



## Cutback bitumen classification too stringent



PHOTO: OLDFIELD ASPHALTS

**In 2002, in the process of transferring hazardous substances from the Dangerous Goods regulations to the Hazardous Substances and New Organisms (HSNO) regulations, New Zealand's Environmental Risk Management Authority (ERMA) announced that bitumen with the addition of kerosene between 2.5 and 20 percent by weight was to be classified as a 9.1C substance that is 'ecotoxic to the aquatic environment'.**

Cutback bitumen, as it is known, is composed of a mixture of bitumen and kerosene, the purpose of the kerosene being to temporarily soften the binder to assist in the process of forming a strong aggregate mosaic with the surfacing chips.

The proposed classification — along with others, including the classification of straight bitumen as 9.1D ecotoxic — drew submissions from the road contracting industry, whose members use cutback bitumen extensively in chipsealing operations.

They argued that bitumen, with its low bioavailability, should not be classified as toxic and that the classification for cutback bitumen wrongly implied all cutback bitumen fell under the same classification as long as it contained less than 20 percent kerosene.

With most cutbacks used in roading averaging no more than five to six percent kerosene content, industry representatives requested that the kerosene content

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### Your views

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## Cutback bitumen classification too stringent

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should be stated for cutback bitumen to be classified as toxic or ecotoxic.

### Aquatic toxicity tests

ERMA's 9.1C ecotoxicity classification was derived from a calculation based on the aquatic toxicity of kerosene. This implied an assumption that the kerosene in cutback bitumen has the same bioavailability as pure kerosene and therefore had the potential to harm aquatic life.

Following discussions between the road contracting industry and ERMA, a research project was commissioned to establish whether this assumption was valid and whether the 9.1C classification for cutback bitumens was warranted.

This research focused purely on aquatic toxicity – other possible environmental effects of cutbacks in the atmosphere or terrestrial environment were outside the scope of the project.

Given the lack of data on the aquatic ecotoxicity of cutbacks, a programme of testing was undertaken by Opus Central Laboratories and Landcare Research Ltd. Aquatic toxicity tests were undertaken by NIWA using standardised methodologies. Bitumen and kerosene are both multi-component substances that have very low solubility in water. Testing the aquatic toxicity of such materials is difficult. The procedure generally used for preparing media for testing of sparingly soluble materials is the water accommodated fraction (WAF) method.

In this approach, the test material is brought in contact with water

## Editorial

The June issue of *Land Transport Research* coincides with the announcement of the 2006/07 National Land Transport Programme, which incorporates Land Transport NZ's research programme for the coming year. In parallel with significant new funding levels for transport infrastructure just announced, it is vital that expenditure on transport research keeps pace in order to ensure that future investments are based not only on sound economic and social rationale but also on the latest advice in technical, planning and engineering terms.

The list of research projects confirmed by the Board for the coming year, details of which form the greater part of this issue, covers a fully representative spread of all key topic areas.

In addition we cover the findings of a report on the classification of cutback bitumen, widely used in chipsealing, which will be of significance to the road contracting industry.



A flurry of new research reports published this year and listed in recent issues of *Land Transport Research* will provide plenty of material for coming issues. If there are topics you'd particularly like to see covered, do please let us know.

**Wayne Donnelly**  
Chief Executive  
Land Transport New Zealand

until those components that are soluble in water have reached an equilibrium concentration in the water phase. The water is separated from the insoluble material and test organisms are introduced. The concentration of the test substance is expressed as the bulk 'loading rate' (mg of substance per litre of water) rather than in terms of the aqueous concentration of the individual soluble components (which in most cases are unknown and impractical to measure).

In terms of modelling likely 'real-world' scenarios by which cutback may contaminate aquatic ecosystems, the WAF approach represents a worst-case scenario. The scenarios in which an equilibrium concentration could be reached are not entirely unrealistic — for example, a tanker of kerosene-modified bitumen emulsion spilling into a small pond or lake — and therefore cannot be discounted.

In other scenarios, such as leaching of a cutback chipseal surface by rainwater, concentrations would probably be very much lower.

A cutback with a kerosene concentration of 9.8 percent (13.6 pph) was used to prepare the WAF for aquatic ecotoxicity testing. This concentration of kerosene is not typical, but represents the upper limit in use in practice. To determine the time needed for water-soluble kerosene components to reach equilibrium in the water phase, a spectrophotometric method was developed in which water samples were extracted with pentane and the absorbance at 215 nm (nanometres) measured.

## Toxicity test results

Two 9.8 percent kerosene cutback loadings (10 mg/L and 100 mg/L) were tested using *Daphnia magna* (a minute crustacean) in an acute toxicity test. Results showed that acute toxicity occurs at levels above 100 mg/L for the 9.8 percent cutback. Two 9.8 percent kerosene cutback loadings (1 mg/L and 100 mg/L) were tested using an algal growth inhibition test. Algal growth tests are considered chronic tests because the effects are assessed over several generations during the exposure period. Significant toxicity to algae occurred at 100 mg/L (where growth was 81 percent of that in the control). No significant toxicity was observed at a loading of 1 mg/L. These results indicate that chronic toxicity occurs at a loading of 9.8 percent cutback greater than 1 but less than 100 mg/L.

## Too stringent

ERMA provides four grades of aquatic toxicity. The object of this work was to determine whether the 9.1C classification for cutback bitumen was warranted. The *Daphnia* test results show that acute toxicity of 9.8 percent cutback bitumen occurs at loading levels above 100 mg/L, indicating that the 9.1C classification is too stringent.

Although not specifically measured, data from the algal tests indicate it is highly likely that the 'no-observed effect concentration' (NOEC), would have been greater than 1 mg/L (especially given the relatively small effect on growth observed at the highest concentration of 100 mg/L). As such, the lower 9.1D

classification for cutback bitumen may also be unwarranted.

Although it has been demonstrated that some kerosene components can migrate from the cutback into the water column — and kerosene has been shown previously to be not readily biodegradable and is bio-accumulative — the toxicological evidence presented in the project report indicates that cutback bitumen may in fact meet the 'not classified' criteria.

It should again be noted that these tests were conducted with 9.8 percent cutback, adopting a 'worst-case' scenario. In practice, the level of kerosene present in cutbacks would usually be almost half of that used for the tests and therefore the current classification is certainly too stringent.

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Land Transport New Zealand  
Research Report 285, *Aquatic ecotoxicity of cutback bitumen*, \$20.00. See details on page 24 for purchasing copies of reports.

# 2006/2007 Land Transport New Zealand Research programme

## Key topic area: Asset Management

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| <b>Project</b>               | Tyre/road contact stress distributions measured and modelled in three coordinate directions  |
| <b>Research organisation</b> | University of Canterbury   |
| <b>Objectives</b>            | <p>Transit New Zealand and the consulting community see the increased use of recycled and marginal pavement materials as a key factor for more sustainable use of national resources. However, successful use of alternative materials requires the ability to reliably model pavement response and performance. In turn, these models depend on the accurate portrayal of the tyre/road contact stress distributions. The goal of the project is to improve the modelling of pavement response and performance through the measurement of tyre/road surface contact stress distributions in all three of the vertical, longitudinal, and transverse directions. The objectives are as follows.</p> <ol style="list-style-type: none"><li>1. To measure the contact stresses imposed by various tyre types, inflation pressures, and axle configurations, to identify the more benign combinations, particularly with reference to their use on thin surfacings and thin asphalt pavements.</li><li>2. To use the measured data in numerical models of the response of pavements: models have reached a high degree of sophistication, but are currently limited by the input data available.</li><li>3. To use the measured data in analysis of the rutting of pavements.</li><li>4. To support existing research into the scuffing effects of various axle combinations, which currently relies on tyre forces as inputs and could benefit from the measurement of contact stress distributions.</li></ol> |

