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TRANSPORT ACCESS FOR NEW ZEALAND'S RURAL COMMUNITIES

While most New Zealand rural households have a car, there are still some remote communities and sections of the rural population that have very limited access to private or public means of transport. New research looks at the impact that transport deprivation can have on the quality of life of both people and communities, and suggests strategies to improve access and mitigate these impacts at a national and community level.

The research by Fitzgerald Applied Sociology combined Census and Household Travel Survey data, community case studies and consultation with councils, agencies and other stakeholders to build understanding of the social impacts that poor access to transport has in rural New Zealand. Before the study, little social research had been carried out in this area.

A CHANGING LANDSCAPE

Rural communities have long been more self-sufficient than their urban neighbours, with their very nature (low and dispersed populations) meaning fewer services and opportunities are available to them. Historically, in New Zealand, these services and amenities have been available in small towns. But for several decades now, many of these towns (and the rural communities they support) have been in a 'spiral of decline' due to depopulation, attendant loss of demand, and the rationalisation of services and businesses in larger centres.

As a result, rural residents are increasingly forced to resort to larger towns and cities to meet their everyday as well as specialist needs, with a correspondingly greater need for reliable transport. At the same time, public and other forms of passenger transport have all but disappeared in rural areas, except for those bordering on large cities.

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Not surprisingly, the number of rural households with a private motor vehicle has increased, so that at the 2006 Census only 3% of rural households did not have access to one. Because of the distances travelled and the nature of the roads, these vehicles tend to be larger and more expensive to run than those favoured by urban households. This makes rural residents more vulnerable to changes in external factors, such as fuel prices.

As researcher Gerard Fitzgerald of Fitzgerald Applied Sociology explains, this exacerbates the spiral further. 'Without community or public transport solutions available to them, sustained high fuel prices could result in further hardship for some rural residents, further rural depopulation, and ultimately reduced viability for smaller rural centres that support the agricultural sector. A focus of our study has been on identifying and recommending strategies that will increase the sustainability of these communities, and hopefully halt or reverse the depopulation trend.'

EFFECT ON THE MOST DISADVANTAGED

Although access to private motor vehicles by rural households has increased dramatically since the 1990s, there are still over 5500 rural households without access to a vehicle. Ironically, these households tend to be in the more remote rural communities, particularly in the South Island, where there is little or no access to public transport and comparatively high levels of socio-economic deprivation.

The effect is to further increase the risk of deprivation and social isolation among some residents of these communities, especially the elderly, due to the practical difficulties in meeting even their most basic needs.

As part of the study, the researchers conducted case studies of two rural communities (Fairlie and Ohai-Nightcaps) to document the social issues and impacts that poor access to transport had on them. The study also identified local attempts and initiatives to solve these transport problems.

Gerard says, 'A lower level of accessibility is generally accepted as part of rural life, and there is a perception that rural residents need to have the resources and be sufficiently organised to cope with the challenges that this can create. However, one of the main resources is access to reliable, affordable and convenient transport, and for those residents who don't have this, the impacts can be manifold.'

The main impacts identified by the study were to do with people and communities not being able to access the goods, services, activities and opportunities that they need, and the effort and investments needed to overcome these access difficulties. Specific effects noted were on the quality of people's: living environment; material wellbeing; physical and mental health; family, community and social networks; institutions, political structures and equity; and cultural identity and expression.

Gerard says, 'Importantly, our research suggests that poor access to transport is occurring in places that are already struggling in terms of their social and economic sustainability, and that decreasing access to transport, whatever its causes, is amplifying existing poverty in these places and adding to the challenge of sustaining their communities.'

STRATEGIES TO ADDRESS POOR ACCESS TO TRANSPORT

A range of strategies for avoiding or mitigating the impacts of poor access to transport are considered and described in the full research report, along with examples of where they have been implemented. These include traditional approaches, such as local or community bus services that take people to the places where the goods and services they need are located (typically the nearest town), and making more effective use of other types of transport services, such as school buses and couriers, to improve people's mobility.

Promoting lift giving or ride sharing is another way to increase people's mobility, especially for older people, and has the added benefit that it builds relationships and community cohesion. In a similar vein, community-owned and -operated car services have been successfully introduced in some New Zealand communities.

Gerard says, 'Once established, community transport can be extended to include coordination of lift giving and carpooling, volunteer-driver training, and the provisions of charter and group-hire vehicles. Agencies can help reduce the mobility costs of the people most in need by providing petrol and taxi vouchers and concessionary fares, reducing vehicle licence charges, and helping with repairs and maintenance.'

Other strategies focus on moving the goods, services and activities closer to the people who need them, and this is already being done in some rural communities (particularly with health services) with the help of public agencies. Rural community-based resource centres and services, rural telework centres, and mobile shops and door-to-door services also reduce the need for locals to travel (although for the former, securing ongoing funding can be a struggle). Although the internet represents a significant potential improvement in rural residents' access to certain services, the current poor level of rural household access to the internet is limiting this (especially as those households without cars are also those most likely to lack access to the internet). Also, older people often do not have this option available to them.

Based on these strategies, the report includes a host of recommendations for improving transport and accessibility in rural areas. These include: the use of accessibility planning, and anticipatory impact and sustainability assessment in rural districts and services planning; more integration and coordination of the plans and activities of different agencies providing services to rural communities; and more assistance for local rural communities to develop their own solutions to problems with accessibility.

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The social impacts of poor access to transport in rural New Zealand, NZ Transport Agency research report 484

Available online at www.nzta.govt.nz/resources/research/reports/484

MODELLING BUILDS HOLISTIC PICTURE OF SAFETY

Data from 238 urban intersections was pooled to develop crash prediction models for the key vehicle movements that cause crashes at traffic signals.

Data was collected from major signalised intersections in Auckland, Hamilton, Wellington, Christchurch, Dunedin and Melbourne. Collectively, they represented a range of low- and high-speed, three- and four-arm configurations in a variety of urban environments. Drawing on the data, separate models were built for peak periods, crashes between motor vehicles, and crashes between motor vehicles and pedestrians.

Shane Turner of Beca says that, in addition to the prediction models, the project aimed to develop a safety toolkit that transport engineers could use to estimate the number of crashes that might be expected to occur at new and upgraded traffic signal sites.

'The majority of crash black spots in New Zealand cities are at major intersections,' says Shane. 'And most of these have signalised control. While a number of tools are available for assessing the efficiency of these intersections, there are limited tools that engineers can use to assess the potential safety effects of upgrading existing intersections or building new ones of particular designs. There was also limited data about the probable effects on crash rates of various phasing configurations, the overall cycle time of the signals, and the intersection's degree of saturation.'

From this basis, the research sought to quantify the effect that signal phasing had on various crash types for various travel modes at traffic signals, taking into account speed limits, intersection geometry and surrounding land uses.

Data was collected on a wide range of physical and operational characteristics for the intersections involved, including intersection layout and geometry, signal phasing and coordination, road user counts (for motor vehicles and pedestrians) and signal displays, among other things. SCATS® data was also analysed to provide information about signal operation, including phasing, degree of saturation, signal cycle times, green, orange and all-red phase times, and how frequently pedestrian phases were activated.

THE CRASH PREDICTION MODELS

From the data, the project was able to develop crash prediction models for all of the main types of crashes between motor vehicles, and motor vehicles and pedestrians. For vehicle-to-vehicle crashes these were rear-end, right-turn against, right angle and loss-of-control crashes. For collisions between vehicles and pedestrians, they were right-angle and right-turning crashes.

Insufficient data was available about crashes involving cyclists, and the study highlights the need for more comprehensive and better-quality data to enable well-fitting cycle crash models to be developed.

