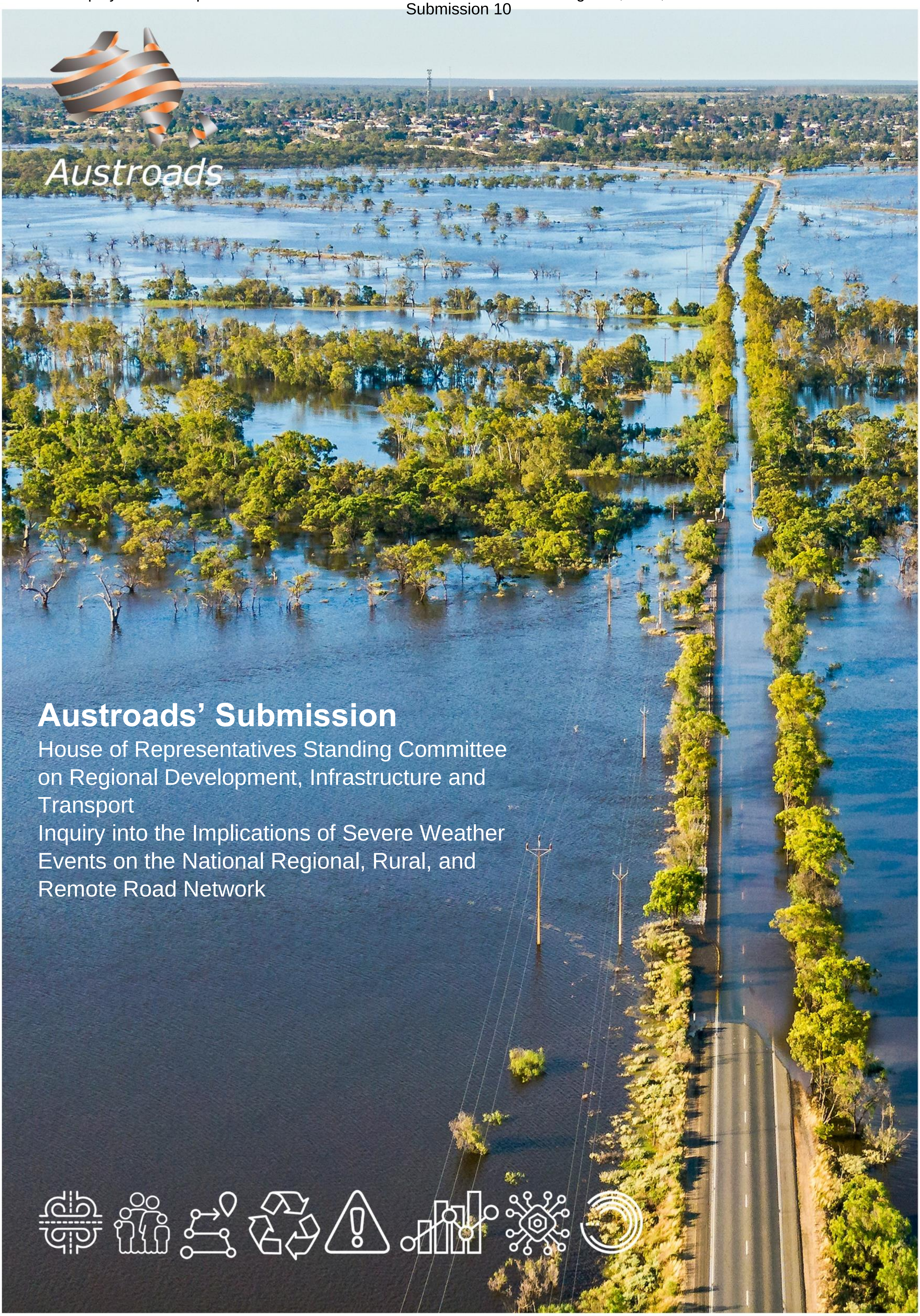

Austroads

Austroads' Submission

House of Representatives Standing Committee on Regional Development, Infrastructure and Transport

Inquiry into the Implications of Severe Weather Events on the National Regional, Rural, and Remote Road Network

Contents

1. Introduction

Austroads welcomes the opportunity to make this submission to the House of Representatives Standing Committee on Regional Development, Infrastructure and Transport inquiry into the implications of severe weather events on the national regional, rural, and remote road network. Our submission responds to the terms of reference for the inquiry.