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| <b>Project</b>               | Investigating the contribution of sealing chip application rates to the early failure of chipseals.   |
| <b>Research organisation</b> | Fulton Hogan Limited  |
| <b>Objectives</b>            | <p>Chipsealing is the predominant resurfacing used on the state highway network in New Zealand. An important component of chipseals is the sealing chip layer that is applied to protect the binder layer and provide surface texture and surface friction. There are a number of specifications written to ensure that the correct sized, shaped, and PSV sealing chip is used but no specification on chip application rates. Early life failure of chipseals is generally attributed to wrong binder, wrong application rate or weather; however, incorrect sealing chip application rates may contribute significantly to these early failures.</p> <p>The objectives of the research are as follows.</p> <ol style="list-style-type: none"><li>1. Determine the effect of variations in chip application rate by constructing several seals with varied chip application and monitoring seal performance for two years.</li><li>2. Compare the effect of cubical versus flaky sealing chip along with the varied chip application rates.</li><li>3. Compare the effect of the time of sealing with chip application rates and chipseal success rate.</li><li>4. Develop pictorial and quantitative guidelines for the correct application rate for sealing chip.</li></ol> |

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| <b>Project</b>               | Identification of sites that promote poor truck ride quality using road profile variance.   |
| <b>Research organisation</b> | Opus Central Laboratories   |
| <b>Objectives</b>            | <p>The project is concerned with developing a more reliable methodology for identifying, and prioritising for treatment, road sections that promote poor ride quality for heavy commercial vehicles.</p> <p>This methodology will be based on wavelength analysis of the road profile. The wavelength analysis is in the form of profile variance, as used routinely in the UK, and which is presently being acquired for the first time for the state highway network as part of the 2005-06 SCRIM survey. This profile variance data will be compared with (1) existing measured truck response data for parts of the state highway network, and (2) available roughness and geometry data from the RAMM database. The comparison will determine how to apply the interpretation of the profile variance data to New Zealand conditions, particularly combinations of small curvature radii, steep gradients, and high cross fall.</p> <p>Threshold levels for short, medium and long wavelength profile variance values will be determined. These will be based on comparing the extracted profile variance data with measured truck response data and driver assessments of ride/safety quality.</p> <p>The research objectives will be achieved through analysis of existing profile variance data and truck ride data for approximately 2,000 km of the state highway network. The derived threshold values for ride/safety will be applied to the latest survey data to identify candidate sites for truck ride improvement works. Network managers and industry sources will be asked to comment on the appropriateness of the candidate sites, particularly those exceeding the thresholds for long wavelength roughness. This assessment will be based on their experience and knowledge.</p> |

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| <b>Project</b>               | The use of risk analysis to optimise pavement design.  |
| <b>Research organisation</b> | Opus Central Laboratories  |
| <b>Objectives</b>            | <p>To develop a robust methodology that will identify the risk of a premature failure to the range of pavemen types available in New Zealand (eg, granular/chipseal, granular/thin asphalt, structural asphalt, concrete).</p> <p>This methodology will have the ability to take into account the effects of variables such as traffic volume, pavement thickness and material properties.</p> |

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| <b>Project</b>               | The design of stabilised pavements in New Zealand.  |
| <b>Research organisation</b> | Transit New Zealand   |
| <b>Objectives</b>            | <p>To improve the sustainability of New Zealand roads by undertaking the following tasks.</p> <ol style="list-style-type: none"> <li>1. Determine the benefits of cement/lime modified aggregates in terms of increased performance (rutting resistance) and incorporate this in a design methodology, filling a gap identified by Austroads.</li> <li>2. Validate the benefits of foam bitumen stabilised aggregates in terms of increased performance (rutting and fatigue resistance) and incorporate this in a design methodology, building on the research of Dr Salah and/or the <i>South African interim technical guidelines</i>.</li> <li>3. Refine the boundary between modified (unbound) and cemented (bound) behaviour.</li> <li>4. Review the appropriateness of the Austroads tensile strain criterion for bound aggregates, which many New Zealand designers consider too conservative, for consideration with the current Austroads accelerated pavement testing programme reviewing the sensitivity of the criterion to higher vehicle loadings.</li> </ol> |

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| <b>Project</b>               | Performance tests for road aggregates and alternative materials — stage 2: establishing grading limits.  |
| <b>Research organisation</b> | Transit New Zealand  |
| <b>Objectives</b>            | <p>This project will repeat the repeated load triaxial (RLT) tests from stage 1 at two gradings either side of the one originally tested. Results in terms of rut depth predicted will be determined and compared to the original grading.</p> <p>The objective of this research is to determine the maximum variation in grading where changes in strength/rut resistance are still acceptable for the materials classified use (low, medium or high traffic in wet or dry conditions).</p> <p>The following tasks aim to achieve this objective.</p> <ol style="list-style-type: none"> <li>1. Review current RLT results from the first stage and select an aggregate to vary the grading.</li> <li>2. Analyse the results by using a rut depth model to predict rutting for three standard pavement cross-sections.</li> <li>3. Based on results and the defects weighting system used for variations on particle sized distribution applied in the <i>RTA QA Specification 3051 unbound and modified base and sub-base materials for surfaced road pavements</i> determine a methodology for determining grading limits to specify in the basecourse specification.</li> <li>4. Revise the specification for the assessment of pavement materials.</li> </ol> |

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| <b>Project</b>               | Compliance testing using the falling weight deflectometer (FWD) for pavement construction, rehabilitation and area wide treatments.   |
| <b>Research organisation</b> | Transit New Zealand   |
| <b>Objectives</b>            | <p>The objectives of the research project are as follows.</p> <ol style="list-style-type: none"> <li>1. Assess all current methods of FWD analysis to predict performance of an agreed dataset obtained on state highways and local roads, together with CAPTIF pavements where performance is known.</li> <li>2. Develop and agree on a national standard for FWD testing and analysis to predict pavement life for compliance testing of pavement construction, area wide treatments and rehabilitation treatments.</li> <li>3. Develop a new method of FWD analysis to improve the prediction of pavement life.</li> <li>4. Continually review, monitor and revise the nationally agreed FWD analysis method.</li> </ol> |

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| <b>Project</b>               | Determining an appropriate choice of asphalt surfacing and how to ensure it meets its design life.   |
| <b>Research organisation</b> | Transit New Zealand  |
| <b>Objectives</b>            | <p>The research aims to reduce costs by minimising the number of asphalt surfaces that do not meet their design lives (expectations are at least seven years). The research has the following objectives.</p> <ol style="list-style-type: none"> <li>1. Develop guidelines on determining the most appropriate asphalt surfacing combined with pavement strength improvements that will result in the lowest whole-of-life costs. The output of this research will be data and design guidelines necessary for determining the most appropriate treatment for a given situation.</li> <li>2. Improve construction and quality control practices for asphalt. The research will undertake a review of latest international practices used to achieve and maintain consistently high quality asphalt surfacings. Changes necessary to current New</li> </ol> |

Zealand practices to improve asphalt quality will be identified after extensive consultation with industry.

3. Quantify the benefits of polymer modified binders on the long-term performance — taking into account binder oxidation — of asphalt mixes (including OGPA) compared with that of standard bitumen and to provide practical criteria for the specification of polymer modified asphalts based on field performance related properties. Field performance related properties measured will include fatigue cracking resistance, fretting resistance (OGPA), and resistance to water stripping. Accelerated aging of compacted mix, which is a key component of the work, will be carried out using SHRP methods and for OGPA a test procedure developed under a previous Transfund research project (Research Report 265). Studies on laboratory prepared samples will be supplemented by mix specimens obtained from contractors as part of their commercial operations.

