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WAKA KOTAHI

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Your views

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Business as usual sooner after sealing

Speed delays following resealing can lead to traffic build-up and frustrated motorists. But new research has shown that traditional reduced-speed periods can be safely shortened, easing the resealing process for road builders and users.

In the past, roads have typically had traffic speed restrictions of 48 hours following resealing. The rationale for speed restrictions is sound, in that a period of lower speeds gives the chipseal time to bed down and set, reducing the possibility of damage to the seal itself, and to vehicle paintwork and windscreens from flying stone chips.

However, prolonged periods of 30km/h speed limits can lead to extensive traffic build-up, and delays and frustration for motorists, especially in busier areas. With the rising emphasis being placed on the needs of the motorist (a feature of the road building industry since the early 1990s), these delays are becoming increasingly unacceptable. Road controlling authorities are faced with balancing the need for a good seal with the aspirations of the travelling public, who want no speed restrictions but also no damage to their cars.

John Patrick of Opus International Consultants, who led the research project to find an alternative, says that the current fast turnaround alternative of using hot-mix asphalt instead of chipseal was at least four times more expensive. 'We urgently needed another solution, and our objective in the project was to find a combination of seal and binder type that would allow newly constructed chipseal to be reopened to normal traffic speeds within one working day.

'I'm pleased to say that we believe we have found that. By using the optimum choice of seal type and binder, and ensuring there is effective traffic control within those crucial first few hours after sealing, we found that the new seal could be opened to normal traffic much sooner than the traditional 48 hours.'

The important factors enabling a new approach are the significant changes over the past two decades in the types of materials, including seal types, being used on New Zealand's road network and the way the surface is constructed. Multi-coat seals, which use a small chip to lock a larger chip in place, have become increasingly popular, and these types of seals (two-coat, sandwich and racked-in) are able to withstand higher traffic stress. Polymer-modified binders, with the potential to increase the shear strength of chipseal, have also been introduced.

John says, 'The net result is that not only can we have less severe speed restrictions than the current 30km/h, but we can also open up the new seal to normal traffic within a much shorter time.'

The study used laboratory testing, and urban and open road field trials of newly constructed racked-in seal to test the hypothesis about lesser speed restrictions. The results were positive with the testing demonstrating that:

- racked-in seals can handle the stress of high-volume traffic
- racked-in seals can be constructed in an eight-hour working day, including sweeping and road marking
- by closely controlling chip allocation rates, contractors can ensure that there is minimal loose chip on the completed surface, which in turn means that there is a minimised risk of chips being flicked by vehicle tyres
- speed restrictions can be lifted to between 50 and 70km/h following line marking
- by ensuring that no bitumen is exposed to tyres, contractors can minimise chip pick-up and flick, and the risk of bitumen tracking
- the seal will withstand unrestricted traffic by the morning following the resealing (eight hours following road marking).

John says, 'Although the roads in the trials were only opened to traffic speeds of 50 to 70km/h on the first night after resealing, the excellent condition of the seals on the roads with lower traffic densities showed that in fact they could have been opened to unrestricted traffic flows as soon as construction was complete.

'In the report, we recommend that a requirement could be included in construction specifications that resealed roads are to be open to traffic speeds of at least 70km/h for peak evening traffic, which would go a long way towards addressing motorists' frustration at the delays caused by resealing.'

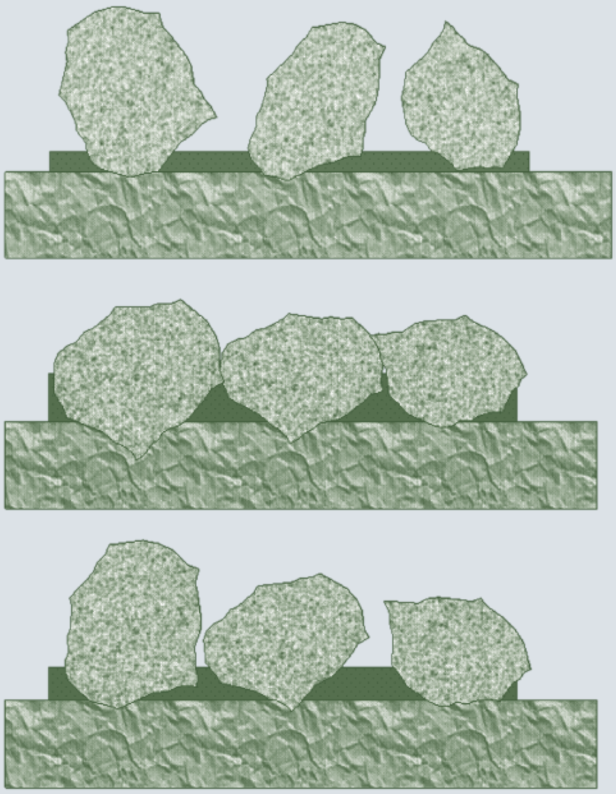
How chipseal works

For seal to be opened to traffic, it must have gained sufficient strength to resist the plucking and turning stresses of the vehicle tyres. Seal strength results from a combination of:

- the binder strength during and after construction
- the extent of binder coverage
- aggregate interlock
- adhesion of the chip to the binder and the binder to the substrate.

In a new seal, binder strength is low and is directly related to its viscosity. A low-viscosity binder allows adhesion to occur, while a high-viscosity one can significantly increase the time required.

As the new seal is compacted, first under the roller and then by traffic, the binder rises up around the chip. This increases the surface area of the chip in contact with the binder, resulting in greater chip retention and strength, and resistance to seal damage. The compaction process also moves and re-orients the chip, creating a chip mosaic, which further strengthens the seal.



Binder applied followed by chip

Chip movement and binder adhesion after rolling

Chip interlock and binder rise after exposure to traffic

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Minimising traffic delays during resealing, NZ Transport Agency research report 400.

Freely available online at *www.nzta.govt.nz/resources/research/reports/400.*

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Overseas cities demonstrate value of public transport network planning for New Zealand

Examining how the network planning approach has been applied overseas has provided useful guidance on how public transport services could be made more efficient and cost-effective in New Zealand.

Current transport systems in New Zealand cities rely overwhelmingly on the private car. Yet, for a variety of reasons, it is becoming increasingly important that more cost-effective and less polluting ways are found to get urban travellers around.

An NZ Transport Agency-funded research project has examined the network approach to public transport service planning (also known as network planning) as it has been applied overseas, to see what lessons can be learned for the local context.

Dr Imran Muhammad from the School of Environment and Planning at Massey University says, 'Because of their relatively small populations and dispersed settlement patterns, New Zealand cities face significant challenges in creating high-quality public transport services that offer a true alternative to the car. However, recent research has suggested that network planning is the critical element when it comes to making public transport successful in small and medium-sized cities, such as we have here.

'This criticality appears to be because network planning maximises the network's flexibility for travellers, by making it quick and easy for them to transfer between different services and modes. As a result, the services are more attractive and better patronised and the subsidy required from the government reduces.'

To better understand what it was about network planning that made it so important, and how this should be applied in a local context, the research compared three of New Zealand's main cities with three comparable cities overseas. Cities were selected that had similar characteristics to each of the New Zealand cities in terms of urban form, demographics and public transport infrastructure, with the final pairings being: Auckland and Vancouver; Wellington and Zurich; and Christchurch and Schaffhausen in Switzerland.

Network planning is used in all three of the overseas cities, with useful data already available about travel patterns and operating conditions within them.

What is the network approach?

Imran says, 'Public transport systems in Europe and North America have managed to serve a diverse range of users, such as commuters, shoppers and people without cars, while at the same time providing a high level of service and achieving good cost recovery. While there are undoubtedly factors at play in these places, such as high population densities, that make it easier to achieve good outcomes, service planning philosophies and strategies are also crucial, and this is where network planning comes in.'

Network planning makes use of transfers to provide a 'ready-made' service that can meet diverse transport users' needs. Instead of having 'tailor-made' public transport services (which cater specifically for different markets, but offer reduced environmental and economic advantages), the network approach enables 'anywhere to anywhere' travel by carrying different kinds of travellers on the same services. And because public transport systems using the network approach are based around transfers, they can still offer travellers access to a large number of destinations, while maintaining high occupancy rates and making the services economically viable for operators.

Imran says, 'Traditional public transport planning has treated transfers as an inconvenience to be avoided at all cost. With the network approach, transfers are the building blocks of a multidimensional system, and present many new travel opportunities for passengers. However, it is recognised that they also can cause inconvenience, so if you're aiming to create truly effective transfer-based public transport systems, then a lot of careful planning is required to ensure that any inconvenience is minimised.'

The recommendations

The full research report begins with a review of the international literature on the principles of network planning and its potential for improving the patronage and cost efficiency of public transport services.