Austroads is the peak body for Australasian road transport and traffic agencies. As an organisation owned by all Australia's roads or transport departments and the Australian Local Government Association, Austroads assists our members and Australia's local government agencies to adopt harmonised road design, construction, management and safety, practices.

1.1 Purpose of this submission

The purpose of this submission is to help inform the Committee on the implications of severe weather events on the national road network and to advise on actions the Commonwealth could take to support a road network more resilient to severe weather and climate effects.

The submission focuses on:

- road engineering and construction standards required to enhance the resiliency of future road construction,
- identification of climate resilient corridors suitable for future road construction projects, and
- opportunities to enhance road resilience using waterproof products in road construction.

The submission also considers the emergency and operational management implications for road managers when responding to severe weather events on the national road network.

The submission does not necessarily represent the views of member organisations.

1.2 Who we are and what we do

Austroads is a not-for-profit company owned by the transport and roads departments of all Australian governments. Austroads' owners are our members. We serve our members by:

1. supporting safe and effective management and use of the road system
2. developing and promoting national practices, and
3. providing professional advice to member organisations and national and international bodies.

Austroads members are collectively responsible for the management of over 900,000 kilometres of roads valued at more than $250 billion, representing the single largest community asset in Australia and New Zealand.

Austroads' core activities are delivered using a program management approach. Our activities are arranged into five program areas, each focused on an operational area of the road system and managed by a program manager with extensive knowledge and experience in road transport matters. Our program areas are supported by Task Forces that each comprise experts representing our members.

Austroads outputs include:

- *Guides* which are a reference for transport and roads departments and promote national consistency and harmonisation. Austroads' member organisations have agreed to adopt Austroads Guides as the basis of their operation.
- *Research reports* and *technical reports* which are designed to share newly-generated knowledge about a topic.
- *Applications* which are computer-based tools designed to help member organisations.
- *Other tools and services* which are a collection of miscellaneous activities to improve asset performance and road safety.

1.3 Austroads' role in helping road and transport agencies mitigate the effects of severe weather events and climate change

Road managers are responsible for the safe operation of their networks throughout severe weather events. When severe weather causes sections of the network to be closed, or limits access in any way, road managers prioritise the rapid reopening of the network. Reopening the network as soon as possible is crucial to support emergency services, limit community severance, and enable economic recovery.

Climate change is causing more severe weather events, meaning unfortunately more people are likely to experience impacts of climate change to their journeys. Road managers must engage with communities, emergency services, and the media on how to safely respond to these events.

An improved understanding of the expected impacts of future climate change by road planners, designers and asset managers could engender considerable cost savings in the long term. At the broad strategic level, if road providers are forewarned of any costly future effects on existing infrastructure, they can better prepare to deal with them.

1.3.1 Guides

The Austroads Guides are substantial and comprehensive publications, detailing agreed practice among our members. The Guides cover a range of topics and include guidance on designing, operating and maintaining our roads considering the effects of weather events and climate. The Austroads Guides are:

- Guide to Asset Management
- Guide to Bridge Technology
- Guide to Pavement Technology
- Guide to Project Delivery
- Guide to Road Design
- Guide to Road Safety
- Guide to Road Tunnels
- Guide to Traffic Management
- Guide to Temporary Traffic Management.

1.3.2 Research, technical reports and seminars on climate change and resilience

Austroads member agencies have invested in research to help prepare for the impacts of climate change for 20 years. A list of research and technical reports detailing projects that consider infrastructure resilience and network operations resilience are listed in Appendix A.

On Wednesday 8 February 2023, the Queensland Transport and Main Roads and Austroads jointly hosted a seminar on natural disasters and resilience. Appendix B includes links to the presentations from the Queensland Transport and Main Roads and Austroads seminar *Improving Resilience in Transport Infrastructure: Future proofing, shared experiences and essential tips*. The presentations provide further context to this submission.

Research on climate change and resilience in relation to bridges was shared with attendees of the 11th triennial Austroads Bridge Conference. The conference brought together more than 400 delegates from Australia and New Zealand. It was held in Adelaide from 15 to 18 November 2022.