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| <b>Project</b>               | Pavement deterioration models for asphalt surfaced pavements in New Zealand.  |
| <b>Research organisation</b> | MWH New Zealand Ltd   |
| <b>Objectives</b>            | This is a joint proposal by MWH New Zealand Ltd and Transit New Zealand-CAPTIF. The intent of this research is to extend existing pavement deterioration models to include asphalt pavements, based on data from CAPTIF and the Transit New Zealand LTTP programme. This proposal covers the work required in order to raise model developments for asphalt pavements to the same status it has for chipseal pavements. |

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| <b>Project</b>               | Optimising the pavement maintenance strategy for asphalt pavements in New Zealand.  |
| <b>Research organisation</b> | MWH New Zealand Ltd   |
| <b>Objectives</b>            | The intent of this research is to improve the long-term forecasting of the maintenance requirements of motorway pavements in New Zealand, with the following objectives. <ol style="list-style-type: none"> <li>1. Propose a strategy for the optimal maintenance procedure on asphalt pavements.</li> <li>2. Investigate the performance of the existing pavements in relation to the maintenance strategy and lifecycle costs.</li> <li>3. Propose a method to disseminate this knowledge and incorporate it into current asset management systems with a framework for adoption into deterioration modelling.</li> </ol> |

## Key topic area: Safety and personal security

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| <b>Project</b>               | Distractive effects of cellphone use.  |
| <b>Research organisation</b> | TERNZ Ltd  |
| <b>Objectives</b>            | The proposed research is a comparison of the distractive effects of cellphone use and passenger conversations on driver performance using the University of Waikato driving simulator. The proposed research will investigate the role of conversational suppression (when drivers and passengers stop talking when approaching particularly demanding or hazardous driving situations). It is hypothesised that because one of the parties in a cellphone conversation cannot see the current driving situation, the pacing and attention demands of the conversation have an adverse effect on driver performance well beyond that produced by conversations with passengers. This research is specifically designed to assess the degree to which conversational suppression is present (or absent) in cellphone conversations, and examine its effects on drivers' mental workload and driving performance. An additional manipulation will explore methods of producing conversational suppression with warning tones emitted by the cellphone in the presence of potential road hazards. |

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| <b>Project</b>               | Crash rate relationships for quantifying the safety improvement potential of road networks.   |
| <b>Research organisation</b> | Opus Central Laboratories   |
| <b>Objectives</b>            | <p>This project is concerned with refining and adding extra variables to a Poisson-regression statistical model developed by Cenek and Davies as part of Transfund/Land Transport New Zealand research project PR3 0709.</p> <p>The purpose of this project is to copy crash, road condition and road geometry data acquired since 2002, when the model was developed, to refine relationships so that the predicted estimates of crash rates are more reliable and to enhance the models capabilities to include crash severity, one vehicle and multi-vehicle crashes and local authority roads.</p> <p>Specific research objectives are as follows.</p> <ol style="list-style-type: none"> <li>1. Recreate the original database used to derive the model to include: <ol style="list-style-type: none"> <li>a. state highway related CAS crash data and corresponding high speed (ie SCRIM) road geometry and road condition data for the six year period 2000 to 2005</li> <li>b. CAS crash data and corresponding SCRIM road geometry and road condition data for approximately 2700 lane-km of arterial and collector roads for 8 territorial local authorities (TLA's).</li> </ol> </li> <li>2. Separate out the effect of moderate (5-10 percent) gradients as in the present model these have been combined with the effect of T/10 skid site category 3 (ie, down gradients 5-10 percent, approaches to road junctions, and motorway junction areas including on/off ramps).</li> <li>3. Incorporate crash severity by exploring relationships between fatal and serious crashes and all injury crashes.</li> <li>4. Differentiate between one vehicle and multi-vehicle crashes.</li> <li>5. Investigate possible interactions between selected predictor variables, these being cross-fall, shoulder width, lane width, and texture by comparing crash rate relationships derived for state highway networks, which have well developed design and maintenance standards, with those derived for less regulated TLA arterial roads.</li> <li>6. Investigate the effect of sudden changes in changes in road characteristics, particularly curves immediately following a long straight.</li> <li>7. Trial an improved statistical method for handling non-Poisson variances observed in the previous modelling project.</li> </ol> |

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| <b>Project</b>               | Fatigue engineering countermeasures in New Zealand.  |
| <b>Research organisation</b> | ARRB   |
| <b>Objectives</b>            | <p>The research will investigate suitable engineering countermeasures against fatigue crashes on New Zealand roads, and specifically for roads that have a high number of known fatigue crashes. The project will also trial one or more of the countermeasures to determine their impact on the reduction of incidents and crash severity.</p> <p>Innovative fatigue measures that are in use overseas will be assessed through an extensive review of the international literature and through personal contact with key research organisations. Promising new measures will then be assessed for their application in the New Zealand context, and then the most promising measure(s) trialled. The selected measure(s) will then be evaluated to determine the effect on fatigued drivers and subsequent safety.</p> |

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| <b>Project</b>               | New techniques (countdown pedestrian timers) to improve the safety and efficiency of signal controlled pedestrian crossings.  |
| <b>Research organisation</b> | MWH New Zealand Ltd   |
| <b>Objectives</b>            | <p>To provide practitioners with guidance on the assessment and reporting of accessibility issues undertaken as part of transportation project scheme selection, assessment and the subsequent applications for funding. The project will take the form of a pilot trial of two sites with high pedestrian demand in order to achieve the following objectives.</p> <ol style="list-style-type: none"> <li>1. Provide some background to the types of countdown pedestrian timers in use overseas.</li> <li>2. Discuss the ease of implementation of the selected trial equipment at two pilot sites.</li> <li>3. Assess the effectiveness of the countdown pedestrian timers in before-and-after studies of observed pedestrian crossing behaviour.</li> <li>4. Evaluate pedestrians' response to and impression of the countdown pedestrian timers by way of questionnaire surveys.</li> <li>5. Offer suggestions to practitioners for application to other sites.</li> <li>6. Consider interpretation of the results.</li> </ol> |

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| <b>Project</b>               | Personal security in public transport travel - problems, issues and solutions.   |
| <b>Research organisation</b> | Booz Allen Hamilton (New Zealand)  |
| <b>Objectives</b>            | <p>To investigate the extent to which perceived concerns about personal security are a deterrent to greater use of passenger transport services in New Zealand, and the causes of these concerns; and to develop policy recommendations/guidelines to address these causes and hence to increase personal accessibility and the use of passenger transport.</p> <p>The research will involve the following.</p> <ol style="list-style-type: none"> <li>1. An international review of evidence and experience with personal security issues related to the use of local passenger transport (bus/train) services, and in particular the extent to which personal security concerns are a deterrent to potential users, the associated extent of deterred passenger transport trips, and the effectiveness of measures to address security concerns.</li> <li>2. Review/appraisal of any research evidence in New Zealand, and discussions with local passenger transport operators around the importance of the issue.</li> <li>3. Qualitative market research (focus groups) to better understand the incidence and nature of security concerns and the effectiveness of potential measures to address these concerns.</li> <li>4. Quantitative market research (random sample surveys) in the three main New Zealand centres with people who have security concerns relating to their use of bus/train services. These will investigate the nature and extent of these concerns, the effectiveness of measures to address them, and likely impacts on patronage.</li> <li>5. Draw conclusions and recommendations in the New Zealand context on the current extent of personal security issues and concerns, and appropriate and cost effective policy guidelines to help ameliorate these concerns and increase the use of public transport services.</li> </ol> |

## Key topic area: Environmental effects

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| <b>Project</b>               | The development of gravel deterioration models for adoption in a New Zealand gravel road management system (GRMS).   |
| <b>Research organisation</b> | MWH New Zealand Ltd  |
| <b>Objectives</b>            | <ol style="list-style-type: none"><li>1. To interrogate the gravel loss data with the purpose of developing condition deterioration models such as gravel loss.</li><li>2. To investigate the need and practicality of incorporating other/new condition performance measures such as profile shape index (GrPSI) into a GRMS system. (Note that data to date has suggested that some roads fail because of loss in shape rather than loss of aggregate).</li><li>3. Develop a framework for adopting the deterioration models and/or other practical consideration into a decision framework for the GRMS</li><li>4. Propose some strategic level best practice guidelines for managing gravel roads from a performance perspective</li></ol> |

