



# Taking an intelligent approach to use and demand

With the increasing difficulty (due to space constraints) and undesirability (from cost and environmental perspectives) of building new transport infrastructure, attention is turning to the latest technologies to help us use existing transport infrastructure in smarter ways.

Intelligent transport systems (ITS) step into this role, enabling us to harness cutting-edge technologies to improve the quality, safety and capacity of existing transport infrastructure, and so make it better able to cope with increasing transport demands.

But the choices are overwhelming. With so many ITS options available internationally, how are transport managers and planners to choose?

This is a question that a recent Land Transport New Zealand-funded project has sought to answer, and succeeded. By collating international (and local) experience of the benefits that ITS can provide, and comparing these benefits against the government's national outcomes for transport, the project has been able to identify which types of systems are best placed to meet our needs.

James Date of Hyder Consulting, who was part of the team that carried out the research, says, 'We wanted to provide a tool for transport managers, operators and planners to identify the different ITS applications they could use to tackle the particular

transport issues they faced. For those applications, the tool also needed to be able to assess what the benefits were and which were the most effective.

'Both the *Land Transport Management Act 2003* and Land Transport New Zealand's allocation process are strongly focused on maximising the use of existing transport networks and, where new infrastructure is necessary, ensuring that demand on that infrastructure is managed. That's why we chose in the research to focus on the potential benefits of ITS in those particular areas.

'ITS has many potential benefits, but these two national-level outcomes – enabling demand management and optimising use of existing infrastructure – stood out as areas where the benefits could have the most impact.'

## What are the transport outcomes?

In New Zealand, high-level government policy and strategy for transport is set out in the New Zealand Transport Strategy 2002.

## What is ITS?

ITS (intelligent transport systems) refers to 'the integrated application of advanced information, electronic, communications and other technologies to the management and operation of surface transport systems'.

When correctly targeted, ITS can:

- improve travel safety, reliability and convenience
- increase mobility
- mitigate traffic congestion

- reduce fuel consumption and emissions
- more effectively manage transport infrastructure
- better control and operate vehicles (private, public and commercial)
- improve the quality and availability of information for both transport users and providers
- enhance the ability of transport products and services to be used in different places and environments.

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## Your views

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The government's overall vision for transport – that, by 2010, New Zealand will have an affordable, integrated, safe, responsive and sustainable transport system – is underpinned in the New Zealand Transport Strategy by a series of principles and objectives. The *Land Transport Management Act 2003* backs up the strategy, requiring that all transport programmes contribute to the strategy's objectives.

From these two sources, the research identified 10 desired outcomes against which the effectiveness of each ITS application could be measured:

- economic development
- safety and personal security
- access and mobility
- public health
- sustainability
- energy efficiency
- integration
- responsiveness
- affordability and cost effectiveness
- implementation risk.

## Fitting the application to the need

The range of ITS applications is wide, and the flexibility of the technology involved means that systems can be tailored to suit the need. However, the benefits that a system can supply are only as good as the underlying assessment of the environment where it will apply and the issues to be resolved.

To address this and as a first step, the research identified nine target areas where ITS could be of particular use in New Zealand:

- congestion relief
- demand management
- incident management
- compliance
- safety
- route security
- quality and efficiency
- travel time reliability
- environmental mitigation.

By identifying these areas, the research could then assess each application's potential benefits in the New Zealand context (as opposed to just looking at all the benefits the application could provide, some of which may not be particularly relevant).

The research then collated all the ITS applications with potential benefits in New Zealand. Fourteen different types of ITS were identified, each with numerous possible applications (49 in total). The 14 categories of ITS were:

- motorway management systems
- arterial management systems
- integrated urban traffic control systems
- bus management systems
- rural highway systems
- emergency management systems
- advanced traveller information systems
- information management
- crash prevention and safety
- roadway operations and maintenance
- road weather conditions management
- electronic road user charging
- fleet management systems
- tunnel management systems.

The 49 potential ITS applications were fed into a contribution matrix, which also included the outcomes of the New Zealand Transport Strategy and the *Land Transport Management Act 2003*, and the elements of those outcomes that would be used for assessment purposes (eg, the safety and personal security outcome was assessed with respect to the elements of: number of crashes; level of fatalities; level and severity of personal injury; level of conflict between vehicles, cyclists, pedestrians and other road users; perceived personal safety and security for non-car mode trips; and compliance with traffic and transport regulations).

