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NZTA research

NZ TRANSPORT AGENCY
WAKA KOTAHI

SAFETY AND EFFICIENCY IN INTERSECTION PROJECTS

Recent research explored the feasibility of developing a framework to take into account both safety and efficiency, and quantify the trade-offs between them, when making decisions about intersection improvements.

The project, undertaken by Resolve Group in Auckland, reviewed current approaches to evaluate proposed safety and efficiency improvements at intersections.

While the NZ Transport Agency (the Transport Agency) and other road controlling authorities now have established best-practice approaches for evaluating and improving safety (eg the High-risk intersections guide (NZ Transport Agency 2013)) and efficiency (eg the network operating frameworks) at intersections, the objectives underlying the approaches often clash, resulting in an intersection design that does not balance safety and efficiency as effectively as it would have done, if an integrated approach had been used.

The report authors, Tim Brown and Steve Griffith of Resolve Group, say, 'Intersections can pose complex problems when attempting to manage the movement of people and goods on the transport network, so it is important to consider the needs of a range of road users and ensure that solutions minimise delays while maximising safety.

'Despite there now being robust design standards, plans and legislation in place (underpinning the importance of safety and efficiency as separate considerations), in practice the decision-making frameworks used by road controlling authorities tend to consider one aspect over the other, depending on the reason that a particular intersection is being constructed or upgraded – safety or efficiency. We currently have no acceptable way of developing projects that maximise outcomes for both safety and efficiency in a coordinated manner.'

Accordingly, the research aimed to develop an evaluation framework that incorporated best practice guidance relating to both safety and efficiency, to determine whether, in principle, it was possible to develop an optimum outcome that addressed the competing objectives of safety and efficiency.

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Specifically, the research aimed to:

- identify the impacts of proposed changes to an intersection on a reasonably consistent basis, which could be applied to both rural and urban intersections. This required the impacts of safety and efficiency improvements to be measured in a common value, allowing any trade-offs between the two components to be identified and assessed
- put the safety and operational characteristics into a common framework to allow robust solutions to be developed.

It is important to note, while the research examined the benefits and impacts of different intersection treatments, it did not set out to provide guidance on the specific treatments to be applied at particular locations. Instead it aimed to produce a tool for road controlling authorities to support their decision making for specific intersection projects.

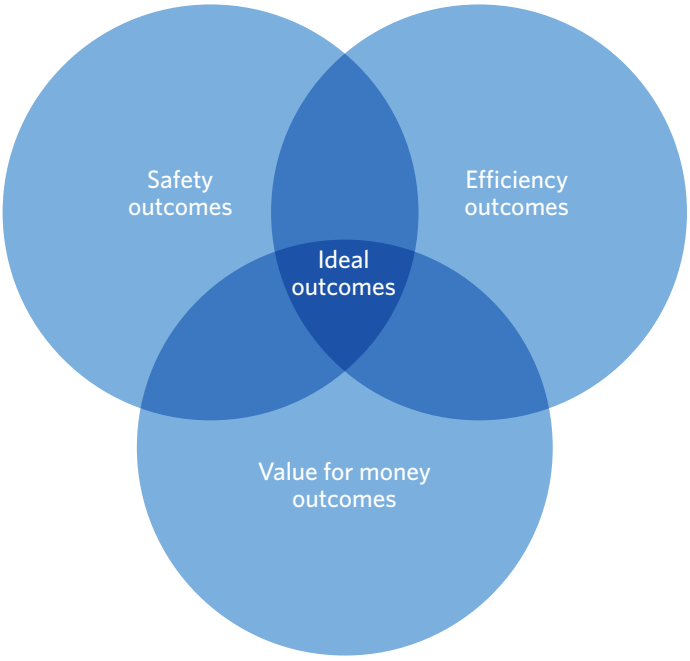
DEVELOPING THE FRAMEWORK

An initial scan of national and international literature and best practice, found at present there is 'no known way of developing projects that maximise outcomes for both safety and efficiency at intersections in a coordinated manner.' It also found very little to define what is considered an acceptable trade-off between safety and efficiency at intersections.