A summary of the study's findings on the impacts of the various intersection parameters on the key types of crashes is shown in the table on page 4. The factors listed are all of those that were found to be significant in one or more of the models developed. Cells shaded red show where an increase in crashes can be expected as a result of the parameter, while those shaded green indicate a reduction in crashes.

A full version of this table (available in the report) also shows the individual results returned by the various models developed during the study (as different models did not necessarily produce the same result), and includes explanatory notes for each parameter.

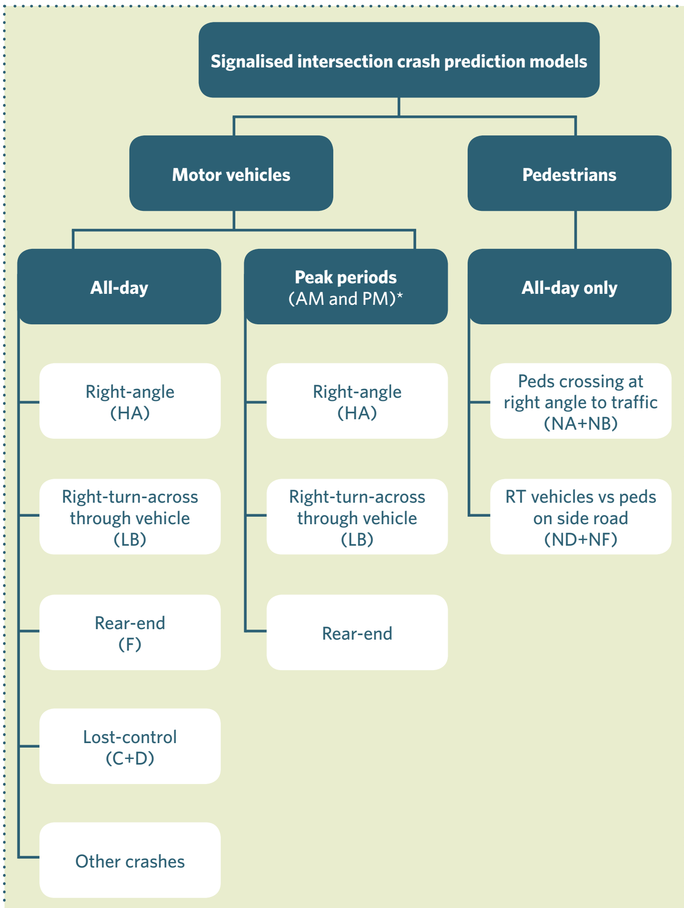
ABOUT THE CRASH PREDICTION MODELS

Crash prediction models are mathematical models that relate crashes to road user volumes and other road layout and operational features. A number of different modelling methods are used internationally.

The cross-sectional models used in this study are negative binomial regression models, developed using generalised linear modelling methods. This is one of the more popular methods used internationally. Cross-sectional regression models have some limitations, which need to be considered when interpreting their results.

The modelling undertaken as part of the study aimed to develop relationships between the mean number of crashes (as the response variable), and traffic flows, as well as non-flow predictor variables. The figure below presents the various categories of crash prediction models that were developed as a result. Models were developed for the main crash types to understand how changes in signal geometry and phasing would affect them. This also enabled the study to assess how certain interventions may improve the safety of a particular crash type, while potentially negatively affecting the safety of other crash types.

CRASH PREDICTION MODELS DEVELOPED



* Two-hour weekday peak periods were used for developing the peak-period models. The time periods used were 7:00–9:00 (AM) and 16:00–18:00 (PM).

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Effect of intersection parameters on motor vehicle crashes

Parameter	Right-angle	Right-turn-against	Loss-of-control	Rear-end crashes		
				Small intersections	Medium intersections	Large intersections
Higher traffic volumes	⇧	⇧	⇧	⇧	⇧	⇧
Higher degree of saturation		⇧	⇧			
Larger intersections	⇧					
More approach lanes			⇧		⇧	⇧
More through lanes		⇧				
Longer cycle time	⇩	⇩	⇩			
Longer all-red time	⇩					
Longer lost time (all-red + inter-green)				⇩	⇧	⇩
Full right-turn protection		⇩				
Split phasing	⇩		⇧	⇧	⇧	⇩
Mast arm	⇩					
Coordinated signals	⇧					
Additional advanced detector loops	⇧					
Shared turn lanes (eg right-turn/ through and left-turn/through)	⇧					
Shared right-turn/through turn lane		⇩				
Raised median/central island	⇩	⇧				
Length of right-turn bay/lane		⇩		⇩		⇩
Free left turn for motor vehicles			⇧	⇧	⇧	⇧
Exit merge			⇧			
Cycle facilities		⇧		⇩	⇩	⇧
Upstream bus bay within 100m			⇧	⇧	⇩	
Upstream parking			⇩			
High speed limit (≥80km/h)			⇧		⇧	

Key

- ⇧ Increase in crashes due to the parameter
- ⇩ Decrease in crashes due to the parameter
- (blank) No identified change in crash rate due to the parameter

Shane says, 'A significant advantage from building crash prediction models for the different types of crashes is that it enables us to take a holistic view of safety at a given intersection. This enables us to assess the effects that various intersection treatments will have on each crash type. Some treatments may have a positive effect on some types of crashes, but a negative effect on others. For example, longer cycle times increases the likelihood of right-angle crashes between motor vehicles and pedestrians, but reduces most of the crash types that only involve motor vehicles. Hence shorter signal cycle times are better at intersections with more pedestrians than motor vehicles, or where pedestrian volumes are higher; for intersections with very few pedestrians, longer cycle times will perform better overall. This illustrates that the individual features or characteristics of an intersection need to be considered when managing road safety, rather than applying blanket treatments across all traffics signals in an area.'

Shane says, 'We acknowledge that some of the results from the study don't agree with results returned from other research studies, or practitioners' experiences on the safety of the various factors we looked at.

'What we can say is that if the majority of the models show an increase or decrease in crashes for a particular road feature, then we can have some confidence in whether the road feature has a positive or negative effect on overall safety. To confirm the specific level of effect for each crash type, for say a 20 percent reduction in crashes or a 40 percent increase, we'd need to compare our results with other studies of this type. If they are relatively consistent, we can have confidence in the results.

'Going forward, we're suggesting that our results could be reviewed by an expert panel, and potentially issued as guidance notes to the industry.'

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Crash prediction models for signalised intersections: signal phasing and geometry, NZ Transport Agency research report 483

Available online at www.nzta.govt.nz/resources/research/reports/483

MIND THE GAP: MODELLING CRASH RATES AT PRIORITY-CONTROLLED INTERSECTIONS

A pilot study to develop a crash prediction model for priority-controlled urban intersections sets the scene for more comprehensive modelling once more data becomes available.

The original aim of the study was to develop a modelling tool that local authorities and the NZ Transport Agency could use to assess when the crash risk at particular intersections had reached a level that required the intersection's layout to be changed. This would enable authorities and the NZ Transport Agency to be more proactive about making and requiring intersection upgrades.

The tool would be based on a new approach to crash-prediction modelling, developed as part of the study, especially for high-volume priority-controlled urban intersections. Existing crash prediction models indicate that crash risk per driver reduces as traffic volumes increase, but this is not likely to be the case at higher traffic volumes due to a shortage of gaps in the main traffic stream.

Shane Turner of Beca explains that there is an urgent need for research in this area. 'At present, it can be difficult, particularly for new developments, to ascertain exactly when an intersection needs to be upgraded due to safety concerns – especially if the issue is brought before the Environment Court. The Land Transport Management Act 2003 and the national road safety strategy, Safer Journeys, require that we safely manage our road networks, and if we are to do this, then we need evidence to back up a requirement to upgrade intersections.'