Each ITS application was assessed against the elements and allocated a scale depending on whether it made a high, medium or low overall contribution towards achieving the outcomes. Scales were also allocated for each of the elements to show whether the ITS application had made a positive, insignificant or partial contribution towards that element.

The matrix is a useful decision-making tool, providing an at-a-glance assessment of each

ITS application's performance with respect to national transport outcomes.

In addition to the matrix, the research report provides an in-depth assessment of the type and scale of benefits that each application could be expected to produce, potential problem areas and the conditions in which it is best applied.

## Which ITS are best?

Using the information from the assessments, the research was able to identify (and rank) the ITS applications that had the greatest potential to provide benefits in terms of the outcomes of the New Zealand Transport Strategy and the *Land Transport Management Act 2003*.

Systems with the greatest potential to provide benefits were those that had a strong focus on travel demand monitoring, management and control. Also important were those systems that provide early detection and management of problems in congested areas. Examples were: monitoring, predicting, informing, response and treatment systems; adaptive traffic control systems; electronic road and congestion pricing systems; incident detection systems; traffic surveillance systems; parking management and surveillance systems; and pre-trip and en-route information systems.

James Date says, 'The results reflect the fact that, in urban situations, by better managing demand and traffic conditions we can also make significant impacts on other areas that are important under the New Zealand Transport Strategy. For example, economic efficiency, safety and environmental impacts can all be improved if we improve our performance with respect to travel demand and congestion in cities.'

The research concludes that the ITS that were best aligned with national outcomes were those that:

- improved transport users' and managers' ability to make informed choices (eg, advanced traveller information systems)
- influenced travel choice through direct means (eg, congestion charging)
- controlled and managed traffic flow (eg, adaptive signal control, ramp metering and parking systems)
- enabled early detection and management of incidents (eg, detection and monitoring systems).

'Use of ITS is already growing rapidly in New Zealand,' says James. 'To make the best use of those systems, we need good early planning with a focus on ensuring the systems are integrated and inter-operable, coupled with a clear understanding of the risks and issues that are going to influence the systems' success.

'If we were to identify from the research three key areas of major benefit for ITS deployment in New Zealand in the future, these would be developing adaptive signal controls, deploying road user and congestion charging, and developing integrated traveller information systems. There are other factors, obviously, but from what we saw in the research we recommend that more work is required on these three measures if we are going to maximise the benefits ITS can offer with respect to transport outcomes.'

## Contact for more information

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*Intelligent transport systems: What contributes best to the NZTS objectives?*, Land Transport NZ research report 302, \$45.00. See page 12 for details about buying reports.

# 2007/08 Land Transport New Zealand research programme

Land Transport New Zealand has recently announced its 2007/08 National Land Transport Programme, which incorporates the research programme for the coming year.

This year, we will be funding 26 research projects across all the key topic areas. These projects are outlined below.

## Asset management

**PROJECT** | Rationalisation of the strength definition and quantification of New Zealand roads based on falling weight deflectometer tests

**RESEARCH ORGANISATIONS** | MWH New Zealand Ltd and the University of Auckland

**OBJECTIVES** | The structural number principle (SNP) is a very important measure for road pavements, since it is the basis of most prediction models in the dTIMS maintenance planning system. It is also an important measure of the pavement capacity of networks. However, the SNP has its limitations, and this research project seeks to address these.

The research's objective is to provide a method of deriving SNP that will ensure this parameter is based on principles that relate directly to the performance of real pavements (in particular, the benchmark sites set up by Transit New Zealand in 1999 and those set up by local authorities in 2003).

The research project will also achieve the following goals:

- all previously developed pavement deterioration models will be reviewed in order to take account of the enhanced measure
- the new SNP method will be used to develop a method of quantifying 'risk to failure' of pavements on a network basis

- using the new measure, the project will deliver a robust statistically derived sampling regime policy for falling weight deflectometer (FWD) tests.

**PROJECT** | Abrasion resistance of aggregates in asphalt

**RESEARCH ORGANISATION** | Bartley Consultants Ltd

**OBJECTIVES** | The objective of this project is to investigate the durability and mechanical integrity of high-polished-stone-value weathered aggregates for use in hot mix asphalt, particularly chips or coarse aggregates for use in stone-on-stone mixes like stone mastic asphalts and open-graded porous asphalts.



Current Transit specifications for aggregates may not be sufficient. There are many examples where weathered aggregates are being used that meet the two standard source property tests of crushing and weathering, yet they still degrade and break down.

This research project will review the current source property tests and acceptance criteria for aggregates to assess whether they are appropriate for specifying durable stone-on-stone mixes.