2. Responses to the terms of reference

2.1 Introduction

Road infrastructure is a long-lived investment. Roads typically have design lives of 20 to 40 years. Bridges may have design lives of 100 years.

Road infrastructure is a key asset of governments and the community. The effective functioning of the road network is central to the functioning of the economy and to social cohesion.

Our road network is multi-modal. It supports the travel of people walking, cycling, riding and driving, It connects rail, sea, air and inland ports to markets. It enables journeys which connect people to work, recreation and each other. It also enables the delivery of health and safety services.

The importance of the road network, the longevity of infrastructure and the variety of infrastructure types and materials requires complex lifecycle management. Increases in traffic loadings, and severe weather events subject to a changing climate, add additional layers of complexity to this task.

Roads are vulnerable to the effects of severe weather, including rains and flooding. Heatwaves and bushfires may also have a deleterious effect on our road network. Rainfall and flooding are the primary weather risk to road structures. In terms of road surfaces, the impact of high temperatures is more prevalent to bituminous materials (i.e. asphalt and sprayed seals), whereas the effect of high rainfall is more prevalent on unbound granular pavement materials.

Climate change is an observable and significant event. While the evidence of extreme weather events and the effects on roads are difficult to ignore, the effects of climate change on the road network can be both subtle and obvious.

Climate change has direct and indirect impacts on road infrastructure in the following ways:

- rainfall changes can alter moisture balances and accelerate pavement deterioration,
- increases in temperature can affect the aging of bitumen resulting in an increase in embrittlement that causes the surface to crack which allows, water to enter the pavement causing potholing and rapid loss of surface condition,
- flood heights and flood frequency can raise water tables and reduce the structural strength of pavements,
- indirect impacts of climate change on roads due to the effects population and activity changes, altering the demand for roads[1]

Australia has a wide variety of climatic extremes. The effects of climate changes in Australia will not be uniform. As a result, the nature and scale of climate change on Australia's road network will depend on a wide range of variables and will not be consistent.

In broad terms, however, climate change is expected to increase flooding duration, frequency and intensity, and increase the frequency and severity of heatwaves and bushfire risk.

[1] Austroads publication: *Impact of Climate Change on Road Infrastructure* (2004)

2.1.1 Flooding, rainfall and water run-off

Flooding and high-intensity rainfall have the potential to sever road networks and to damage road infrastructure. Australia is experiencing an increasing frequency of natural disasters in general, including major flooding. Accurate flood estimations are crucial for road designers who must apply suitable drainage design practices, in the context of a changing climate, while considering the cost of over-engineering the design and the adaptability of the infrastructure to subsequent upgrades.

A critical part of road design is to define the flood immunity of the road, which is the risk of road closure from flooding. A road of any flood immunity can be made resilient against flooding, provided the designer understands the context and frequency of overtopping to adapt the design to the local conditions. In general, however, the less a road is overtopped in practice the more flood resilient it will likely be.

Designers must also consider the management of flow patterns in extreme floods. These could have unexpected consequences that are not apparent in smaller floods. Avoiding excessive impacts during extreme events will result in more resilient infrastructure.

Road drainage performance plays a critical safety function for road users, particularly during flood and extreme weather events.

Debris blockage during flooding is a serious issue that can affect the resilience of road infrastructure. In a number of recent flood events, debris blockage has resulted in full or partial blockage of drainage structures (including major culverts and even bridges) to the extent where major flows have been diverted causing significant infrastructure damage and property loss.

2.1.2 Bridges and scouring

Scour is the result of the erosive action of water, excavating and carrying away material from the bed and banks of streams and from around the piers and abutments of bridges. Different materials scour at different rates, for example loose granular soils are rapidly eroded by flowing water while cohesive or cemented soils are more scour resistant.

Designing road infrastructure to avoid or limit scour is a critical factor in achieving more resilient road infrastructure. Excessive scour has the potential to damage bridges and their approaches, culverts and floodways, and in hilly terrain can impede drainage systems resulting in landslips and significant damage to road pavements.