'This is because the two jurisdictions or considerations are currently treated completely separately,' the report authors say. 'For the same reason, there was little information available about the interdependencies between safety and efficiency at intersections.'

However, it was clear to the authors that, for the optimum or ideal outcome to be achieved for an intersection, any framework they developed would have to consider both safety and efficiency, regardless of the focus that was driving the improvement projects.

OVERVIEW OF ACHIEVING THE IDEAL OUTCOME



The resulting 'proof-of-concept' evaluation framework developed by the authors provides a shortlist of available treatment options, with a ranking assigned for each option based on the expected percentage improvements in safety and efficiency flowing from it. Safety improvements were assessed as the crash reduction percentage to be expected if a specific measure was implemented (in line with the High-risk intersections guide). Efficiency improvements were assessed as the difference between the level of service expected from the improvement (drawing on One Network Road Classification definitions of levels of service, and converted to a percentage) measured against the existing level of service for efficiency. The assigned ranking is referred to as the safety/efficiency framework trade-off score. In addition, the framework allows an indicative budget to be assigned to options, enabling users to consider those options that fall within their allocated budget.

To test whether the outputs from the framework were sufficiently accurate, it was applied to a number of case studies where intersection improvements had either occurred or were planned.

The report authors comment, 'The case studies demonstrated that the ranking of solutions generated by the framework tended to place the constructed, or yet to be constructed, improvement schemes as high priorities on the list. From this, we were able to conclude that, in principle, the methodology appears to be relatively sound.'

The case studies also demonstrated a potential way of expressing the safety and efficiency elements of an intersection in terms of a common unit.

The authors state, 'With further development, this approach would enable the framework to make a direct comparison between safety and efficiency, or to express the trade-offs involved between particular schemes, rather than, as at present, having to rely solely on arbitrary percentage improvements.'

The research report concludes on page 50, 'This report provides a recommended process by which desired safety/efficiency outcomes can be measured against the existing levels of performance in a meaningful way. In many cases, improving safety at an intersection often comes at a cost to efficiency. The process developed in the proof-of-concept evaluation framework offers some way to better understand the trade-offs. However, the extent to which it quantifies the trade-offs (as a percentage difference between existing and proposed) assumes a 5% improvement in safety is as valuable as a 5% improvement in efficiency. This is a limitation that will be resolved in further development of the evaluation framework."

The report contains several other recommendations for development of the framework 'from first principles'. An appendix to the report contains the proof-of-concept framework/tool, which the authors recommend the transport sector consider using as a decision-support tool, when considering intersection improvement projects.

Safety and efficiency at intersections,
NZ Transport Agency research report 600

Available online at **www.nzta.govt.nz/resources/research/reports/600**

NEW EVALUATION PROCEDURE SHOULD OPEN UP MORE ROUTES FOR LARGE VEHICLES

A recently published Transport Agency research report proposes a new procedure for evaluating the composite bending capacity of channel shear connectors in composite bridges.

The proposed procedure incorporates a newly developed design equation for channel shear connectors and adopts a Eurocode-based evaluation solution, which covers a wide range of applications. The procedure is an extension of the existing evaluation steps in the Transport Agency's 2014 Bridge manual (3rd edition).

BRIDGE CONSTRUCTION IN NEW ZEALAND

At present, there are around 270 bridges on New Zealand's state highway network, and many more bridges on local roads with steel–concrete composite superstructures.

The figure below shows the distribution of these bridges throughout the country, with particularly high numbers evident in the central North Island and on the west coast of the South Island.

Map showing number of composite bridges within each NZ Transport Agency territorial region, according to the Transport Agency's 2009 Bridge data system structural guide

Most of these bridges have reinforced concrete deck slabs connected to braced steel I-beams, with welded channels or studs used to provide the longitudinal shear connection. Most (over 70%) were constructed between 1950 and 1970, with approximately three-quarters designed by the Ministry of Works.