The research will identify three sites where durability issues have occurred in stone mastic asphalts and open-graded porous asphalt materials. Samples will be removed from these sites to undergo a suite of aggregate source tests, such as crushing, weathering, LA abrasion, wet and dry crushing strength, and polished stone value. A determination will then be made about which tests are most appropriate for identifying durability.

### **PROJECT | Design moisture condition guidelines for pavement design and material assessment**

**RESEARCH ORGANISATION |** Opus Central Laboratories

**OBJECTIVES |** This research project will develop guidelines for estimating the moisture conditions that exist in pavements.

Assuming in situ moisture conditions are less than saturated, the guidelines will allow pavement designers to be less conservative than usual in design, and to therefore use base materials that may be regarded as moisture sensitive in areas where the risk of moisture ingress is low.

The guidelines will be intended for use with the base, sub-base and sub-grade layers. They will be based on a US model of equilibrium moisture conditions calibrated to suit New Zealand conditions.



The guidelines will also be useful for determining the moisture conditions that should be used when the environmental risks of incorporating recycled waste materials in pavements are being assessed.

### **PROJECT | Resealing strategies to increase seal life and prevent seal layer instability**

**RESEARCH ORGANISATIONS |** Opus International Consultants and Opus Central Laboratories

**OBJECTIVES |** The aim of this project is to produce seal design guidelines for resealing chip seal roads, which will eliminate or reduce the incidence of premature failure through flushing.

Despite considerable research, chip seal flushing remains a longstanding and widespread problem, and is the single greatest cause of premature failure on New Zealand roads.

The research will combine laboratory and field studies, which build on earlier work. It will measure the change in void volume under traffic of both laboratory-constructed multiple layer chip seals and road samples.

From this, a design will be developed that will enable multiple chip seals to be constructed without premature flushing. The research will also enable seal designers to use the appropriate treatment when a seal fails prematurely, to ensure they do not build into the pavement problems associated with multiple layer instability.



### **PROJECT | The influence of binder rise in reducing tyre-road friction**

**RESEARCH ORGANISATION |** Opus Central Laboratories

**OBJECTIVES |** Focusing on New Zealand's chip seal road surfaces, this project will:

- identify the most robust algorithm to detect the extent of binder rise for state highway management purposes
- quantify the reduction in friction associated with binder rise (this will be achieved using the University of Auckland's dynamic friction tester).

Specific elements of the research will include:

- identifying the best statistic to detect flushing from two-dimensional laser profiles of the road surface
- establishing whether or not the dynamic friction tester can simulate high-speed locked-wheel braking performance to a sufficient degree to allow its use in investigating wet friction characteristics of flushed road patches
- quantifying the friction reduction that occurs on flushed surfaces.

This research will build on the findings of Transit's operational research, which has identified that the statistics material:bearing ratio and peak count may be preferable to the currently used statistic of mean profile depth to detect flushing from two-dimensional laser profiles.

**PROJECT | Long-life porous asphalt****RESEARCH ORGANISATION |** Opus Central Laboratories

**OBJECTIVES |** Asphalts made with epoxy resin modified bitumen are at the centre of current international research into high-strength, very long-life surfacing. New Zealand is collaborating in this work through a current Land Transport NZ project in which the exceptional strength and resistance to oxidation of epoxy modified open-graded porous asphalt (OGPA) has been clearly demonstrated in the laboratory.

The current research project will build on this work and will involve conducting full-scale field trials of epoxy modified OGPA to determine its likely long-term performance in the field. Sections of standard (20 percent) and very open (30 percent) OGPA will be constructed.

Noise reduction and the ability of the material to resist clogging and damage from surface abrasion will be monitored and compared to standard OGPA sections. Water permeability and texture changes will be measured to assess clogging and surface fretting. Results will be compared to control sections constructed using standard bitumen.

**PROJECT | Multi-grade bitumens****RESEARCH ORGANISATION |** Opus Central Laboratories

**OBJECTIVES |** This research will evaluate the potential for multi-grade bitumens to improve the poor performance of chip seals in hot weather by improving chip retention and reducing chip roll-over, binder pick-up and bitumen tracking.

Multi-grade bitumens are accepted internationally, particularly in the UK and Australia. The research will demonstrate multi-grade bitumen technology to the New Zealand road industry, and evaluate the potential of the materials as a solution to hot weather seal problems. The research will complement other research being funded by Land Transport NZ, which has highlighted the need for bitumens with improved high temperature properties.

