ready Scotland: Climate Change Adaptation Programme 2019-2024](#). Climate change adaptation and mitigation are intrinsically linked - the more global mitigation, the less there is a need to adapt to the impacts of climate change.

For existing infrastructure, improving monitoring, information, practices, operations and interventions which go beyond maintenance are considered low-regret adaptation options. Low-regret options are relatively low cost and provide relatively large benefits under predicted future climates. For new infrastructure, mainstreaming climate change adaptation and resilience into planning and design would help to avoid retrofitting later.

No-regret options exist in the form of improved weather and climate services, including early warning systems, which have been found to have high benefit to cost ratios. There are further opportunities through the use of digital platforms and remote sensing in real-time network management which reduce the costs of disruption and thus deliver economic benefits in terms of travel time. No-regret options are cost-effective now and under a range of future climate scenarios.

This recommendation would support continuation of activities by Transport Scotland to:

- Build on evidence available of vulnerable locations to develop a fuller picture of those areas on the trunk road and motorway network most at risk of disruption due to weather events;
- Identify, prioritise and implement measures to strengthen the resilience of Scotland's trunk road and motorway network to the impacts of a changing climate and respond to unplanned events, such as flooding, landslides and high winds; and
- Build on Transport Scotland's existing road asset management plan, disruption

risk management process and incident response plans to help mitigate the impact of disruption associated with severe weather-related events as a result of the impacts of climate change.

While the location and nature of the improvements on specific routes requires further detailed study, potential locations and measures include but are not limited to:

- A85 Glen Ogle – geotechnical and hydrological study;
- A77, A82, A83 and A87 – sea wall improvements, strengthening or replacement;
- A78 – sea wall improvements, strengthening or replacement, and coastal fence upgrade;
- A9 – slope stability at Scrabster; and
- Additional proactive inspections / assessments such as LiDAR of embankments / hillsides / sea walls.

1.2. Relevance

Relevant to all areas served by the trunk road and motorway network

[The UK Climate Projections developed by the Met Office show that over the last few decades Scotland has experienced a warming trend, shifting rainfall patterns and rising sea levels:](#)

- Temperature - Scotland's 10 warmest years on 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;
- Rainfall - there has been an increase in rainfall over Scotland in 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; and
- Sea level rise - mean sea level around the UK has risen by approximately 1.4mm a year from the start of the 20th century.

[Transport Scotland has been reviewing the Scottish Trunk Road Network's exposure to Climate Change and severe weather-related risks.](#) It is identifying which sections of the network are most vulnerable to the impacts of severe weather and how this may change over time as a result of climate change.

The outputs of this review are used to inform which parts of the network require the most attention to minimise future disruption and cost associated with severe weather-related response and repair. It also helps to inform and facilitate the development of adaptation interventions and support future investment decisions.

Climate change directly affects the transport system through an increasing number of severe weather events and the disruption they cause. The impact that these events are having across the trunk road and motorway network in Scotland is already being seen as illustrated by the examples which follow.

[In August 2020 on the A68 at Fala, failure of the embankment below the route occurred and caused damage to the carriageway where there were no known defects on the network following a period of heavy rainfall.](#)

East Hamilton Street on the A8 through Greenock is prone to severe flooding. In August 2021, flash flooding caused the closure of the route to all vehicles. Drainage maintenance work was undertaken in October 2021 to repair damage to the existing drainage pipe to assist with flood management issues.

In January 2020, there was also failure of a section of the sea wall on the A82 at Achintore Road as a result of Storm Brendan, which caused significant sea swell and gusts of wind up to 80mph.

The ‘Beast from the East’ in February 2018 resulted in extreme snowfall across Scotland’s transport system, causing significant disruption, with notable closures on the M80 and M876. As a result of hazardous conditions, hundreds of vehicles were stranded and the M80 southbound was closed for approximately 25 hours. It also caused the formation of a 3-metre-high snow drift on the M90.

Two sections of the A78 (Fairlie and Largs to Skelmorlie) are known vulnerable locations which feature in the South West Operating Company’s disruption risk site register. Flood Management Plans have subsequently been developed for both locations.

[The A83 Rest and Be Thankful has been identified as posing a high level of risk due to landslides and debris flow hazards.](#) These have increased in frequency over recent years due to heavy, intense and prolonged periods of rainfall. Transport Scotland is undertaking action to adapt this section and identify a long-term solution to the hazards. The recommendation Access to Argyll (A83) (29) covers more detail and responds to the need to improve resilience for strategic traffic currently using the A83.

The Queensferry Crossing has been designed with increased wind shielding capabilities which has improved the resilience of a key transport and supply route across the Central Belt and which connects with the north of Scotland.