The potential for achieving similar benefits in New Zealand was then examined by comparing experiences in Auckland, Wellington and Christchurch with those in the cities overseas. Local public transport operating practices are detailed and the major findings of the research presented. This includes a discussion of how network planning could be applied to the specific conditions found in New Zealand cities, including an analysis of institutions and public processes, network structure and network operations.

'We've also looked at the current policy framework for New Zealand's transport system, both regional and national, and identified those policies that are supportive and those that tend to act against improving patronage and efficiency for public transport operations,' says Imran.

'While regional land use planning has increasingly recognised the need to promote transit supportive urban forms, these policies cannot, on their own, ensure that public transport will improve. However, if they were coupled with the network approach, there is scope for important gains to be made.

'Further research is needed to quantify what the specific benefits would be. However, even from what we've seen so far through the project, we believe that there is considerable potential to improve public transport at an affordable cost and in ways that contribute to the government's strong economic growth agenda.'

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Public transport network planning: a guide to best practice in NZ cities, NZ Transport Agency research report 396.

Freely available online at *www.nzta.govt.nz/resources/research/reports/396.*

Hard copy $35.00.
Email *research@nzta.govt.nz* to order.

Opportunities for change

Comparing experiences here and overseas revealed three key areas of change that would improve service planning for public transport in New Zealand cities.

1 Appropriate institutions and public processes

- Establish a public agency to plan the network across the whole urban region.
- Redirect private sector competition into producing best value tenders for the delivery of part, or all, of a publically planned system.
- Use well-designed public education and consultation programmes to manage changes.
- Provide a simple fare system that avoids the imposition of penalties for transfers.

2 Network structure

- Provide a simple and stable network of lines throughout the day.
- Base mode choice for different lines in the network on required capacity, comfort and speed.
- Consider locations for suburban interchanges on the basis of predicted travel patterns and efficient vehicle operations.

3 Network operations

- Simplicity and directness
  - Organise the network on the principle of one section – one line.
  - Avoid deviations in the physical routes chosen for bus services.
  - Provide pendulum lines through key activity centres and interchanges.
- Speed and reliability
  - Aim for travel speeds comparable to or faster than door-to-door travel times that can be achieved by car.
  - Provide on-road signal and traffic-lane priority to allow buses to meet connections.
  - Aim to have vehicles stopping only as required to pick up and drop off passengers.
- Frequency
  - Establish 'forget-the-timetable' headways (10 minutes or less) in key travel corridors.
  - Set up integrated timetables outside high-frequency areas.
- Location of stops and access to services
  - Carefully plan the location of stops to minimise the number of stops and ensure their optimal location in relation to major trip attractors, intersecting lines and pedestrian access ways.
  - Locate stops in car-free precincts close to important destinations, to give public transport a significant competitive advantage.
  - Change current access to trunk services from park-and-ride facilities, to access by bicycle, walking or feeder bus, in order to cater for long-term growth in patronage.
  - Ensure that walking distances between services in interchanges are very short, preferably no more than 10 metres.
- Marketing for first-time and occasional users
  - Create a simple line structure that makes the network easy to understand.
  - Use maps, online information, vehicle livery and on-board displays to reinforce understanding of the line layout and transfer opportunities.

No cracks doesn't mean no water

Research has confirmed that water can be forced through chipseal surfaces, even when they display no visual signs of cracking.

Potholing, shallow shearing and rutting are all potential consequences of water being forced through pavement surfacing. And in pavements where the basecourse material is sensitive, the likelihood of these problems occurring is even higher.

Although several past research projects have looked at whether water penetrates chipseal, what has not been clear is how and in what conditions this occurs. A recent project, carried out between 2006 and 2008, has confirmed that traffic can force water through first-coat chipseals that do not show any visual signs of cracking, and that this occurs when a film of water settles on the pavement surface after a shower of rain.

John Patrick of Opus International Consultants who conducted the research says that such ponding tends to be associated with pavement geometry.

'It can occur either through rutting of the pavement, or when the crossfall and longitudinal shape of the pavement are such that rainfall does not disperse and a sheet of water forms on the surface.'

The research tested pavements at nine sites in Nelson, Taupo, Rotorua and Wairarapa. Measurements were taken on a variety of pavement surfaces and over a range of traffic loadings, with a nuclear density meter in backscatter mode used to measure the moisture content in the basecourse, both before and after rain.