Laboratory tests and full-scale field trails will be used to evaluate the effectiveness of multi-grades in reducing chip loss, binder pick-up and tracking by tyres at high road temperatures.

**PROJECT | Influence of surface treatments on the surface lives of concrete bridges****RESEARCH ORGANISATION |** Opus Central Laboratories

**OBJECTIVES |** The research objectives are to:

- develop guidelines for selecting appropriate concrete surface treatments that delay the onset of reinforcement corrosion
- develop a methodology for establishing a financial justification for using surface treatments, by determining the influence that the treatments have on the service lives of bridges.

The research will be based on a critical review of overseas developments in the performance and use of concrete surface treatments. It will draw on existing international knowledge, and will include:

- a detailed literature review of current research
- consultation with key Australian road controlling authorities
- a review of the approach taken by the UK Highways Authority.

From these sources, practical decision-making tools will then be developed and assessed.

**PROJECT | Development of a base course/sub-base design criterion****RESEARCH ORGANISATION |** Pavespec Ltd

**OBJECTIVES |** The Austroads Pavement Design Guide is currently used in New Zealand for pavement design. The guide includes a design criterion for the sub-grade, limiting the sub-grade strain value. In the past few years, significant concerns have been raised by the industry in New Zealand about the validity of the Austroads sub-grade strain criterion.

This research will:

- conduct and analyse repeated load triaxial tests on different base course and sub-base materials regarding the elastic strain/plastic strain rate relationship
- develop a new base course/sub-base strain criterion based on the repeated load triaxial test result
- validate the base course/sub-base strain criterion to observed field performance at the Canterbury accelerated pavement testing indoor facility
- implement the repeated load triaxial test method to determine the base course/sub-base strain criterion in Transit's repeated load triaxial testing specification and revise Transit's supplement to the Austroads Pavement Design Guide to incorporate the base course/sub-base strain criterion.

## PROJECT | Pavement thickness design charts derived from rut depth models

RESEARCH ORGANISATION | Pavespec Ltd

OBJECTIVES | This research aims to use previously developed rut depth models to derive pavement thickness design charts for granular pavements. The rut depth models will first be validated and then

extended to predict pavement lives for a complete range of base course materials (good, intermediate and poor performing), pavement depths and sub-grade types.

From this, several new pavement thickness design charts will be produced for the different strength base courses, based on the rut depth model predictions. Before being implemented, the design charts will be checked against the measured performance of Transit's long-term pavement performance sites.

# Safety and personal security

## PROJECT | School bus safety

RESEARCH ORGANISATION | TERNZ Ltd

OBJECTIVES | This project has been established at the request of the Bus Safety Technical Advisory Committee (BUSSTAC).

Approximately 60,000 students are transported to and from school each day on bus services contracted by the Ministry of Education. BUSSTAC has identified a range of issues to do with these services, with the six most important forming the project's objectives.

The objectives of the research are to:

- improve the safety of school bus services
- prevent injuries by improving vehicle standards
- improve the safety of bus stops and turning points
- improve compliance with the 20 km/h speed limit that applies when vehicles are travelling past school buses that have stopped to let children on and off
- determine the feasibility of requiring seatbelts to be fitted in school buses
- address problems with passenger behaviour that adversely affect safety and personal security.

## PROJECT | Rural crash prediction models – next generation

RESEARCH ORGANISATION | Beca Infrastructure

OBJECTIVE | The objective of this study is to better understand the relationship between rural road crashes and road features by developing the next generation of crash prediction models for rural roads.

Current models are deficient in that they do not include all the key factors that influence crash occurrence. Based on previous research, the following key variables have been identified that need to be taken into account:

- traffic volume
- access density

- horizontal geometry
- horizontal geometry consistency
- seal width
- shoulder environment
- roadside hazards
- region in New Zealand
- SCRIM coefficient.

The study will consider all nine variables and the relationships between them. This will enable road safety specialists to assess the trade-offs between improvements aimed at keeping drivers on the road and safety improvements in the roadside environment.



**PROJECT | The usability and safety of audio tactile profiled road markings****RESEARCH ORGANISATION |** TERNZ Ltd**OBJECTIVES |** This research will investigate the usability and safety of audio tactile profiled (ATP) road markings by motorists and cyclists and make practical recommendations for their use.

Although decisions to use ATP road markings are often made in consideration of factors such as shoulder width, cyclist use and surrounding environment, there is very little objective evidence to support these decisions. Planners are forced to subjectively judge whether ATP markings are suitable for road improvement projects, which leads to inconsistent use.