The Climate Change Risk Assessment (CCRA) is published every five years and sets out the risks and opportunities facing the UK from climate change. The most recent [CCRA3 assessment](#) was published in June 2021. The CCRA3 Independent Assessment reports that the gap between the level of risk faced by climate change and the level of adaptation underway has widened. The risks below were identified where more action is needed in Scotland:

- Risks to infrastructure networks (water, energy, transport, Information and Communications Technology (ICT)) from cascading failures;
- Risks to infrastructure services from river, surface water and groundwater flooding;
- Risks to the transport network from slope and embankment failure; and
- Risks to the transport network from high and low temperatures, high winds and lightning.

Following a review of climate change projection modelling developed by the Met Office (UKCP18), CCRA3 suggests a worsening of many of these risks under future climate change (high, medium and low) emissions scenarios. Adaptation Scotland produces a summary for Scotland based on CCRA3 and UKCP18 which sets out associated impacts on the trunk road and motorway network.

The impacts include increases in the frequency and intensity of rainfall, high summer temperatures/heatwaves and wind speeds which more frequently exceed operational limits for infrastructure, such as bridges. It is also projected that the increases in high rainfall combined with periods of dry weather may lead to a greater incidence of slope failure and scour around bridges.

Impacts already being experienced and future projections underline the need for continued research to understand the impact of climate change on the trunk road and motorway network, with further investment in adaptation interventions needed to address changes which are likely to occur. This investment is pivotal alongside efforts to achieve net zero by 2045.

1.3. Estimated Cost

£1,001 million - £2,500 million Capital

Transport Scotland is in the process of preparing a high-level Approach to Climate Change Adaptation and Resilience report. It is envisaged a recommendation within this document would be to develop a Roads Climate Change Adaptation Plan. This plan would set out specific actions required to adapt the trunk road and motorway network and establish associated costs.

While the final cost cannot be estimated accurately at this time, a banding of £1,001 million – £2500 million capital cost over the life of STPR2 has been established to reflect the anticipated increase in investment required to adapt the trunk and motorway network to the impacts of climate change, however this figure could change over time as it would be subject to the latest climate change predications over the life of STPR2.

Further detail can be found in the Affordability section of this appraisal summary table.

1.4. Position in Sustainable Investment Hierarchy

Maintaining and safely operating existing assets

This recommendation would contribute to five of the 12 NTS2 outcomes, as follows:

- Adapt to the effects of climate change;
- Promote greener, cleaner choices;
- Be reliable, efficient and high quality;
- Use beneficial innovation; and
- Safe and secure for all.

1.5. Summary Rationale

Summary of Appraisal

	TPO					STAG					SIA				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Low Scenario	+	+	+	+	+++	+	+++	++	+	+	+	+	+	+	+
High Scenario	+	+	+	+	+++	+	+++	++	+	+	+	+	+	+	+

Climate change is already having far-reaching impacts on Scotland’s weather systems with heatwaves, intense rainfall and floods increasing in scale and frequency. Reducing global greenhouse gas emissions is essential to combating future catastrophic climate change. However, due to current and historic emissions, further changes to the weather system are already locked in. Therefore, adapting to the impacts of climate change is vital to ensuring that the trunk road and motorway network, including associated active travel, is safe, reliable and resilient for the people of Scotland and its visitors. The severity of this issue is reflected in a stark warning from the Climate Change Committee, who highlighted that net zero commitments will fail unless we invest in adaptation across the nation and increase climate resilience.

The need for pro-active climate change adaptation and resilience on the trunk road and motorway network has been highlighted in the STPR2 National Case for Change Report. This recommendation is related to protecting the operation of the asset, including carriageways and structures, from increasing levels of flooding, slope deterioration/failure and other impacts related to climate change.

The impacts as a result of climate change will extend beyond the 20 year time frame of STPR2, however adapting to climate change and investing in resilience interventions could address the impacts already experienced. Further, it could aid in understanding how to mitigate future risks to the trunk road and motorway network as the weather and impacts becomes less predictable and potentially more extreme. Within the Sustainable Investment Hierarchy, this recommendation sits in both ‘Maintaining and safely operating existing assets’ and ‘Targeted infrastructure improvements’. The recommendation performs well against the Transport Planning Objectives, STAG, Statutory Impact Assessment and Deliverability criteria.

Details behind this summary are discussed in Section 3, below.

2. Context

2.1. Problems and Opportunities

This recommendation could help to tackle the following problems and opportunities:

Relevant Problems & Opportunity Themes identified in the National Case for Change

