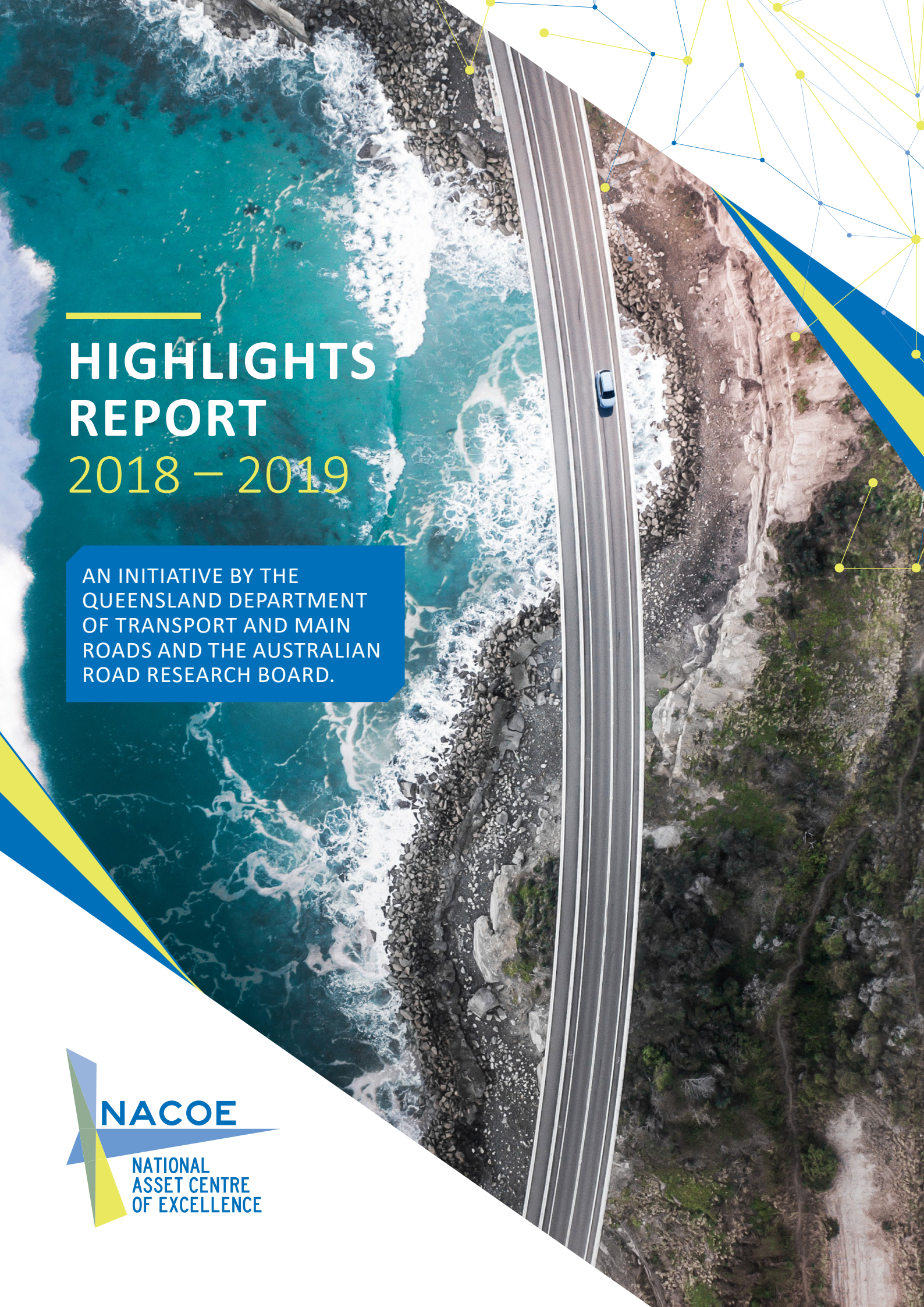


HIGHLIGHTS REPORT
2018 – 2019

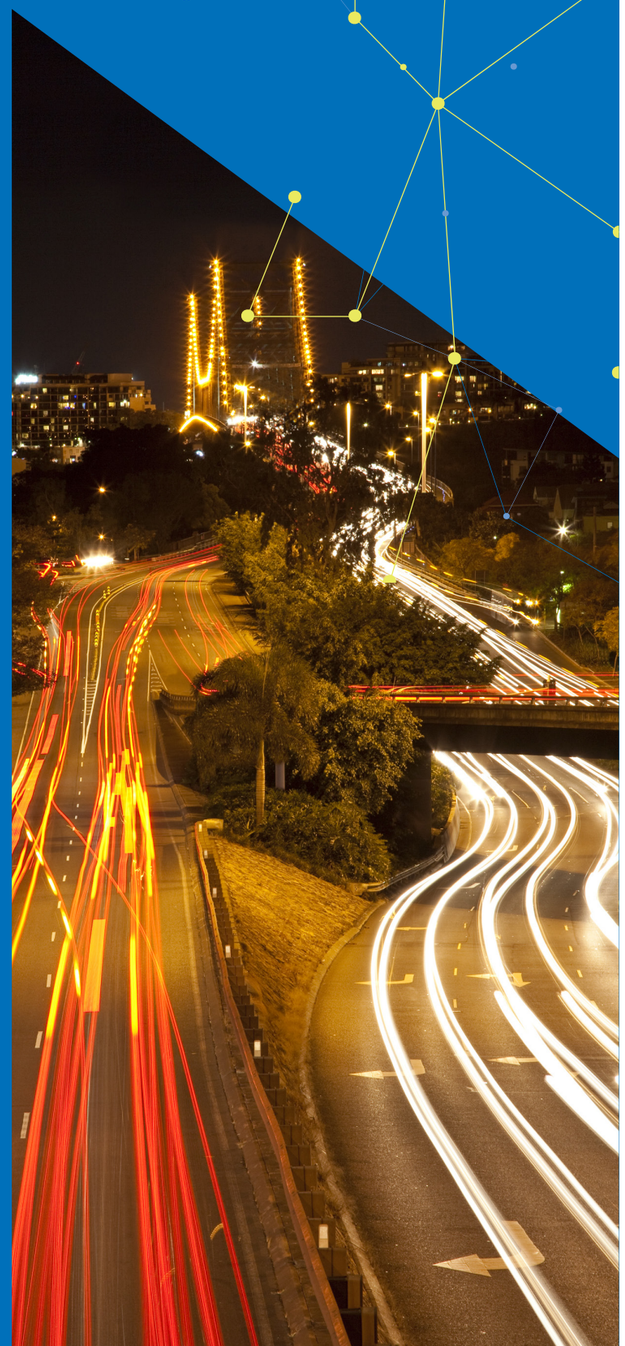
AN INITIATIVE BY THE QUEENSLAND DEPARTMENT OF TRANSPORT AND MAIN ROADS AND THE AUSTRALIAN ROAD RESEARCH BOARD.

NACOE
NATIONAL ASSET CENTRE OF EXCELLENCE

OUR MISSION

NACOE will drive savings and enhance national technical capability in transport and roads asset engineering through:

- UNLOCKING INNOVATION
- IMPLEMENTING INTERNATIONAL BEST PRACTICE
- TRANSLATING NEW KNOWLEDGE INTO PRACTICE



STRATEGIC OBJECTIVES

COST SAVINGS

Delivering economic benefits to the Queensland network through cost-effective innovation and higher performing pavements, refined asset management practices, efficient management of structures and by optimising road safety and network operation outcomes

COLLABORATION

Working in partnership with industry, universities and government bodies to leverage research and resources, helping to deliver mutually beneficial outcomes

DEVELOPMENT

Developing the capabilities of staff and disseminating learnings to TMR and regions

IMPLEMENTATION

Facilitating demonstration projects, establishing research tools and infrastructure to help implement new technologies and practices in Queensland

ACKNOWLEDGMENTS

We would like to acknowledge our partners, the Queensland Department of Transport and Main Roads (TMR) and the Australian Road Research Board (ARRB) for their collaboration on the development of the NACOE Program since its inception in 2013.

We would also like to thank and acknowledge the organisations, universities and industry associations who collaborated on NACOE projects, of whom without their valued support and input, much of the road research work we do, would not be possible.

- Tyre Stewardship Australia
- Logan City Council
- Central Queensland University of Australia
- Gold Coast City Council
- Austroads
- Australian Local Government Association
- Queensland University of Technology
- Western Australia Road Research Innovation Program
- Department of Environmental Science

ABOUT OUR PARTNERS:

Queensland Government | Department of Transport and Main Roads

Queensland Department of Transport and Main Roads (TMR)

The Department of Transport and Main Roads (TMR) moves and connects people, places, goods and services safely, efficiently and effectively across Queensland. They plan, manage and deliver Queensland's integrated transport environment to achieve sustainable transport solutions for road, rail, air and sea.

TMR's vision is to create a single integrated transport network accessible to everyone. The integrated transport planning approach ensures TMR contributes to people's quality of life, Queensland's economic wellbeing, and a sustainable environment.

Australian Road Research Board (ARRB)

ARRB was founded in 1960 and is the source of independent expert transport knowledge, advising key decision makers on our nation's most important challenges. ARRB has a strong heritage of supporting and delivering high quality applied research for Australian and New Zealand state road agency members and for the community.