In addition, the risks of cyclists losing control when riding over the markings has not been compared with the benefits that the lines provide to increase the separation distance between cyclists and motorists.

Best practice for the use of ATP markings for motorists is also unclear.

In the first part of the research, a review will be carried out to determine current best practice for ATP markings in New Zealand and overseas. Where information is inconsistent or non-existent, a mixture of interview, questionnaire and field-based measures will be used to address issues. Finally, recommendations for ATP use will be made, based on the evidence gathered.

## Environmental effects

**PROJECT | Enhancing the control of contaminants from New Zealand's roads****RESEARCH ORGANISATION |** National Institute of Water and Atmospheric Science Ltd (NIWA)**OBJECTIVES |** Metal and hydrocarbon contaminants from vehicle component wear and emissions are conveyed through road drainage systems to surrounding water bodies.

This research project aims to answer the following questions.

- Which roads, or parts of roads, are likely to require some form of contamination control, and which are not?
- How effective are existing controls?
- Where controls are needed, what are the appropriate options?

The research's objectives are to enhance the control of contaminants on New Zealand's roads, by quantifying and providing guidance on:

- representative contaminant loads for different types of roads
- the effectiveness of existing contaminant control measures.

The resulting guidance will improve the ability of road managers to prioritise road run-off treatment needs and select appropriate contaminant control measures.

**PROJECT | Improved effectiveness and innovation for audio tactile profiled road markings****RESEARCH ORGANISATION |** Opus Central Laboratories**OBJECTIVES |** This project aims to ensure that audio tactile profiled (ATP) road markings are established and maintained at dimensions that ensure their maximum effectiveness. It will also enable the industry to produce new, improved forms of ATP markings, by establishing a reliable process by which the markings' performance can be determined.

The project will develop two numerical models that separately link the dimensions and shape of the ATP road markings to:

- the noise response
- the vibratory response
- a model that relates the noise and vibration effects to the subjective response of drivers.

Working from the driver response thresholds identified, the models will then be used to establish minimum and maximum dimensions that are acceptable tolerance limits for ATP road markings.

**PROJECT | Cold in situ recycling of PAH-contaminated roads using foam bitumen/cement stabilisation methods****RESEARCH ORGANISATION |** National Institute of Water and Atmospheric Science Ltd (NIWA)**OBJECTIVES |** Internationally, and in New Zealand, coal tar has been widely used for road construction. Coal tar contains extremely high levels of polycyclic aromatic hydrocarbons (PAH), a class of persistent environmental contaminants.

Until relatively recently, the problems of coal tar contaminated asphalt were relatively unknown. Recent media attention has focused on contamination being found in children's play areas, yet despite this there is still very little awareness of the presence of hazardous tar in subsurface layers in New Zealand's roads.

The aim of this research project is to, firstly, raise general awareness of the issues relating to tar-contaminated roads and, secondly, working with the Christchurch City Council and Fulton Hogan, test in situ foamed bitumen and cement stabilisation techniques to immobilise or lock in the toxic tar PAH.

# Travel behaviour

## **PROJECT** | Overcoming barriers to cycling to and from school

**RESEARCH ORGANISATION** | TERNZ Ltd

**OBJECTIVE** | The objective of this research is to identify barriers to urban school student commuter cycling and determine a threshold at which cycling to school is likely to become more acceptable to parents and schools, and favourable for school students.

This threshold will then be used to estimate the increase in cycling to school that would occur, given a level of intervention that is economically feasible. This will help predict the likely return that could be expected from various cycling safety and promotion initiatives.

A process for addressing cycling issues with specific schools will be developed that can then be used to increase commuter cycling within individual schools in the future.



## **PROJECT** | Auditing public transport accessibility in New Zealand

**RESEARCH ORGANISATION** | Pinnacle Research and Policy Ltd

**OBJECTIVES** | This project will review international best practice for auditing and monitoring public transport accessibility, and from this develop and pilot a New Zealand-specific public transport accessibility audit methodology.

There are a variety of ways to consider accessibility and previous research has identified seven types of transport-related exclusion, which can potentially influence individuals' and groups' access to transport:

- physical – associated with the individual, eg, disability
- geographical – lack of spatial coverage by transport modes
- facilities – associated with the ability to access desired activities, facilities, services, etc
- economic – associated with the cost of transport
- time-based – temporal constraints and scheduling conflicts

- fear-based – personal safety and security
- space – to do with design of transport interchanges, stops and stations, and other public spaces.