The connectors used in these bridges play an important role in transferring the longitudinal shear force between the deck slab and girders or beams, thereby ensuring the bridge's composite behaviour. Although many different types of connectors have been used historically, the most common are welded channel (used in approximately 67% of bridges) and welded V-angle connectors (approximately 24%), with the balance comprising a mix of shear studs, bent plates and riveted angles.

Unfortunately, most of these shear connectors are not covered by the evaluation standards currently referenced in the Bridge manual (NZS 3404 and AS 5100.6). In particular, the design equations based on the standards are outdated and fail to take into account recent international tests (in terms of a safety margin).

This has implications for assessing the capacity of composite bridges. Although, based on their design live loadings, most of these existing bridges are expected to be capable of supporting full high-productivity motor vehicles, significant variations tend to arise in their assessed live load capacities, using existing design equations.

The aim of the research project was therefore to develop new design guidance for evaluating the capacity of existing bridges that incorporate welded channel shear connectors. (The research focused on this type of connector due to their prevalence.) It was anticipated, as a result of this study, high-productivity motor vehicles and 50MAX vehicles would be able to access more of the existing highway network.

WHAT'S IN THE REPORT

The research first investigated the results of recent international experiments on shear connectors, and the design equations relating to them that had been incorporated in various international standards.

Drawing on this, the research went on to develop a new design equation for the resistance of welded channel shear connectors. The equation retained the form of that in NZS 3404; however, the capacity reduction factor was re-evaluated based on British Standard BS EN 1990. The analysis showed the design resistance of the connectors should be lower than that used in the existing equations. A method to identify the ductility of the welded channel shear connectors was also developed.

The research report introduces a proposed new design method for evaluating beam bending capacity in composite bridges, which incorporates the new equation for the connectors. The new design method is to be accepted in the forthcoming AS/NZS 2327 as a general solution for composite structures in New Zealand.

The report also sets out a proposed new evaluation procedure, which integrates the new design method. The procedure is based on the existing procedure in the Bridge manual, but has a broader scope, taking into account multiple design options, depending on the degree of shear connection, ductility of the shear connection, steel section compactness, minimum degree of shear connection and construction method, ie propped and un-propped construction methods.

The research report's appendices include a worked example of the new procedure, together with historic steel properties to use when the nominal material strengths at the time the bridge was designed are uncertain. The example is based on an existing New Zealand bridge and compares the results with the existing methods in the Bridge manual, demonstrating that the new method gives a more accurate prediction.

Evaluation of shear connectors in composite bridges, NZ Transport Agency research report 602

Available online at **www.nzta.govt.nz/resources/research/reports/602**

RECOMMENDATIONS WILL BRING ALGORITHM UP TO DATE

Developed over 25 years ago, the Transport Agency's treatment selection algorithm has begun to be updated, with a project recommending ways the algorithm can be modernised, strengthened and clarified.

The treatment selection algorithm is used to guide decisions about the future surface and pavement maintenance works needed for roads.

The improvement recommendations in the project report focus on improving specific aspects of the algorithm, rather than changing the core process of the algorithm itself.

Mike Tapper of Beca Ltd who led the multi-agency research project says 'The Transport Agency's treatment selection algorithm has performed well and has been broadly used since it was developed in the 1980s. It now needs to be updated to reflect current knowledge and recent experience. The fact that there is a drive to update, rather than replace it, demonstrates how well it has performed in the field.'

The treatment selection algorithm is a relatively sophisticated system capable of reflecting multiple parameters and performs well compared with similar systems used internationally.

The project report sets out a host of recommendations for updating the algorithm. However, the report comes with the caveat that since the research project began in 2012 the Transport Agency has introduced its One Network Road Classification System, which introduces a level-of-service driven regime for road maintenance investments. The report cautions that 'further analysis and consideration' is needed to understand how the updated algorithm will fit with the new system.