FOREWORD

by NACOE Board Chair Amanda Yeates

Welcome to the 2018-19 Annual Report for the National Asset Centre of Excellence (NACOE). I want to take this opportunity to reflect upon the continued commitment between the Queensland Department of Transport and Main Roads (TMR) and the Australian Road Research Board (ARRB) over the past six years to deliver cost-effective, safe, and practical solutions to Queensland road users through the NACOE program. It has been wonderful to see the many shared achievements that are highlighted throughout this report and I am pleased to share with you that our research in implementing international best practises to Queensland, is being recognised and adopted into the national standards across Australia.

In our roles as engineers, we are always striving to improve the world around us through creativity, community, and collaboration. Over the past several years, we have been working with the industry to build a more sustainable, safe, and resilient transport sector with innovative technologies for the Queensland community.

I am proud of our achievements to date, and in June 2019 we were presented with the Queensland State Innovation Award by the Australian Asphalt Pavement Association (AAPA) for the NACOE program, which acknowledges innovation in research initiatives.

Our aim is to become nationally recognised for delivering engineering excellence through leading road asset research that welcomes innovation. It was an absolute honour to receive this award and have our efforts recognised by the industry (read more on pg. 7).

In 2018-19, NACOE has had a key focus on bringing the best innovative technologies from overseas and working with our industry partners to adopting these technologies to Queensland conditions.

We have had the opportunity to work with some wonderful industry partners over the year, including AAPA, Tyre Stewardship Australia, City of Gold Coast, and the Western Australian Road Research Innovation Program (WARRIP).

Through these partnerships we have:

- Progressed our investigation into Intelligent Compaction and its potential role in future road construction.
- Increased the use of recycled tyres in our pavements.
- Delivered a pilot specification for Crumb Rubber Modified Open Graded and Gap Graded Asphalt.

In a first for Australia, the specification was successfully trialled on a live road which was implemented in collaboration with the City of Gold Coast (read more on pg. 11).

Looking to the future, we will continue to work together with our stakeholders and delivery partners to implement research outcomes, share knowledge nationally and drive savings that benefit the Queensland community and beyond.

I would like to take a moment to acknowledge and say thank you to our people and our partners in the industry, who have played a key role in delivering these mutually beneficial outcomes for everyone involved and I hope you enjoy reading the rest of the highlights featured in this report.

Amanda Yeates
Chair (TMR)

Dennis Walsh
TMR

Matthew Bereni
ARRB

Richard Yeo
ARRB

BENEFITS OF NACOE

NACOE is continuing to deliver strong economic and sustainability benefits to the Department and broader Queensland community. The program has delivered many high value research projects since it started in 2013. Some of the key benefits of NACOE to-date include:

- a significant reduction in the thickness of heavy-duty asphalt pavements where EME2 has been adopted, which has led to savings in construction costs, construction time and material, resulting in sustainability benefits to the community
- increased use of recycled vehicle tyres in sprayed seals resulting in environmental benefits
- leading the way in the use of high percentages of recycled asphalt pavements
- reduced ongoing agency costs as a result of improved whole-of-life transport solutions
- improved asset management practices that have resulted in reduced agency and road user costs
- improved risk management practices for the planning, design and maintenance of transport infrastructure
- an improved understanding of the behaviour of bridges under live traffic loading, resulting in possible cost savings due to the deferment of strengthening or replacement projects
- guidance to the department for reducing crash risks on Queensland roads.

The benefits of NACOE will continually be monitored in future to ensure that the department allocates its research funding in areas that will continue to make a real difference to Queensland.

17
PROJECTS COMPLETED

156
MILESTONES DELIVERED

21
PUBLICATIONS DEVELOPED

AWARDS AND ACHIEVEMENTS

AAPA QUEENSLAND STATE INNOVATION AWARD

ARRB and TMR were recognised by the Australian Asphalt Pavement Association (AAPA) for the innovative work of the NACOE program. In June 2019, Matthew Bereni, ARRB's Queensland State Technical Leader, and Jeffrey Lee, Principal Professional of ARRB's Future Transport Infrastructure team attended AAPA's Queensland Industry Awards and were presented with the prestigious award.

TMR and ARRB were honored to accept the award, which recognises innovation in research initiatives. The NACOE program has always had a focus for providing cost-effective, safe and practical solutions for Queensland road users. It was a great opportunity to have these efforts recognised within the industry.

CAPABILITY DEVELOPMENT

The NACOE program has supported a number of important capability development opportunities and knowledge transfer activities, including:

- Two secondments between ARRB and TMR, with a further secondment proposed for 2019-20
- Presentation of a research paper at the 28th ARRB International Conference, held in Brisbane
- Acceptance of a research paper for publication and presentation at the Transport Research Board's International Conference on Managing Pavement Assets (IMCPA), in Chicago, US
- 14 reports, presentations and papers from 2018/19 available on the NACOE website.

SECONDMENT SUCCESS STORIES

In the second half of 2018, TMR Manager (Structures Strategic Asset Management) Angela Ransom was seconded to the ARRB Structures team and contributed to TMR's new Weigh-in-Motion (WIM) strategy. Angela used her extensive knowledge and relationships within the Department to facilitate diverse stakeholder engagement, which was a key project input. Angela also provided valuable input to ARRB's team, developing a new manual for repairs for non-timber bridges under the NACOE program.

Over a similar time period, ARRB Chief Technology Leader Dr Tim Heldt was seconded to the TMR structures management team, and provided support to the Department, including reviewing current bridge and culvert management practices. This team has re-imagined the strategic approach to the management of bridge assets, with particular focus on those assets that are critical to network performance.

Looking to the future, Robert Meiklejohn of ARRB is set to begin a secondment with TMR in the structures space at the beginning of 2020.

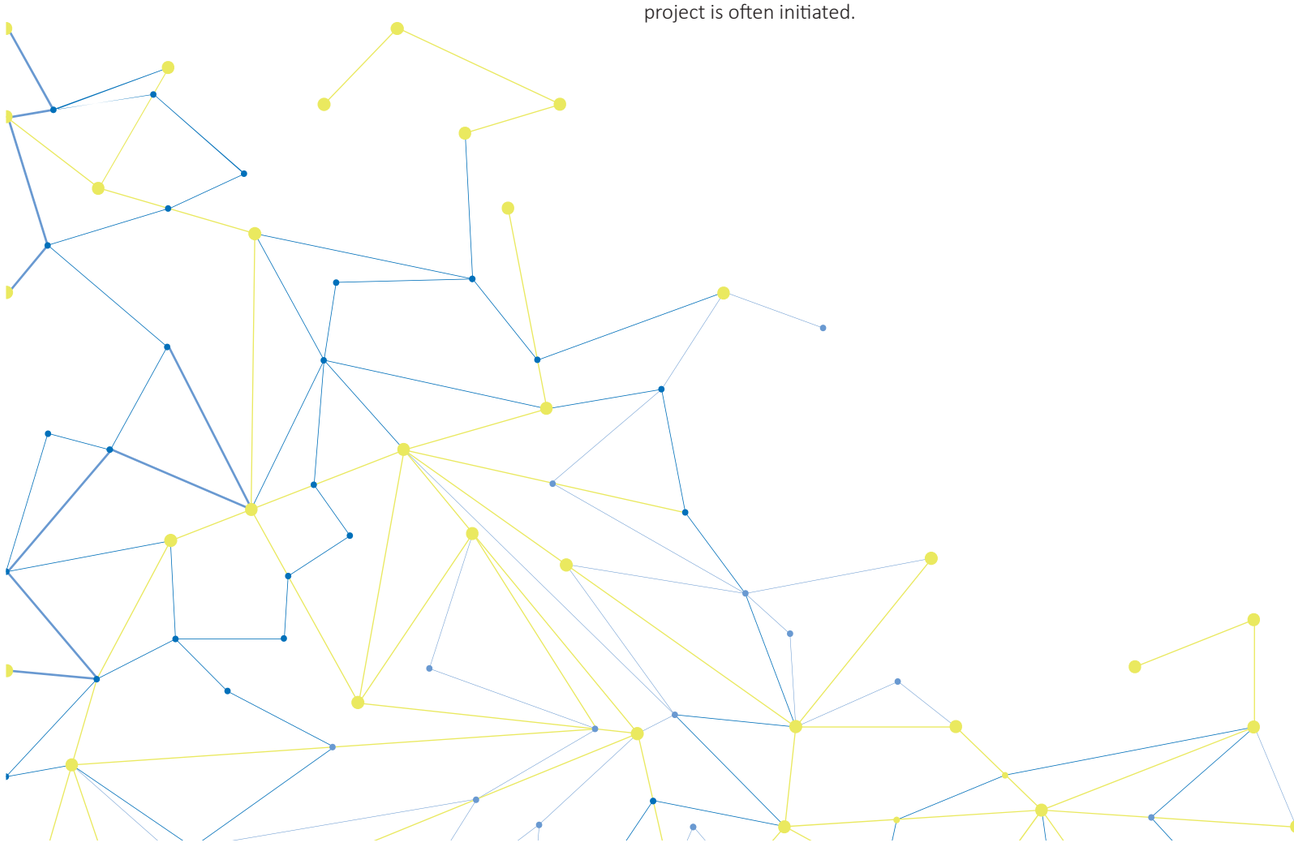
NACOE RESEARCH PROGRAM IMPLEMENTATION

The outputs of the NACOE research program are implemented in various ways, including but not limited to:

- the development of technical notes and design guidelines
- the development of new technical specifications
- implementation through demonstration projects
- the dissemination of learnings through presentations, seminars and webinars
- the preparation and presentation of technical papers and industry events
- validating existing practice through data gathering and analysis.