2.1.3 Heatwaves and fires

Fires, while active, present an obvious emergency risk to road operations and people's safety. The legacy effects of a fire, too, may compromise road infrastructure. Immediate effects include debris or infrastructure damage resulting from the fire. Less apparent effects may include compromised vegetative root systems or cracking in surface rocks, both of which increase the risks of moisture penetration and soil instability, potentially leading to landslips.

Heatwave effects are often worse in cities because hard surfaces such as bitumen can retain heat and drive-up temperatures (known as the 'heat island effect'). Extreme heat makes it less attractive for people to walk and cycle. The planning of places and liveable neighbourhoods needs to consider how the urban heat island effect can be mitigated, particularly in areas with a higher proportion of vulnerable people.

Building materials can support the mitigation of the urban heat island effect such as lighter-coloured paving and more permeable paving. In some circumstances where it is difficult to expand the urban tree canopy, innovative design measures can be used to increase shade and reduce heat.

In extreme heat the bitumen on some roads may bleed (a thin layer of soft binder appears on the road surface). Bleeding is an irreversible process and can be treated by spreading additional aggregate over problem areas. Bleeding can be avoided by using higher durability materials.

2.1.4 Maintenance

The life of sprayed seals is influenced by climate including such effects as seasonal temperature variation, moisture change in pavement materials and binder oxidation at high temperatures. These factors will influence both the type of treatment and frequency of retreatment. Rainfall may also influence the choice of treatment to achieve particular texture levels without compromising waterproofing.

Australia's climate has warmed, and the duration, frequency and intensity of extreme heat events have increased across large parts of Australia. As a result, bituminous binders typically used in the past may not function as optimally as they have previously.

Weather conditions also influence:

- the amount of care required to prepare and precoat aggregates,
- the use of cutter oils and adhesion agents,
- the effect of modified binders, and
- after-care of the completed work.

2.2 Road engineering and construction standards required to enhance the resiliency of future road construction

Austroads continually conducts research and updates agreed practice in its Guides to improve the design, engineering and construction standards for roads. Some relevant practices for road designers and engineers are outlined below. Our changing climate and the learnings from severe weather events means continual review of standards and practice is needed.

It is crucial to consider *betterment* when replacing or maintaining roads. Long-lived infrastructure is likely to have been built to superseded standards. The increasing risks driven by climate change means that replacement or repaired infrastructure should not be designed and built to the original standards, but re-evaluated for ongoing weather and climate resilience. Without betterment of our road infrastructure, we increase the risk that it will fail prematurely in the wake of more frequent severe weather events.

2.2.1 Flooding, rainfall and water run-off

Austroads road design and pavement technology guidance provides detailed practical instructions on mitigating flood events and managing water.

The calculation of flood immunity needs to take account of the hydrologic and hydraulic features of the catchment flowing to the road as well as the statistical analysis of the flood impact on the road. The design flood immunity needs to be set for each project by either applying standard guidelines that are defined for each road classification, or by undertaking a project-specific risk assessment. The Austroads Guide to Road Design provides general guidance on flood immunity for various circumstances including special cases like tunnel portals, which can have very significant risks if floodwater enters the tunnel.

New editions of Austroads' drainage guidance (Guide to Road Design Parts 5, 5A and 5B) were published in January 2023. The updates support the application of best-practice road design in relation to flood estimation and drainage design practices. The latest design rainfall and flow estimation techniques are incorporated, consistent with the Australian Government's *Australian Rainfall and Runoff* published in 2019 (ARR19). Specifically:

- The guidance addresses climate change and acknowledges its effect on flooding (including sea level rise for coastal areas). Consideration of climate change is recommended for road planning and design, and specific advice is provided. The guidance provides a risk-based design procedure, consistent with ARR19, for building in climate change risk in road design.
- The guidance covers extreme weather events. In the past, consideration of design rainfall events was limited to the road design flood immunity (often 2% or 1% Annual Exceedance Probability), with little consideration given to what happens in larger events. A resilient design should not suffer total failure or extreme damage of large sections in larger flood events. Austroads guidance now requires designers to consider what happens to the road infrastructure in larger events, typically up to the 1 in 2000 Annual Exceedance Probability event (although the designer can look at larger events if critical).
- ARR19 research into vehicle, cyclist and pedestrian safety during flooding has been incorporated into the guidance, so that rigorous assessment of road user safety can now be conducted when the road drainage capacity is exceeded (e.g., the road is overtopped by flood waters, or the drainage system is blocked and surcharging onto the road/footpath). These techniques now guide designers on the assessment of various scenarios and the determination of whether road users are likely to be safe and, if not, what mitigation options are required.
- Guidance consistent with ARR19 on debris blockage assessments on road drainage systems has been included. These new approaches lead to an assessment of blockage potential and debris allowance in drainage design, as well as sensitivity analysis to consider the worst case.