THE TREATMENT SELECTION ALGORITHM

The treatment selection algorithm is used to forecast maintenance timing and treatments for roads, with the aim of keeping roads in good condition, for the least whole-of-life cost, in the short to medium term.

The algorithm is primarily used as a project decision-making tool for road maintenance planning. Its purpose is to identify candidate sites for road asset managers' short-term forward work programmes. As such, it does not predict or quantify longer-term maintenance or renewal needs.

The algorithm calculates treatment and maintenance costs, and examines drainage and seal widening options. It also allows a variety of economic scenarios to be tested. It can be used at both a treatment length and network level, and has also proved useful nationally for comparing and benchmarking network maintenance needs.

The current algorithm has several advantages, including its relative sophistication and inclusion of numerous parameters. However, there have been significant advancements in road maintenance understanding and practice since the algorithm was developed in the 1980s. Foremost among these are:

- The long-term pavement performance monitoring sites have yielded much practical information.
- Pavement and surface condition measurement techniques and parameters have been developed.
- Economic analysis parameters have changed.
- There is greater use of thin asphaltic surfacing.
- The vehicle operating cost model and benefit–cost ratio funding mechanisms used in the current algorithm have been superseded.
- Learnings on pavement and surfacing performance from high-speed data capture and falling weight deflectometer test data need to be incorporated.
- The quantity and accuracy of maintenance cost data is now much more prevalent, particularly with the use of RAMM Contractor.
- Past assumptions, for example the progression of maintenance requirements, need to be reviewed and replaced with evidence-based models.

The treatment selection algorithm now requires updating to reflect these and other factors.

RECOMMENDED UPDATES

The project report recommends numerous updates to strengthen and modernise the treatment selection algorithm.

The most significant recommendation is the replacement of the current benefit–cost ratio funding mechanisms and vehicle operating cost model in the algorithm with a present value-based approach. This will also enable a more flexible approach to the use of discount factors.

The second major recommendation is to include falling weight deflectometer data, in particular, to determine the cause of pavement failure and therefore the preferred treatment type. The treatment types recommended in the project report are not very different from the current options used in the algorithm, in terms of their cost and assumed treatment form. The main difference from the recommended update will be in the basis upon which treatment options are assessed.

Other main recommendations are listed below. The research report also contains a number of smaller recommendations:

- Include historic maintenance costs in the test, in addition to the current condition, wherever the life of the current surfacing has been extended beyond its optimum intervention. This is because maintenance interventions may mask indicators that the surfacing has reached the end if its life.
- Add a new cost set table for thin asphaltic surfacing, as its routine maintenance costs are different from those for chipseal surfacing. The trigger for using asphaltic surfacing treatment would be on a 'like-for-like' basis.
- Replace the current smoothing and strengthening options in the algorithm with modified basecourse treatment and full pavement renewal options. The treatment type options within the algorithm for smoothing and strengthening could be applied to the basecourse improvement or full pavement renewal respectively.
- Use traffic as a trigger for changing from a granular or stabilised base to a full structural asphalt construction, for example greater than 20,000 vehicles per day and/or quantity of heavy vehicles.
- Retain the two-year assessment window, as without any forecasting of condition three-year criteria are difficult to achieve with any credibility.
- Adapt the algorithm process to allow for customisation according to road classification. A simple method, such as a user-defined table populated with standard default settings for each road classification, could be applied.
- Ensure a pavement renewal treatment will only be triggered if the treatment length meets particular criteria.
- Where falling weight deflectometer data is available, use a combination of radius of curvature and central deflection to determine the failure mode and therefore treatment option for pavement renewal.
- Where only high-speed data is available, and there is no falling weight deflectometer data, use the flushing test to determine a possible pavement failure and therefore the pavement renewal treatment required. (Note that a recommended test is also given for where neither type of date is available.)
- Include a more definitive test for seal layer instability, as this is a failure mechanism that is becoming more prevalent.
- Retain the current mechanism for calculating present value of future maintenance, as the logic is strong and the programming is already in place within the algorithm to perform the calculations.
- Enable the user to select the appropriate discount factor. This will make it easier in the future to reflect changes in the discount rate policy should the Transport Agency have a shift in policy on this matter.
- Discontinue the benefit–cost ratio determination, as the vehicle operating cost and benefit–cost ratio methodologies no longer match Transport Agency policies and processes. Use the present value method to assess whether to select the shape correction treatment option.
- Even if resurfacing is the selected option, evaluate the treatment length for extreme levels of distress that would indicate a pavement renewal is still required.