- **Adapting to Climate Change:** climate change directly affects the transport sector through the increasing number of more severe and frequent extreme weather events and the disruption they cause to the transport system. Disruption often disproportionately impacts vulnerable communities with fewer and less resilient transport options and can lead to significant disruption and high economic costs.
- **Productivity:** whilst Scotland's productivity level is not solely driven by the efficiency of its transport system, improvements in transport connectivity between businesses reduces costs and increases productivity, thus generating higher levels of economic growth.
- **Labour Markets:** people often need transport to access employment, education and training and therefore help reduce the numbers out of work and support Scotland's ambitions for growth. Transport can ensure that the skills and experience of those in the labour force are effectively matched with the needs of businesses, helping to increase incomes and improve productivity.
- **Trade and Connectivity:** transport is crucial for trade and competitiveness, within Scotland, across the UK and internationally.
- **Tourism:** transport plays a vital part in supporting tourism. It enables people to get to, and travel within, Scotland and allows them to explore the many sights and experiences the country has to offer. Whilst tourism benefits are recognised, tourists should be encouraged to travel using sustainable modes.
- **Funding and Resources:** the way in which the transport system is paid for and funded needs to be fair and sustainable and support wider outcomes. A key challenge relates to managing transport assets effectively and investing efficiently in the resources needed to maintain and safely operate them and make better use of existing capacity.
- **Reliability:** without intervention, forecast increases in traffic volumes on the road network will impact negatively on reliability through increased congestion and more roadworks as greater pressure is placed on the operational efficiency of the network.
- **Safety and Security:** Scotland's transport system needs to be safe. Whilst the [number of road accident casualties reduced by 11% between 2017 and 2018](#), the number of fatalities has increased. Women and disabled people in particular feel vulnerable when using public transport – particularly at bus stops, train stations or other transport interchanges.
- **Resilience:** a key challenge is providing a transport system that is resilient and speedily recovers from disruption, thus minimising impacts of delayed journeys on networks and users.

2.2. Interdependencies

This recommendation has potential overlap with other STPR2 recommendations and would also complement other areas of Scottish Government activity.

Other STPR2 Recommendations

- Access to Argyll (A83) (29);
- Trunk road and motorway safety improvements to progress towards ‘Vision Zero’ (30);
- Trunk road and motorway renewal for reliability, resilience and safety (32);
- Future Intelligent Transport Systems (33);
- Traffic Scotland System renewal (34);
- Intelligent Transport System renewal and replacement (35); and
- Access to Stranraer and the ports at Cairnryan (40).

Other areas of Scottish Government activity

- [National Transport Strategy \(NTS2\)](#);
- [Revised Draft Fourth National Planning Framework \(Revised Draft NPF4\)](#)
[National Developments 11: Stranraer Gateway and 16: Hunterston Strategic Asset](#);
- [Climate Change Plan 2018-32 Update](#);
- [Climate Ready Scotland: Scottish Climate Change Adaptation Programme 2019-24](#)**Error! Bookmark not defined.**
- [Infrastructure Investment Plan 2021/22 – 2025/26](#);
- [Scotland’s Road Safety Framework to 2030](#); and
- [Future Intelligent Transport Systems Strategy \(2017\)](#).

3. Appraisal

This section provides an assessment of the recommendation against:

- STPR2 Transport Planning Objectives (TPOs);
- STAG criteria;
- Deliverability criteria; and
- Statutory Impact Assessment criteria.

The seven-point assessment scale has been used to indicate the impact of the recommendation when considered under the ‘Low’ and ‘High’ Transport Behaviour Scenarios (which are described in Appendix F of the Technical Report).

3.1. Transport Planning Objectives

1. A sustainable strategic transport system that contributes significantly to the Scottish Government’s net-zero emissions target

Low Scenario	High Scenario
+	+

As Scotland moves towards net zero emissions by 2045 there are a number of changes and implications for the trunk road and motorway network that need to be supported. Climate change adaptation and resilience should address existing and predicted climate change impacts and support the changes that are necessary to reach the Scottish Government’s net zero target. The shift towards electrification of road passenger transport and associated infrastructure, and a greater dependency on public transport and active travel (walking, cycling and wheeling) would also require significant adaptation interventions to maintain resilience of the trunk road and motorway network and its ability to meet evolving transport needs, including associated active travel infrastructure.

As the climate and weather systems continue to change, coupled with an increased reliance on electricity and ICT related to modal shift, the potential for cascading risks as a result of intense weather events may lead to a rise in disruption associated with this infrastructure. Alongside risks to the existing asset there would also be risks to new infrastructure. For example, the addition of more electric vehicle charge points on the trunk road and motorway network may create the conditions for cascading risks which may not currently be considered within the Flood Risk Assessment process.

Health and safety risks posed by extreme weather may impact an increased number of cyclists and pedestrians using active travel routes which form part of the trunk road and motorway network. Therefore, climate change adaptation interventions must support activities that aim to decarbonise journeys on the trunk road and motorway network and support a change towards more journeys being undertaken

by sustainable modes of travel. An increase in extreme weather events may also cause a decrease in the uptake of sustainable modes of travel due to health and safety concerns, as a result of extreme heat and flooding, as well as comfort and convenience.

In the high and low scenarios it is expected that climate adaptation would have a minor positive impact on this TPO. The options within this recommendation have the potential to facilitate and maintain sustainable travel while also improving the resilience of the trunk road and motorway network. Further environmental assessment may be needed to confirm this.

This recommendation is expected to have a minor positive impact on this objective in both the Low and High scenarios.

2. An inclusive strategic transport system that improves the affordability and accessibility of public transport.

Low Scenario	High Scenario
+	+

This recommendation would support the reliability of public transport that uses the trunk road and motorway network on routes which could be susceptible to coastal, river, surface water or groundwater flooding and/or erosion (including slope deterioration/failure). These impacts may increase disruption, incur significant repair costs and potentially isolate communities.