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| <b>Project</b>               | Residual binder extraction from emulsions for quality assurance testing.  |
| <b>Research organisation</b> | Fulton Hogan Limited  |
| <b>Objectives</b>            | <p>The project aims to develop and validate a method that is acceptable to the New Zealand roading industry of extracting the binder from bitumen emulsions used for chipsealing for quality assurance testing and auditing. The project has the following objectives.</p> <ol style="list-style-type: none"><li>1. Review current methods in use around the world.</li><li>2. Develop an industry-acceptable method of extracting the residual binder from emulsions based on current international best practice.</li><li>3. Validate the method by comparing binder properties before emulsification with those of the same binder after recovery.</li><li>4. Test samples from all emulsion suppliers in the New Zealand Roading Industry to ensure the method is widely applicable and will gain acceptance in the industry.</li></ol> |

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| <b>Project</b>               | Long term dust suppression using the Otta seal technique.  |
| <b>Research organisation</b> | Fulton Hogan Limited   |
| <b>Objectives</b>            | <p>This project aims to trial the Otta seal technique for dust suppression on gravel roads around New Zealand using local gravels with emulsified binders.</p> <p>Specific objectives are as follows.</p> <ol style="list-style-type: none"><li>1. To trial the Otta seal technique using emulsified binder and various locally sourced aggregates as a dust suppressant under varying climatic conditions.</li><li>2. To develop a guideline for the construction of Otta seals.</li><li>3. To compare the emissions, costs, and performance of the Otta seal with other dust suppressant materials and conventional unsealed road maintenance techniques.</li><li>4. Compare the sustainability of the Otta seal versus the traditional methodology with respect to the reduced use of non-renewable resources such as the maintenance metal and diesel burnt by machinery on the regular grading cycle.</li></ol> |

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| <b>Project</b>               | Environmental effects of emulsions.  |
| <b>Research organisation</b> | Opus Central Laboratories  |
| <b>Objectives</b>            | This project aims to evaluate the effect of chipsealing emulsions on flora and fauna by carrying out an eco-toxicological study of a selection of emulsions, using a modification of the methodology developed recently for a Land Transport New Zealand study of the ecotoxicity of cutbacks (Research Report 285, Herrington et al, 2005 — see pp. 1-3). There has been a steady movement in New Zealand towards sealing with bitumen based emulsions instead of hot bitumen binder cut back with kerosene. For some local authority areas emulsion is now the dominant sealing binder. Emulsions constitute approximately 10 percent of state highway sealing, but Transit New Zealand is currently reviewing the practice with a view to increasing this to around 90 percent. |

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| <b>Project</b>               | The effect of adding recycled glass on the performance of basecourse aggregate.  |
| <b>Research organisation</b> | Transit New Zealand  |
| <b>Objectives</b>            | <p>The objective of this research is to determine acceptable percentages of recycled glass that can be added to a basecourse aggregate, used under a thin surface typical of New Zealand, without reducing its performance/rut resistance by undertaking the following tasks.</p> <ol style="list-style-type: none"> <li>1. Review international literature on the addition of recycled glass and waste materials to aggregates to aid in determining recycled glass percentages to test in the RLT (repeated load triaxial) apparatus.</li> <li>2. Determine glass/aggregate mixes for testing their suitability as a basecourse aggregate by considering available sources (eg, literature review) and from consultation with glass recyclers, local councils and contractors.</li> <li>3. Undertake RLT tests with the selected aggregate at three different percentages of crushed glass.</li> <li>4. Analyse the results by using a rut depth model to predict rutting for three standard pavement cross-sections.</li> <li>5. Based on results, determine recycled glass percentage limits to specify in the basecourse aggregate specification.</li> <li>6. Revise the basecourse specification to allow the use of a percentage of recycled glass material as an aggregate.</li> </ol> |

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| <b>Project</b>               | Disposing of road sweepings and catch pit sediments: towards a more sustainable solution.  |
| <b>Research organisation</b> | NIWA   |
| <b>Objectives</b>            | <p>To identify long-term sustainable solutions for managing the use and/or disposal of street sweepings and catch pit sediments. Specific objectives are as follows.</p> <ol style="list-style-type: none"> <li>1. Characterisation of New Zealand road sweepings/catch pit sediments.</li> <li>2. Determine the distribution of contaminants on different particle size fractions: is there a difference between road sweepings and catch pit sediments?</li> <li>3. Determine how environmentally inert the road-derived particulate are.</li> <li>4. Determine the effect of amendment on contaminant leachate characteristics.</li> <li>5. Identify alternative disposal and/or reuse options.</li> </ol> <p>The intention of this study is that it will provide the necessary starting point to determine whether more sustainable management options for the growing waste stream of road sweepings and catch-pit sediments are feasible in New Zealand, and, if so, to function as a catalyst for the additional research required to implement new management options.</p> |

## Key topic area: Travel behaviour

**Project:** Correlating New Zealand and United Kingdom (UK) trips & parking rates

**Research organisation:** New Zealand Trips & Parking Database Bureau (NZTPDB)

**Objectives:** To provide New Zealand transport practitioners with better quality and quantity of trip and parking prediction information by making UK data applicable in New Zealand.

This research extends the work originally commenced through an earlier study (Transfund RR209 *Trips and parking related to land use*) by bringing New Zealand and UK data together into comparative tables for equivalent land uses. This research is an effective way to increase the NZTPDB database and enjoys wide support from practitioners, local government and government agencies who agree it would greatly assist the planning processes to predict the travel demand and hence transport effects of developments.

**Project:** Older people's travel: analysing changes in New Zealanders' travel patterns using the *New Zealand household travel survey (NZHTS)*

**Research organisation:** Pinnacle Research

**Objectives:** To update earlier study with a comparative analysis of older people's travel patterns using the recently compiled 2003/04 NZHTS database. The analysis of changes over a period of time (trend analysis) is useful to detect travel patterns that could lead to future quality or infrastructure provision problems (eg, creating pressures or bottlenecks in infrastructure use) as well as forecast future demand periods. Understanding the trends in older New Zealanders' travel behaviour is also helpful to decision and policy makers wanting to select and target travel demand management and travel behaviour change programmes designed to encourage more sustainable transport use while maintaining the high levels of accessibility and mobility that our aging population expects.

**Project:** Trends in trip chaining and tours: analysing changes in New Zealanders' travel patterns using the *New Zealand household travel survey (NZHTS)*

**Research organisation:** Pinnacle Research

**Objectives:** To update an earlier study, applying programming to the updated NZHTS database and thus monitor trends in travel patterns. This analysis of changes over a period of time is useful to detect travel patterns that could lead to future quality or infrastructure provision problems (eg, creating pressures or bottlenecks in infrastructure use) as well as forecast future demand periods. Understanding the trends in New Zealanders' travel behaviour is also helpful to decision and policy makers wanting to select and target travel demand management and travel behaviour change programmes designed to encourage more sustainable transport use.

**Project:** Reliability of use predictions for new cycling facilities.

**Research organisation:** MWH New Zealand Ltd

**Objectives:**

1. To compare cycle traffic flows after facilities have been built with the predictions made before construction and submitted as part of the *Economic evaluation manual's* (EEM) simplified procedure No. 6 (SP6) funding application process.
2. To study 10 projects previously funded by Land Transport New Zealand. Facility types will include off-road cycle paths and on-road cycle lanes.
3. Analyse data from these 10 locations and the original cycle traffic estimates.
4. Develop a tool for estimating cycle traffic volumes on new (or improved) facilities for use by cycle facility providers such as local authorities and Transit NZ.

- Project:** Development and application of New Zealand car ownership and traffic forecasting model.
- Research organisation:** Booz Allen Hamilton (New Zealand)
- Objectives:** To develop and show the application of improved methods of forecasting future car ownership and traffic growth in New Zealand, for application:
- in replacing the current EEM forecasting guidelines used for roading scheme economic evaluation throughout New Zealand
  - as a major component in the development of a New Zealand National Traffic Model
  - as a key input to the upgrading of the MOT Vehicle Fleet Emissions Model.