Review of the NZ Transport Agency treatment selection algorithm, NZ Transport Agency research report 599

Available online at **www.nzta.govt.nz/resources/research/reports/599**

TOOL WILL STRENGTHEN EXPRESSION OF HERITAGE ECONOMIC VALUES IN TRANSPORT PROJECTS

A report by Landcare Research provides a framework for assessing the economic values of historic and cultural heritage as part of transport projects.

The Transport Agency and other road controlling authorities routinely consider heritage and cultural values as part of their decision-making, planning and delivery processes for transport infrastructure projects. Road controlling authorities also often own or manage heritage properties and structures that either form part of their networks, or have been acquired during projects. Conserving these assets requires (at times substantial) investment. Yet, despite this, there is a current lack of consistent national guidance on how to assess the economic values – the costs and benefits – of heritage, and how these values are taken into account within business case, planning and investment decisions.

The Transport Agency-funded Landcare Research report proposes a Heritage Economic Benefits Framework and tool that road controlling authorities can use 'for identifying and expressing the economic benefits of engaging in heritage conservation and minimising some of the project risks related to the loss of heritage.'

The framework provides a means of better understanding, quantifying and monetising heritage values, in order to improve decision making around heritage investment as part of transport projects.

PRESERVING THE PAST

The current Government Policy Statement on Land Transport (July 2015) seeks to establish a land transport system that supports economic growth and productivity, and provides road safety and value for money. It must also be in the public interest by supporting economic, social, cultural and environmental wellbeing.

Stemming from this, road controlling authorities have an obligation to avoid, if possible, or minimise the impacts of transport projects on heritage sites, but without placing an unreasonable funding burden on ratepayers. Other obligations arise from the Land Transport Management Act 2003, the Resource Management Act 1991, the Heritage New Zealand Pouhere Taonga Act 2014 and the Treaty of Waitangi.

National guidance and industry understanding as to how to acknowledge and quantify the economic implications of these heritage values is currently evolving. However, there is broad variation in how heritage impacts are included in transport projects. This creates significant potential economic risks for road controlling authorities. Foremost among these are:

- inadequate identification of heritage impacts, particularly during the early stages of a project, which can stop projects entirely and lead to the loss of any resources invested to date (including time, effort and property acquired)
- either over-investment or under-investment in maintaining heritage sites acquired for projects, leading to preventable losses or missed opportunities to add value during the project or later when the sites are subsequently sold
- an unexpected discovery, such as archaeological or cultural remains, during the implementation of a project, which can cause significant delays and unforeseen costs.

There are also reputational risks, if road controlling authorities are perceived to be undervaluing heritage or not taking a sufficiently thorough or precautionary approach to protecting historic and cultural values. Such risks can subsequently hinder authorities when it comes to implementing future projects.

To help road controlling authorities address these risks, the Transport Agency contracted Landcare Research to develop a means of assessing the benefits of heritage conservation investments.

'Adding an economic perspective to heritage conservation decisions has the potential to improve the value for money delivered by heritage investments and to achieve better outcomes for New Zealand's heritage stock,' the research report says.

The Ministry for Culture and Heritage has led some preliminary work in this space. The Transport Agency's research develops this further with tools and practical application to transport infrastructure assets and projects.

THE HERITAGE ECONOMIC BENEFITS FRAMEWORK

The Heritage Economic Benefits Framework and associated tool described in the project report aim to help road controlling authorities identify and express the economic benefits of engaging in heritage conservation, to maximise the benefits and minimise some of the project risks related to heritage.