This may more acutely affect communities in remote areas who rely on a single route on the trunk road and motorway network/public transport services that use these routes to access employment, education and services.

Routes with bridges which are a critical transport asset often reflect a single critical point of network failure. Therefore, flooding, erosion or scour (the eroding of soil around bridge foundations) due to increased rainfall can increase vulnerability of the asset.

This recommendation is expected to have a minor positive impact on this objective in both the Low and High scenarios

3. A cohesive strategic transport system that enhances communities as places, supporting health and wellbeing.

Low Scenario	High Scenario
+	+

Disruption on the trunk road and motorway network caused by weather-related impacts as a result of climate change can have an impact on communities, particularly in remote areas where the trunk road forms part of a single access route and/or where there are structures, such as bridges, that are susceptible to a single point of failure.

Without sufficient adaptation and resilience to address the impacts associated with climate change, the trunk road and motorway network may be increasingly vulnerable to rising temperatures, flooding, scour, slope erosion/deterioration and high winds. By identifying locations on the network that may be vulnerable to the impacts of the changing climate, leading to increased disruption and may require intervention, there can be protection of the trunk road and motorway network from these risks particularly where it links communities and provides access to vital services such as healthcare.

This recommendation would provide greater resilience to the trunk road and motorway network in relation to the impacts associated with climate change. This supports a cohesive transport system that enhances communities by enabling places to thrive through reliable trunk road and motorway connectivity including associated active travel infrastructure. This should have a positive effect on maintaining access for communities, particularly rural communities (where less options for alternative routes exist), which supports their health and wellbeing and access to essential services.

This recommendation is expected to have a minor positive impact on this objective in both the Low and High scenarios.

4. An integrated strategic transport system that contributes towards sustainable inclusive growth in Scotland.

Low Scenario	High Scenario
+	+

Without appropriate adaptation in relation to severe weather events, the level of disruption is likely to increase, effecting the resilience of the trunk road and motorway network, including associated active travel infrastructure. Increased disruption would further impact on communities and businesses that depend on the network across Scotland to access employment, education, services and markets and the connectivity it provides to onward transport connections by Rail and/or ferry. The recommendation is expected to have a minor positive impact on this TPO with

adaptation being important to ensure the continued operation of the trunk road and motorway network, connecting communities to employment and businesses to markets and labour catchments.

The scoring is the same in both low and high scenarios as the impacts of climate change can cause a single point of failure on the network that affects all users.

This recommendation is expected to have a minor positive impact on this objective in both the Low and High scenarios.

5. A reliable and resilient strategic transport system that is safe and secure for users.

Low Scenario	High Scenario
+++	+++

Adaptation to climate change will be necessary to maintain a safe, reliable and resilient trunk road and motorway network including associated active travel infrastructure. The importance of adaptation is emphasised by the Climate Change Committee in CCRA3. The frequency and intensity of extreme temperature and rainfall events will likely increase in the future, with the extent of change depending on global efforts to reduce greenhouse gas emissions.

[CCRA3 reports that there is an expected difference in future rainfall trends in Scotland](#), depending on the season. In winter, rainfall is expected to increase by approximately 7% by the 2050s and by 7% to 13% by the 2080s, from a 1981-2000 baseline. Conversely, summer rainfall is expected to decrease by approximately 7% by the 2050s and by 12% to 16% by the 2080s. The same analysis for summer shows that, despite overall summer drying with wet days projected to become less frequent, when it does rain the rainfall will be more intense. These types of weather events are already impacting on the operation of the trunk road and motorway network as illustrated by the examples described in the earlier Relevance sub-section.

Such rises would lead to an increase in likelihood of associated risks, such as flooding of coastal communities and associated trunk road and motorway network infrastructure in proximity to coastal settings. The changing trends would also lead to an increase in the risk of erosion leading to slope deterioration/failure as well as scour around structures such as bridges. CCRA3 evidence also suggests that by 2100 many areas in Scotland could see daily temperatures exceed 30°C more often.

Overall, this recommendation is scored to have a major positive impact on this TPO with adaptation integral to ensuring the trunk road and motorway network including associated active travel infrastructure is safe, reliable and resilient. The scoring is the

same in both low and high scenarios as the impacts of climate change can cause a single point of failure on the network that affects all users

3.2. STAG Criteria

1. Environment

Low Scenario	High Scenario
+	+

See Strategic Environmental Assessment (SEA) below.

This recommendation is expected to have a minor positive effect on this criterion in both the Low and High scenarios.

2. Climate Change

Low Scenario	High Scenario
+++	+++

This recommendation focuses on identifying vulnerability to the effects of climate change on the trunk road and motorway network as well as identifying measures to assist in adaptation to the effects of climate change. Climate change adaptation and resilience shall address existing and predicted climate change impacts and support the changes that are necessary to reach the Scottish Government’s net zero target for greenhouse gas emissions. The shift towards electrification of road passenger transport and associated infrastructure, and a greater dependency on public transport and active travel (walking, cycling and wheeling) would require significant adaptation interventions to maintain resilience of the trunk road and motorway network, including associated active travel infrastructure, and its ability to meet evolving transport needs.