- Project:** The impacts of road improvements on congestion
- Research organisation:** Booz Allen Hamilton (New Zealand)
- Objectives:** To review international evidence on the effects of urban road capacity expansion on congestion levels (in both the short and long term), having regard to 'induced traffic' effects; and in the light of this to appraise the likely impacts of the major investment programme proposed for roads in New Zealand's main urban centres (principally Auckland). In particular, to examine the impact on traffic congestion and the effectiveness of modelling and evaluation techniques currently used in reflecting these impacts.

## Key topic area: Traffic management

- Project:** Evidential based guidelines for temporary speed limits
- Research organisation:** Opus Central Laboratories
- Objectives:** To improve the setting of temporary speed limits (TSLs) by providing easily applied guidance on appropriate speed restrictions.
- A desktop review of previous studies and available data will be undertaken to establish the relationship between road conditions and travel speeds. A survey of driver perceptions on road conditions in areas with temporary speed restrictions will be carried out to test if driver behaviour is consistent compared to unrestricted areas. Findings of the review and the survey will be combined with information available in road design guides to formulate an easy to apply guide for the setting of TSLs at road work sites. A number of situations will be covered, including dry and wet conditions, straight and windy alignments, site activity, and pavement condition (eg, uneven/loose material/reseal site). The guide will consider the above in relation to each other and based on crash data a risk-based guide will be developed which will be simple to use when preparing a traffic management plan (TMP). Innovative aspects of this research involve relating to people's perceptions of their driving conditions in limited speed zones to the actual conditions that prevail, and the way these perceptions may vary from those under normal driving conditions.

- Project:** Effectiveness of incident management on network reliability.
- Research organisation:** University of Canterbury
- Objectives:** To investigate the ability of automated traffic signal network controllers (such as SCATS) to detect and respond to serious traffic incidents, (eg, by implementing a pre-determined incident management plan).
- The research will involve the following.
1. A literature review of techniques and software/systems currently used in New Zealand and elsewhere in the world to manage congestion and incidents.

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2. An exploratory study modelling incident detection and response in a New Zealand urban network using micro-simulation.

The resulting findings will enable determination of whether there is a need for further more detailed investigation in this area.

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| <b>Project</b>               | Short-through lane utilisation database for traffic signals.  |
| <b>Research organisation</b> | GHD Ltd   |
| <b>Objectives</b>            | <p>Extensive Land Transport NZ research has already been undertaken to improve lane utilisation at traffic signals. The existing research was limited to the analysis of only two intersections. A statistically significant database requires the analysis of around 30 sites. The collection of sufficient information on the database will provide significant results that could take the following into account.</p> <ol style="list-style-type: none"><li>1. The relative effect of either a lengthier approach or departure short lane on short-through utilisation.</li><li>2. Short-through lane utilisation at traffic signals with two through lanes.</li><li>3. The length and utilisation of adjacent left-turn slip lanes and their impact on short-through lane utilisation.</li><li>4. The length and utilisation of adjacent right-turn pockets and their impact on short-through lane utilisation.</li></ol> <p>A statistically significant database will enable engineering practitioners to accurately predict the expected utilisation of proposed short lanes at intersections, which could be used to improve traffic model calibration. This would enable improved analysis and design and greater accuracy with regard to modelling and economic assessment.</p> |

## Key topic area: Sustainable land transport

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| <b>Project</b>               | Integrating statutory land use and transport planning.   |
| <b>Research organisation</b> | Ward Wilson Research   |
| <b>Objectives</b>            | <p>To date, there has been little formal research undertaken focusing specifically on the issue of integrating land use and transport planning. This research project is aimed at identifying and documenting links between land use and transport planning and comparing New Zealand and international experience in this area with a view to facilitating more integrated planning in the future.</p> <p>The research will, in summary:</p> <ul style="list-style-type: none"><li>● produce a clear analysis of the New Zealand situation, identifying its strengths and weaknesses</li><li>● identify overseas best practice in this area</li><li>● develop models for revised New Zealand arrangements</li><li>● test models with practitioners</li><li>● demonstrate models in workshops and report results.</li></ul> <p>The work will entail the following tasks.</p> <ol style="list-style-type: none"><li>1. Identifying and describing central and local government land use and transportation planning processes that are undertaken on both a statutory and non-statutory basis.</li><li>2. Evaluating the relationship between land use and transport planning processes (both statutory and non-statutory) to identify linkages and gaps.</li><li>3. Reviewing international arrangements to identify examples of good practice in land use and transport planning integration.</li></ol> |

4. Developing a framework (or planning 'map') and guidelines to illustrate ways that closer links can be made between land use and transport planning.
5. Presenting the findings in workshops and a written report.

**Project**

Improving social responsibility in the land transport sector: what does it really mean?

**Research organisation**

Pinnacle Research

**Objectives**

The purpose of this research is to define and clarify one part of the social and environmental responsibility concept, that of social responsibility, and to develop some practical guidelines on its practice and implementation for local and central government organisations in New Zealand's land transport sector. There is a general belief that environmental responsibility has been better defined and acknowledged by land transport sector agencies and does not need further clarification at this point in time.

The following methodology will be used.

1. Inception - in conjunction with key end users.
2. Review of international and New Zealand based materials regarding social responsibility.
3. Develop land transport sector social responsibility framework (including definition and principles or characteristics) based on findings from the review of international experience and literature and discussions with end users.
4. Prepare a draft summary guidance document for circulation to focus group participants, key end users and peer reviewers.

**Project**

Development and application of accessibility planning methods.

**Research organisation**

Booz Allen Hamilton (New Zealand)

**Objectives**

To explore the desirability, feasibility and merits of adopting an accessibility-based approach to transport planning and evaluation in New Zealand, in the light of the New Zealand transport strategy (NZTS) objectives and policies. Also, as appropriate, to develop potential accessibility measures, standards, analysis and evaluation methods relevant to the New Zealand context.

The project is designed to build on initial work on this topic currently being completed by Booz Allen (for MoT). The main tasks involved are as follows.

1. Prepare a position paper summarising the state-of-the-art internationally in accessibility planning, its potential in New Zealand and project proposals for its further development in the New Zealand context (effectively an inception report for the project).
2. Further development of accessibility-based transport policy, planning and evaluation approaches in the New Zealand context, including aspects of:
  - the role of accessibility planning as a diagnostic tool and as a programme/project appraisal tool
  - roles for accessibility planning at national, regional and local levels
  - accessibility indicators and measurement issues
  - the approach and implications to setting accessibility standards
  - implications of incorporating accessibility modelling within major regional transportation models
  - implications of pursuing accessibility approach for existing project and programme appraisal/evaluation framework.

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3. Stakeholder consultations/workshop to review outputs from the previous tasks and to address the appropriateness and implications of pursuing the accessibility-based approach in New Zealand.
4. Preparation of accessibility planning manual/guidelines.
5. Detailed case studies, acting as pilot projects and illustrating application of methods.