This is particularly relevant for road controlling authorities who are responsible for managing and mitigating the safety impacts of new developments, and are increasingly looking to pass the costs of these safety mitigation measures onto developers. To be able to do this they need good-quality research to back up their design and developer contribution policies.

'It's difficult to produce strong evidence to justify future intersection upgrades on safety grounds,' says Shane. 'Yet, if an intersection is or becomes unsafe due to high traffic volumes, then this is clearly something that authorities would want developers to address – for example, by undertaking to upgrade a priority intersection to a roundabout, once the development reaches a certain size.

'At present, the default approach is often to include a monitoring clause in contracts that requires intersections to be upgraded if the number of crashes exceeds a threshold after five years or so. But this is very much a reactive approach to the problem, whereas good planning requires a proactive approach. Also, it is highly possible that the developer may have moved on after five years and that the cost of upgrades will then fall back onto the authorities, which naturally they want to avoid.'

Despite the clear need for the tool, it became apparent early on in the study that there was not enough data available to complete the modelling.

Instead, the study focused on developing a pilot data collection methodology that would enable sufficient data to be collected in future from which the full models could be built. Gap acceptance surveys, using the pilot methodology, were then conducted at several Christchurch sites, and the data collected was analysed to show at each site:

- turning times (from waiting area to completion of turning movement)
- accepted gaps taken by drivers (and the rejected gaps)
- distribution of waiting times of drivers
- distribution of headways in the traffic stream (for different major road traffic volumes).

A basic crash analysis was subsequently carried out to determine if a relationship between gap acceptance and crashes could be produced for the small sample of sites.

THE PILOT SITES

Shane says that one of the most challenging parts of the study was finding sufficient sites to collect data from.

The aim was to identify at least 100 high-volume priority-controlled intersection sites, located on two-lane arterial and collector roads, nationwide. This proved difficult, as suitable intersections with high crash rates had often already received intersection improvements, including new forms of traffic control (such as signals and roundabouts).

The pilot study was carried out at eight Christchurch sites, selected based on high traffic volumes, local knowledge of intersections that cause high delays to turning drivers and crashes involving right turns.

Data was collected at each intersection using aerial photos, site observations and video analysis, and included:

- curvilinear distance between the waiting position of the vehicle and the point where it was safely free of collision with the opposing flow
- approach lane widths, to determine whether one or two vehicles can wait at the limit line
- headways between vehicles in both directions on the major road
- speed of straight-through vehicles on the major road
- right-turn counts during the survey period
- waiting times of right-turning traffic (right turn from major road to minor road and right turn from minor road to major road)
- size of gaps accepted and rejected in the major road traffic stream (single direction for right turn from major road and both directions for right turn out).

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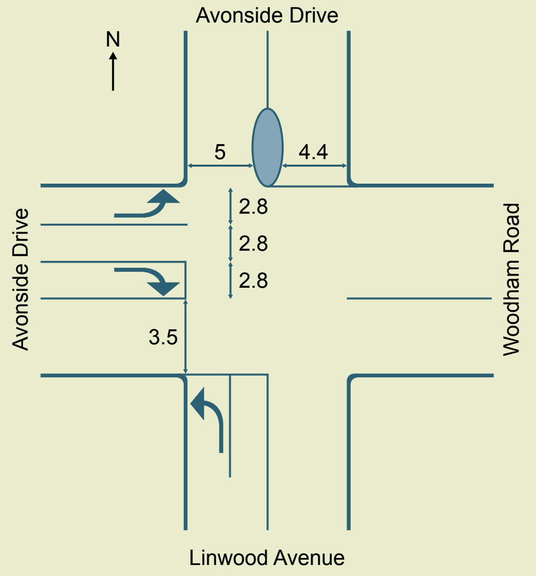
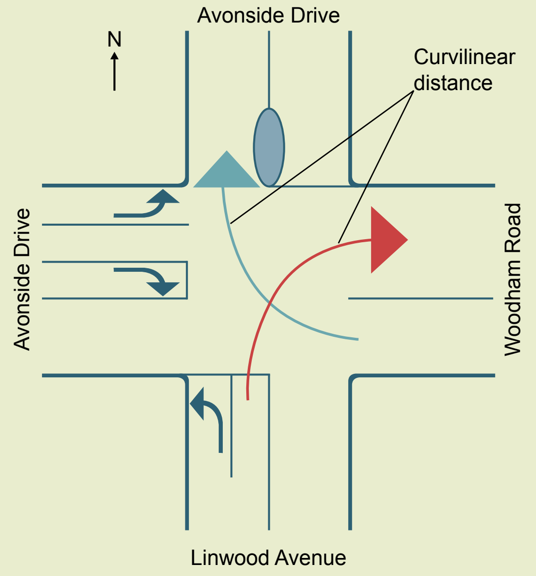
Sample intersection geometry measurements



Surveyed movements showing curvilinear distance



In addition to the average, the distribution of waiting times, accepted gaps and headways is of interest, as different drivers react in different ways. The average and distribution of these factors also varies from intersection to intersection.

Very few drivers accepted gaps in the main traffic stream of less than 4 seconds. The minimum gap in high-flow periods was typically between 4 and 6 seconds, but this varied between drivers and on the availability of gaps. This aligns well with the minimum gap acceptance parameters used in traffic modelling packages like Sidra and Cube Voyager (of between 4 and 7 seconds depending on the turning movement).

At most of the sites, during low and moderate major road traffic volumes, the waiting times to make each right-turn movement were 4 seconds or less. During higher traffic flow periods, drivers typically waited between 8 and 14 seconds before turning, with some waiting over 25 seconds.

As expected, there was a clear correlation between wait times and headways on the major road – as headways between vehicles reduce, wait times increase. While the data does seem to indicate that as wait times increased, drivers became more inclined to accept smaller gaps, there is insufficient data to be confident with this conclusion. This is an area that warrants further investigation in a larger study.

The analysis also compared the selected gap acceptance distribution at each site and their crash history (based on data extracted from the NZ Transport Agency's Crash Analysis System for the five-year period 2004 to 2008). No clear relationship emerged between the two, which Shane says reinforces the need for additional data collection.

'Further work is needed to collect data from a larger sample of priority-controlled intersections from across New Zealand,' says Shane. 'We suggest a sample set of at least 100 to 150 sites, as this would address the large variability in data we observed between the different sites. Tapping into local knowledge of sites with higher traffic delays and crash problems would help identify suitable sites. Ideally any future study would also want to use automated analysis of video data, as this would significantly cut down the time and costs required to analyse this quantity of data.

'Using this approach, and the methodology piloted in our study, we believe that it should be possible to develop a full safety model linking gap selection and crashes.'

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Gap acceptance road safety modelling: pilot study, NZ Transport Agency research report 480

Available online at www.nzta.govt.nz/resources/research/reports/480

NEW ZEALAND'S AGEING POPULATION WILL AFFECT TRAVEL DEMAND AND NEEDS

Projections that are used to plan New Zealand's future transport network will need to take account of the country's changing age structure if they are to cater effectively for the population's needs.

Recent research by Opus International Consultants, MKM and Monash University Accident Research Centre has found that travel projections that ignore the changing age structure of the population risk overstating the expected increase in household travel by as much as 40 percent. This is due to large projected increases in the number of people aged 65 years and over, who are less likely to travel, and to travel far, than people from the younger age groups.

The research, carried out in 2010, provides practical predictions of what the transport demand by older people (defined as those aged 65 years and over) will be in New Zealand until 2056, and how this and other demographic changes will affect the country's transport networks.

