Deficiency database and prioritisation progress report November 2005

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Summary

The deficiency database and prioritisation project is a project that has been jointly sponsored by the Ministry of Transport and Land Transport NZ. The requirement for this project to be undertaken eventuated through the rapid take-up of safety management system development by road controlling authorities throughout New Zealand. One of the fundamental outcomes of having a well-developed safety management system is for a road controlling authority to also have an operational safety deficiency database (SDD) and prioritisation process.

The Ministry of Transport and Land Transport NZ identified the benefit of evaluating the options currently available for deficiency databases both in New Zealand and overseas. While they are not in a position to dictate the use of software packages, there is scope to achieve an agreed and consistent baseline specification for such a database and prioritisation process.

The project sought to achieve three goals:

- To provide a baseline specification for a deficiency database and prioritisation process.
- To evaluate existing systems against the baseline.
- To develop and trial a very basic database (ie list) and prioritisation process.

To achieve the project goals above, the project has been divided into four stages:

- Stage 1 Establish a baseline.
- Stage 2 Evaluate existing systems.
- Stage 3 Develop preferred system/s, undertake trials and report.
- Stage 4 Publish findings and encourage take-up of the preferred system/s.

This report is the output of stages one to three, with stage four to follow at a later date in conjunction with other safety management system implementation activities.

Stage one involved the formation of a working group of industry representatives from road controlling authorities, consultants already involved in the development of such systems and representatives from the Ministry of Transport and Land Transport NZ.

The working group developed the attributes that should be considered when considering a deficiency database and prioritisation process.

Stage two provided an overview of existing systems both developed in-house and by third parties and some overseas systems from information that could be found from a literature search through and via the internet. New Zealand and Australian based consultants were questioned about the systems that they had developed and operated.

The output of this stage was an overview of the existing system/s that had been identified, a deficiency database and prioritisation process checklist (developed in conjunction with the working group) for those who were thinking of developing or researching existing systems.

Stage three involved the trial of existing systems by members of the working group with a common data input to ascertain:

(a) The baseline requirement for input data to provide effective storage and identification of a deficiency in a system and the subsequent prioritisation of those. In short, how much information is needed to input and rank deficiencies and does the data provided meet the minimum requirement to enable entry and prioritisation?

(b) How well the existing systems allow input, storage and prioritisation of the deficiencies.

(c) Whether or not the simple evaluation matrix provided with the test provided a method which allowed a usable, coarse ranking of the deficiencies.

(d) Whether the system checklist contains any gaps not yet identified.

(e) Whether a consistent result in terms of ranking could be produced from the calculation in the simple risk matrix (refer to Appendix D). [This requires the person entering the data to make a subjective evaluation as to whether the crash frequency, severity or exposure will reduce as a result of the treatment and by how much.]

The recommendations arrived at as a result of this report are as follows:

- It is important to first get the information contained within this report to a wider group of RCAs[1] and then get some feedback to determine their needs before any further research is done in this area.
- Land Transport NZ should develop a simple brochure, similar to the initial safety management system overview and disseminate an initial summary of this brochure first to their engineers and then to road controlling authorities. The brochure should include a flowchart showing the process steps required to develop a deficiency database and prioritisation process.
- This report should be provided to all Land Transport NZ engineers within the regions to ensure they are current with this work and to provide support to their road controlling authorities.
- This report should be provided to the road controlling authorities by Land Transport NZ engineers to enable them to work through any issues with the road controlling authority[2].
- The local Land Transport NZ engineers and the RCAs need to develop a plan to deliver an operational system based on:
  - what the RCAs need are, ie RCAs need to conduct a simple gap analysis (it would be worthwhile to have Land Transport NZ support/involvement in this process)
  - review the report to get a feel of what a deficiency database can do and:
    - decide what information from the report they can take to further understand their needs, and
    - come up with potential solutions, and check this against their needs, and
    - then determine what the best path forward should be for them and what support they require.
- Wider feedback on the weightings used in the simple risk matrix would be of value in ensuring they are reasonably robust and if applied nationally would provide a measure of consistency in outputs.
- That any system developed should be peer reviewed to ensure that the risk scoring and weighting used attains a level of consistency with other systems in use within New Zealand.

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[1] The project working group comprised a small number of RCAs who due to time constraints would not have had the chance to fully absorb all of the information and data being discussed in realising this report.