## **Committed funding from 2005/2006**

### **Key topic area: Asset management**

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| <b>Project</b>               | Stage 2 new standard bridge beams.  |
| <b>Research organisation</b> | Beca Carter Holling & Ferner Ltd  |
| <b>Objectives</b>            | <p>The purpose of this two-stage project is firstly to identify the most appropriate precast concrete beam shapes and spans that should be adopted as New Zealand industry standards (stage 1) and then secondly to carry out design calculations to produce standard beam and superstructure drawings and specifications (stage 2). Stage 1 of the project was funded in the financial year 2002/2003 and is complete. The tasks involved in stage 2 are as follows.</p> <ol style="list-style-type: none"><li>1. Confirming the definition of standard bridge and spans to be designed — currently envisaged as a 10.6 metre wide rural bridge with no footpaths, HN-HO-72 loading, test level 4 edge protection, coastal B1 durability.</li><li>2. Produce preliminary designs and drawings for hollow-core, super-T and I beams including superstructure designs for standard bridge width.</li><li>3. Consult with the industry group — RCA consultants, bridging contractors, Cement and Concrete Association (CCANZ) and Precast New Zealand.</li><li>4. First independent verification of designs.</li><li>5. Second independent verification of designs (peer review).</li><li>6. Complete standard drawings and specifications.</li><li>7. Publicise new designs at workshops in Auckland, Napier, Rotorua, Wellington, Christchurch and Dunedin and through articles for IPENZ, CCANZ and Contractor publications.</li></ol> |

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| <b>Project</b>               | Total voids in unbound granular pavements.   |
| <b>Research organisation</b> | Bartley Consultants Ltd  |
| <b>Objectives</b>            | <ol style="list-style-type: none"><li>1. To determine the optimum particle size distribution for maximum density.</li><li>2. To study the characteristics of pavements that have developed premature ruts.</li><li>3. To establish practical limits for maximum density.</li><li>4. To apply the results of initial phases of the study to the construction of a pavement and study its performance.</li></ol> |

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| <b>Project</b>               | Climate and stress based selection guideline for chipsealing binders.  |
| <b>Research organisation</b> | Fulton Hogan Ltd   |
| <b>Objectives</b>            | The objective of the research is to develop and trial a climate and stress based selection guideline for chipsealing binders. The guideline and material property requirements will be based on the concept of the continuing research in the SHRP programme on climate specifications for chipseal binders and current research by Opus International Consultants within New Zealand on specifying the stress |

environment for surfacing treatments. Once developed the guideline will be trialled in each of the climate and stress zones throughout New Zealand by comparing chipseals constructed with traditionally used binders to those constructed with binders selected using the guideline.

The project has the following objectives.

1. Develop a practical guideline that helps sealing practitioners throughout the country to select the most appropriate binder for each sealing site.
2. Extend the lifecycles of chipseal surfacing treatments.
3. Establish relevant measurements of the surfacing climates around New Zealand.
4. Develop climatic regions and binder selection guidelines for each of these regions.
5. Develop a relevant stress categorisation system and a method of utilising it to establish selection for each system guideline category.
6. Measure the on-road performance of binders that meet the guidelines.
7. Ensure that using the appropriate binder for each site reduces the cost and waste caused by specifying inappropriate binders.

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| <b>Project</b>               | Construction of waterproof pavement surfacings.   |
| <b>Research organisation</b> | Opus Central Laboratories   |
| <b>Objectives</b>            | <p>To determine if there are combinations of surfacing types and traffic loadings that are essentially waterproof.</p> <p>Conditions that result in a permeable surface require more stringent material selection and construction control than those that are essentially waterproof. In the construction of granular pavements, the first coat seal is expected to waterproof the base. This research will determine the relative ranking in terms of waterproofing of commonly used New Zealand surfacings. This will enable the most appropriate surfacing to be chosen especially where moisture susceptible base materials could be affected.</p> |

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| <b>Project</b>               | Compaction of thick granular layers.   |
| <b>Research organisation</b> | Opus Central Laboratories  |
| <b>Objectives</b>            | <ul style="list-style-type: none"> <li>● To minimise premature post-construction rutting of granular pavements.</li> <li>● To obtain reliable estimates of post-construction rutting that can be used in deterioration modelling.</li> <li>● To obtain an estimate of the traffic volume that can be carried on a granular chipseal surface pavement.</li> </ul> |

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| <b>Project</b>               | Prediction of pavement remaining life.  |
| <b>Research organisation</b> | Opus Central Laboratories   |
| <b>Objectives</b>            | <p>To develop criteria that define the end of life condition of pavements that can then be used in pavement deterioration modelling and mechanistic pavement design to obtain a more robust measure of remaining life. These criteria can then be used in dTIMS, PSMC and the New Zealand supplement to the <i>Austroads Pavement design manual</i>.</p> <p>The existing dTIMS models for roughness and rutting will be combined with a new model for maintenance costs to define the distress level at which rehabilitation needs to be performed in terms of maintenance costs, roughness or rutting level.</p> |

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| <b>Project</b>               | Selection of aggregates for skid resistance.   |
| <b>Research organisation</b> | Opus Central Laboratories  |
| <b>Objectives</b>            | <p>This project seeks to improve the ability of the industry to provide skid resistant road surfaces by establishing whether or not the source of a roading aggregate is a better determinant of in-service skid resistance performance than its polished stone value (PSV), which is a laboratory derived ranking of an aggregate's ability to resist the polishing action of heavy commercial vehicles (HCV).</p> <p>The availability of 10 m and 100 m averaged wheelpath skid resistance values for the entire 22,000 lane-km of sealed state highway network means that a sufficiently large database can be created to allow identification of statistically significant relationships between measured in-service skid resistance (the dependent variable) and road geometry, traffic characteristics, regional effects, and aggregate characteristics (the independent variables).</p> <p>Previous studies have employed aggregate PSV, which is a numerical parameter typically taking values in New Zealand from 43 to 65, to characterise the roading aggregate, but with little success. For this study, a categorical parameter — the name of the quarry from which the aggregate is sourced — will be used. This categorical parameter, therefore, encompasses not only PSV but also all other important influencing factors such as chip shape, chip hardness, mineralogical properties and crusher type.</p> <p>If correlations between quarry name and in-service skid resistance are found to be significantly better than for PSV, in-service equivalent PSV values will be generated for comparison with the laboratory derived PSV test values supplied by Transit New Zealand so that any significant discrepancies meriting investigation can be highlighted.</p> <p>As all the required data is already held by Transit New Zealand, the proposed statistical study will be performed as a desktop exercise.</p> |

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| <b>Project</b>               | Deterioration of prestressed concrete bridge beams.  |
| <b>Research organisation</b> | Opus Central Laboratories  |
| <b>Objectives</b>            | <p>The key objective of the research is to determine the current and future risk of prestressing steel failure in bridges that include prestressed concrete beams constructed in the 1960s and early 1970s. The findings will provide the basis for Transit New Zealand and local authorities to make informed decisions regarding the management of these structures. The research will initially investigate the design of the Hamanatua bridge, identify other bridges of similar design on the state highway network by interrogating the Transit bridge descriptive inventory (BDI), then carry out a literature search to consider international experience with failures on similar bridges. Hamanatua bridge would then be the subject of a detailed condition assessment including metallurgical analysis of the failed wire, assessment of the condition of remaining wires and measurement of concrete contamination levels which may have contributed to steel corrosion. A similar condition assessment would be carried out on a range of bridges of similar construction type throughout the state highway network selected to represent a range of reported conditions and environmental exposure.</p> |

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| <b>Project</b>               | Performance tests for road aggregates and alternative materials.   |
| <b>Research organisation</b> | Transit New Zealand  |
| <b>Objectives</b>            | <ol style="list-style-type: none"> <li>1. To trial, validate and refine the practical RLT test developed in the Transfund New Zealand project, 'Predicting in-service performance of alternative pavement materials' on materials currently used on New Zealand roads with known performance.</li> </ol> |

2. To trial and validate the practical RLT test method into Transit New Zealand's policy (TNZ M22) as a means of categorising materials in terms of low, medium, and high traffic and either wet or dry conditions.
3. To evaluate the RLT test method to quantify the benefits of modifying/stabilising an aggregate in terms of increase in number of wheel loads to reach a certain rut depth.
4. To implement a test procedure that allows alternative materials (including aggregates, marginal materials, stabilised materials, those from recycled sources etc) to be used in the pavement with appropriate limits to the level of traffic and moisture condition.