Potential measures to address the greatest risks of climate change to vulnerable areas of the trunk road and motorway network are detailed in this recommendation. In addition, having a well-maintained network also assists the resilience of the existing network to the impacts of climate change, and so supporting reduced vulnerability to the effects of climate change and ability to adapt. The recommendation Trunk road and motorway network renewal for reliability, resilience and safety (32) details recommendations for a well-maintained network that works in a complementary way to this one.

The focus of this recommendation in the climate change criterion is to identify vulnerability to the effects of climate change and also identify ways to adapt to the effects of climate change on the trunk road and motorway network. The

recommendation also supports mechanisms for the reduction of greenhouse gas emissions from transport. The scoring is the same in both Low and High scenarios as the impacts of climate change can cause a single point of failure on the network that affects all users.

This recommendation is expected to have a major positive effect on this criterion in both the Low and High scenarios.

3. Health, Safety and Wellbeing

Low Scenario	High Scenario
++	++

[Evidence suggests that currently there is a small proportion of road traffic accidents per year in Scotland that is due to the effects of the weather on the road environment or users contributing to an accident.](#) Contributory factors in 2019 included slippery road (due to weather) (10%); rain, sleet, snow or fog (2%); and spray from other vehicles (<1%).

Where weather becomes more extreme, these risk factors may increase. In addition, where there is increased flooding, slope failure and coastal erosion there is a greater potential for loss of life from unexpected events (for example structural or embankment failure), particularly where there may be no known defects on the trunk road and motorway network to inform responses in advance. Adaptation is therefore essential to keep users of the trunk road and motorway network safe when they are travelling.

Transport Scotland has a method of systematically assessing and ranking the hazards posed by debris flows. This methodology is outlined within the [Scottish Road Network Landslide Study](#), which was used to identify the A83 Ardgarten to Rest and Be Thankful as one of the most highly ranked debris flow hazard sites in Scotland.

Adaptation would also be necessary to improve perceived and actual safety of the trunk road and motorway network for all users. For example, severe weather events may cause flooding which could affect underpasses or high winds which may impact overbridges. Adaptation may also be required at locations to ensure bus lay-bys on the trunk road network remain in operation during severe weather and that appropriate lighting continues to function to support the security of travelling passengers.

Ongoing research is essential to addressing the changing climate. For example, as part of regular reviews of the Transport Scotland High Wind Strategy and National Wind Management Guidelines, the Met Office has undertaken a bespoke project on behalf of Transport Scotland to produce a new dataset of wind modelling over a 30 year period. This data would inform an update of high wind strategy and associated guidance, and provide a reference for Operating Companies for their own high wind management plans.

This recommendation is expected to support access to active travel and public transport infrastructure that supports health and wellbeing. It is not expected to have an impact on visual amenity.

Overall, this recommendation is anticipated to have a moderate positive impact on the Safety Criteria with adaptation integral to ensuring the safety of the trunk road and motorway network for all users as the impacts associated with climate change occur. In the Low and High scenarios, climate change adaptation would be required to the same extent, as impacts can cause a single point of failure on the network that affects all users.

This recommendation is expected to have a moderate positive impact on this criterion in both the Low and High scenarios.

4. Economy

Low Scenario	High Scenario
+	+

[Upland and mountainous areas, for example the A83 at the Rest and Be Thankful, are more prone to natural slope failures and landslides due to their topography which is compounded by the impacts associated with climate change](#), (the increased frequency of heavy, intense and prolonged periods of rainfall^{Error! Bookmark not defined.}). Single landslip events in Scotland have been estimated to cause direct costs, for example emergency response and remedial works, of between £400,000 and £1.7 million, with indirect consequential costs (associated with loss of utility of infrastructure) between £180,000 and £1.4 million for the five Scottish case studies assessed for the [International Conference on Transportation Geotechnics \(ICTG\)](#). The case studies included consideration of the economic impacts of subsequent road closures due to debris flows at the A83 Glen Kinglas to Cairndow, A9 North of Dunkeld, A85 Glen Ogle, A83 Rest and Be Thankful and A77/A76/A71 Belfield Interchange.

There have been several recent weather events which have led to significant disruption resulting in a large economic impact. [The 'Beast from the East' in February 2018 cost the UK economy at least £1 billion per day as gridlocked roads and limited public transport resulted in large parts of the workforce being unable to access their places of work](#) .

This recommendation would seek to limit the economic impact associated with such severe events, providing communities the ability to maintain access to services, employment and education. Adaptation interventions may also reduce the need for lengthy detours with associated journey time and vehicle operating costs, that could be reflected in any review of transport economic efficiency.