[2] Note: One significant issue identified in the evaluation stage was a need to ensure that RCAs who use risk as part of their prioritisation process have a clear and consistent understanding of the concepts of risk. This would be a good stage in the process for the Land Transport NZ engineer to clarify this with the RCA.

- It is important that any deficiency database and prioritisation system has the ability to filter out/sieve maintenance items, for action by the contractor, that are reported as deficiencies.

It should be noted that while outside the scope of this project the issue of data capture also needs to be discussed and further work done on providing advice to RCAs as to how they can undertake this within their existing work programmes.

Introduction Background to the project

Land Transport NZ is currently involved in the development of safety management systems (SMS) with road controlling authorities (RCAs), as one of the government's *Road Safety to 2010* strategy projects. One of the outputs from this is the development/use of a safety deficiency database (SDD[3]) by the RCAs.

As a result of safety management systems, RCAs who are now at the implementation stage are in the process of looking to develop a 'deficiency database'.

Land Transport NZ's *Guidelines for implementing a safety management system* defines a safety deficiency database as: '… a database maintained by the network consultant, which lists all of the known safety deficiencies on the road network. These deficiencies are then classified and ranked. Deficiencies, which are recurring but not preventable such as snow fall, flooding, etc are classed as such and listed in the hazard register. The safety deficiency database is dynamic and should be updated regularly.'

Currently there is no standard for such a database in New Zealand. There are a number of third party tools which are available to RCAs to create and/or manage deficiencies, such as OPUS Consultants software package SNAP and ARRB's Road Safety Risk Manager software. For some time Land Transport NZ has been involved in trials of the ARRB Road Safety Risk Manager software with a number of RCAs. Other available software packages had not been evaluated prior to this project.

As the need for a deficiency database and prioritisation process became pressing, Land Transport NZ in partnership with the Ministry of Transport identified a benefit of evaluating the options currently available both in New Zealand and overseas for deficiency databases. While they are not in a position to dictate the use of software packages by RCAs, there is scope for the consideration of achieving an agreed consistent baseline specification for such a database and prioritisation process. This project attempts to:

- provide a baseline specification for a deficiency database and prioritisation process
- evaluate existing systems against the baseline, and
- develop and trial a very basic database (ie, list) and prioritisation process.

To achieve the above the project has been divided into four stages as follows:

- Stage 1 Establish a baseline.
- Stage 2 Evaluate existing systems.
- Stage 3 Develop preferred system/s, undertake trials and report.
- Stage 4 Publish findings and encourage take-up of the preferred system/s.

[3] Note: Throughout this document the abbreviation SDD is used for safety deficiency database. The reader should understand that the use of the abbreviation SDD for this report encompasses a (safety) deficiency database and prioritisation system.

This report is the output of stages one to three, with stage four to follow at a later date in conjunction with other safety management system implementation activities.

There are two other ongoing Land Transport NZ projects which have some synergies with this project. These are:

- the road infrastructure safety assessment project (RISA), and
- the road side hazard management project.

A simple overview of these two projects is provided in Appendix F.

While it is inevitable that outcomes from each of these projects will provide feedback and inputs into one another, neither of these projects are yet at a stage to make full allowance of the other projects work. The information presented in this report should be disseminated to those involved with the two projects discussed above to ensure they are kept informed of progress and issues arising from the deficiency database and prioritisation process project.

1 Stage 1 Establish a baseline

Stage one of the deficiency database project involved establishing a working group and facilitating a workshop to establish baseline requirements. The workshop was held in Christchurch in April 2005. This section of the report is a documentation of the outcomes of this workshop.

1.1 The working group

Members of the working group were selected to ensure a valid representation of the key stakeholders. The members are:

- RCAs
  - Gore District Council, Murray Hasler
  - Dunedin City Council, Ron Minnema
  - Christchurch City Council, Kieron McGhie
  - North Shore City Council, Rohan Jayawardene
  - Masterton City Council, Abu Hasanuzzaman
- Transit NZ National Office, Ray Cook
- Consultants
  - Opus, James Park, Christchurch Office
  - ARRB, Rob McInerney, Queensland Office
  - MWH, Mike Smith, Christchurch Office
  - Beca, Shane Turner, Christchurch Office
- Land Transport NZ
  - Ian Appleton, National Office
  - Robyn Denton[4], Hamilton Office, Safety (unable to attend workshop)
  - Ian Duncan, Dunedin Office
- Ministry of Transport,
  - Alan Dixon, Wellington (unable to attend workshop)

[4] Following the formation of the working group, R. Denton changed positions within Land Transport NZ and resigned her position on the working group. Her place was subsequently filled by Bill Greenwood of Land Transport NZ, who was already providing technical advice to the project.