TMR is a member of Austroads, which undertakes research to develop nationally consistent guidelines. The work of NACOE and Austroads is often complementary to each other, whereby NACOE research further develops the Austroads findings to ensure that Queensland conditions and materials are fully considered and implemented. In many instances, the outputs from NACOE research have been fed through the various Austroads task forces and working groups, which then filter down into national documents.

In some instances, an explorative study (typically comprising of a desktop study only) is undertaken to better understand the research need, benefits or application prior to progressing with a more in-depth study. Where there is confidence in achieving a positive result, a follow-on project is often initiated.



COLLABORATION AND DISSEMINATION OF LEARNINGS

Collaboration with industry, universities and government bodies is one of the key strategic objectives for NACOE. The NACOE Board believes ongoing collaboration will allow the Department to leverage off research and resources from other organisations, which in turn will deliver mutually beneficial outcomes to everyone involved. In 2018-19, NACOE worked with a number of external organisations, including:

- The Queensland Department of Environment and Science- to develop technical guidelines and specifications for the use of recycled tyres and glass.
- Local Government Association of Queensland – to develop Local Government Heavy Vehicle Route Assessment Guidelines
- Central Queensland University – to develop an objective, automated method and software for identifying roadside objects and road design features for road safety assessment
- The Queensland University of Technology - to quantify the benefit of geosynthetics for the mechanical stabilisation of subgrade materials and develop guidelines for pavement design
- The Western Australia Road Research and Innovation Program on a number of collaborative research projects
- Tyre Stewardship Australia – facilitating the use of recycled tyres in Queensland
- Logan City Council – investigating the benefits of subgrade reinforcement using geosynthetic layers
- City of Gold Coast – implementation of crumb rubber modified gap graded asphalt
- AAPA – the implementation of Intelligent Compaction technology into Queensland, as well as the development of a new specification for crumb rubber modified gap graded asphalt.

It is believed these collaborations are one of the key success factors of the NACOE research program and will continue in future years.

Another important strategic objective of NACOE is ongoing development through the dissemination of learnings to industry and the regions. In July and August 2018, TMR held a set of NACOE sprayed sealing workshops, building off the pavement workshops that had previously been held in late 2017 and early 2018.

To further enhance national knowledge dissemination, NACOE research has been prepared for presentation at ARRB's inaugural Smart Pavements Now masterclass event (September 2019). Smart Pavements Now is a three day event, showcasing the latest trends, emerging issues and best practice in all aspects of pavements, facilitating hands-on learning in a highly interactive environment.

PAVEMENTS

The Pavements subprogram represents the largest proportion of the NACOE program, with a significant number of the total projects and approximately half the total investment. This program is focused on delivering engineering best practice across:

- asphalt
- road surfacings
- unbound granular and marginal materials
- stabilised/modified pavements
- several sustainability and innovative technology projects (including alternatives to traditional pavement materials).

When implemented, findings from this research have the potential to deliver significant cost savings to Queensland and potentially other states, which will allow more road projects to be constructed.

The major outcomes from the NACOE pavements program to date include:

- reduced depth of asphalt structural layers through:
  - adoption of EME (Enrobé à Module Élevé) high modulus pavement, and
  - refinement of thickness design based on improved asphalt pavement design procedures
- improved understanding of the full implications of using non-standard and/or marginal granular materials through performance validation and evaluation guidelines. These pavements are widely used in western Queensland, due to non-availability of conforming materials. While they offer significant savings, they can involve increased risk of poor performance, so these risks need to be understood
- upgrading of many department specifications, based on the review of world's best practice, and laboratory research
- increased use of recycled materials in bituminous products across the network, to deliver environmental benefits and enhanced sustainability.

The program also has a strong focus to collaborate with industry and universities.

CRUMB RUBBER MODIFIED GAP GRADED ASPHALT

The sustainable and environmentally friendly management of end-of-life vehicle tyres remains a challenge, both locally and internationally. In Australia alone, approximately 56 million equivalent passenger tyres reached the end of their life in 2015-2016. The roads industry can however play an important role in re-using this valuable source of recycled material.

The crumb rubber obtained from end-of-life tyres has successfully been used internationally to improve the performance of sprayed seals and asphalt mixtures for more than 40 years. However, uptake of this technology in Queensland has been somewhat limited to date. This project (co-founded by Tyre Stewardship Australia) was aimed at facilitating the use of recycled tyres in gap-graded asphalt mixtures and leveraged off previous NACOE studies which facilitated the use of recycled tyres in seals and open-graded asphalt surfacings on TMR's road network.

Crumb rubber modified gap-graded asphalt potentially has superior crack resistance and fatigue performance compared to conventional dense-graded mixtures and has successfully been used internationally (particularly in California and Arizona) to overlay jointed concrete pavements and rehabilitate existing pavements. NACOE, together with the Western Australian Road Research Innovation Program (WARRIP) and the Australian Asphalt Pavement Association (AAPA), developed the technical basis criteria that formed the basis for the pilot specification- Crumb Rubber Modified Open Graded and Gap Graded Asphalt that was published by AAPA in 2018.

A project specific technical specification was also developed for the manufacture and placement of crumb rubber modified asphalt on TMR projects.

In a first for Australia, the AAPA specification was successfully trialled on a live road by the City of Gold Coast.

This technology has the potential to recycle at least three equivalent passenger tyres for every square metre of 50 mm thick surfacing placed.

BENEFITS OF TRAFFIC SPEED DEFLECTOMETER (TSD) DATA IN PAVEMENT ANALYSIS

With this project in Year Three, the scope included expanding on the experimental plan trialled in Year Two, conducting 'ground-truth' experiments, analysing data from experimental work and exploring applications for using traffic speed deflectometer (TSD) data in pavement analysis. Analytical models used to design and rehabilitate pavements are becoming increasingly sophisticated. The most appropriate process for verifying the accuracy and usefulness of these new analytical models (as well as for calibrating the parameters included in these models) is to observe the behaviour of pavements in the field.

The main aim of this project was to acquire a better understanding of TSD deflection data by installing ground instrumentation (i.e. sensor arrays using geophones, accelerometers, and strain gauges) and monitoring the 'true' surface response when heavy vehicle traffic, or other deflection testing devices, travel over the pavement. To compliment the two deflection validation sites established in Western Australia (near Perth), this year's NACOE project established a permanent instrumentation site on Deception Bay Road in Queensland.

Since data collection commenced in 2014, the Traffic Speed Deflectometer has collected over 20,000km of surface condition and structural capacity data each year. International research notes that the TSD measurement can provide meaningful data and is more capable than merely use as a screening tool.

IMPLEMENTATION OF INTELLIGENT COMPACTION TECHNOLOGY IN QUEENSLAND

Year One of this project consisted of a literature review for the recent advances in the use of intelligent compaction (IC) technology and its applications to the construction of asphalt layers and for earth fill, granular and stabilised materials. The project reviews IC instrumentation systems, lessons learned from applications and the identification of benefits of the technology in terms of improving compaction and construction.

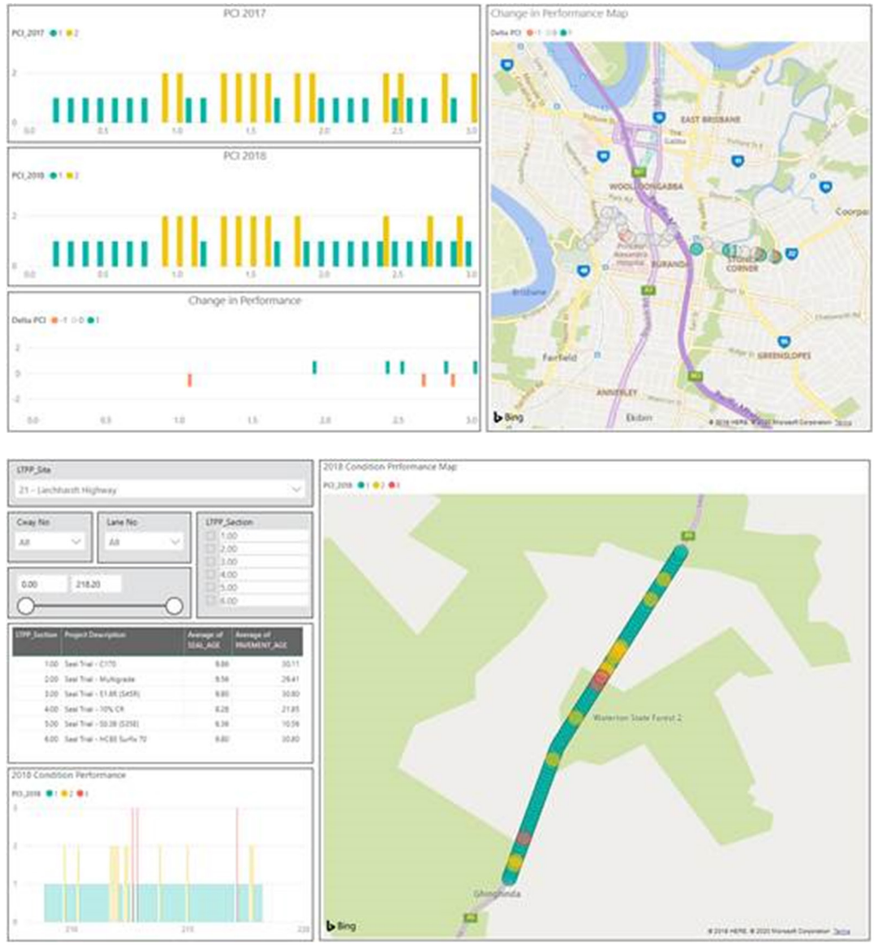
Findings indicate the key benefits for use in asphalt are the improved compaction quality and uniformity, and reduction in construction and maintenance costs. The review covers international research, and highlights the benefits for quality control using such technologies. Overseas research is currently underway to improve the model for use in asphalt and may lead to an expansion in the use of IC technology in the future. Australia has limited experience in using IC technology in asphalt pavement applications. The project made recommendations to TMR to develop IC technology specifications for use in the quality control of the construction of asphalt pavements.