NEW ZEALAND'S CHANGING POPULATION

Bill Frith of Opus says that information about older people's demand for transport was urgently needed.

'At a policy level, the government has indicated that older people need safe and sustainable means of mobility if they are to age positively and productively. New Zealand's population is ageing and in order to proactively plan and cater for the travel needs of this growing segment of the population, we need good-quality information about their demand for transport,' says Bill.

The research did not attempt to cover all issues relating to ageing and transport, but only those that could be realistically incorporated into road network planning. It created projections for future household travel on the road network and safety levels, based on the Ministry of Transport's Household Travel Survey for the former and official safety data for the latter. The projections were expanded using three different Statistics New Zealand's population growth scenarios: low, medium and high.

All of the population projections showed that there will be a steady increase in people aged 80 and over, both in absolute numbers and as a proportion of the population, with the rate of increase rising rapidly around 2020 and levelling out from 2040. There will be much smaller increases in the number of young people, who are expected to decrease as a proportion of the total population.

Bill says, 'From this alone, you can see that if planning fails to take population projections into account, it is going to get the future transport needs of the population wrong. Because personal travel tends to decrease for people over 55, the predicted change in our population's age structure is going to create less demand for travel than could be expected from a population of the same size but with the current age structure.

'An older population is also likely to have much different transport characteristics than the current population. For example, older people tend to travel more in urban areas than on the open road, which again puts up the need for any travel planning for different road environments to take age into account if it is to be accurate and responsive.'

The effect that the age structure of the population can be expected to have on household travel is shown in the figures on page 8: figure 1 illustrates the difference between projections that do and do not take population age structure into account, while figure 2 shows the impact that the three different growth scenarios have on transport demand.

THE STUDY'S MAIN RECOMMENDATIONS

- New Zealand has an ageing population. Projections used in future planning of our transport network should take this factor into account, given the lower travel propensity of older people. A failure to do so is likely to produce excessively high travel projections, overstating the increase in household travel on New Zealand roads between 2006 and 2056 by around 40%.
- Projected network travel changes differ markedly by region so that region-specific policies will be required in future.
- Highway design should be moderated to meet the special mobility and safety challenges presented by a larger proportion of older drivers in the future.
- Pedestrian safety regarding both injuries from motor vehicle crashes and non-motor-vehicle incidents on the road or roadside will need greater attention as the number of older pedestrians increases. This is an area for territorial authorities to consider with regard to both pavement design and maintenance, and for the NZ Transport Agency and regions to consider with regard to standards.
- Encouragement to cycle should be carefully moderated by knowledge of older cyclists' increased frailty and vulnerability to injury in the event of a crash.
- Attention is needed to make public transport and special transport more acceptable to and useable by older passengers.
- Further encouragement is needed for people to take their transport needs into account when making housing decisions.
- Urban planning needs to ensure that community services and facilities are more accessible by public transport and non-motorised forms of transport, including walking.

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Figure 1: Household travel projections by road (Statistics New Zealand, series 5, medium assumptions indexed to 2006=1 using overall population projections (for 15+) and also taking population age structure into account)

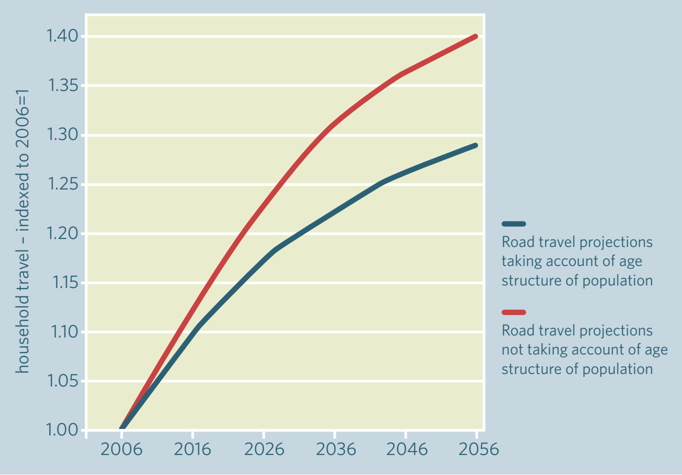
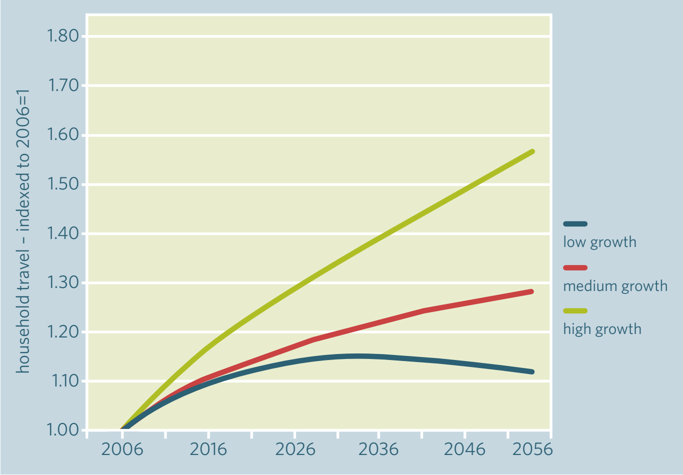


Figure 2: Household travel projections (base 2006=1) assuming traffic growth mirrors age-specific population growth



CHARACTERISTICS OF OLDER TRAVELLERS

In general, people's demand for travel decreases after they turn 55. However, if the future population of older people enjoys better health than the current population, as is predicted, this decrease may become less marked. At present, people aged 65–79 indicate that they are relatively happy with the transport system and how it meets their needs. People older than this, however, have indicated that they might travel more if travelling was made easier for them. This is an important statement of need for transport planners to take into account, given that a greater segment of the population will fall into this age bracket in the future.

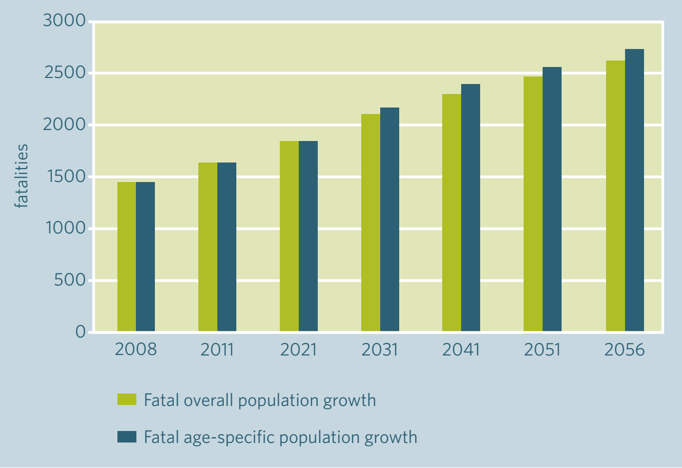
Older people living in cities tend to congregate on the outskirts of the main urban area, and this trend is expected to continue into the future. This has implications for public transport use, as these areas are not easily or traditionally well-serviced by public transport. Private vehicles therefore tend to be the preferred means of travel for older people. However, initiatives such as the SuperGold card (a free discount and concession card for New Zealand residents aged 65 years or over, which includes free off-peak bus travel) are noticeably influencing the travel behaviour of people aged 65 and over. If the scheme remains, and continues to offer cost advantages over private car travel, then substantially more older people can be expected to use public transport in the future, as the population ages.

Work, and work-related travel, is another area that will be affected by the ageing population. A 190 percent rise in the number of workers aged 65 and over is expected by 2056, compared with a 26 percent increase for the population as a whole. This increase in work-related travel for older people will outweigh the general reduced propensity for people in this age group to travel, creating a total additional 500 million kilometres of travel each year by 2056.