Guide to Pavement Technology Part 4 deals extensively with the characteristics and performance of pavement material. Pavement materials can be classified into essentially five categories according to their fundamental behaviour under the effects of applied loadings:

- unbound granular materials,
- modified granular materials,
- bound materials, including
  - stabilised materials,
  - asphalt,
  - concrete.

Granular materials commonly used in pavements throughout Australia are often moisture sensitive, meaning that the performance of these materials is a function of the moisture condition at the time of loading.

Pavement cracking can allow moisture into underlying materials causing loss of pavement strength, increased roughness and increased levels of patching and routine maintenance.

Moisture related pavement failures (typically in the form of blow-outs or permanent deformation) are common across the road network following severe rainfall events and can be very costly to repair[2]. The Austroads Guide to Pavement Technology Part-4K assists with the selection and design of suitable sprayed seals.

2.2.2 Bridges and scouring

Bridges must be designed and constructed to reduce scour at the piers and abutments. The Austroads Guide to Road Design Part 5, along with Austroads Guide to Bridge Technology Part 8 (Hydraulic Design of Waterway Structures), both recognise the critical importance of avoiding or minimising scour and provide designers with numerous proven and cost-effective avoidance/mitigation techniques and approaches (e.g., abutment scour protection for bridges and scour protection at culvert outlets).

[2] Austroads publication: Impact of Climate Change on Road Infrastructure (2004)

2.2.3 Heatwaves and fires

Where practical, clearance of fuel loads from the road corridor helps reduce the risk of fire impacts on roads. Fire-resistant designs and structures reduce immediate safety risks (allowing evacuation and emergency services access) and also support quicker re-opening of road networks and recovery efforts.

Polymer modified binders consist of bitumen blended with a synthetic polymer or crumb rubber. Polymer modified binders are used to enhance the performance of binders on heavily trafficked or distressed pavement surfaces, often in adverse climatic conditions.

Polymer modified binders improve pavement properties such as reduced temperature susceptibility, increased elasticity or resilience, increased cohesion and improved tenacity once a bond has been established. In terms of sprayed sealing, performance improvements include lower risk of bleeding, improved crack resistance, better aggregate retention and less deformation at high temperatures. These improvements are the basis of the use of polymer modified binders in strain alleviating membranes, strain alleviating membrane interlayers and high-stress seals.

Austroads has published specifications for the use of polymer modified binders since 2006. The most recent, published in 2019, outlines the requirements for the use of polymer modified binders in sprayed sealing and asphalt applications. It is subject to regular review as further information and experience with the performance of different bituminous binders is obtained.

2.2.4 Maintenance

Timely retreatment of sprayed seals on granular pavements, before extensive cracking and pavement deformation develops, is desirable and cost-effective in terms of maintaining most rural road pavements. Even relatively poor-quality granular materials can perform satisfactorily as road pavements if the moisture regime is well-controlled and temperature effects are allowed for in design.

Austroads' Guide to Pavement Technology Part 7 provides broad guidance on routine maintenance practices for sealed pavements suitable for use by both supervisory and field staff. It is supported by the Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design which covers periodic maintenance and pavement rehabilitation. The maintenance of unsealed pavements is addressed in Guide to Pavement Technology Part 6: Unsealed Pavements.

2.3 Identification of climate resilient corridors suitable for future road construction projects

Climate resilient corridors are roads that are of high strategic importance to the areas, communities and businesses they service. The intrinsic value of these routes is often due to the lack of alternatives, or the relative inconvenience or lower operating standards provided by alternative routes.

Emergency-affected communities are also at risk of economic harm from potential impacts on essential and general freight movement. Future economic activity is highly correlated with freight movement, and any reduction in the latter leads to reductions in the former. A 2016 Austroads study 'Freight Movement in Emergency Situations' confirmed that ensuring essential and general freight movement, as well as emergency response heavy vehicle movements is 'a key factor in minimising community social, employment and economic distress during and after emergencies'.