Regarding earth fill, granular and stabilised materials, the report discusses current IC equipment, including original IC rollers and retrofit opportunities. A summary of existing specifications adopted in Europe and the USA is also presented, which may serve as references for the development of Australian specifications on the use of IC. Based on the findings obtained from the case studies and the existing specifications for earth fill, granular and stabilised materials, the report summarises the general IC in situ calibration procedure which may be adopted as a guideline to carry out an IC trial in Queensland. Finally, preliminary recommendations are made on how IC can be incorporated into current Department of Transport and Main Roads Technical Specifications, including MRTS04, MRTS05 and MRTS07B.

LONG TERM PAVEMENT PERFORMANCE PROJECT

A key requirement for a robust pavement engineering research program is that findings be supported by, and validated against, long-term pavement performance (LTPP) data collected in the field. The LTPP program provides crucial field data to narrow the gap between design model predictions and actual outcomes of the real in situ performance.

There are currently 24 sites monitored under the project, covering trial sites for Enrobé à Module Élevé (EME2), a heavy-duty asphalt pavement with 40% reclaimed asphalt pavement (RAP), crumb rubber modified seals and asphalt, high standard granular pavements, and foamed and bitumen treated base pavements. Performance data collected annually at these sites includes roughness, rutting, cracking, structural strength and skid resistance data. The results are captured in a database that can easily be interrogated and visually represented using modern software packages.



BEST PRACTICE IN COMPACTION QUALITY ASSURANCE FOR PAVEMENT AND SUBGRADE MATERIALS

This ongoing project is aimed at modernising testing procedures currently used for quality assurance (QA) in earthworks, pavement and subgrade materials. The first two years of this project saw a comprehensive literature review completed, encompassing potential QA test techniques and a review of international trials, followed by equipment acceptance testing of those selected for further evaluation.

In Year Three of this project a 'live' earthworks construction site was chosen for alternative QA testing methods to be assessed in parallel with traditional QA methods. The field assessment involved direct comparison between innovative test equipment and conventional methodology, to compare factors such as ease of use and repeatability.

Various traditional methods were included in the study, namely in situ Relative Density via Nuclear Density Gauge, Field Moisture Content and Static Plate Load Testing. Alternative equipment assessed included Light Falling Weight Deflectometer, Clegg Hammer, Soil Stiffness Gauge, PANDA Probe and Dynamic Cone Penetrometer.

INVESTIGATING THE MOISTURE SUSCEPTIBILITY OF CEMENT TREATED MATERIAL

Granular layers underneath sprayed seal, asphalt, or concrete surfacings can be highly susceptible to moisture induced damage. If the degree of saturation (DoS) is not controlled, rapid premature failures can occur. Current practice in the regions is to treat granular materials with small quantities of cement (typically one to two percent) in order to improve properties and avoid the requirement to control DoS during construction.

The objective of this multi-year project is to determine the threshold, in terms of cement content and moduli, at which each material transitions from behaving as an unbound granular material to a cement modified material with reduced risk of moisture damage and early pavement failure. The anticipated benefits of this project is to gain improved understanding on the impact of moisture on lightly bound materials and minimise premature failures in pavements that could have otherwise been avoided.

The testing shows that, as expected, moisture content (and degree of saturation) has an impact on the performance of lightly bound materials when assessed using the repeat load triaxial (RLT) test. To remedy this shortcoming, changes to the specifications regarding lightly bound materials have been recommended. Further testing will aim to better define what the specifications will need to be before surfacing can be done in order to minimise these failures.

- Testing shows that moisture content (and degree of saturation) has an impact on the performance of lightly bound materials.
- Further testing is to be done to better define the changes to specifications.

Moisture related pavement failures

OPTIMISING THE USE OF RECYCLED MATERIALS IN QUEENSLAND FOR UNBOUND AND STABILISED PRODUCTS

There is a global focus on reducing the reliance on finite resources including virgin quarry materials. Processing construction and demolition (C&D) waste for unbound and stabilised granular pavements is a sustainable and economical alternative to conventional quarry materials. However, this is only the case where the engineering properties and performance of these recycled materials still satisfies relevant road construction specifications.

The use of recycled materials in Queensland's unbound granular and stabilised granular pavement materials has traditionally been relatively low, despite TMR permitting the use of recycled materials in specification MRTS35 *Recycled Materials for Pavements*. The aim of this multi-year project is to identify how the use of recycled materials can be optimised on TMR projects to achieve cost, sustainability and long-term performance benefits. To help facilitate the increased use of recycled materials in unbound pavements, Year One included a literature review of existing practice in Australia focussing on the permissible uses for unbound pavement materials that include recycled materials, to facilitate the increased use of these materials where appropriate.

This project found that the use of recycled materials is widely accepted in unbound and stabilised pavement materials throughout Australia. While different agencies specify different limits, most of the publications identified have shown that in terms of performance; recycled materials are suitable for base and subbase applications. Additionally, the state road agencies outside Queensland, in NSW, SA and Victoria have combined or have closely aligned their specifications for traditional quarried materials and recycled materials. This allows for a simplified process in specifying alternative materials in tenders and/or contracts.

The project recommended amendments to the TMR specification MRTS35 *Recycled Materials for Pavements*. The proposed amendments will increase the allowable proportions of recycled materials permitted in recycled material blends, aligning TMR limits more closely with NSW, SA and Victoria. The amendments also propose removing the permissible use restrictions, allowing recycled materials to be used in unbound and bound basecourses.

Future work will address some remaining issues, including the variability of recycled materials between suppliers in Queensland and determining compliance against current and proposed specification limits. This will include determining likely performance using laboratory testing to assist TMR in updating specifications.

- Developed a testing programme to undertake classification and performance testing of several recycled material suppliers in Queensland.
- Proposed updates to MRTS35 *Recycled Materials for Pavements* to facilitate the increased use of recycled materials in unbound and stabilised pavement layers throughout Queensland.

THE USE OF RECYCLED GLASS IN ROADS

Approximately 850,000 tonnes of glass are consumed in Australia each year, with 350,000 tonnes recovered for recycling. In November 2018, the Queensland Government introduced a container refund scheme (CRS), increasing the amount of glass available for recycling. The reuse of glass in road infrastructure has been identified as a possible high-value use for these materials. Several road jurisdictions in Australia and internationally already allow for limited amounts of recycled crushed glass (RCG) in the structural and surfacing layers of a pavement.

TMR already allows for small percentages (up to five percent) of RCG to be used in the lower layers of unbound granular pavements. Yet there are opportunities to use this resource in higher value applications (such as granular base courses and asphalt layers). This project was undertaken to investigate the viability of increasing the allowable proportion of RCG permitted in granular pavement layers and asphalt layers to provide a high-value use of RCG in Queensland.

The first year of this multi-year project included a literature review evaluating the current practice nationally and internationally, including the benefits, risks and potential implementation barriers of increasing RCG usage in pavements. To ensure RCG could successfully be incorporated into an asphalt mix, one design mix was subject to an exploratory laboratory testing regime to characterise the engineering properties, validate the design mixture and investigate the performance of the mix.

The initial literature review indicated asphalt was a 'quick win' so the early work has focused on this application with work on other road applications to follow later. Furthermore, asphalt surface courses incorporating 10% RCG by mass were reported to perform in-service as well as conventional asphalt mixes, although based on limited studies. Initial laboratory testing undertaken during this project also suggested that up to five percent RCG can be successfully incorporated into a typical TMR asphalt mix. Future work will include additional laboratory testing on mixes containing zero percent and 10% RCG to characterise the engineering properties and performance of a typical TMR asphalt mix, which will also assist in the development of a TMR RCG specification.