Regional variations will also be significant, requiring region-specific policies about transport provision and safety in the future.

Bill says, 'Not all regions are predicted to experience the same increases in population over the next 50 years, although within their regional population growth, all of the regions except Southland will experience over 80 percent growth in the number of people aged 65 and over. What this means is that each region will have to take its own approach to transport planning and provision, taking into account both the overall size of the predicted future population and the proportion of older people within it.'

Figure 3: Projections of fatalities with overall population growth and age-specific population growth for New Zealand (Statistics New Zealand medium growth assumptions)



SAFETY

The research found that, contrary to popular perceptions, older people are as safe as middle-aged people when using the road network. A related finding was that the changing age structure of the population is unlikely to have any impact on safety, with the number of road deaths and injuries remaining constant for the size of the population. What will change is the number of road-related deaths and injuries of older people, which will increase overall purely because of the increased proportion of the population that older people will represent.

Again, there will be regional variations, with regional road injuries by older people projected to increase by 42–97 percent, depending on the region of the country being considered.

Bill says, 'These increases, and the regional variations, should influence regional road safety priorities. Any road safety programmes relating to older drivers will need to include a significant local component, taking into account both the nature of the local road network and the needs of the local population.

'A good example is highways, which will need to be designed in future to better cater for older drivers, who often have decreased visual and other sensory capabilities. Regional policy will have to look at the prevalence of highways among the local road network, and the proportion of older people in the regional population, before deciding what design strategies to adopt.'

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Demand for transport services: impact on networks of older persons' travel as the population of New Zealand ages, NZ Transport Agency research report 481

Available online at www.nzta.govt.nz/resources/research/reports/481

ONLINE SURVEY MEASURES HOW WE'LL ADAPT TO FUEL SHORTAGES

An innovative survey into the capacity of people and urban areas to adapt to future fuel shortages is the first of its kind in the world, with important implications for transport policy and planning.

The NZ Transport Agency funded this research by the Advanced Energy and Materials Systems Laboratory (AEMSLab), an interdisciplinary research group at the University of Canterbury. The research aimed to break new ground in the area of future travel demand adaptation in response to oil shocks, fuel price pressure and peak oil issues.

The research used an innovative survey method (an online travel adaptive capacity assessment – TACA) to capture the data needed to assess how adaptive particular groups of participants and activity centres in urban areas (such as a university) would be. The survey also collected information about participants' preferred alternative modes of transport, if escalating fuel costs meant that travel by private car was no longer a desirable option.

THE IMPACT OF FUEL SHORTAGES

Over the past decade, the price of oil in real terms has increased nearly 10-fold, with world oil production reaching the point where there is little spare capacity. Peak oil, fuel shocks, price spikes and reductions in long-term oil supply are becoming familiar concepts and major issues for transport and urban planners, especially as current indications are that alternatives to conventional oil (such as biofuels and electric cars) will not be able to fill the gap between declining oil production and increasing demand.

Planners need to be able to respond to these issues. However, there is a current lack of data and analysis methods available to assess how vulnerable, responsive and sustainable our current preference for private vehicle travel will be in the face of a world oil shortage for a particular urban area or demographic group, as explained by Professor Susan Krumdieck, Associate Professor in Mechanical Engineering at the University of Canterbury and a member of the AEMSLab research team.

'Nearly all the published studies on fuel price elasticity were conducted at times when there was a surplus in the world's oil supply capacity,' says Susan. 'These studies examined the costs and social drivers for behavioural change when the convenient option of a personal car was readily available and there was no fuel crisis looming.'

The study proposes travel adaptive capacity – that is, how vulnerable or otherwise particular groups of people, urban areas and organisations are to oil shocks – as a key metric for shaping how future transport resources are allocated and managed. The survey developed is a first step to enable this, by providing a means of collecting reliable TACA data, which can subsequently be analysed to shape investment and development decisions.

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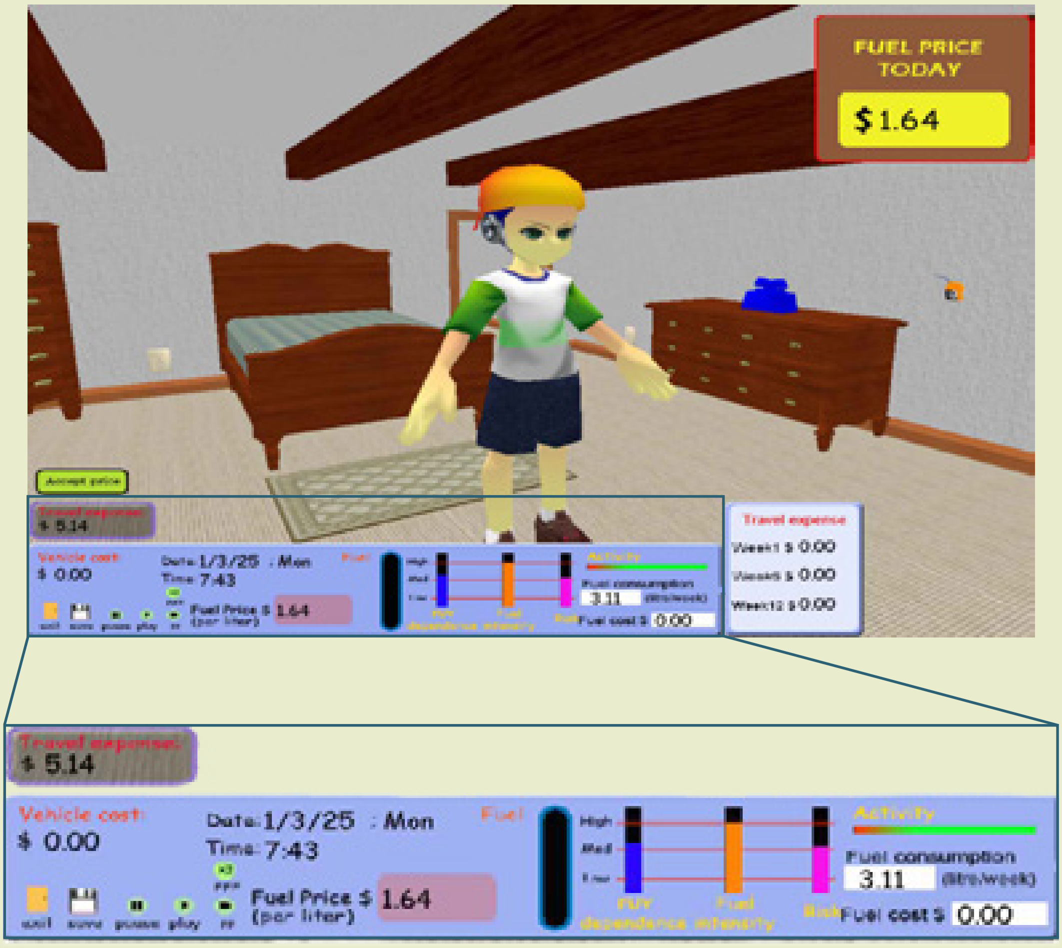
Screen shot from travel sim game that simulates the situation of a fuel shock



What is travel adaptive capacity?

The survey looked at both the travel adaptive capacity and the preferred mode alternatives (travel adaptive potential) of 550 participants from Christchurch, Oamaru and Dunedin.

Travel adaptive capacity is defined in the study report (p7) as:

> a measure of the resilience of transport activity systems to a reduction in fuel use for personal vehicle trips while not reducing participation in activities. Travel adaptive capacity characterises the vulnerability to oil shocks of a particular urban area, organisation, socioeconomic or demographic group.