The audit methodology will be piloted with at least one urban and one rural/semi-rural area. Lessons learned will be considered across all modes of transport to facilitate future development of an accessibility audit methodology for all transport modes.



## **PROJECT** | National travel profiling – (a) Description of daily travel patterns

**RESEARCH ORGANISATION** | New Zealand Trips and Parking Database Bureau Inc

**OBJECTIVE** | The objective of this research is to investigate and determine New Zealand travel behaviour for main urban areas and rural areas, by different travel modes related to different land uses, for varying trip purposes. This will provide practitioners with better quality information upon which to make transport planning decisions.

The research will use the past four years' data from the Ministry of Transport's national travel survey.

The analysis will use daily trip profiles, including:

- daily arrival profiles
- daily arrival profiles by purpose and mode
- daily arrival profiles by types of households with defined vehicle ownership
- daily arrival profiles by region
- daily arrival profiles by main urban, secondary urban and rural areas.

All the trip purposes included in the national travel survey data would be considered, including trips to home, work, education, shopping, social welfare, personal services, medical and dental, social and recreation, accompanying someone else, change mode and leaving the country.

## PROJECT | Appraisal of factors influencing public transport patronage

RESEARCH ORGANISATION | Booz Allen Hamilton

OBJECTIVE | The overall objective of the project is to build a sounder basis for future forecasting of public transport patronage demands.

Key points of the research will include:

- exploring trends in public transport patronage and identifying key factors that may have attributed to those trends
- using econometric models to estimate the relationships between

public transport patronage and key factors; these econometric models will serve two purposes

- to estimate parameters and elasticities for each of the key factors
- to identify the contribution of each of the key factors to overall variation in public transport patronage.

The project will develop and test a range of econometric forecasting models for public transport patronage and, based on these findings, will recommend models that could be implemented as spreadsheet models. The spreadsheet models could then be used for forecasting patronage and patronage revenue, and for assessing the impact of key factors (such as fare changes) on the forecast patronage.

## Network management

### PROJECT | Effectiveness of incident management on network reliability – stage 2

RESEARCH ORGANISATION | University of Canterbury

OBJECTIVES | This project is a continuation of the 2006/07 Land Transport NZ research project of the same name.

The overall aim of the next stage of the project is to:

- investigate the ability of intelligent transport systems (such as adaptive signal control and variable message signing) to detect and respond to traffic incidents
- determine the most appropriate traffic management strategies (in terms of overall network reliability) to apply when such incidents are detected.



The project will build on the previous research by expanding the modelling used, in terms of area modelled, incident scenarios tested and treatment options. It will also incorporate a field data collection component to more accurately calibrate the models used, and will investigate how motorists respond during incidents.

### PROJECT | Minimum design parameters for cycle connectivity

RESEARCH ORGANISATIONS | Opus International Consultants and Opus Central Laboratories

OBJECTIVES | This research will determine the minimum design parameters for cycle connectivity on urban roads that do not have special provisions for cyclists (ie, cycle spaces that are less than 1.2 m wide or are disrupted by objects that narrow the available space to less than 1.2 m).

The outcome of the research will contribute to design guides, specifying the minimum space conditions that allow cyclists to stay outside the normal vehicle path.

The relationship between the space for cycling and risk of conflict will be formed into a matrix (with other influencing factors) that can guide new developments and the retro-fitting of existing roads that cannot accommodate an ideal space for cyclists.

### PROJECT | Improved rate-of-rotation design limits

RESEARCH ORGANISATION | Opus Central Laboratories

OBJECTIVES | This research will improve the knowledge about and design of curve transitions (ie, super-elevation development lengths) in roads. Appropriate design standards for rate of rotation (also known as warp factor) will be developed that are representative of the road geometries prevalent in New Zealand, and that also account for the types of vehicles found on our roads.

The research will include three elements:

- Transit's road asset maintenance management (RAMM) database will be interrogated to identify the range of road geometries present on the state highway network
- field trails will be conducted in an instrumented vehicle on suitably selected road sections
- computer modelling will be completed of different vehicle types on varying road geometries and designs.

Data from the three research elements will be drawn together to create the design standards for rate of rotation.

## Sustainable land transport

**PROJECT** | Integrated and sustainable transportation and urban planning: How to solve the gap between 'best practice' and 'business as usual'?