- Developed a testing programme to undertake classification and performance testing of several RCG suppliers in Queensland to ascertain variability and characterise the physical properties.
- Initial findings suggest that up to 15% RCG can be included in asphalt mixtures.

ASSESSING THE POTENTIAL GREENHOUSE GAS EMISSIONS REDUCTIONS AND SUSTAINABILITY BENEFITS OF INNOVATIVE PAVEMENT SOLUTIONS

A number of innovative pavements have been and continue to be developed under the NACOE program and the Department is doing its part to reduce its greenhouse gas emissions. TMR is also requiring that all major infrastructure projects undergo an Infrastructure Sustainability Council Australia (ISCA) lifecycle sustainability rating. The rating system assesses infrastructure over four sustainability criteria i.e. economic, social, environmental and governance.

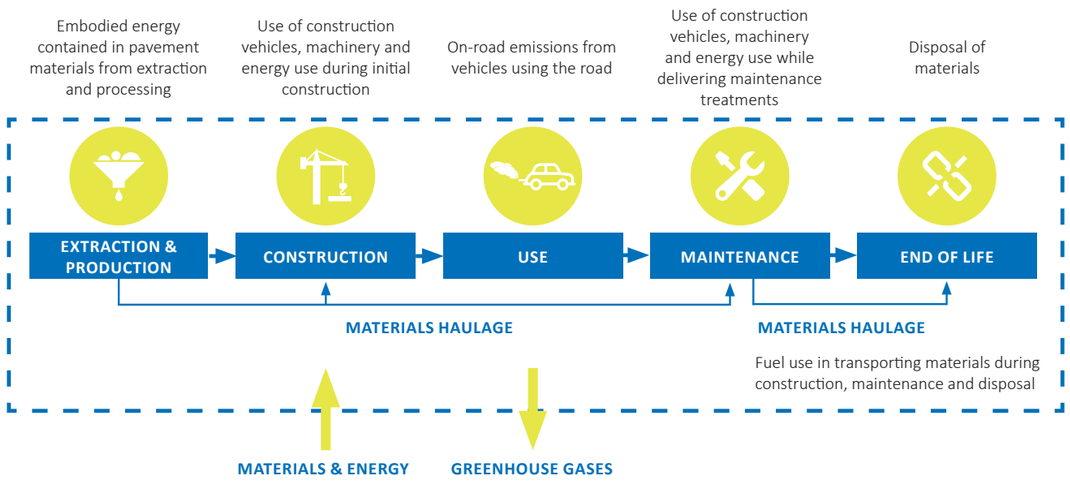
Five innovative pavement technologies were assessed for their greenhouse gas reductions over the pavement lifecycle and compared to a business as usual base case. Designs were developed for both an urban road and rural road application.

These innovative pavement technologies included Enrobé à Module Élevé (EME2), Recycled Asphalt Pavement, Crumb Rubber Modified Asphalt and Sprayed Seals, Foam Bitumen Stabilisation and Marginal Materials. Key reportable metrics from the modelling included total lifecycle greenhouse gas reductions (CO2e) and reductions by lifecycle stage. The lifecycle Net Present Value (NPV) was also assessed, including a carbon price, so that the externality cost was incorporated into TMR's decision making.

The majority of the technologies achieved greenhouse gas reductions and cost savings in the right context, as well as other benefits like the use of recycled materials and diversion from landfill, and the promotion of a local circular economy. A number of sensitivity and scenario analyses were also done including but not limited to road alignment, traffic controls, resilience to flood event, electric vehicle and haulage distances and the incorporation of a landfill levy. The findings of this project will help promote the uptake of these innovative technologies across Queensland and potentially Australia.

This project will continue to assess the sustainability benefits of any new technologies introduced through the NACOE program.

GHG emissions through a pavement lifecycle:



NACOE

ASSET MANAGEMENT

The NACOE Asset Management subprogram is focused on advancing asset management knowledge and practice through improved risk assessment and evidence-based performance modelling and the underlying assumptions within these models, and the application of these as part of continuous business improvement.

In addition, the program has included research into new funding strategies that explore life cycle costing implications, particularly considering the risk of major weather events and flooding across Queensland.
It is expected that the program will deliver benefits to the department in terms of:

- more robust risk assessment methodologies and asset management tools and models, which will enable the department to better prioritise maintenance and rehabilitation spending, through more informed, risk-based decision making
- a whole of life cycle cost-based approach to assessing pavement impacts from heavy vehicles
- life-cycle costing of asset management strategies, with a focus on how to improve resilience of the network to rain and flood events with a limited budget and against increasing climatic threats, and
- assisting the department and regions with the implementation of business improvements aligned with ISO55000 and the Austroads Guide to Asset Management.

NACOE

HARMONISATION OF PAVEMENT IMPACT ASSESSMENT: UPDATED MARGINAL COST VALUES FOR SEALED AND UNSEALED ROADS

The Department has produced a new guideline to assess the transport impacts of development. The new guideline, named the 'Guide to Traffic Impact Assessment' (GTIA), replaces the 'Guidelines for Assessment of Road Impacts of Development' (GARID), which was published by the Department in 2005.

The GTIA requires that impacts on the state-controlled road network, i.e. in cases where the pavement life is not consumed during the loading period, measures are implemented to avoid, reduce or compensate for the effects on the asset life of state-controlled roads. For practical application there is a need to identify the relevant marginal cost (MC) rate per loading unit, which for sealed roads is the number of standard axle repetitions per km travelled (SAR-km) and for unsealed roads is the number of axle pairs per km travelled. The project developed the technical basis for the GTIA, and a database of values developed from the following:

a. For sealed roads, the values are based on the latest asset information, including outputs from the Traffic Speed Deflectometer (TSD) and applying these to the national Long-Term Pavement Performance trial derived road deterioration models and works effects models developed by ARRB under the Austroads research program.
b. For unsealed roads, the values draw on a matrix of conditions and assumptions representing each TMR district informed by the Australian Local Roads Deterioration Study findings and more recent research under Austroads.

A Practice Note which supplements Chapter 13 of the GTIA has been published by the Department which provides further guidance for industry on how to prepare a Project Impact Assessment (PIA) using the new marginal cost methodology and the concepts of load related damage included in the methodology.

BENCHMARKING ASSET MANAGEMENT PRACTICES AND DEVELOPING IMPROVEMENT ACTIONS, STAGE ONE

TMR has embraced and lead in the development and application of sound asset management processes over many years. With the publication of ISO55000 and production of the newly updated Austroads Guide to Asset Management which draw heavily on international and national practices and standards, the opportunity was taken in 2018/19 (Stage One) to initiate a review and benchmarking of the Department's current processes related to the management of its road infrastructure assets.

The review builds on work undertaken directly by TMR, and on its behalf, including the Asset Management Review which sought to assist TMR's program of updating its Asset Management Policy and Strategy, and which identified TMR's current strengths and weaknesses in managing its asset portfolio. Since then, an internal project was initiated (in 2016) to develop and implement a TMR System Improvement Plan.

The review focused on assessing the strengths, opportunities, and challenges in developing and delivering effective and consistent road asset management programs. It has involved desktop assessments, participation in Queensland Road System Performance Plan (QRSPP) District consultation process, internal workshops with element managers. The findings to date mainly related to the QRSPP process were categorised as below, with examples of easy wins identified and areas for development.

- **Overall Strengths**
  - » Well defined, transparent, consistency
  - » Quantitative and largely evidence based
  - » Reasonable flexibility
  - » Acknowledges differences (e.g. location and demand driven)
- **Specific Strengths**
  - » Preventative maintenance focus, and trade-offs across elements
  - » District leadership/oversight
  - » M-Y Planning and delivery coordination
  - » Willingness to take initiative, justify, check
- **Challenges**
  - » Risk management
  - » Knowledge, acceptance/responsibility
  - » Management of service providers
  - » Unevenness in AM maturity and needs/risk assessment, and resources
  - » Reliability of data and AMS outputs
  - » Specific assets – unsealed, timber
  - » New assets – ITS/Traffic
- **Improvement Opportunities**
  - » Comprehensive risk assessment
  - » Routine maintenance
  - » Sharing and applying proven technology from district experience
  - » Improved data and system outputs (incl. wider use of NACOE solutions)
  - » Guidance and use of whole of life cycle-based selection.

Further targeted consultation and self-assessments, and in-depth coverage of a wide range of asset types including roads (on and off pavement), bridges, ITS, marine and active travel is planned in the continuation of this work.

CUSTOMER BASED LEVELS OF SERVICE IN ROAD MAINTENANCE

This project commenced in early 2018 (2017/18) with the aim of relating customer-based levels of service (CLoS) to the technical levels of service (TLoS) used in road maintenance by TMR. These relationships, if soundly based, allow a customer focus to asset management demonstrating that the CLoS are being met as much as practically possible within the constraints of available budgets and asset management strategies. A pilot survey was conducted in 2017/18 to test the survey methodology on a limited number of participants who were selected from TMR and local government road agencies in Queensland. A report on the outcomes of literature review and the pilot study was published in November 2018. This report confirmed the pilot survey methodology due to the correlations achieved by customer ratings for the factors used for safety and accessibility on both rural and urban roads. This was an encouraging outcome for the future of the project with the decision by TMR to proceed with the extended customer survey in 2019/20.