Wider economic benefits may also benefit businesses and sectors that are reliant on the trunk road and motorway network to access domestic and international markets, helping to support the national economy as well as regional and local economies.

The recommendation would also help reduce the cost of remedial work by supporting proactive action to adapt to the impacts of climate change and lessen the gap between the risk of climate change and level of adaptation underway.

Overall, the recommendation is scored to have a minor positive impact on the Economy criteria in both the Low and High scenarios, reflecting the role of climate change adaptation in maintaining the operation of the trunk road and motorway network to support national, regional and local economies. Proactive action is also expected to have less cost implications compared to responding to network disruption or failure.

This recommendation is expected to have a minor positive impact on this criterion in both the Low and High

5. Equality and Accessibility

Low Scenario	High Scenario
+	+

The impacts of climate change on the trunk road and motorway network can have a bearing on the ability of communities to access employment, education and services due to full/partial route closures and diversions. This has been experienced across the network, in both urban and rural areas as illustrated by the examples in the Relevance sub-section.

This can impact on all users of the trunk road and motorway network, including drivers of private vehicles, public transport services that operate on the network as well as users of active travel routes that form part of the network. For example, in 2018 the ‘Beast from the East’ impacted on the whole of Scotland and caused severe disruption on all trunk road and motorway network routes.

The Scottish Highlands may be impacted to a greater extent where remote communities are served by a single access route that forms part of the trunk road and motorway network. This may lead to isolation in the event of an incident cutting off access or longer diversionary routes during periods of disruption. [For example, the diversion route for the A83 Rest and Be Thankful involves a journey time of typically 66 minutes which is an increase in 31 minutes and an increase in distance of 25 miles between Tarbet and Inveraray using the pre-planned diversion route.](#) As noted earlier, the STPR2 recommendation Access to Argyll and Bute (A83) 29 has been developed to improve resilience for strategic traffic currently using the A83.

[The Scottish Road Network Landslides Study](#) **Error! Bookmark not defined.** documents a comprehensive picture of the future risk of landslides in Scotland and identified sites with a landslide hazard ranking score of High or Very High to all be situated in rural areas. In 2009, Transport Scotland published an Implementation Report. This report identifies areas of high hazard in Scotland and provides recommendations on assessing the Scottish road network and management approaches which could be adopted to mitigate the effects of landslides. To protect

the accessibility and social inclusion of communities, measures to mitigate landslide hazards and associated impacts form part of the recommendation proposals.

This recommendation would not increase coverage of public transport or active travel networks but could support the retention of a fully operational network in the face of potential closures where there are vulnerable locations and there has been a failure to adapt to the impacts of climate change. Comparatively, impacts by people group are in relation to active travel provision associated with the trunk road and motorway network. Comparative accessibility by geographical location is expected to be differential, with most benefits for communities in rural locations that have less route options, there would also be some benefits to urban areas using the trunk road and motorway network where vulnerable locations are identified.

Overall, this recommendation is expected to have a positive impact on the Accessibility and Social Inclusion criteria. This is reflected across supporting different adaptation approaches to the impacts of climate change that effect both rural and urban areas of the trunk road and motorway network. The level of impact is anticipated to be the same in the Low and High scenarios as impacts can cause a single point of failure on the network that affects all users.

Also refer to EqIA/ICIA/FSDA/CRWIA Assessment in the next section.

This recommendation is expected to have a minor positive impact on this criterion in both the Low and High scenarios

3.3. Deliverability

1. Feasibility

Delivery of this recommendation is largely feasible. Methods for adapting infrastructure to climate change vary in size and scale depending on the location and age of an asset. There are methods that have proven to be effective, for example [Sustainable Urban Drainage Systems \(SuDS\) which have been prevalent for over 20 years and are a requirement for new infrastructure](#). As technologies are developed and innovation moves forward to combat the changing climate, there may be further methods applied.

[Design standards and assessment of road schemes give consideration to climate change as part of sustainability and environment appraisal](#). There are two key factors which are assessed: impact of the project on climate (Greenhouse Gas emissions); and the vulnerability of the project to climate change (adaptation).

The design and development of climate change adaptation schemes on the trunk road and motorway network would include the identification of any likely significant impacts as a result of exposure to these climatic changes. Assessment of the latest climate information would also be taken into consideration for all new road schemes and climate change adaptation embedded from the outset.

The feasibility of adaptation schemes and monitoring regimes, remains to be fully investigated. However, by incorporating standard engineering design approaches to existing infrastructure assets, based on the latest advice on the risks of climate change, engineering feasibility is not expected to be a constraining factor.

[The Scottish Road Network: Climate Change Study \(2005\)](#) and [Implementation Plan \(Transport Scotland, 2008\)](#) set out 28 recommendations to adapt the Scottish road network to cope with climate change, and detailed progress on the recommendations. This study and implementation plan used the previous UK Climate Projections (UKCIP02 and UKCIP09). [A network exposure study was also completed in 2017 \(again based on UKCIP09\) and consideration is being given to revise the output based on UKCIP18.](#)

Innovative solutions, such as nature-based and blue-green networks (networks of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services) outside the normal sphere of the trunk road and motorway network, may be required going forward to manage and adapt effectively to climate change.