John says, 'Although the testing showed a statistically significant increase in moisture over all sites, the increase was not dramatic. What the tests did confirm was the idea that water can be forced through a seal by traffic, although not to the extent we initially expected.

'However, we still consider the results to be significant. With the current push to use more marginal aggregates and recycled materials in pavement construction, the ability of the surfacing to keep moisture out of the basecourse becomes more critical.'

The research highlights the need to ensure that pavement shape is maintained, not only for safety reasons, but to retain the integrity of the pavement. It is also crucial when using marginal aggregates, to ensure that the crossfall is maintained, even in areas such as intersections.

The report recommends that specifications for basecourses, allowable rutting and high-build road markings be reviewed to take into account the new findings. It also urges pavement designers to take extra care to ensure that water ponding does not occur, especially in areas subject to high traffic volumes.

John says, 'What we need to do now is carry out further research into the relationship between the thickness of the surface water film and the rate of infiltration. We also need to look at the effectiveness of treatments, such as prime coats and second-coat seals, in impeding water ingress.'

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The waterproofness of first-coat chipseals, NZ Transport Agency research report 390.

Freely available online at *www.nzta.govt.nz/resources/research/reports/390.*

Hard copy $10.00.
Email *research@nzta.govt.nz* to order.

Requests for guidance met by project

Requests by road and stormwater managers for guidance on the types of roads most likely to release harmful contaminants into surrounding aquatic environments were the impetus for a recent research project, jointly funded by the NZ Transport Agency and the Auckland Regional Council.

Road runoff typically contains a range of metal and hydrocarbon contaminants that are released from vehicle component wear and emissions. Following rainfall, these contaminants are carried by road drainage systems to receiving water bodies, where they have the potential to be harmful to plant and animal life.

Although road runoff treatment devices are commonly used on motorways and busy urban roads, there is uncertainty among road controlling authorities about how effective these are, and whether, and in what circumstances, they should be used in other locations (for example on quiet urban or rural roads).

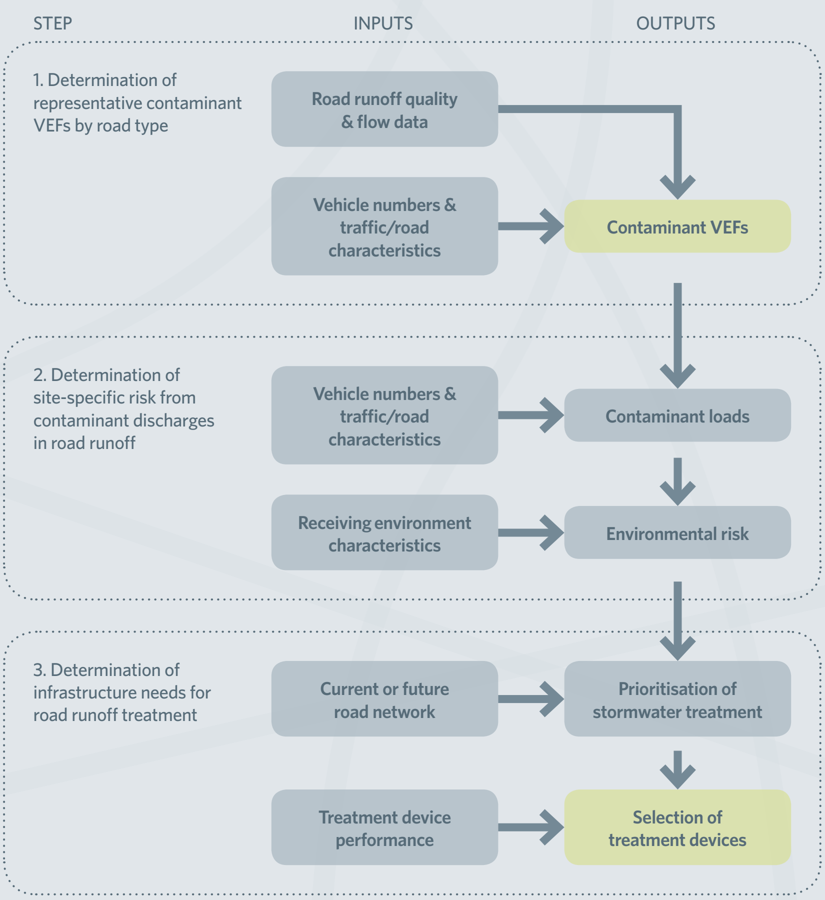
Research carried out at four sites in the Auckland region, between February 2008 and June 2009, looked at two of the areas that authorities have to take into account when planning road runoff control measures – variations in the loads of contaminants generated from different parts of the road network and the effectiveness of various road runoff treatments.