IDENTIFICATION OF RESIDUAL RISK FOR EACH ELEMENT AND DEVELOPMENT OF A FUNDING ALLOCATION METHODOLOGY OF ELEMENTS

TMR faces a challenge in addressing the funding needs of multiple asset elements and the impacts on them from traffic use and the environment. Asset performance, and therefore needs and risks, are impacted by a combination of factors, with climate related factors increasing in importance.

The need for a more comprehensive and rational basis to assessing and managing risks was identified. The intent is to enable TMR to better manage its portfolio by more rigorous, risk-based planning and programming, and the provision of clearer guidance to inform implementation.
This project aims to deliver a framework, guidance and tools aimed at supporting a comprehensive, risk-based methodology to assist in funding allocations to different elements, with the latter representing different asset activities, responsibilities and system management issues which drive a response through specific works or operational responses.

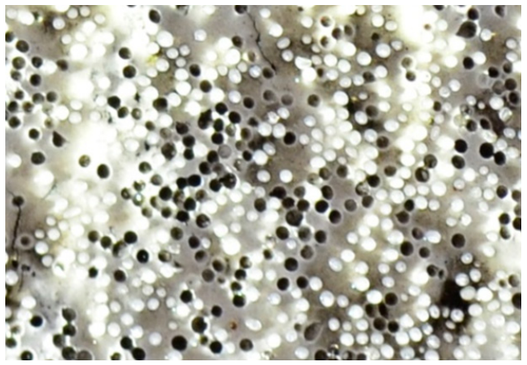
This project will require the appropriate use of both a network level approach and a more road section-based approach. For example, certain impacts have a significant disruptive, potentially catastrophic, effect on a network and impede the flow of traffic, whereas others are more confined and have marginal network impacts.

Stage One of this project has involved the development of the Pavement Residual Risk Model (PRRM). The PRRM is based on an Analytical Hierarchical Process (AHP). The AHP applied to the calculation of residual risk was adapted from RIVA, a GIS (geographical information system) based risk analysis tool used in Germany to account for natural hazards. The PRRM include five major risk dimensions including access/vulnerability of road assets due to hazards, and the impact of hazards on stakeholders and community, safety performance, legislative compliance and operations of the asset. Further stages of this project will endeavour to assess the entire TMR network. The approach shows the potential to estimate values on the relative residual risks associated with road segments located in different geographical and geological areas subject to differences in traffic and environmental impacts. Critically, the approach relies on an extensive and well-maintained database.

INVESTIGATE AND COMPARE THE PERFORMANCE AND LIFE-CYCLE-COST BENEFITS OF TYPE B-HR AND TYPE D-HR GLASS BEADS IN LINEMARKING COMBINATIONS IN WET CONDITIONS

Type D-HR and Type B-HR glass beads are primarily used to provide retro-reflectivity on long lines and pavement markings on the Queensland state-controlled road network. It is believed that at night in wet conditions, Type D-HR beads provide higher levels of retro-reflectivity than Type B-HR beads. The application of Type D-HR beads commenced in 2010, initially on three priority one roads which was then extended to seven priority one roads in 2016. The cost of application of Type D-HR beads is approximately twice the cost of Type B-HR beads.
The purpose of the project was to investigate and compare the retro-reflectivity performance and resulting life-cycle-cost of Type D-HR and B-HR glass beads in long lines (edge and centre line markings). The resulting knowledge of life-cycle costs of alternative treatments which meet performance requirements will assist decision making in the future use of Type D-HR beads.

The objectives of this project were to determine if Type D-HR beads provide higher retro-reflectivity during wet conditions compared to Type B-HR beads and provide a comparison of life-cycle-cost for glass bead retro-reflectivity.



Up to 35 different linemarking combinations were provided in a test deck on a sprayed seal and asphalt surface. The retro-reflectivity data was collected in dry and wet (simulated) conditions at fortnightly and monthly intervals for 24 months. The life cycle, based on minimum reflectivity criteria to define end of life, and life-cycle-cost for dry and wet conditions was identified for each linemarking combination. Four linemarking combinations met the required performance criteria and provided the lowest life-cycle-cost, all of which used Type D-HR glass beads.

Type D-HR glass beads were the only beads to meet the retro-reflectivity intervention level of 80 mcd/m2/lx and maintain retro-reflectivity above this level for the 24-month trial. Therefore, Type D-HR beads are seen to provide higher retro-reflectivity levels in wet conditions compared to Type B-HR glass beads. Type D-HR beads also return a lower total life-cycle-cost.

Additionally, the study identified a number of linemarking combinations that provided low life-cycle-costs for retro-reflectivity in dry conditions, as well as recommending the future research opportunities to:

- investigate the incorporation of crash risk and safety benefit considerations in the linemarking program
- undertake trials to better understand retro-reflectivity performance of structured linemarking in wet conditions
- link retro-reflectivity performance to Connected and Automated Vehicles confidence levels for identifying and interpreting linemarking in all weather conditions.

Example of glass bead loss (Type D-HR)

Retro-reflectivity is dependent on headlight beam being retro-reflected to a driver. The level of retro-reflectivity is dependent on the size and number (density) of glass beads (in good condition) that are retained in the paint. This example shows the loss of glass beads after 8.6M vehicle passes. This photo is of an Asphalt surface with Type D-HR glass beads installed at a density of 500 g/m2 on Cold Applied Plastic Paint at a thickness of 500µm. The dark ‘spots’ are holes remaining after glass beads have been dislodged by vehicles.

STRUCTURES

The Structures subprogram seeks to deliver benefits to the network in a number of ways, including:

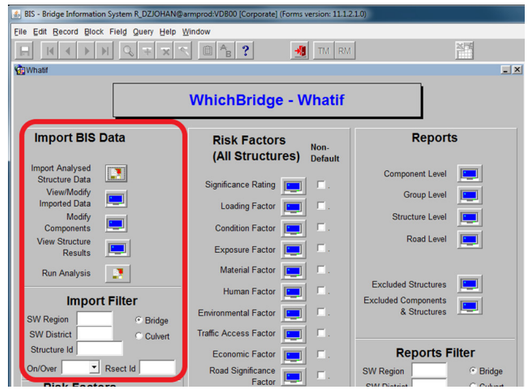
- destructive testing and analysis of vehicle interactions on load limited and critical bridges to gain a better understanding of the capacity and performance of these structures
- development of staff capacity in the use of advanced assessment technologies and instrumentation of structures
- improving bridge monitoring and management through the use of advanced systems and by adopting world's best practice in asset and risk management
- introduction of advanced materials and technologies into structures across the network.

REVIEW OF WHICHBRIDGE UTILISATION IN TMR

The WhichBridge algorithm is a qualitative risk management tool that is used to benchmark network performance and assist in the prioritisation of bridge and culvert rehabilitation works within TMR. WhichBridge was first implemented by TMR in 2003 and was integrated into the Bridge Information System (BIS) in 2005. There have been a number of changes and updates to the algorithm to better reflect the existing network. The user manual has not been updated to reflect these changes.

The overall aim of this project was to review the use of WhichBridge across TMR operational districts and historical changes to the algorithm, in order to identify issues or limitations of the algorithms and inconsistencies in the outputs (risk scores). Based on the findings of the review, various recommendations have been made on changes to the algorithms and further calibrations required to better reflect the existing condition of the network and current TMR practice in data collection, management and maintenance/rehabilitation prioritisation and programming. The WhichBridge User Manual has also been updated accordingly.

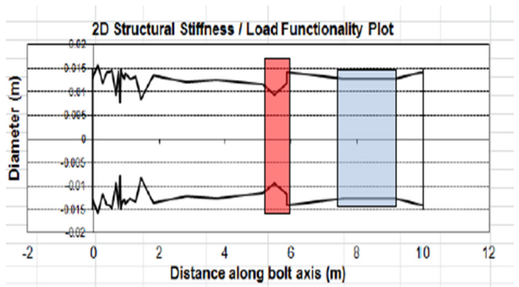
- Provide an updated user manual for WhichBridge, which includes a targeted guide for how to perform common tasks within WhichBridge and WhatIf modules.
- Improve TMR knowledge on how WhichBridge is used in regions and stakeholders' expectations for future improvement.
- Improve TMR knowledge of factors that affect risk scores and risk score anomalies.
- Capture corporate knowledge on the historical changes to the WhichBridge algorithms.
- Provide recommendations for the improvement of the WhichBridge algorithms to better reflect the existing network conditions and operational needs.



REVIEW OF TRANSVERSE STRESSING BAR REPLACEMENT TECHNIQUES

Approximately 40% of TMR current bridge stock is deck unit (DU) bridges. Transverse stressing bars (TSB) are a key structural component on DU bridges, however, a reliable method to quantify damage to TSB and its impacts to bridge performance is not currently available. There is also lack of a consistent approach to rectify TSB damage including TSB replacement statewide. Non-destructive testing (NDT) technologies have been trialled but mixed results have been reported.

This project undertook a study into the implementation of NDT technologies in the condition assessment of TSBs on DU bridges through a review of available literature and the NDT trials conducted by TMR. The project also reviewed the current practice in the replacement of TSB on DU bridges, in order to formalise current TMR TSB replacement procedures.