Austroads developed a tool for road managers to assist in identifying and prioritising 'Life Line' routes ('Identification of a Risk Indicator to support Life Line Freight Routes'). The tool enables road managers to identify Life Line Freight Routes based on factors such as whether each road is an identified strategic route, whether it has a high Annual Average Daily Traffic rate, whether it has a high number of freight vehicles, whether there is an alternative route, whether the route is used by tourists and whether incident management teams could be expected to respond to problems on the route within 12 hours.

Austroads has a current research project 'NEF6396 Opportunities to increase freight and supply chain resilience'. The project is intended to support a broader cross-government effort to identify and mitigate risks for freight supply chains, particularly in the wake of recent COVID-19 and weather-related disruption and upheaval.

2.4 Opportunities to enhance road resilience through the use of waterproof products in road construction

In urban and semi-urban environments, asphalt materials can deliver good resistance to water and recover well in the event of flooding, if properly design and constructed. Furthermore, appropriate asphalt mix design and materials selection (e.g. the use of polymer modified binders) can also reduce the risks associated with increased pavement temperatures. Enrobés à module élevé (EME2) in Australia is just one example of an asphalt material with increased structural capacity and high resistance to rutting in warm climates which can deliver resilient roads at lower cost to the community. Austroads has supported extensive studies to support the local use of EME2.

Between major cities, sealed granular pavements constitute the majority of the road network. Environment factors such as rainfall and heat are often combined with an increased freight task.

Austroads has a program of research to investigate structural and material enhancement to deliver more reliant infrastructure. As an example, foamed bitumen stabilisation has a proven track record to provide resilient pavements during previous flooding events in Queensland. Austroads is testing full-scale foamed bitumen pavements. A first phase of the testing program has confirmed the good rut resistance in warm conditions and a second phase is currently assessing the resistance to fatigue cracking.

Crumb rubber modified binders are also gaining popularity across Australia as a sustainable and resilient technology that can provide improved performance when used in sprayed seals and asphalt, especially in severe and challenging locations. A number of road authorities are currently investigating opportunities to facilitate the increased use of this high-performance binder on their road networks.

Preserving roads in a good condition in remote regions is extremely important to maintaining access between communities during extreme weather events connected. However, sourcing good-quality road materials can be challenging and locally occurring natural materials are often moisture sensitive and perform poorly when exposed to high moisture conditions. In order to better address the risk of using these materials on rural roads, it is important to manage situations where naturally occurring material can deliver value for money compared with transporting material from distant quarries.

Internationally, there is a strong drive towards performance-based specifications for pavement materials and surfacings to better cope with increased traffic volumes and local environmental conditions. Locally, Austroads has also been developing improved laboratory assessment methods and performance-based specification framework for road making materials including granular, stabilised and bituminous materials.

These performance specifications are also a key element to the assessment of material with increased proportion of recycled constituents supporting sustainable practices. Reclaimed asphalt pavement and crushed glass or crumb rubber are commonly used in pavement materials reducing the need for premium quarry aggregates to be produced.

2.5 Operational effects of severe weather events on the road network

Road managers are responsible for the safe operation of their networks throughout severe weather events. When severe weather causes sections of the network to be closed, or limits access in any way, road managers prioritise the rapid reopening of the network. Reopening the network as soon as possible is crucial to support emergency services, limit community severance, and enable economic recovery.

Road managers must also engage with communities, emergency services, the media on how to safely respond to these events.

Typically, road managers have non-emergency communication responsibility for freight and passenger safe movement across road and transport assets, and the related content and systems. Road managers also must provide the single point of truth for heavy vehicle operators, to enable them to operate safely and defer freight movements depending on road network availability.

In emergency situations road managers continue being the single point of truth, but with increased focus. The jurisdictional payback for timely single point of truth information for road freight operators is intended to be a reduction in emergency personnel distracted from their primary task by repeated information requests.

Importantly, emergency and police agencies are responsible for community safety and emergency management. Their role does not displace nor detract from road agency responsibilities for essential and general freight movement (and road user) performance and communication outcomes over impaired assets.