Urban aquatic scientist Jonathan Moores from NIWA was part of the team that conducted the research. He says, ‘Our long-term goal is to help improve the control of contaminants being washed off New Zealand roads. In this study, we sought to do this by providing information and guidance to make it easier for road managers to prioritise where road runoff treatments are needed and, having made that judgement, to select the control measures that are appropriate for those sites.

‘We've been able to do this through research by quantifying and providing guidance on the representative contaminant loads that you would expect for different types of roads, as well as on the effectiveness of various contaminant control measures that are already commonly used in New Zealand.’

The information needs and evaluation process that road authorities follow when deciding on local contaminant control

FIGURE 1 Information requirements and evaluation process for deciding on the measures needed to control contaminants from road runoff



The field programme

Road runoff volume was measured, and samples collected and analysed from four sites in the Auckland region. The sites were selected based on their traffic and road drainage characteristics, and the nature of the stormwater treatment systems already present.

The sites were:

- SH18 at Westgate – most congested, no treatment in place
- SH1 Northern Motorway at Northcote – congested, treatment by grass swales
- SH16 at Huapai – free-flowing traffic, adjacent roadside drainage channel
- SH1 Northern Motorway at Redvale – free-flowing traffic, treatment by a pond.

Instrumentation was installed at all of the sites to measure flow and collect water samples during storm events. Eight rainfall events were sampled at Redvale and Huapai, seven at Northcote and six at Westgate, with rainfall depths varying from 7 to 75mm, and sampling events ranging from 3 to 83 hours.

requirements is shown in figure 1. The green boxes are those addressed by the study.

The results

Although there are a number of metals and hydrocarbon compounds that are of concern with respect to road runoff, the study focused on zinc, copper and total petroleum hydrocarbons. Total suspended solids in runoff were also measured.

Runoff was collected and analysed from four sites in the Auckland region. Concentrations of copper and zinc were found to be higher at a congested site than at two sites where the traffic generally moved freely. This backed up previous New Zealand research that suggested that higher emission rates of these metals tend to coincide with roads where there is greater brake and tyre wear, while lower rates are generally associated with roads where traffic moves relatively freely.

However, in the study, substantially lower total suspended solids and metal concentrations were measured at a moderately congested site, which ran counter to expectations. This could have been due to recent resealing of the road with open-graded porous asphalt, which may have resulted in sediment and contaminants being trapped in voids in the road surface, rather than washed off to the road edge.

From the data, a contaminant accumulation/wash-off model was used to develop guideline vehicle emission factors (VEFs) for copper and zinc, for both congested roads and intersections, and 'normal' roads. These VEFs can be used to estimate loads of copper and zinc discharged in untreated runoff from any point in the road network.

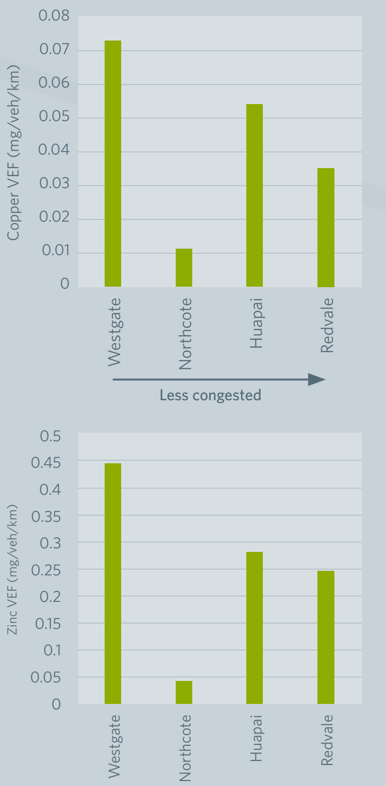
TRAFFIC CHARACTERISTICS	TOTAL COPPER (MG/VEH/KM)	TOTAL ZINC (MG/VEH/KM)
Normal traffic	0.047	0.28
Congested traffic & intersections	0.095	0.62

The second part of the study focused on measuring the performance of a stormwater pond, grass swale and roadside drainage channel with respect to treating road runoff. The three methods were assessed for how efficient they were at removing contaminants, and for how the quality of the runoff from them compared with water quality guidelines. Although not usually designed or constructed specifically to act as a contaminant control measure, the roadside drainage channel was found to be the most effective method for removing total suspended solids, copper and zinc. The pond was the least effective method, mainly because of its ineffectiveness in removing dissolved metals.