The review of the current trials of NDT undertaken by TMR reveals that the trialled NDT have not been found to be effective in detecting defects in existing TSBs. The vendors of different systems have not been able to demonstrate that the various technologies trialled have a sufficient level of accuracy and reliability. It was recommended that none of the trialled technologies should be considered for routine use in assessing the condition of TSBs within the TMR bridge stock. Further technological improvements are required for selected technologies in order to demonstrate the reliability and quality of the output.

A draft technical specification has been prepared based on the findings of this project to provide practitioners with a works method statement and procedure for effective removal and replacement of defective TSBs on TMR deck unit bridges.

- Provided knowledge on the effectiveness and applicability of currently available non destructive testing technologies in assessing the condition of transverse stressing bars on TMR deck unit bridges.
- Demonstrated that the various technologies trialled have insufficient level of accuracy and reliability. None of the trialled technologies should be considered for the routine use of assessing the condition of TSBs within the TMR bridge stock.
- Captured the current best practice in the removal and replacement of transverse stressing bars and develop a standard method statement and technical specifications for the removal of damaged
transverse stressing bars on deck unit bridges.

IMPACT OF CORROSION INHIBITOR ADMIXTURES ON DURABILITY OF CONCRETE

A large volume of TMR infrastructure is situated in aggressive marine environments, therefore corrosion protection materials/technologies are of interest. Corrosion inhibitor admixtures (CIAs) are marketed by chemical companies as a method of proactively protecting reinforcing steel in concrete, however, their performance is not well assessed and documented. TMR is interested in a review to assess the use, performance, specifications and effectiveness of CIAs, in order to establish its position regarding the use of CIAs on concrete.

This project conducted an investigation into the current use, performance and specification of CIAs through a review of the outcomes of available field and laboratory studies on CIAs, specifications relating to the use and formulation of CIAs, impacts on concrete properties, effectiveness requirements for CIAs, as well as consultation with industry to investigate the current use and performance of CIAs in Australia.

The review reveals that in a laboratory environment, CIAs can improve the corrosion inhibition of reinforcing steel in concrete by producing longer corrosion initiation times, higher critical chloride thresholds, and a reduction in the chloride penetration. CIAs may have adverse impacts on concrete properties, which vary among available products (concrete strength, setting time, permeability, etc.). In addition, there exist some environmental concerns due to the toxic nature of inorganic CIAs for handling and disposal of concrete with CIAs.

Due to the lack of literature/reported field data/long-term data and mixed performance results reported, no conclusive assessment can be made on the effectiveness of CIAs in infrastructure applications. Therefore, it was recommended that TMR maintain its position which is not to use CIAs in concrete. Industry needs further work to prove the performance and effectiveness of CIAs.

- Report the findings from a literature review and consultation with key industry stakeholders to gather evidence regarding the applicability of CIAs as a suitable method of protecting reinforcing steel and enhancing the durability of reinforced concrete.
- Mixed performance results were reported. While CIAs can improve the corrosion inhibition of reinforcing steel in concrete by producing longer corrosion initiation times, higher critical chloride thresholds, and a reduction in the chloride penetration, they also cause adverse effects to concrete properties, including concrete strength, setting time, permeability.
- This project provided TMR with a sound basis for retaining its current position which does not allow the inclusion of CIAs in concrete. Further work is required for the industry to prove the performance and effectiveness of CIAs.

FUNCTIONAL REQUIREMENT FOR BRIDGE RISK AND PRIORITY CLASSIFICATION

TMR currently uses the maintenance prioritisation tool 'WhichBridge' as a proxy risk management tool for bridges and culverts, however, WhichBridge does not provide a measure of risk consistent with recognised standards. In addition, the current TMR corporate risk management framework is comprehensive and consistent with AS/NZS ISO 31000:2009. Alignment with this framework could be readily achieved if it formed the basis for TMR bridge risk quantification.

This project mapped TMR requirements for bridge risk quantification and developed a functional specification for bridge risk consistent with emerging risk management best practice to support TMR's business needs. A process was recommended for the implementation of the developed functional specification.

- Reviewed TMR corporate risk practice and contrasted with the use of WhichBridge
- Reviewed other risk management projects currently active in TMR
- TMR corporate risk practice was found to be consistent with ISO 31000:2009, but there is limited linkage between this framework and the management of bridge risk
- Developed a functional specification for TMR bridge risk management based on state-of-the-art risk management practice
- Recommended a process for the implementation of the developed functional specification.

NACOE

MORE FROM NACOE

A number of projects are funded under NACOE in the fields of Network Operations, Road Safety, Sustainability and Heavy Vehicle Management.

Current departmental initiatives include:

- targeted efforts to reduce the road toll through investigating key crash types and cost-effective techniques to minimise serious and fatal injuries
- assessing multi-model transportation costs, driving savings through improved network efficiency and adopting best practice modelling
- streamlining heavy vehicle policy to remove barriers to industry while delivering the best outcomes for the network as a whole.

Through NACOE, a number of projects will also be looking to advocate the use of smarter technology and sustainable solutions on Queensland roads.

NACOE

SUSTAINABILITY

CLIMATE CHANGE ADAPTATION FRAMEWORK FOR TMR

Unless drastic action is taken to address the release of greenhouse gases into the atmosphere, increasing levels of adaptation will be required year on year. As global temperatures climb, so do the costs of adapting to a warmer world.

Queensland's climate is changing, and adaptation action is essential for the continued prosperity of Queensland's communities, environment and economy. Extreme climatic or weather events have the potential to damage and/or disrupt the operation of road infrastructure with unacceptable associated social, environmental and economic consequences.

The Climate Change Adaptation Framework (the Framework) is designed to help TMR increase the resilience of Queensland's state-managed road networks and assets to changed climatic conditions and extreme weather events.

The TMR Framework, provides a structured process and guidance for undertaking consistent climate change adaptation evaluations for road infrastructure and incorporating these findings into decision making. The Framework incorporates TMR policy, tools and practice and includes Queensland-specific case study examples of climate change adaptation projects and assessments.

Before reconstruction

After reconstruction

ROAD SAFETY

AUTOMATING ROAD DATA COLLECTION FOR ROAD CONDITION MONITORING AND ROAD SAFETY IMPROVEMENT THROUGH IMAGE PATTERN RECOGNITION

For improved road safety, TMR routinely undertake risk assessment of the road network for the identification and treatment of high crash-risk sections. The risk assessment models used include the Australian Road Assessment Program (AusRAP). This risk model requires the collection of more than 50 road infrastructure and roadside features at 100 meter intervals, which based on the current method is labour intensive, expensive and prone to many errors.

Automating the collection of road attributes from using a digital video recorder (DVR) using advanced image analysis and deep learning, and cross-validation with other data sources such as Mobile Laser Scans (MLS), has the potential to provide reliable, consistent and inexpensive road condition and road safety related data sets. Research indicates that machine learning is much better at scanning video images of long stretches of roadways than human beings.

Working in collaboration with researchers from Central Queensland University (CQU), the aim of this three-year project is to develop and evaluate deep learning neural network-based methods for the automatic extraction of the road attributes required by the AusRAP risk assessment model. The ultimate deliverable of this research work is an objective, automated method and software for identifying roadside objects and road design features for AusRAP road safety assessment.

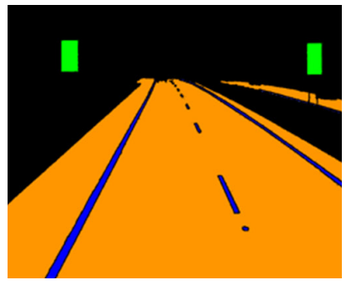
The research to date has developed a framework and method for detecting road attributes and roadside features based from DVR video and MLS data sets. The experimental results for detecting selected road features are promising, with high precision and accuracy levels. These features include poles, trees, posted speed limit signs, line markings, paved roads, metal barriers, rumble strips, etc. A 100 percent object-wise accuracy has been achieved for detecting the two most frequently occurring roadside objects i.e. poles and trees. Although distance calculation is more accurate on MLS data than DVR data, there were many issues with MLS data. Annotation is difficult and time consuming, the number of attributes that can be recognised is limited. Furthermore, MLS data is available for a limited number of roads.

Further development is focused on using DVR data only (due to limitations of MLS data) to:

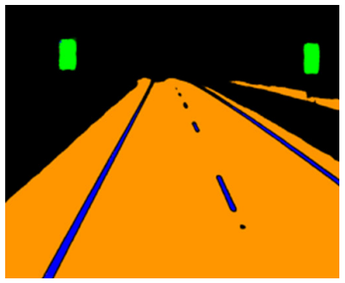
- optimise the framework/algorithm for identifying all AusRAP attributes
- develop an automated software system for extracting AusRAP attributes
- apply the software to determine AusRAP attributes over the state-controlled roads.

Original image

Ground Truth



Result



DEVELOPMENT OF CRASH REDUCTION FACTORS

Crash Reduction Factors (CRFs) are essential data inputs for evaluating road projects. CRFs are used primarily to estimate expected savings in crashes from road improvements projects. They are used as an input in estimating the benefits of a proposed project in terms of crashes saved and benefit cost ratio, enabling the prioritisation and selection of treatments.