1.2 The workshop

Prior to the development of any new product (or service), it is vital to determine the customer's needs and wants, as these will drive the product requirements and then the product specifications. As customers' requirements can vary within the same market segment, it is vital to ensure the initial stage of the product development process is well thought through, and the expectations clearly defined.

The aim of the workshop therefore, was to determine the needs and wants of the customer ie, the RCAs, to allow for the development of the safety deficiency database requirements. Questions, using the basic process flow approach noted below, were put to the working group in order to develop the requirements of an ideal safety deficiency database.

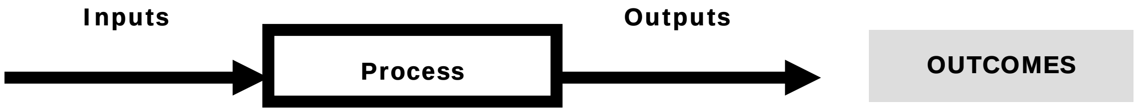

Figure 1 Process flow diagram

OPUS, MWH and ARRB consultants provided closed door, (ie other consultants not present) overviews of their systems to the members of the working group. A summary of the key features of those systems is noted in Appendix A.

The working group then revisited the earlier questions to ascertain if the information as presented by the consultants would influence or change their previous answers. The result is a list of customer requirements for a deficiency database and prioritisation process. This has been transcribed into the form of a process flow diagram, (see Figure 2 overleaf) based on Figure 1 above.

Data INPUT process attributes

- The system must be user friendly, simple to use and easy to access.
- The system should not require the use of engineering judgement when data is being entered, ie while an RCA engineer might be involved in the collection and identification of data, the system must be simple enough to ensure that data entered into the system could be done by administrative staff.
- The system should allow for the option to electronically transfer data from one system into another and also allow for manual transfer and input of data.

PROCESS design attributes

- The system must be able to generate responses quite rapidly – real-time responses are expected.
- The system must be able to store, analyse and prioritise the safety deficiencies identified.
- The system could be hosted internally or externally or could be a web-based system that is accessed as and when required. Large RCAs might wish to host and own the system, whereas small RCAs might wish to have the system hosted and owned by an external consultant.
- Contractors and consultants should be able to use the system. In some cases, they may own the system and use it to deliver services to RCAs.
- The system will be used as a tool to assist RCAs in their analysis of safety issues and safety expenditure – the amount of decision making capability that the system should have must be flexible.
  - At one extreme, the system could provide an analysis of different safety deficiencies, e.g. it could provide "what if" options when identifying solutions and the outcomes and costs of those solutions.
  - At the other extreme, the system could simply be used as a 'data repository', where pertinent details of safety deficiencies are simply recorded.
- The system must be designed to facilitate and process, where it adds value, the input of data into the system from different sources e.g. RAMM, CAS, etc.
- While the system might require the use of engineering judgement at the output stage to understand the outputs, the process to produce the outputs must be transparent and understandable to the lay person.
- It is important to appreciate that any system used by an RCA must be able to meet the IT requirements of the RCA, as these requirements will have a significant impact on how the system is hosted, used and operated within the RCA.
- The system needs to be able to capture new data on existing deficiencies and to be able to use this data to update the 'value' of the existing deficiencies.
- The system should be able to rank and prioritise the safety deficiencies on a range of different criteria – safety concerns, mitigation costs, high risk deficiencies, etc.
- The system should allow the RCAs to prioritise their projects by use of a 'safety return' criteria.
- The range and depth of safety deficiencies that the system must be able to record should be flexible – to facilitate the capture of every single deficiency identified on an RCA's network.
- Any system used must be simple, robust, accurate and secure.