**RESEARCH ORGANISATION** | MWH New Zealand Ltd

**OBJECTIVES** | The aim of this research is to achieve a better understanding of the reasons why land use development in general, and residential development in particular, are still based predominantly on private car use, while there is growing awareness of the benefits of more sustainable land use development.

The research will focus on what the key denominators are for a more successful approach and which factors are preventing this.

The overall objective of the research is to identify success factors for integrating sustainable transport and urban planning.

**PROJECT** | The implications of discount rate reductions on transport investments and sustainable transport futures

**RESEARCH ORGANISATION** | Hyder Consulting

**OBJECTIVES** | This research will assess whether a significant decrease in the discount rate (used in benefit:cost analyses) leads to significant impacts on New Zealand's mix of land transport investments and the implications of this for the future land transport environment.

## Risk management

**PROJECT** | Earthquake performance of long-span arch culverts

**RESEARCH ORGANISATION** | Opus International Consultants

**OBJECTIVES** | This project will undertake applied research using numerical analysis to assess the earthquake performance of long-span arch culverts. The end objective is to develop design criteria to ensure that long-span culverts are designed and constructed in a manner that provides for reliable performance in natural hazard events, such as earthquakes.

The research has two key purposes: to further inform the debate as to what the appropriate discount rate should be; and to provide stakeholders with knowledge about the impacts from a rate reduction, so as they can respond appropriately.

There are a range of plausible discount rates that could be chosen, and it is a value judgement as to which rate to use. This judgement should be made in the context of assessing the impacts and outcomes of a discount rate change.

The research objectives are to:

- document the range of plausible discount rates using different theoretical models
- assess the materiality of a range of possible discount rates for altering the nature and mix of New Zealand's road, passenger transport, walking and cycling, sea and rail investments
- evaluate how this changing mix of investments, and the nature of those investments, bequeaths future generations a sustainable transport future
- provide workable policy advice on how stakeholders could best respond to the effects from a range of lower discount rates
- provide policy advice on what the appropriate rate should be, taking into account the impacts on sustainability.

The first stage of the project should identify the natural parameters affecting seismic performance of long-span arch culverts. However, past research indicates that there are a number of lesser parameters and structural variables that also influence performance.

The second stage of the project will study these critical parameters and structural variables to a level where design guidelines can be produced, and possibly so that, in a subsequent stage of the project, design criteria can be developed for Transit's bridge manual.

# New research publications

## ***School journey safety: A comparative study of engineering devices***

Research report 271

B Wigmore, Wigmore & Associates Ltd | C Baas and P Baas, TERNZ | W Wade, WBW Traffic

\$25.00

This research, carried out in 2004, is to improve safety for children on their journey from home to school. The effectiveness of engineering safety devices used in both New Zealand and other countries is compared, and a framework for the development of a comprehensive toolbox is provided to help engineering practitioners and the community select appropriate devices. Crash data from New Zealand's then Land Transport Safety Authority (LTSA) indicates that approximately 40 percent of child pedestrian injuries occur on the home-to-school journey. This report focuses on engineering devices that can be used as part of an integrated approach to providing safe trips for schoolchildren.

This study was in four stages:

- stage 1 – a literature review drawing on sources from both New Zealand and abroad
- stage 2 – a survey on road controlling authorities (RCAs) (both national and international) on the effectiveness of engineering devices used
- stage 3 – an analysis of key themes from the literature review and the survey information
- stage 4 – development of a framework for a toolbox, which, when completed, will draw together best practice in a form that can be easily used by practitioners.

## ***Energy risk to activity systems as a function of urban form***

Research report 311

Dr A Dantas, Dr S Krumdieck and S Page, University of Canterbury

\$20.00

This research investigated future fuel shortages and the associated risks to urban forms and transport systems. A method was developed to assess the risks posed by fuel shortages to urban activities. Particular attention was given to the relationships between different urban forms and risk. In addition, factors that could possibly mitigate the risks of fuel shortages or the impacts were identified.

The risk assessment method was implemented as prototype software called RECATS. Using the software, four future development options for the Urban Development Strategy of Greater Christchurch were assessed. Various oil shortage/crisis scenarios were imposed on each 2041 urban form development option. Using RECATS, we verified that all urban forms would lose and/or change trips, but the risk to activities was very different for different future cities. Option A (concentrated and limited development) would minimise the risks to participation in activities, while option C (urban sprawl) would pose the highest risks in all simulated scenarios. Further studies are recommended in order to

obtain reliable data/information on travel behaviour under fuel constraints.