Travel adaptive potential, on the other hand, measures the long-term potential growth in demand for alternative modes of transport (including public transport, ride sharing and active modes of transport), in the event of fuel shortages. The survey examined the alternative modes that are currently available to participants, and the likely rates of uptake.

'These options that participants currently perceive they have, although not strictly predicative, provide us with a good indication of the shifts in transport modes that we can expect to see, for particular urban forms, as pressure on fuel supply increases,' says Susan.

The survey method

The project used a web-based interactive survey to assess participants' travel adaptive capacity (the TACA survey). The survey was based on previous research by AEMSLab that developed a novel virtual reality sim game survey method (the travel sim game), where oil shocks are simulated and resultant adaptions in normal travel behaviour are recorded.

The TACA survey used a simplified version of the game to collect information about participants' habitual or normal weekly travel patterns (as opposed to the Household Travel Survey, which records actual trips on a particular day), and any potential alternative modes of transport that they would consider using to complete the trips (with participants given the option of 'no alternative' where they did not feel any other options were available to them). Participants were not asked to consider price or environmental issues, nor encouraged to reduce personal vehicle travel or use alternative transport modes.

The research team then calibrated the collected data to represent the reduction in fuel demand that could be expected in the face of a five-fold increase in fuel prices (calculated from the travel sim game).

Susan says, 'As such, the TACA survey represents what participants could do if there was a fuel emergency and not what they would do under normal circumstances. Although we have no way to test the hypothesis, we propose that the TACA survey assessment of travel adaptive capacity is a proxy for emergency fuel reduction behaviour and for long-term trends in travel behaviour induced by the pressure of declining fuel supplies.'

The survey also indicates the relative adaptive capacity of particular urban forms. (Urban form is one of the chief factors that influences what alternative modes of transport are available to people.) The results show which urban areas (and populations within them) will experience the greatest pressure for change in the event of fuel insecurity and scarcity, and which will be more resilient and adaptable.

The project's research approach and results have already been widely reported on in prestigious journals and at conferences overseas. AEMSLab researchers are currently studying the data, which has been collected and organised into a searchable database and is also available for in-depth analysis by other researchers.

Although no in-depth analysis of the data was undertaken before the publication of the research report, a preliminary adaptive capacity analysis was conducted and included. This includes analysis of the travel demand patterns for each cohort of participants, including their current and adapted mode splits. From this the potential for fuel savings is analysed, by looking at the current vehicle travel that could be adapted to lower energy modes.

The report also presents a method for calculating personal adaptability from the data, and completes this for participants, with the outcomes analysed according to participants' income levels. Results are plotted against maps of participants' towns to show the relationship between adaptability and urban form.

The research team recommends (among other things) that TACA surveys should be conducted for all cities in New Zealand as part of planning for how to adapt to world oil supply issues.

Susan says, 'If transport planners, asset managers and councils want to start dealing with the issue of peak oil vulnerability, then they'll need to use the survey to diagnose the current travel adaptive capacity of their area and understand the local potential to shift to more energy-efficient modes of transport. Access to the TACA data will also be necessary to identify the groups who are most at risk from fuel shortages, and where investments are needed in cycling, walking and other infrastructure.'

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Travel adaptive capacity assessment for particular geographic, demographic and activity cohorts, NZ Transport Agency research report 486

Available online at www.nzta.govt.nz/resources/research/reports/486

HOW TO TELL WHEN AN AUDIBLE ROADMARKING IS WORN OUT

Research into audio tactile profiled (ATP) roadmarkings examined drivers' responses to the physical effects of different types of markings, with a view to determining when markings should be replaced.

The research project's objectives were to develop an economical way of determining whether particular ATP roadmarkings were meeting performance standards (in terms of the noise and vibration levels they produced), and to set the minimum dimensions that roadmarkings needed to achieve these standards, including application tolerances.

Vince Dravitzki of Opus Central Laboratories says, 'It's well known that ATP roadmarkings deteriorate over time, but their effective life is uncertain and may range from 4 to 8 years. We need to have a much better method of defining the point at which they become ineffective. By setting optimum and minimum dimensions for markings, road agencies can decide when particular sections of markings need to be replaced. We also have a way to judge whether new types and profiles of ATP roadmarkings will be effective, without the need for expensive and complex human-response tests.'

Vince adds that the study is a good example of how research does not always go to plan.

'Initially, we'd assumed roadmarkings would have a dose-response effect on drivers, where the higher the block height and the greater the noise, the more noticeable they would be. Early on in the work, we found that we could not get a consistent measure of the noise and vibration effect from a single pass, but instead had to do multiple passes to obtain an average result for each set of dimensions. This consistent tracking along the roadmarkings is obviously quite different to how drivers would encounter markings in practice, where they are more likely to run onto them briefly and in a variety of ways. But even the consistent tracking returned highly variable effects in terms of noise and vibration generated.

'So we adjusted the study to examine driver response around the threshold effect, which is the level of effect needed before the roadmarking becomes noticeable to most drivers. After this level is reached, increases in noise and vibrations will not have a material impact, because most drivers will already be aware of the markings. A similar effect is found with road signs, where after a certain point, making a sign bigger or brighter does not make it more noticeable.'

MEASURING THE MARKINGS

The study builds on previous research by Opus Central Laboratories, which looked at ways to measure the noise and vibration effects that roadmarkings generate. Measurements made on in situ roadmarkings showed high variability and this was attributed to the variability of their dimensions (due to wear and tear).

To get around the variability issue, the current study used blocks (mainly of wood, but also plastic) to form pseudo roadmarkings with differing dimensions (length, width, height and angle of the rising edge that faced oncoming vehicles). These were then fixed to the road surface at various pitches (the distance between one marking and the next).

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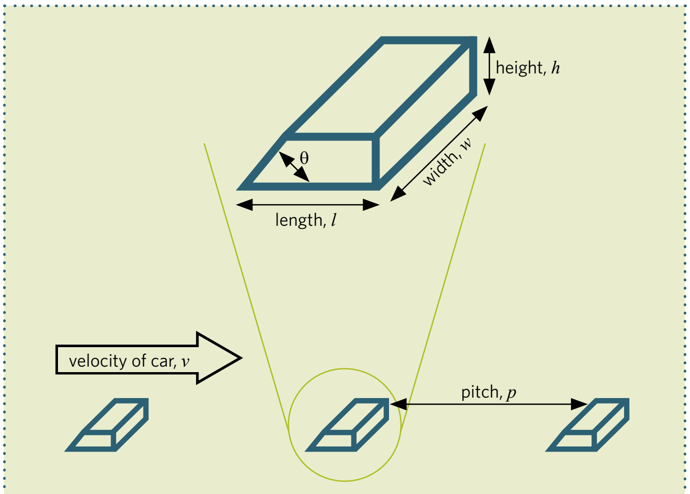
Terms used for dimensions of the ATP blocks



Test strips of the various dimensions of blocks were created by positioning blocks in a single line with consistent pitches of 250mm, 500mm or 750mm for each line.

A test car was driven over each strip, at speeds of 40, 60 and 100km/h, with the noise and vibration levels inside the vehicle measured for each run. Noise was measured using a sound-level meter mounted behind the driver's left ear, while vibration was measured using a tri-axial accelerometer mounted in the footwell on the vehicle's passenger side.

However, despite the now uniform block dimensions, the results still showed considerable variability between repeat runs over the same test strips, even when the width of the test line was widened to make contact more certain.

Vince says, 'To address this, we made several adjustments to our testing method. In the end, we found that a reliable method was to take average effects calculated from multiple runs and use spectral analysis to establish trends.'