The CRF matrix currently used by TMR has evolved over time and there has been no review to verify their reliability and accuracy based on current research. The purpose of this two-year ongoing research project is to update the department's existing CRFs based on review of recent research and existing jurisdiction CRFs. A key objective is to improve the accuracy and scope of the CRF matrix to cover different vehicle types in different speed environments, supported by research that reflects the true safety performance of the treatment.

The review of published research and existing jurisdiction CRFs identified that generally, the CRFs have not been categorised by vehicle type, crash type or traffic volumes. Furthermore, there is wide variability in study methodology, robustness, quality and reliability of available research. Hence the updated CRFs have not been provided by vehicle type, they are being provided by Definitions for Coding Accidents (DCA) group for each treatments under the main crash types, namely, head-on crashes, intersection crashes, run-off-road crashes, rear-end crashes and others (covering vulnerable road users and other treatment types).

The updated CRFs for each treatment is a recommendation by a stakeholders technical working group made up of TMR and ARRB experienced staff based on a review on the research findings, existing jurisdiction CRFs, and using judgement where confidence levels from research findings are low.

The final deliverable of the project when completed will be an updated and more accurate CRF matrix covering approximately 120 treatments. The results obtained will be used to update TMR's technical guidance and management protocols. The use of the more accurate CRFs will improve the effectiveness of road safety infrastructure programs by improving the prioritisation of projects that best reduce the occurrence and severity of crashes. This in turn will allow for more informed decision making when making investments in the road network.

NETWORK OPERATIONS

DEVELOPMENT OF HYBRID DATA MODEL PROTOTYPE FOR THE ENHANCED COST OF CONGESTION METHODOLOGY

This project was set-up to develop a web-based prototype system, that works to test the main functions of an automatic system that will report the cost of congestion (CoC) for a network with roads from different jurisdictions (e.g. TMR and local governments). The project uses a hybrid data model, which blends in data from multiple sources including detection loops, bluetooth devices and probe vehicles, (this model type is regarded as the ultimate data source).

During Year One a web based CoC prototype system has been developed, that incorporates multiple data sources. The enhanced CoC calculation was conducted, including reporting at link, route and network level.

The project made use of the ARRB Toolbox to enable an agile software design and development process, allowing users to test main functions of the enhanced CoC methodology in a fast and convenient way. It provides a modern and interactive visualisation function for users to select link, route or network, define data source and time range, and automatically produce CoC related results in both table view and map visualisation view on the same screen.

Using the prototype, some preliminary CoC comparisons between the hybrid data and STREAMS data were conducted. Key comparison findings include:

- Data coverage is increased significantly from 68 percent to 80 percent by using the hybrid data.
- For four different road types, i.e. TMR motorway, TMR arterial, council arterial and council side street, the number of National Performance Indicator (NPI) links, data coverage, vehicle-kilometres travelled (VKT) and CoC are all consistently higher using the hybrid data.
- The map visualisation tool provides a straightforward snapshot of the comparison between the two data sources. Users can zoom in to more detailed view to observe the difference between the two data source at network, route and link level.

The prototype developed in this project is intended as a starting point to enable TMR to apply the CoC methodology at network level. The prototype has the flexibility and potential to serve as a standalone visualisation tool for internal CoC reporting and can also be further transitioned in a different environment (netBI or custom implementation) that automates the CoC analysis upon completion of this project.

REAL-TIME DETERMINATION OF SPARE CAPACITY OF ROUTES FOR ENHANCED MANAGEMENT OF CONGESTED ROAD NETWORKS

A system that can determine real-time roadway spare capacity has been considered an important ingredient to advance traffic management strategies but has been constrained by the geographical coverage of traffic data. Knowledge of spare capacity in real-time would lead to enhanced traffic management strategies and techniques, such as providing more accurate traveller information, gating and managing or optimising traffic signal control strategies. Such a system may now be possible with the rapid transaction of loop detector, probe and Bluetooth data.

This project is a multi-year project that aims to develop a system for determination of real-time spare capacity in four stages as follows:

- Stage One: industry review and design capacity (Year One)
- Stage Two: stakeholder consultation, prototype development and case study (Year Two and Three)
- Stage Three: system review (Year Four)
- Stage Four: system development (Year Four and Five).

The system is intended to utilise a variety of information on the network in real-time, including information on demand and flow; road space and control; and traffic conditions. Through a traffic state and capacity estimation methodology developed in this project, key information on design, operational capacity and spare capacity will be estimated. Real-time information of spare capacity would then be utilised by traffic managers to enhance productivity of the network.

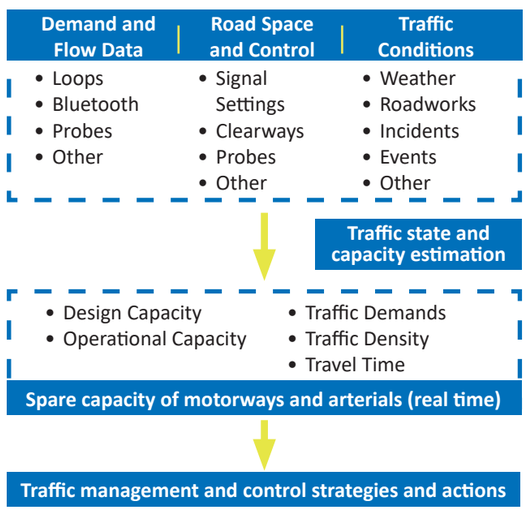
Stage One, which was completed over 2018/19, developed a methodology to estimate design capacity. Case studies applying this methodology were conducted on a motorway (Centenary Highway) and arterial road (Samford Road). Using this methodology, real-time operational capacity was estimated based on two principles:

1. If the segment is operating in saturated operation regimes, then the realised flow is the operational capacity of the segment. Otherwise, the operational capacity is equal to the design capacity.
2. The operational capacity of an upstream segment is constrained by the operational capacity of the adjacent downstream segment.

Stage Two is currently underway and began with consultations with practitioners in arterial and freeway management and operations from TMR, VicRoads, Transport for NSW and Main Roads Western Australia. This stage will aim to develop and test an algorithm to apply the 'first principles' methodology prepared in Stage One. It will explore the application of approach-side detectors as input for the algorithm and the potential to use Bluetooth and HERE data for input speeds. The project will conduct a case study along Smith St Motorway and Kumbari Avenue in the Gold Coast as the STREAMS controlled intersections along these corridors have both approach and departure loops. It will also examine the use of permanent counting station sites for developing a historical baseline for the algorithm.

At this stage, the project will not yet consider integration into the TMR system but will focus on refining techniques.

Preliminary Framework for Real-time Spare Roadway Capacity System



HEAVY VEHICLES & FREIGHT

LOCAL GOVERNMENT HEAVY VEHICLE ROUTE ASSESSMENT GUIDELINES

To improve the safety and efficiency of freight transport on Local Government (LG) roads in Queensland, ARRB was requested to review existing heavy vehicle route assessment methods and develop new guidance for LGs. While this project was undertaken through the NACOE program, it was initially instigated by the Local Government Association of Queensland (LGAQ).

The new Local Government Heavy Vehicle Route Assessment Guidelines were developed based on existing heavy vehicle route assessment criteria and road engineering practice from each relevant engineering discipline. The information within the guidelines was collated from existing state road authority heavy vehicle route assessment guidelines throughout Australia, Austroads guides, reports and research, and practical experience within road agencies and local government.

The guidelines were developed to assist LG road managers or consultants to assess the suitability of prescriptive and Performance Based Standards (PBS) Class two heavy freight vehicles when accessing LG routes under the Heavy Vehicle National Law within Queensland. The guideline aims to ensure that all key factors have been considered during the route assessment process, which includes assessing:

- geometric performance
- road safety implications
- structural capacities
- amenity considerations.

To assist LG road managers further, the guide provides an Microsoft Excel®-based route assessment form and a risk assessment process. The route assessment form assists in identifying which attributes on a route should be assessed and provides a high-level assessment of the route to determine which attributes meet the guideline and which require further investigation. The risk assessment process allows road managers to approve access when a route does not meet the guidelines by applying operating conditions to a permit or through mitigating treatments.

- Provides comprehensive guidance on heavy vehicle route assessment, with new and expanded guidance aimed towards assisting Local Governments. New guidance on risk-based decisions to provide appropriate access with inclusion of suggested mitigation treatments.
- Guideline delivers new or expanded guidance for: low speed or constrained environments; low speed, low volume rural roads and unsealed roads; and risk assessment process for risk-based decision making.

GET INVOLVED

HOW TO GET INVOLVED

The NACOE program runs on a rolling four-year basis, with projects generally spanning one to three years.
The program relies on the input and collaboration of TMR, ARRB and industry personnel to develop ideas for projects across the four key discipline areas of pavements, asset management, structures and other (network operations, road safety and heavy vehicle management).
Any suggestions for projects can be submitted through the NACOE website, at nacoe.com.au or through the NACOE email address info@nacoe.com.au

FEEDBACK AND CONTACT DETAILS

The NACOE Agreement Managers can be contacted with any feedback or to make enquiries regarding the program or specific projects.

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