## ***Safety implications of flush medians in Auckland city: Further analysis***

Research report 312

S Cleaver and I Jurisich, GHD Ltd | R Dunn, University of Auckland

\$25.00

Between July 2004 and February 2006, research was continued on the safety implications of flush medians in Auckland, New Zealand. A site-by-site benefit/cost analysis found that 38 percent of studied sites achieved a negative benefit/cost ratio, proving that separate analysis is required for every proposed flush median site. The width of a flush median was found to have no effect on overall benefit/cost ratios.

Crash types that increased as a result of installing a flush median were investigated. JA-, FD- and LB-type crashes were shown to increase as a result of installing a flush median.

It was concluded that JA-type crashes increased because installing a flush median reduces visibility. To mitigate the expected increase in crashes that a flush median is likely to cause, visibility from side roads should be improved.

It was concluded that FD- and LB-type crashes increased as a result of more congestion, which caused longer queue lengths and longer peak periods. This can be minimised by ensuring adequate capacity at all intersections along the route.

A methodology was formed to predict crash patterns at proposed flush median sites. *Preliminary guidelines for safer flush medians* was updated to include findings from this research. A general process to follow when implementing flush medians was formed, including the identification of site characteristics, prediction of crashes using the methodology, and remedial measures to improve safety. The use of these guidelines should ensure safety increases and crash savings at all flush median sites.

## ***Effects of toll removal on Tauranga Harbour Bridge, New Zealand***

Research report 313

A Murray, Beca Infrastructure Ltd

\$20.00

As toll roads and other forms of road pricing become of more interest to road controlling authorities in New Zealand, the importance of providing robust forecasts of motorists' responses to tolls increases. While procedures for forecasting patronage on toll roads are in common use internationally, the applicability of international practice to the New Zealand context is uncertain.

The Tauranga Harbour Bridge, Bay of Plenty, New Zealand, was opened in 1988 and included a \$1 toll for its use. Over the next 13 years, the daily traffic flow on the bridge increased from 10,000 vehicles per day (vpd) to 27,500 vpd because of the continued strong residential development across the harbour from the city centre.

The removal of the toll in 2001 created an opportunity to investigate the effect of tolls on traffic behaviour in New Zealand. This study, carried out in 2004, provides information that could improve or benchmark the forecasting of flows on proposed new facilities. The parameters and elasticities obtained could help develop and validate models that aim to forecast the effect of new toll projects.

#### **Accident benefits of sealing unsealed roads**

Research report 314

J Minchington and P Bradshaw, Beca Infrastructure Ltd  
\$20.00

Research was carried out between 2005 and 2006 to determine if there were benefits or dis-benefits associated with sealing unsealed roads, and if so, to determine a procedure for calculating the accident savings (or costs). Road data and seal extension site information were obtained from various district councils in New Zealand and combined with the Ministry of Transport's accident data to give accident rates before and after sealing.

No statistically significant change in the accident rate was found following the sealing of roads. To determine any regression to the mean effects, a background trend analysis was conducted. This analysis found no significant overall change in the accident rate during the period 1990–2005.

The research concludes that there is no statistical benefit or dis-benefit associated with sealing unsealed roads and recommends that site-specific before-and-after studies are conducted into the study outliers and a portion of flat South Island sites.

#### **Identifying sensitive receiving environments at risk from road runoff**

Research report 315

L Gardiner and B Armstrong, MWH New Zealand Ltd  
\$45.00

A GIS-based screening tool is described for identifying and ranking sensitive receiving environments (SREs) at risk from road runoff from state highways and local roads in New Zealand. The tool focuses on the particulate fraction of runoff and the risk this poses to 'depositional' receiving environments.

The tool uses the source-pathway-receptor concept and is applied on a catchment basis. Source strength is expressed in either vehicle kilometres travelled (VKT) or relative pollutant load. Pathways are assigned an attenuation factor in terms of 'connectivity' to the receiving environment. Receiving environment sensitivity is based on depositional characteristics of the water body type, with secondary attributes covering ecological and human use values.

Tier 1 identifies SREs potentially at risk using VKT per sub-catchment. Tier 2 further assesses risk using a model to estimate vehicle contaminant load (particulate matter, zinc and copper) for comparing road networks. Risk factors are combined to give an overall measure of relative pollution risk for ranking road networks on a comparative basis.

The paper outlines the method and findings from a pilot study in the Porirua area of Wellington. The tool is intended to help roading authorities prioritise areas that could benefit from the installation/upgrade of treatment systems for road runoff.

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