Recent Austroads research into Multimodal Incident Management provides a framework for road managers to plan to respond to incidents on the road network which affect the safe performance of multiple modes (as is typically the case in severe weather events).

2.6 The Commonwealth's role in road resilience planning

One key area where the Commonwealth can play a role inroad resilience planning is on *betterment*. Betterment is where local governments and state agencies are funded to rebuild essential public assets to a more resilient standard to help them withstand the impacts of future natural disasters.

Betterment is a superior funding mechanism than the Disaster Recovery Funding Arrangements where the Commonwealth funded 75% of the cost of rebuilding damaged infrastructure to the previously existing standard.

Betterment of our road networks and road infrastructure is critical: the specifications and standards to which our current road networks are built are not necessarily appropriate for road infrastructure works today.

Successful recovery from natural disasters provides opportunity to prepare for, and build resilience to, future disasters. Upfront investment in stronger infrastructure and more resilient communities, through betterment, can save money for all levels of government in the long-term.

Austroads understands that the Commonwealth is working with state and territory governments on incorporating betterment as a permanent aspect of natural disaster recovery funding. Austroads commends this Commonwealth initiative

Appendix A Austroads research and technical reports

Infrastructure resilience

Year	Report title	Description
2004	Impact of climate change on road infrastructure	This report provides an assessment of likely local effects of climate change for all Australia for the next 100 years, based on the best scientific assessment currently available assesses likely impacts on patterns of demography and industry, and hence on the demand for road infrastructure identifies likely effects on existing road infrastructure and potential adaptation measures in road construction and maintenance; and reports on policy implications arising from the findings.
2004	Salinity and Rising Water Tables: Risks for Road Assets	This report identifies the potential impact of dryland salinity on construction and maintenance of the road asset.
2007	Managing the Impacts of Rising Watertables and Salinity on Remaining Pavement Life	This report comprises a technical review and update on new knowledge about salinity impacts and pavements. A review of recent literature and research outputs has indicated that there are knowledge gaps in the area of how salinity affects pavements and these are discussed in the report.
2008	Impact of Rising Watertables and Salinity in Pavement Performance	This final project report found evidence that pavement damage is likely to be influenced by the presence of different salt species, the parent material (pavement and sub-base), local conditions that control capillary rise, including groundwater and its spatial and temporal variability, and climate. Most road damage occurs on thin granular pavements, particularly sprayed seal surfacings.
2010	Impact of Climate Change on Road Performance: Updating Climate Information for Australia	Quality modelling of pavement performance requires quality predictions of likely future climate profiles. Climate modelling is a complex task, requiring highly complex sophisticated software and meteorological experts. The project aimed to increase the ease of access to climate data, both historical and simulated future data, by providing a combination tool and database. The tool will be available as a download from the Austroads website (www.austroads.com.au). The project developed an Excel database that requires the user to input a GPS location reference to access a wide range of historical climate data between 1960 and 2007, and a range of simulated climate data from 2008 to 2099. The tool was designed with the user in mind and contains simple-to-use forms to extract the required data quickly.
2017	High Modulus High Fatigue Resistance Asphalt (EME2) Technology Transfer: Final Report	The purpose of this project was to assist industry in the successful transfer of French Enrobés à Module Elevé Class 2 (EME2) technology to Australia. EME2 technology offers the prospect of reduced asphalt thicknesses for heavy duty pavements, and lower construction and maintenance costs. EME2 mixes are produced using a hard paving grade bitumen applied at a high binder content (approximately 6%). Compared to conventional asphalt bases with unmodified binders, EME2 asphalt is characterised by high stiffness, high durability, superior resistance to permanent deformation and good fatigue resistance. International and Australian experience indicates that significant pavement thickness reductions can be achieved using EME2.
2021	Prolonging the Life of Road Assets Under Increasing Demand: A Framework and Tools for Informing the Development and Justification of Asset Preservation and Renewal	This report provides an evaluation framework, practices and supporting tools for evaluating road preservation and renewal treatment options for predominantly sprayed seal flexible pavements. The Pavement Life-cycle Cost Demonstration Tool can, among other things, examine the effect of pavement structural strengthening improvement, a change in climate or a change in traffic growth.