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| <b>Project</b>               | OECD project phase II: Design and testing of long life wearing courses.   |
| <b>Research organisation</b> | Transit New Zealand   |
| <b>Objectives</b>            | <p>To participate in an international research programme being conducted by the European Conference of Ministers of Transport (ECNT) joint OECD/ECNT Transport Research Centre which has as its primary aim, the development of economic long-life surfacings for use in heavily trafficked pavement applications. The research performed in New Zealand will form part of phase II (laboratory study and accelerated pavement testing) of the OECD project. A low noise OGPA (open graded porous asphalt) long-life surfacing using an epoxy/bitumen binder will be tested on a small section at Transit New Zealand's accelerated pavement testing facility, CAPTIF. This research will be conducted in parallel with other research being conducted at CAPTIF to reduce the cost of the project. The OGPA epoxy asphalt material was chosen for testing at CAPTIF as this has the most potential for use in New Zealand of the long life surfacings being researched by other OECD member countries.</p> <p>Phase II of the project involves laboratory and accelerated pavement testing of a number of surfacing materials nominated during phase I, 'Economic evaluation of long life surfacings' as worthy of further evaluation. New Zealand, Germany, Denmark, United States, France, Greece, Italy, Japan and the United Kingdom are all involved in the project. Through the collaboration of all the countries, it is considered that advances will be made in the assessment of the application of this type of material. New Zealand involvement in the programme involves the use of epoxy/bitumen binders in surfacing mixes, specifically the properties of a standard OGPA and a high-voids (30 percent) mix developed during Transfund research project 204, Increased effective life of porous asphalt, using the standard design methods. In addition, the durability of the mixture will be assessed using the methodology developed in Transfund research project 803, Porous asphalt durability. A range of properties including fatigue and modulus will be measured along with accelerated pavement testing. Samples of the New Zealand mixtures may be sent to other participating overseas laboratories for supplementary testing. The accelerated testing will be conducted at Transit New Zealand's CAPTIF test track.</p> |

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| <b>Project</b>               | Quantifying the effect of road roughness (and test speed) on GripTester measurements.  |
| <b>Research organisation</b> | Auckland UniServices Ltd   |
| <b>Objectives</b>            | To develop a better understanding of the effect that roughness has on skid resistance values and to develop guidelines for collection of skid resistance data on areas with high roughness. Finally, relationships will be determined to convert skid values obtained at lower speeds to a normal test speed value. Separate relationships will have to be developed for different surfaces given that preliminary observations suggest that the conversion is highly sensitive to surface type. |

## Key topic area: Natural hazard risk management

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|------------------------------|---|
| <b>Project</b>               | Earthquake performance of long span arch culverts.  |
| <b>Research organisation</b> | Opus International Consultants  |
| <b>Objectives</b>            | Applied research will be used to assess the earthquake performance of long span arch culverts, with the assistance of numerical analysis techniques. The objective of the research is to lead to development of design criteria to ensure that long span culverts are designed and constructed in a manner that provides for reliable performance in severe natural hazard events, such as earthquakes. |

## Key topic area: Safety and personal security

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|------------------------------|--|
| <b>Project</b>               | Delineation investment priorities.   |
| <b>Research organisation</b> | TERNZ Ltd  |
| <b>Objectives</b>            | <p>The aim of this research is to develop a management tool that will assist road controlling authorities and their consultants to prioritise where and what type of delineation treatments should be used to obtain the greatest road safety benefits. Factors that will be considered include the following.</p> <ul style="list-style-type: none"><li>● Crash history including loss of control, fatigue and overtaking crashes.</li><li>● Traffic volume.</li><li>● Road geometry and condition (alignment, seal width, geometry, curves etc).</li><li>● Treatment type including line width, profile format (shape and spacing) and materials.</li><li>● Wet-night visibility and profiled edge lines.</li><li>● The estimated reductions in crash rates for different types of treatments.</li><li>● Durability of markings in different traffic, road and climatic conditions.</li><li>● Post installation issues such as snow ploughing, resealing and traffic traversing the lines.</li></ul> <p>The research will include the development of a delineation investment model based on analysis of the CAS and RAMM databases (which includes crash history, AADT and other related data), the results of the literature review undertaken as part of the 'Review of lane delineation' undertaken by TERNZ for Transit New Zealand, road geometry, treatment life expectancy, costs and benefits. The model will be constructed so that it can be refined as further information and new treatments become available after the completion of the research.</p> <p>The model will then be used to generate recommendations on what road sites should be treated and what type of treatment should be applied. This may result in, for example, the use of profiled line markings on curves with given traffic volumes and curve severity (based on curve advisory speed).</p> |

## Key topic area: Environmental effects

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|------------------------------|---|
| <b>Project</b>               | Guidelines for proving compliance with the noise conditions of roading consents.  |
| <b>Research organisation</b> | Opus Central Laboratories   |
| <b>Objectives</b>            | This project will establish an agreed methodology for determining whether new roads or roading improvements have complied with agreed noise conditions required by the council or Environment Court hearing. The project will thereby eliminate both the high costs or over-design of noise mitigation measures and the high risk of disputes over whether roading authorities have complied with the noise consents attached to their new construction projects. |

## Key topic area: Travel behaviour

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| <b>Project</b>               | 'Before and after' studies of new/improved pedestrian facilities.  |
| <b>Research organisation</b> | Beca Infrastructure Ltd  |
| <b>Objectives</b>            | <p>The objective of this research project is to determine the effect of new and improved pedestrian facilities on the induced number of pedestrians.</p> <p>This project aims to record examples of induced pedestrian rates due to implementation of new facilities or improvement of existing facilities in a standardised format that can be used in transport planning and project funding (eg, for the Economic evaluation manual).</p> |

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| <b>Project</b>               | Optimisation of heavy vehicle performance.   |
| <b>Research organisation</b> | TERNZ Ltd  |
| <b>Objectives</b>            | <p>To improve the performance of the heavy vehicle fleet as a means of deriving economic benefits, protecting the infrastructure investment, improving safety (lower heavy vehicle exposure), reducing congestion (fewer heavy vehicles) and achieving environmental benefits (reduced fuel consumption and emissions). This includes both trucks and buses and is quite separate from the 'Heavy vehicle limits' project. The benefits will accrue irrespective of any general increase in vehicle weights or dimensions.</p> |

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| <b>Project</b>               | Developing school-based cycle trains.  |
| <b>Research organisation</b> | Pinnacle Research  |
| <b>Objectives</b>            | <p>The purpose of this project is to develop, trial and evaluate a process for implementing cycle trains at primary/intermediate schools. A cycle train is essentially a walking school bus on wheels — adult volunteers cycle along a set route to school, collecting children from designated stops along the way.</p> <p>(Background: Working with EECA and North Shore City Council on the 'Travelwise to school' pilot project in 2002, the researchers surveyed the parent community to ascertain their interest in various alternative modes for their children's travel to and from school. They found that 87 of 184 families responding would allow their children to cycle to school in a group with another adult supervising their ride. One third of these families offered to supervise the children on a rostered basis. This suggests that there is a high, albeit latent, interest in the wider community in the cycle train concept.)</p> |

## Key topic area: Sustainable land transport

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|------------------------------|---|
| <b>Project</b>               | Freight transport efficiency: a comparative study of coastal shipping, rail and road modes.   |
| <b>Research organisation</b> | Opus Central Laboratories   |
| <b>Objectives</b>            | <p>'Hard data' regarding the relative performance of coastal shipping, rail and road modes for freight transport will be obtained from the following perspectives.</p> <ol style="list-style-type: none"> <li>1. A national perspective (ie, fuel use and associated CO2 emissions).</li> <li>2. A customer perspective (ie, freight rates, damage potential to carried goods, length of transit time, reliability in meeting delivery instructions and reliability in meeting scheduled arrival times).</li> </ol> |

This data will be derived from a comparative study of long distance haulage of goods and will enable government agencies and consumers to make more informed investment decisions regarding freight modes.

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The comparative study will involve monitoring the progress of instrumented containers to and from a depot in Wellington to a depot in Christchurch or Napier, so that the effect of inter-modal and storage operations required by coastal shipping and rail will be accounted for when considering use of resources.