The framework and tool provide suggestions for expressing heritage economic values, so they can be included in multi-criteria assessments of transport project options. Road controlling authorities will be able to distinguish the nature and extent of benefits and costs arising from the heritage components of one project option from another, and to do so consistently across different projects affecting different types of heritage.

Both the framework and the tool also facilitate the comparison of conservation costs, which are often known, and the benefits of conservation. They strengthen economic rationality when deciding on the appropriate level of heritage investment. Where heritage can generate economic benefits, such as from future rental income, refurbishment of vacant buildings, tourism or regeneration of urban areas, the tool can help identify such benefits.

The framework describes the four steps involved in using the tool in detail, and explains how they fit within a generic transport project development and delivery cycle (for example, with the Transport Agency's business case logic). The explanation is kept sufficiently broad to allow transport organisations to incorporate the tool in their own processes.

Tables in the framework (and others in the report) list and describe the potential heritage values and benefits that might apply to heritage areas, sites and items; suggest indicators for the values and benefits with potential sources to find information; and provide methods to quantify values and benefits and, where possible, estimate their monetary value.

The framework recommends using a suite of techniques to quantify (or otherwise express) intrinsic and intangible heritage values. This recognises that robust monetary valuation estimates will only be possible for a few of such values. In cases where monetary estimates are not possible, the framework recommends using 'a rich narrative approach' to document heritage assessments. This combination of qualitative, quantitative and monetary indicators fits with similar valuation approaches promoted by the Treasury in other contexts.

The report also presents a useful overview of heritage as it stems from mātauranga Māori. The overview will help prepare planners for developing partnerships with tangata whenua, by giving insights into the world view of tangata whenua and the concepts that make up the heritage of iwi or hapū.

A key recommendation in the report is that road controlling authorities should engage with tangata whenua, councils, Heritage New Zealand Pouhere Taonga, local community groups and other stakeholders, and consider their views on heritage impacts, from the earliest stages of a project. The report also stresses there is no one-size-fits all approach that will be suited for this process, and that authorities will need to develop ways to engage and move forward that are appropriate for each stakeholder and project.

The report concludes by acknowledging that, while the Heritage Economic Benefits Framework will add a further element to transport project planning, the benefits of using it, and of giving stakeholders 'ample room' to discuss heritage impacts, can be significant.

'An important element of the framework is the engagement and discourse about projects. It aims to support a common language between experts and planners. Furthermore, the emphasis on stakeholder involvement decreases the risk of project delays and litigation by creating ownership of project decisions for affected communities,' the report says.

The report authors acknowledge the comprehensive collaborative effort of the parties on the steering group to direct this research.

'A vital ingredient for success in this research project was the steering group with broad representation from the NZ Transport Agency, Ministry of Transport, Department of Conservation, Heritage New Zealand Pouhere Taonga, Ministry for Culture and Heritage, Auckland Council, Auckland Transport and Wellington City Council. This collaborative effort enriched the understanding of historic heritage and mātauranga Māori.'

Understanding the value of transport investment in historic and cultural heritage, NZ Transport Agency research report 601

Available online at **www.nzta.govt.nz/resources/research/reports/601**

RECENTLY PUBLISHED RESEARCH REPORT ABSTRACTS

Understanding the value of transport investment in historic and cultural heritage

NZ Transport Agency research report 601

Freely available online at www.nzta.govt.nz/resources/research/reports/601

The 2015 Government Policy Statement on Land Transport focuses on economic growth, productivity, road safety, and value for money. The transport system must also support economic, social, cultural and environmental well-being. This means that road controlling authorities (RCAs) must mitigate the impacts of their projects on heritage sites without placing an unreasonable funding burden on the economy.

RCAs such as the Transport Agency have their own approaches for assessing and managing historic and cultural heritage. No consistent national guidelines for heritage conservation actions exist, however, which creates risks and opportunities during project development, delivery and ongoing ownership of heritage.