Year	Report title	Description
2022	Sustainability in Road Tunnels	The impact of ongoing and future environmental and social changes on the operation of road tunnels deserves greater attention. Resilience of a road tunnel is its ability to maintain safe and uninterrupted service in the event of detrimental changes in its surrounding environment. A major driver is climate change – it will lead to more frequent flooding and other climatic events that are risks to the safety and service continuity of road tunnels.
2023	Austroads Road Deterioration Model Update: Cracking Austroads Road Deterioration Model Update: Roughness Austroads Road Deterioration Model Update: Rutting Austroads Road Deterioration Model Update: Deflection	These four technical reports updated the current Austroads Road Deterioration Models. The issues associated with deterioration are "consistent and damaging. The new reports offer updated guidance on how best to manage deterioration in the current changing climate. The reports will help road agencies and industry predict future road conditions and better establish maintenance needs. The data assembled covered the wider loading and climate conditions observed in Australia providing more accurate information that reflects current deterioration patterns in the country.

Network operations resilience

Year	Report title	Description
2015	Safety Provisions for Floodways Over Roads	This report summarises research into effective ways of alerting drivers to the dangers of crossing a floodway when it is under water. Floodways are typically used where it is impractical to provide a bridge or culvert. Despite public campaigns on the risk of crossing a flooded floodway, fatalities continue to occur. The report recommends a range of improvements to floodway signage and warning devices, a floodway design supplement to the Austroads Guide to Road Design, investigations into mobile and in-vehicle warning systems, and ways to better capture information about crashes at floodways.
2016	Freight Movement in Emergency Situations	This study examines how essential and general freight movement assists the economic resilience of industry and communities impacted by emergencies. For the relatively sparse networks of Australasia, keeping essential and general freight moving offers high economic benefits for disaster affected communities.
2016	Identification of a Risk Indicator to Support 'Life Line' Freight Routes	This report summarises and presents the Risk Indicator, a tool designed to identify and support investment in 'Life Line' freight routes. 'Life Line' freight routes are roads that may not deliver highly positive outcomes in traditional upgrade project priority assessments based on AADT measures, but have high value to the communities and regions they support.
2017	Techniques for Incident Management to Support Network Operations Planning	This report investigates current local and international incident management techniques and proposes an Australasian incident management framework that supports network operations planning.
2022	Multimodal Incident Management: Research, Principles and Capability Framework	This report details research into the ways transport agencies manage unplanned incidents that impact the normal operation of more than one transport mode. It includes 10 guiding principles and a capability framework.

Appendix B TMR and Austroads *Improving Resilience in Transport Infrastructure*

Austroads and the Queensland Department of Transport and Main Roads (TMR) presented a joint seminar on 8 February 2023 showcasing Queensland's transport infrastructure resilience and response to weather events.

The event provided a platform for all tiers of government and industry representatives to share their knowledge, experiences and key learnings in disaster recovery management.

The seminar recording and slides can accessed from https://austroads.com.au/publications/asset-management/sem-irti-23

The presentations were as follows:

Introduction

- Neil Scales, Director-General, TMR
- Major General Jake Ellwood (retired) State Recovery Coordinator, Queensland Reconstruction Authority
- Brendan Moon, Coordinator-General, National Emergency Management Agency
- Dr Andrew Johnson, CEO and Director of Meteorology, Australian Bureau of Meteorology

Session 1: Drought, Fire and Flood

- Jimmy Scott, CEO, Queensland Reconstruction Authority
- Allan Uhlmann, Executive Director, Program Management and Delivery, TMR
- Kell Dillon, General Manager, Maritime Safety Queensland, TMR
- Gary Mahon, CEO, Queensland Trucking Association

Session 2: The Response

- Mike Wassing, Deputy Commissioner, Queensland Fire and Emergency Services
- Don Bletchly, Chief, Transport Network Security & Resilience, TMR
- Kym Murphy, General Manager, RoadTek, TMR
- Anne Moffat, Chief Operations Officer, TMR

Session 3: Lessons Learned in Transport Infrastructure

- Noel Dwyer, Deputy Chief Engineer, TMR

Concluding presentations

- Alistair Dawson, Inspector-General of Emergency Management
- Lucinda Hoffman, General Manager, Transport Policy Branch, TMR

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