The approach taken in other countries is generally to undertake a risk-based assessment of climate change impact severity against disruptive effect, with retrofitting at vulnerable locations only being employed where risks are highest. This approach makes a planned series of interventions feasible to address the greatest risks. The feasibility of individual interventions would require review of specific issues at vulnerable locations to determine effective adaptation approaches.

2. Affordability

In the Scottish Government's [Infrastructure Investment Plan 2021-2022 to 2025-2026](#)**Error! Bookmark not defined.**, principles of making the most of existing assets signpost to policies set out in [Climate Ready Scotland: Climate Change Adaptation Programme 2019-2024](#)**Error! Bookmark not defined.**. The Scottish Government has an estimated targeted investment of £60 million to support climate adaptation and resilience in our trunk road network in the five-year period of the Infrastructure Investment Plan but further investment would be required.

Adaptation and resilience are key components of the green recovery from COVID-19. In the [2020-2021 Programme for Government](#), the Scottish Government committed to investing an extra £150 million for flood risk management over the next five years (in addition to the £42 million spent annually), and £12 million in coastal change adaptation to help adapt to sea level rise and protect natural coastal defences from erosion.

There is the potential for there to be significant costs associated with this recommendation. Adaptation investment, however, is also a key driver of economic growth and jobs across Scotland which may present opportunities for Scotland to attract inward investment into this area. It is also critical that investment addresses the widening gap between the risks of climate change and level of adaptation in progress.

Transport Scotland is in the process of preparing a report on a High-Level Approach to Climate Change Adaptation and Resilience. It is envisaged a recommendation within this document would be to develop a Roads Climate Change Adaptation Plan, intended to set out specific actions required to adapt the trunk road and motorway network and establish associated costs. The cost estimate used in the STPR2 appraisal is an indicator of the scale of investment needed and should be used with caution as it is primarily based on the adaption needed to address flooding in highly exposed locations on the trunk road and motorway network to 2050 from previous work undertaken by Transport Scotland. The latest 2018 climate change projections would be used in forthcoming plans and include other impacts such as landslides, high winds, scour and high temperatures. While the cost estimate of the latest plan is unknown at this time, this recommendation is scored as a major negative reflecting the anticipated increase in investment required to adapt the network to the impacts of climate change in both the high and low scenarios.

3. Public Acceptability

Scotland's collective infrastructure asset is central to the transition towards net-zero, however, ensuring that the trunk road and motorway network is well adapted and resilient to the effects of climate change is crucial to keep Scotland moving and its citizens connected, particularly those who live and/or work in more remote parts of the country, as described in the [Scottish Climate Change Adaptation Programme Progress Report, 2021](#).

The Second Annual Progress Report on the Climate Ready Scotland: Climate

Change Adaptation Programme 2019-2024 also reveals progress towards outcomes within the programme for climate change adaptation. This includes a people-centric and place-based approach and comprises the climate justice thread which runs through Scotland’s domestic and international adaptation actions. These had been developed ahead of [United Nations Climate Change Conference COP26](#) (November 2021) held in Glasgow as part of the Scottish Government’s commitment to engaging with and raising global climate ambitions. COP26 in Glasgow presented a unique opportunity to increase awareness of climate change and the need for urgent, collective action to tackle it.

Survey results from [The British Public Perceptions of Climate Risk, Adaptation Options and Resilience \(RESiL RISK, 2019\)](#) published by Cardiff University, provide evidence of a shift in perceptions among the UK public towards greater concern and a general willingness to support steps to address climate change adaptation issues. Very strong support (≥67%) and little opposition (≤8%) was identified for a range of adaptation policies, such as regulations on buildings, building new water reservoirs and spending public money on flood defences.

The well-being of the most vulnerable in society, people’s health and the emergency services were identified as being the top 3 priorities for protection. As part of the RESiL RISK survey, respondents were asked to indicate what level of protection different items should receive when preparing the UK for a changing climate. In terms of quality of infrastructure such as roads and buildings, 2% of respondents felt there should be no protection, 23% minor protection, 54% high protection and 22% extremely high protection.

These results suggest there is public concern about the risks of climate change and support for preparing and responding to impacts on infrastructure such as the trunk road and motorway network. Survey evidence has also shown general public support for investment in climate change adaptation, including interventions related to the trunk road and motorway network. While public acceptability for discrete locations has to be fully established, it is anticipated that it would be minor positive, since disruption to the trunk road and motorway network would not be attractive to users.

3.4. Statutory Impact Assessment criteria

1. Strategic Environmental Assessment (SEA)

Low Scenario	High Scenario
+	+

Adapting or improving the resilience of the trunk road and motorway network to the impacts associated with climate change (flooding, landslides and erosion) should lead to an improvement in the reliability of the network. This recommendation would therefore be likely to support some of the SEA objectives related to quality of life, sustainable accessibility and safety (Objectives 4 and 7), particularly on routes susceptible to impacts. It is also likely to support climate change adaptation (Objective 2) due to increased adaptation and resilience of the trunk road and

motorway network to current and future climate change.