The requirements for heritage conservation follow from designation processes, but do not necessarily strengthen the heritage and cultural values of structures and environments. An economic perspective of such values can improve the value for money of heritage investments, and support New Zealand's heritage stock.

We review the literature on how heritage values are assessed and expressed in heritage and economic literature, and provide an overview of heritage within mātauranga Māori. From this review, we develop a framework for consistent assessment of the economic values of historic and cultural heritage, including meaningful options for their quantification and monetisation.

Evaluation of shear connectors in composite bridges

NZ Transport Agency research report 602

Freely available online at www.nzta.govt.nz/resources/research/reports/602

There are approximately 270 bridges on New Zealand's state highway network and many more bridges on local roads with steel concrete composite superstructures. From an investigation of as-built records, most of these consist of reinforced concrete decks connected to braced steel I-beams, with welded channels or studs used to provide longitudinal shear connection. Over 70% of these bridges were constructed between 1950 and 1970, of which approximately three quarters were designed by the Ministry of Works. Significant variability currently exists in the assessed live load capacity of composite bridges, even when they are designed to identical design loadings.

This report reviews international experiments for shear connectors and the development of design equations in different national standards. A new equation for channel shear connectors was developed and evaluated through reliability analysis to ensure the target margin of safety was achieved.

An evaluation procedure for composite bending capacity is proposed in this report, incorporating the newly developed design equation of the channel shear connectors and adopting the Eurocode-based solution, which covers a wide range of application. The evaluation procedure is an extension of the existing evaluation steps in the NZ Transport Agency's Bridge manual (3rd edition).

A review of methods for analysis of regulatory effectiveness

NZ Transport Agency research report 604

Freely available online at www.nzta.govt.nz/resources/research/reports/604

This project aimed to identify the best approach for determining and monitoring the contribution that government regulatory interventions in New Zealand make to mitigate the major risks associated with the land transport system. It analysed the safety and environmental risks in the New Zealand road transport sector, and reviewed the local and international literature to provide a framework for assessing the effectiveness of regulatory interventions aimed to mitigate these risks.

The literature shows a preference for regulation that is less interventionist and provides greater freedom of choice to those regulated. Findings also suggest many New Zealand transport regulations have been introduced and not revisited. This calls for a more periodic and systematic approach to ex-post (after-the-event) analysis to ensure land transport regulation is fit for purpose.

A suggested approach to evaluation of existing regulations includes the following components: 1) definition of the problem justifying the regulation, based on the identification of market failures and the underlying causes; 2) review of the effectiveness of the regulation in achieving targeted outcomes; 3) identification of options including no regulation; 4) cost–benefit analysis of regulations and alternatives; 5) identification and analysis of opportunities for regulatory improvement.

Drivers' understanding of temporary and permanent slippery road signage

NZ Transport Agency research report 607

Freely available online at www.nzta.govt.nz/resources/research/reports/607

This project aimed to assist the development of understandable, cost-effective static signage to warn drivers of the potential for lower skid resistance in areas renowned for periodic slippery conditions.

The research began with a literature review in which the features influencing road signage effectiveness, in terms of both conspicuity and comprehension, were identified. Based on these findings, alternative signage designs were developed and investigated in relation to the current slippery road surface (SRS) signage through a public focus group followed by an expert focus group.

The outcomes of this process led to the selection of two alternative supplementary plates to be used with the main plate. These signs were constructed to the temporary signage design specifications and compared with the current temporary SRS signage (which consists of a main plate only) in an on-road trial.

Metrocounters measured the free vehicle speed associated with each of the signs at three different curves in both wet and dry conditions. In dry conditions the signs made no practical difference to vehicle speed; however, in wet conditions the presence of a sign resulted in both a significant and practical reduction in free vehicle speed in all three curves.

Planned comparisons revealed the sign that led to the greatest reduction in free vehicle speed in the wet differed at each of the curves.