The noise spectra gathered while traversing the ATP roadmarkings were then compared with the noise spectra of the car travelling on a clear stretch of road, with changes in frequency examined at the point where the test blocks were impacted by the vehicle (for various pitches and vehicle speeds), including the harmonics of that frequency. Increasing the height of blocks increased the tonal peak of the noise generated to a much greater degree than it increased the overall noise (so, for example, increasing block height from 2mm to 6mm increased the total noise by only 2dB(A), but the tonal peak went up by about 10dB(A)).

HOW DRIVERS REACT

The second stage of the research established the human (driver) response to the physical effects of the various profile roadmarkings by laboratory-based simulation.

A set of noise and vibration responses for markings of progressively increasing thickness (2–6mm) were gathered using the methods described above. Noise and vibration responses from travelling over unmarked areas of the road, as well as over common features such as service covers and seal joins, were also obtained.

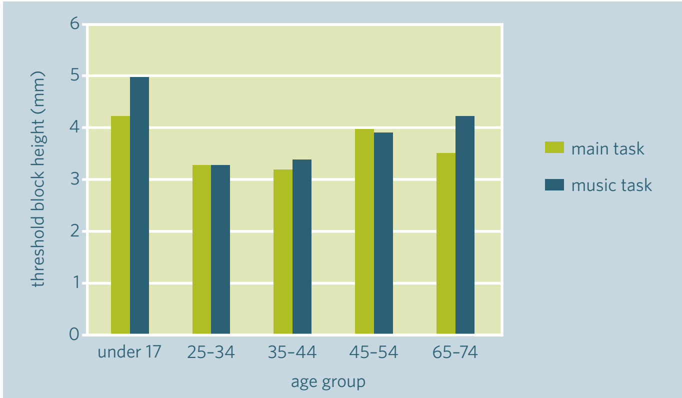
Laboratory-based driver simulation was used to investigate the threshold at which drivers detected a set of progressively increasing noise and vibration effects, ranging from those generated by the road only to those resulting from block heights up to 6mm.

Drivers also had to reliably identify the markings from other sounds, including the ordinary road and common features such as seal joins, that generate noise.

Participants were asked to complete a distractor task while driving the simulator (designed to replicate the cognitive demands of driving) and were tested with and without background music. Signal detector theory was used to pinpoint the point at which participants detected the roadmarkings' physical effects (the threshold).

The study found that the overall threshold block height at which the ATP roadmarkings were reliably noticed by participants was between 3mm and 4mm. Blocks did not appear to become much more noticeable once they exceeded these dimensions, with all participants detecting block heights of 5mm, regardless of age. Having background music playing increased the detectable block height slightly, particularly for older people, but not enough to take it to the next increment tested (that is, an extra 1mm added to the block's height).

Average threshold block height in the main task and the music task, by age group



Vince says, 'Overall, we recommend that for a 500mm pitch, a minimum block height of 4mm should be used, 5mm if a more conservative approach is taken. However, the whole issue of the pitch, or distance, that blocks are spaced at is an interesting one, and warrants further research.

'Informally, some drivers have reported that blocks spaced at closer pitches are more effective, although the restraints of the study did not allow us to test this. There are obvious pros and cons of using closer pitched roadmarkings, including increased material costs as a result of needing more blocks, set against reduced block heights and potentially longer service lives. As a result of the study, we now have an effective method for exploring these permutations.'

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Improved effectiveness and innovation for audio tactile profiled roadmarkings, NZ Transport Agency research report 478

Available online at www.nzta.govt.nz/resources/research/reports/478

NEW RESEARCH REPORTS

Value capture mechanisms to fund transport infrastructure

Research report 511

A Kemp, V Mollard and I Wallis

Freely available online at www.nzta.govt.nz/resources/research/reports/511

Throughout the world, transport infrastructure is increasingly being funded by charges that more closely target the direct beneficiaries of the infrastructure. One form these charges can take is a levy on land owners or developers, ie value capture mechanisms. In New Zealand, a number of mechanisms can be defined as value capture mechanisms: development contributions, financial contributions, targeted rates, and other negotiated mechanisms that sit outside of legislation (ie do not refer to policies contained in a council's long-term plan).

This report outlines the experience to date in using these mechanisms and highlights a number of limitations with, and barriers to, their current use in New Zealand.

This research suggests that the current legislative framework for charging land owners and/or developers in New Zealand provides the basis for introducing charges that levy the beneficial 'value' obtained from transport infrastructure investments. It suggests a number of improvements to these mechanisms that should be investigated in order to increase the feasibility of these mechanisms, and many of the commonly cited international mechanisms (such as 'tax increment financing') could be implemented as variations to existing mechanisms.

Assessing pre-tensioned reinforcement corrosion within the New Zealand concrete bridge stock

Research report 502

RA Rogers, M Al-Ani and JM Ingham – University of Auckland

Freely available online at www.nzta.govt.nz/resources/research/reports/502

Precast pre-tensioned concrete bridge construction became common in New Zealand in the 1950s and a large number of pre-tensioned concrete bridges were constructed between 1953 and 1980. These bridges do not meet today's durability requirements and many are at risk of chloride-induced pre-tensioned reinforcement corrosion. This deterioration can be difficult to detect in visual inspections and has immediate structural implications, so prediction or early detection of at-risk structures is critical for bridges to achieve their required service lives.

This report presents an assessment of the New Zealand pre-tensioned concrete bridge stock and identifies bridges at risk of pre-tensioned reinforcement corrosion. Construction eras based on evolving construction practices are identified, and examples of typical beam types used in each era are presented. The exposure classification of each pre-tensioned concrete bridge on the state highway network was remotely estimated using a Google Earth-based tool developed for the purpose. A sample of 30 bridges was selected for inspection, and chloride profiles and concrete cover depth surveys were obtained from each structure. This data was used in diffusion models to predict the remaining service life before initiation of chloride-induced reinforcement corrosion for each bridge. The results were then applied to similar bridges in New Zealand.

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NEW RESEARCH REPORTS *continued*

The New Zealand accessibility analysis methodology

Research report 512

S Abley and D Halden

Freely available online at www.nzta.govt.nz/resources/research/reports/512

This research considers land use and transport accessibility drawing on international practice from the United Kingdom, Europe, the United States and Australia. An objective of the research was to define accessibility and propose a methodology for how accessibility could be measured and quantified in New Zealand, at both a neighbourhood level or a wider area such as a suburb, city or region.

The result of the research was an understanding of other countries' experiences developing and setting accessibility policy and the success of those approaches. This is important because if New Zealand chooses to set explicit accessibility policy, the research explains how that might be best achieved.

A second result of the research was the development of a new methodology for calculating accessibility that draws on overseas and improved practice. The new methodology quantitatively measures accessibility taking into consideration different modes of travel (walk, cycle, private motor vehicle, etc), travel behaviour (ideally using logistic decay functions), destinations (origin or destination based), activities (consumed or supplied) and multiple opportunities (saturations). The calculation methodology was piloted on Christchurch (a city of some 350,000 people) and the accessibility of every household quantified to a variety of destinations including doctors, supermarkets and schools.

The costs of congestion reappraised

Research report 489

I Wallis and D Lupton

Freely available online at www.nzta.govt.nz/resources/research/reports/489

The purpose of this research was to develop improved approaches to assessing the costs of urban traffic congestion and to make corresponding estimates of the costs of congestion in Auckland, New Zealand.

Various definitions of congestion were reviewed and it was found that the concept of congestion is surprisingly ill-defined. A definition commonly used by economists treats all interactions between vehicles as congestion, while a common engineering definition is based on levels of service and recognises congestion only when the road is operating near or in excess of capacity. A definition of congestion based on the road capacity (ie the maximum sustainable flow) was adopted. The costs of congestion on this basis are derived from the difference between the observed travel times and estimated travel times when the road is operating at capacity.