While this recommendation is not expected to have a notable effect on mode shift, a focus on adapting the existing network is not anticipated to increase traffic volumes or associated emissions. It is therefore not anticipated that this recommendation would have a negative impact on greenhouse gas emissions (Objective 1) or air quality (Objective 3). Similarly, as traffic levels are unlikely to change, significant noise effects are unlikely, although this may be dependent on the proximity of noise sensitive receptors (Objective 5).

While there is the potential for a negative effect resulting from the use of natural resources associated with asset improvements (Objective 9), this should be balanced against potentially reducing the requirement for materials for recurring repairs with focus given to the source and type of materials/natural resources used in construction.

Any opportunity to employ methods for decarbonisation of construction through innovation in design, procurement and construction, should be identified as part of the design and development process, whilst adhering to relevant standards. Similar work undertaken to date in exploring options for decarbonising construction on other road schemes could be used as a basis for developing these methods.

There is potential for negative environmental effects during the construction and operation of road schemes related to adaptation and resilience, on the water environment, biodiversity, soil, cultural heritage and landscape and visual amenity (Objectives 10 to 14).

Given the nature of the recommendation, it is not considered there would be a significant effect on developing a high-quality public realm (Objective 6) or the sustainable use of the transport network (Objective 8). Therefore, a neutral effect is anticipated on these objectives.

The environmental effects (positive or negative) would be determined by the location, complexity, scale and design of any climate change adaptation and resilience improvements on specific routes. These effects are largely related to the construction footprint of any interventions. It is recommended that further environmental assessment is undertaken as options develop to identify potentially significant location specific environmental impacts and mitigation where appropriate. This may identify mitigation opportunities, such as the re-use of construction materials which would align with circular economy principles and may also present opportunities for improving biodiversity in the long-term with adoption of the principle of securing positive effects for biodiversity.

Overall, the cumulative environmental effects are scored minor positive for this recommendation, as there are likely to be positive effects on climate change and communities.

This recommendation is expected to have a minor positive effect on this criterion in both the Low and High scenarios

2. Equalities Impact Assessment (EqIA)

Low Scenario	High Scenario
+	+

This recommendation would support the reliability of public transport, and active travel infrastructure particularly for services that operate on the trunk road and motorway network which could be susceptible to the impacts associated with climate change. This could potentially provide beneficial impacts for a wide range of protected characteristic groups who are more reliant on public transport such as the elderly, children, young people, women and certain ethnic minority groups.

This recommendation is expected to have a minor positive impact on this criterion in both the Low and High scenarios

3. Island Communities Impact Assessment (ICIA)

Low Scenario	High Scenario
+	+

Adapting the trunk road and motorway network, including associated active travel infrastructure and improving its resilience would benefit routes that provide access to ferry terminals operating services to the islands as well as the trunk road on Skye. Overall, this recommendation is anticipated to have a minor positive impact due to increasing the resilience and reliability for travel to and from island communities from the mainland as well as on Skye which is directly served by the trunk road network.

This recommendation is expected to have a minor positive impact on this criterion in both the Low and High scenarios

4. Children’s Rights and Wellbeing Impact Assessment (CRWIA)

Low Scenario	High Scenario
+	+

This recommendation would support the reliability of public transport, particularly for services that operate on the trunk road and motorway network, including associated active travel infrastructure, which could be susceptible to the impacts of climate change. This could potentially provide minor positive beneficial impacts for children and young people, who are more reliant on these services than other age groups.

This recommendation is expected to have a minor positive impact on this criterion in both the Low and High scenarios

5. Fairer Scotland Duty Assessment (FSDA)

Low Scenario	High Scenario
+	+

This recommendation would help mitigate risks associated with the impacts of climate change which may have a particular impact on vulnerable communities.

Socio-economic disadvantage can impact rural and urban areas, including communities that are susceptible to the impacts associated with climate change. Rural areas may experience landslides, flooding and other disruption from weather events. The main benefits from this recommendation would arise where climate change adaptation interventions on the trunk road and motorway network may reduce disruption to vital connections to access employment, education and services for more socio-economically disadvantaged groups. In urban areas the main benefit would result from adapting to flooding on the trunk road and motorway network where it serves more socio-economically disadvantaged communities.

There would be a minor positive impact on tackling inequality. The 2019 Scottish Household Survey indicated that 48% of the most deprived households (SIMD quintile 1) do not have access to a car and are twice as likely to use the bus to travel to work as households in the least deprived three quintiles. Therefore, actions taken to maintain and improve the resilience of the trunk road and motorway network used by local and longer distance bus services could improve accessibility to employment, education, healthcare and leisure activities for those most in need. Support for active travel routes also promotes equality for all users.

This recommendation is expected to have a minor positive impact on this criterion in both the Low and High scenarios