Benchmarking the operations and maintenance of New Zealand's roading sector

NZ Transport Agency research report 605

Freely available online at www.nzta.govt.nz/resources/research/reports/605

This research project aimed to provide an analysis of the suitability of existing benchmarking methodologies for use in the roading sector in New Zealand. The chosen methodology needed to normalise for unique network characteristics outside the control of the maintainer that might impact on cost and quality. Data envelopment analysis, supported by other analysis techniques, was recommended due to its ability to normalise for such characteristics and the fact that it has been shown to work in the highway maintenance and operations sector.

In addition, this research project aimed to collect benchmarking data from two overseas road agencies, to both assess the availability and ease of collection of such data and to enable initial comparisons to be undertaken with the New Zealand roading sector should the Transport Agency wish to do so. Benchmarking data from two overseas road controlling authorities was collected; however, significant challenges were faced with collection of the data including a lack of timely cooperation, composed of delays due to obtaining approvals to release the data followed by delays in interrogating the road and financial databases, as well as differences in performance measurement, definition of maintenance tasks and accounting systems. These challenges are in line with international experience in this area.

Quantifying the economic and other benefits of enabling priority bus egress from bus stops

NZ Transport Agency research report 609

Freely available online at www.nzta.govt.nz/resources/research/reports/609

Buses are finding it progressively difficult to reenter traffic from a bus stop in urban areas. While there has been a focus on improving the efficiency and effectiveness of public transport through the introduction of electronic ticketing, bus lanes and priority traffic signals in recent years, buses in New Zealand currently rely solely on other road users' courtesy to merge back into general traffic flow when egressing from a bus stop. This research project identified and quantified the economic and other benefits that would likely arise if a change in legislation allowed buses leaving bus stops to have priority over general traffic.

The research explored international 'yield to bus' legislation and examined road user attitudes towards a potential 'give way to buses' law change and the likely impacts of facilitating priority for buses at a network level. An economic assessment enabled tangible values to be attributed to the likely benefits arising from a law change under a range of implementation and compliance scenarios.

This report provides an evidence-based assessment of the efficiency of a legislation change concluding that 'give way to bus' legislation provides a viable investment opportunity. The outcomes will aid a review of the existing regulatory setting and provide evidenced-based inputs to compile a full business case.

OBTAINING TRANSPORT AGENCY RESEARCH REPORTS

All research reports published since 2005 are available free of cost for downloading from the Transport Agency's website www.nzta.govt.nz/planning/programming/research

PDF scans of research reports published prior to 2005 are available by emailing research@nzta.govt.nz

A NOTE FOR READERS

NZTA research newsletter

The *NZTA research* newsletter is published quarterly by the NZ Transport Agency. Its purpose is to profile research funded through the Transport Agency's Research Programme, to act as a forum for passing on national and international information, and to aid collaboration between all those involved. For information about the Transport Agency's Research Programme, see www.nzta.govt.nz/planning/programming/research.html.

Advertisements of forthcoming conferences and workshops, that are within the newsletter's field of interest, may be published free of charge when space permits.

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All general correspondence, queries related to conference notices, and requests for additions or amendments to the mailing list, should be made to research@nzta.govt.nz.

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The current edition of the *NZTA research* newsletter is available in hard copy or on the Transport Agency website, along with all previous editions of the newsletter, at www.nzta.govt.nz/resources/nzta-research/.

Email alerts of newly published research reports

Email notifications are provided when new issues of the *NZTA research* newsletter are published. Notification is also provided when new Transport Agency research reports are published on the Transport Agency's website at www.nzta.govt.nz/planning/programming/research.html. Please email research@nzta.govt.nz if you would like to receive these email alerts.

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DID YOU KNOW...

That there is a spreadsheet on the Transport Agency website listing all published Transport Agency research reports?

The spreadsheet is searchable by several criteria and can be found at **www.nzta.govt.nz/planning/programming/research.html.**

The spreadsheet has two worksheets; the first worksheet lists research reports with associated key words and the second lists research reports with the report abstracts.

NZ TRANSPORT AGENCY WAKA KOTAHI

New Zealand Government