From the results, the study produced guideline load reduction factors that authorities can use to estimate the loads of copper and zinc that will be discharged following treatment by the three different control methods.

TREATMENT TYPE		LOAD-REDUCTION FACTOR		
		TSS	TOTAL COPPER	TOTAL ZINC
Vegetated swales and open roadside drains		0.6	0.8	0.8
Storm-water ponds	More vegetation	0.7	0.5	0.65
	Less vegetation	0.5		0.55

Estimated vehicle emission factors of copper and zinc



Using the study

Jonathan says the results from the study will be particularly useful for road authorities in two contexts.

'Authorities will be able to use the results as input data into existing models or tools used to guide assessments of the effects of road runoff discharges.

'Alternatively, they'll be able to apply the four-step approach that we've developed in the report, which provides a first-cut method for identifying the parts of the road network that most require treatment and potentially more detailed investigation.'

The four steps are:

- Step 1 – uses the VEFs recommended in the report to determine the loads of copper and zinc in untreated road runoff.
- Step 2 – uses the load-reduction factors (LRFs) in the report to estimate the copper and zinc loads that will be discharged following treatment of the road runoff.
- Step 3 – assesses the relative importance of contaminant discharges from different parts of the road network, with reference to existing information on the values of the receiving environment (where there is little existing information on these values, the comparison of loads can be used to prioritise the areas where further investigations are needed).
- Step 4 – repeats steps 2 and 3 to compare the extent to which alternative treatment measures will achieve the desired environmental outcome.

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Enhancing the control of contaminants from New Zealand's roads: results of a road runoff sampling programme, NZ Transport Agency research report 395.

Freely available online at *www.nzta.govt.nz/resources/research/reports/395.*

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Rationalisation of the structural capacity definition and quantification of roads based on falling weight deflectometer tests

Research report 401

Tonkin & Taylor Ltd, University of Auckland & MWH New Zealand Ltd

Freely available online at
www.nzta.govt.nz/resources/research/reports/401
Hard copy $35.00

Pavement performance modelling for New Zealand roading networks, currently relies on an adjusted structural number (SNP) which is a single parameter intended to describe the performance of a multi-layered pavement structure in terms of its rate of deterioration with respect to all structural distress modes, as well as non-structural modes. This parameter had its origin in the AASHO road test in the late 1950s, before the advent of analytical methods. Hence refinement to keep abreast of current practice in pavement engineering is overdue.

This research describes the basis for a new set of structural indices and how these can be used to obtain improved prediction of pavement performance – both at network level and for project level rehabilitation of individual roads. The results are:

- effective use of all the data contained in RAMM
- more reliable assignment of network forward work programmes
- reduced cost through targeting only those sections of each road that require treatment
- more efficient design of pavement rehabilitation through informed appreciation of the relevant distress mechanism that will govern the structural life of each individual treatment length.

Development of indicators for monitoring land use transport integration projects

Research report 402

CityScope Consultants Ltd

Freely available online at
www.nzta.govt.nz/resources/research/reports/402
Hard copy $35.00

This report sets out the process needed to develop a monitoring framework for integrated land use and transport projects. The report maintains that each project will need a unique set of indicators that reflect the specific outcome objectives for the project. The monitoring framework is therefore 'policy neutral', interpreting integration as a process rather than an outcome in itself. The process of getting agreement for the project outcomes is the starting point and the basis of integration, defined in this report as joint working for shared outcomes. The distinction is made between final outcomes (which may be difficult to measure and subject to influence by significant exogenous variables) and intermediate outcomes which are more readily measurable and logically linked to policy outputs. Input monitoring is also part of the framework, recognising the importance of committed finance and resources being available on time and in full to successful project outcomes.

Environmental and financial costs and benefits of warm asphalts

Research report 404

Opus International Consultants Ltd

Freely available online at
www.nzta.govt.nz/resources/research/reports/404
Hard copy $25.00

Warm asphalts are asphalts produced at significantly lower temperatures than the approximately 160°c that is typical of a hot mix plant. Depending on the technology used, laying and compaction may also be possible at significantly reduced temperatures. The report gives a summary of current warm asphalt technologies, followed by details of costs, temperature reductions and energy savings. A comparison is made of potential environmental costs and benefits of hot mix manufacture and the different warm mix methodologies.

NZTA research

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