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|------------------------------|---|
| <b>Project</b>               | Energy requirements for new developments in New Zealand urban areas.  |
| <b>Research organisation</b> | University of Canterbury  |
| <b>Objectives</b>            | This research aims to assess energy required for essential activities in new urban development forms for Christchurch City and to develop a method to assess risks to these activity systems from energy supply restrictions. The energy required to access selected activities essential for residents of the new developments will be modelled. The availability of petroleum and alternative fuel supplies will be modelled to specify possible availability constraints, short-term shortages and supply disruptions. Long-term supply patterns as well as the transport sustainability will be evaluated based on indicators of availability, reliability and resilience of the activity systems for assessed risks to the energy supply. The resulting risk to essential activity systems, including the vulnerability of different community members, will then be incorporated into the transportation planning process in order to evaluate development scenarios that promote a more sustainable transport system for New Zealand cities. |

|                              |   |
|------------------------------|---|
| <b>Project</b>               | Transport corridors and community structures.   |
| <b>Research organisation</b> | Douglass Consulting Services Ltd (DCS)  |
| <b>Objectives</b>            | <p>Given that the definition of major long-term land transport corridors for all modes are essential to developing a sustainable transport system, the objectives of this research project are as follows.</p> <ol style="list-style-type: none"><li>1. To identify the potential for the recognition of land transport corridors as a framework for strategies that support sustainable transport facilities and also reinforce sustainable urban growth patterns in our future major urban areas.</li><li>2. To identify, based on current experience and practice, the hurdles and restraints which have hampered the establishment and planning for future transport and urban corridors and their definition within the long term (30-50 years), medium term (20-30 years), short term (10-20 years) and immediate (up to 10 years) planning time frames.</li><li>3. To outline (but not prepare) the list of contents for a proposed guideline of good practice for major transport corridors in the New Zealand context, which could be used by professionals working in both government and private sector agencies in future corridor planning and management.</li></ol> |

## New research publications

### **Multi-lane roundabout designs for cyclists**

Research Report 287

Ivan Jurisich, GHD Ltd

Price \$45

Multi-lane roundabouts are generally viewed by experienced cyclists as a reasonably hazardous element of the road network to be avoided if convenient. Reviewing literature, analysing crash statistics in Auckland and surveying cyclists all confirmed the original focus of this research instigated in 2003, which was to design a low speed multi-lane roundabout for on-road cyclists. This should substantially reduce the critical 'entering vehicle versus circulating cyclist' crash type, and we expect it will also address roundabout exits, which are the other main safety issue concern for cyclists.

The design of a roundabout that reduces unimpeded car speeds to 30 km/h requires a confined geometry. The outcome of the research project is the C-roundabout, which requires an unconventionally narrow roundabout entry that requires larger vehicles to straddle both entry lanes. A preliminary design guide for its application is included in the report.

Another identified alternative is the use of vertical deflection devices on roundabout approaches.

### **Predicting accident rates for cyclists and pedestrians**

Research Report 289

Shane Turner, Beca Infrastructures Ltd

Price \$30

Recent government legislation and policy promotes an increase in walking and cycling as an alternative to the increasing demand for motor vehicle travel. Concern exists, however, that an increase in these modes, particularly cycling, could lead to a substantial increase in pedestrian and cyclist fatalities and injuries. In this research, carried out between 2002 and 2004, accident rates for cyclists and pedestrians were investigated and interviews carried out with casualties. A high under-reporting rate was observed. Using traffic, cyclist and pedestrian counts and reported accidents between the 'active modes' and motor vehicles, accident prediction models (APMs) were developed. These include models for various accident types at signalised crossroads, roundabouts and mid-block locations. These models were used to calculate the likely change in motor vehicle, pedestrian and cycle accidents and also accident rate per road user for a change in mode, particularly motor vehicle trips to pedestrian and cycle trips. It was found that a noticeable 'safety in numbers' effect exists. Generally, the overall increase in cycle and pedestrian accidents was not substantial and the crash rate per cyclist and pedestrian reduced with increases in their numbers.

### **Bitumen durability**

Research Report 291

Phil Herrington, Opus International Consultants Ltd

Price \$20

Three options to improve the test method and acceptance criteria used to assess the in-service durability of bitumen used for chipsealing in New Zealand were investigated in 2004–2005. The preferred option consists of oxidation at 60°C under 2069 kPa air for 30 days. A bitumen would pass if the resulting modulus (at 5°C) did not exceed 86 or 61 MPa for 80/100 or 180/200 grades respectively. The limits are based on the moduli of 'benchmark' Safaniya 80/100 and 180/200 bitumens after the test, plus 50 percent (based on the modulus range of 20-year old field samples).

For bitumens imported to New Zealand some means of confirming (without re-testing durability) that the material shipped is the same as the sample for which durability had earlier been measured and approval given, is desirable. The viscosity ratio (70C/135°C) and Rolling Thin Film Oven retained penetration ratio were investigated as a means of providing a simple bitumen 'fingerprint' without necessitating additional or specialised testing. As both parameters are ratios, they would not be affected by variations within a grade but only by crude source or production route. It was found that these parameters were too imprecise for the purposes of characterisation.

*continued on page 24*

## New publications

(from page 23)

### **Road traffic noise: determining the influence of New Zealand road surfaces on noise levels and community annoyance**

Research Report 292

Vince Dravitzki, Opus International Consultants Ltd

Price \$25

International literature published to date has considered that tyre/surface noise does not have a significant effect on road noise for speeds below 60 km/h, and that a 3 dBA noise level change is just noticeable to most people. This makes the widely observed increases in community annoyance from road resealing hard to explain. The first part of this research investigates the effect that road surface type has on road traffic noise at urban driving speeds (50 km/h), and finds that the road surface does have a significant effect, with the surface contribution varying by up to 7 dBA between common New Zealand surface types. The effects of each surface differed for heavy and light vehicles, but were consistent over all tested driving speeds.

The second part of the research investigates the consequent effect on community annoyance, and finds that small changes in traffic noise level of as little as 1 dBA are matched with changes in behavioural disturbance. The behavioural disturbance index was found to be a more sensitive measure of noise annoyance than traditionally offered techniques. Finally, guidance on including noise considerations in road surface selection is offered.

### **Management of skid resistance under icy conditions on New Zealand roads**

Research Report 293

Neil Jamieson, Opus International Consultants Ltd

Price \$45

The effects of the de-icing agent Calcium Magnesium Acetate (CMA) on the magnitude and duration of skid resistance changes of a range of road surface types were examined through an on-road test programme on New Zealand state highways, during the winter of 2004. This involved a baseline survey of skid resistance on sites where CMA had been used in previous years, followed by a more focused series of skid resistance measurements made with different skid testers. These skid testers included an instrumented car, the British Pendulum Tester, and the GripTester.

Tests were conducted under various conditions, with and without CMA. Road surface types included fine and coarse chipseal, open graded porous asphalt (OGPA), asphaltic concrete and slurry seal. Comparisons were made between the different skid testers for the different surfaces, and different road surface conditions, both with and without CMA. Some potential implications for management of the use of CMA were examined.

## Land Transport New Zealand research programme relocating

From this month all Land Transport NZ research activities are relocating from the Christchurch office to the national office in Wellington. The new contact for all research activities is Patricia McAloon, Manager Land Transport Programme, direct dial +64 4 931 8796, mobile 021 223 1987, email [patricia.mcaloon@landtransport.govt.nz](mailto:patricia.mcaloon@landtransport.govt.nz)

Research publications should still be ordered from Land Transport NZ, Southern Regional Office, PO Box 13-364, Christchurch, phone +64 3 964 2866, fax +64 3 964 2855, email [research@landtransport.govt.nz](mailto:research@landtransport.govt.nz)

Research reports are also on the website at [www.landtransport.govt.nz/research/reports](http://www.landtransport.govt.nz/research/reports) and electronic copies are freely available to download.

## Notification of new research reports

We have established an email database through which we can advise those interested in the availability of the latest research reports as they are published. To add your name to this email list and receive news of the latest published reports, send your email address to: [research@landtransport.govt.nz](mailto:research@landtransport.govt.nz) with 'New publications notification' in the subject line.



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