Estimates were made of the annual costs of congestion in Auckland, based on this definition and also relative to free-flow travel conditions. These estimates covered: the travel time and reliability differences for travel in peak periods; changes in vehicle operating cost, environmental cost and crash cost that are associated with the differences in travel speeds; and schedule delay costs associated with travellers who adjust their time of travel to avoid the congested peak periods.

Econometric models for public transport forecasting

Research report 518

D Kennedy

Freely available online at www.nzta.govt.nz/resources/research/reports/518

This paper presents the findings from an econometric analysis of public transport patronage growth for a selection of New Zealand cities: Auckland, Hamilton, Tauranga and Wellington. The primary objective of the econometric analysis was to provide an explanation of historic growth patterns and, in doing so, provide up-to-date public transport elasticities for use by transport planners and policy analysts.

The econometric methods employed differ from conventional approaches because we used panel data models to analyse patronage patterns at a disaggregated level (ie bus route, bus corridor or train line) rather than at a network or city level. We consider that this approach produces more accurate estimates and demonstrates that statistical methods can be used to 'post-evaluate' the effectiveness of past public transport investments and the impacts of fare increases.

The econometric methodology was developed by DMK Consulting and was designed to ensure that the findings were thoroughly researched and statistically robust. The development and implementation of this econometric methodology took from 2009 to 2012 to complete.

Use of roadside barriers versus clear zones

Research report 517

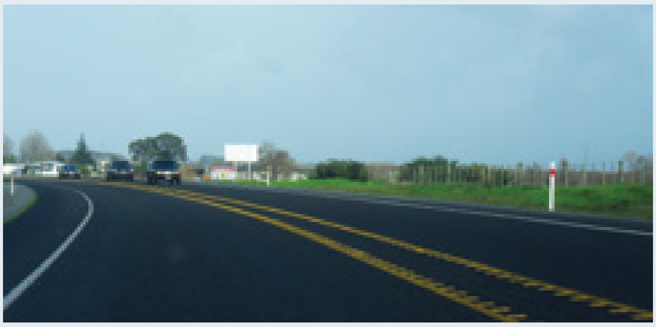
NJ Jamieson, G Waibl and R Davies

Freely available online at www.nzta.govt.nz/resources/research/reports/517

This report summarises research carried out in 2011–12 to quantify through statistical and computer simulation modelling how roadside barriers and clear zones might reduce run-off-road crash numbers and crash severity. The purpose of the research was to provide practitioners with information that would allow them to make safer, more appropriate and cost-effective treatments for specific conditions.

The statistical modelling included extending an existing crash risk model to cover the available parameters relating to barriers and clear zones, eg offset from the road and barrier type. Limited computer simulation modelling of run-off-road scenarios on selected straight and corner road sections was used to confirm and supplement the findings of the statistical modelling.

The key finding was that the roadside condition, whether comprising clear zones of varying widths or different barrier types, had an impact on the crash rate that was statistically significant. However, the results of both the statistical analysis and the computer simulation modelling showed that while the lateral distance offset to the nearest hazard or barrier was important, the type of hazard that was encountered at the far side of this offset distance was also important in determining the crash rate.



The design of stabilised pavements in New Zealand

Research report 498

D Alabaster, J Patrick, H Arampamoorthy and A Gonzalez

Freely available online at www.nzta.govt.nz/resources/research/reports/498

Areas of New Zealand are running out of premium aggregates that meet the demanding specifications used in unbound granular road construction. Stabilising aggregate provides a viable alternative to using premium aggregates.

The objective of this project was to improve the sustainability of New Zealand roads through a combination of Accelerated Pavement Tests at the Canterbury Accelerated Pavement Testing Indoor Facility (CAPTIF) in 2007/08 and 2008/09, and a limited field review of the performance of bound stabilised pavements.

A number of recommendations have resulted from this research concerning the design, testing and construction of modified and bound pavement layers.

Blueprint for a best practice measurement indicator set and benchmarking

Research report 522

T Denne, R Irvine, A Schiff and C Sweetman – Covec Ltd

Freely available online at www.nzta.govt.nz/resources/research/reports/522

This report develops an indicator framework for measuring the contribution of land transport to the aggregate wellbeing of New Zealanders. The starting point is viewing transport as an input into the generation of wellbeing, reflecting the role of transport as a technology that enables human interaction, trade and other activities. Transport improves wellbeing if it better facilitates these activities and/or imposes lower costs. This leads to categories of indicators based on observable characteristics of the transport system that are relevant to aggregate wellbeing, ie network performance and capability, safety, health and environmental effects, and cost.

Impact of urban form on transport and economic outcomes

Research report 513

S Donovan – MRCagney

I Munro – Urbanism+

Freely available online at www.nzta.govt.nz/resources/research/reports/513

Urban form describes the physical shape and settlement/land use patterns of cities and towns. This research addressed two key questions: 1) how urban form impacts on transport and economic outcomes, and 2) how regional and local council planning policies can contribute to a more efficient and durable urban form. We found that urban form has modest impacts on transport outcomes, through reductions in vehicle ownership and drive mode share. On the other hand, urban form was found to have relatively large impacts on economic outcomes, primarily by virtue of its impacts on agglomeration economies. Several promising areas of further research have been identified that would seek to strengthen and deepen our understanding of the linkages between urban form, transport and economic outcomes.

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NEW RESEARCH REPORTS *continued*

Detailed observations and validated modelling of the impact of traffic on the air quality of roadside communities

Research report 516

I Longley, S Kingham, K Dirks, E Somervell, W Pattinson and A Elangasinghe

Freely available online at www.nzta.govt.nz/resources/research/reports/516

Detailed observations of air quality and local meteorology were conducted on either side of a stretch of the Auckland southern motorway, and in the surrounding residential neighbourhood. The data revealed emissions from motorway traffic contributed, on average, to a 10% elevation in concentrations of particulate matter at a roadside site relative to a setback site (150m away or more) and to a doubling in concentrations of nitrogen dioxide. National environmental standards for air quality were not exceeded, but international health research indicates that the spatial variation in traffic-related air pollutants observed in this study represents a risk that is not currently accounted for in risk assessments in this country.

The observational data captured was used to evaluate four different roadside air quality modelling approaches. The most commonly used model in a regulatory context (Austroads) was found to be conservative, but its effectiveness could be undermined by the use of inappropriate (particularly off-site) estimates of background air quality. Less commonly used assessment methods (passive monitoring, semi-empirical and regression modelling) were shown to offer several advantages for assessment.

Supplementary issues of the *NZTA research* newsletter

The significant number of research reports published in recent years has resulted in the need for supplementary issues of *NZTA research*, which are in addition to the standard March, June, September and December quarterly editions.

In 2011 and 2012, three supplementary editions were published in May, August and November. Similarly, there will be three supplementary editions published in May, August and November this year, in addition to the standard quarterly editions.

This is the May 2013 supplementary edition.

A NOTE FOR READERS

NZTA research newsletter

NZTA research is published quarterly by the NZ Transport Agency (NZTA). Its purpose is to report the results of research funded through the NZTA'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 NZTA's Research Programme, see www.nzta.govt.nz/planning/programming/research.

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

Contributed articles are also welcome, should not exceed 1000 words and are to be emailed to research@nzta.govt.nz. Illustrations must be of high quality. *NZTA research* reserves the right to edit, abridge or decline any article.

Enquiries on articles should be made to the authors of research reports whose details are listed at the end of the articles. Otherwise 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.

Editions of this newsletter, *NZTA research*, are available in hard copy or on the NZTA website at www.nzta.govt.nz/resources/nzta-research/. Back editions are available online only.

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