OUTPUT attributes

- The information outputs of the system must achieve a sufficient level of quality to enable RCAs to obtain maximum value for money with respect to safety expenditure.
- The documentation produced by the system should provide a clear line for auditing.
- The system should ideally be able to provide specific reports for key areas or issues to be addressed.
- The information produced by the system needs to be in a format that should allow it to be exported/imported into other generic software – for example MS Excel, MS Word, LTP on-line.
- The information produced by the system must be able to support engineering judgement when decisions are made with respect to solutions to manage the risks being analysed.
- The information used must be able to clearly identify when and why engineering judgement is used in the analysis process and record any and all assumptions made throughout the process.
- The system should be able to produce reports of varying levels of complexity and detail, to meet the user's level of technical capability.
- The final reports from the system must be understandable to a wide range of people ie, easy to read by a wide audience, easy to understand and easy to defend and justify, although interim outputs could require engineering judgement to understand.
- The system should be able to provide ranked lists of all safety deficiencies identified and stored within the system.
- The system should ideally be able to produce a range of outputs eg, text reports, graphical, pictorial representations, etc.
- Reports produced on a micro level might be used by contractors as actions lists to rectify deficiencies.
- Reports produced on a macro level might be used by RCA engineers, management and politicians to analyse trends, develop strategies and policies.
- While the system would be developed with a view to meeting the safety issues and concerns, it should be adaptable in the future, to be able to capture and address information for a range of outcomes – environmental sustainability, etc.

OUTCOME attributes

- A dynamic record of all safety deficiencies noted and identified on the network.
- The safety deficiency database is at the heart of the SMS, in that all info on the network hazards and deficiencies feed into the system.
- The use of such a system should provide the RCA with some form of legal protection from risks identified by providing the RCA with a defendable position, in that it will show that the RCA has been able to identify and prioritise actions to address or mitigate the identified risks and hazards.
- The information produced should quantify all deferred risks, allowing the RCA to better manage their funding allocation.
- The information produced must be used by the RCA to allow it to determine whether they are able to obtain value for money with respect to safety spending.
- The use of the information produced from such a system should identify the consequences of politically driven decisions and as such increases the potential effectiveness of an SMS.
- Information produced by the system must be able to be used to analyse and address deficiencies to allow for the RCA to better manage their SMS.
- The system must only be used as a tool to assist the RCA to determine how it will manage its safety deficiencies – it is not the panacea, but a key tool to allow the RCA to meet it's SMS obligations.
- The use of the information produced by the system should allow the RCA to track and measure its safety performance.
- The system should be able to produce information that could be used on a national level by Land Transport NZ to identify national concerns and issues.

Figure 2 Deficiency database and prioritisation process attributes

2 Stage 2 Evaluation of existing systems

This section of the document provides a literature review of the safety deficiency database systems available in New Zealand from consultants here in New Zealand and in Australia and of systems used by RCAs here in New Zealand and local bodies in a number of other countries.

2.1 Methodology used

Information relating to existing systems local (already in use in New Zealand) and global (elsewhere in the world) was sourced by the following means:

- via Land Transport NZ regional engineers who were asked to identify which RCAs in their area had developed in-house deficiency databases and prioritisation process
- via RCAs who were members of the project working group and were known to have developed a system in-house
- via consultants within New Zealand, including OPUS, MWH, BECA, MAUNSELL and GHD
- via ARRB in Queensland
- via search of the internet
- via a search of Land Transport NZ's information centre for relevant articles, journals, etc.

The information and literature search undertaken should not be considered exhaustive, as the timeframe for the project dictated the amount of time allowed for this. The main focus adopted for this part of the international literature research, looked at combined deficiency database and prioritisation process systems rather than stand alone prioritisation processes of which there were a considerable number.

This section of the report is divided into three main parts:

(a) a summary of the relevant systems (section 2.2 to 2.4)

(b) identifies areas of commonality within the following categories (section 2.5):
  - New Zealand RCAs (including Transit NZ) (section 2.2)
  - Consultant products (section 2.3)
  - International safety deficiency database literature (section 2.4)

(c) a deficiency database and prioritisation process checklist for use by RCAs when making decisions on choosing or developing a deficiency database and prioritisation process systems, developed through the information above and feedback from members of the working group (section 2.6).

2.2 New Zealand RCA safety deficiency database

2.2.1 Transit NZ - Opus

Deficiency prioritisation and work assignment

Transit NZ assigns priorities against the deficiencies identified for determining remedial action as follows:

- urgent work (category A) – safety of road user is being endangered, work must be implemented urgently (priority work) to rectify the deficiency
- rectify under cyclic maintenance (category B) – completion of the work to rectify the deficiency will improve safety and can be programmed/implemented as part of the normal maintenance cycle
- desirable (category C) – desirable lower priority works which can be completed over a time frame that best suits the overall network strategy and short to medium term funding availability
- wish list item (category D) – prioritised for future work to be completed over a timeframe that best suits the overall network strategy and longer term funding availability
- project feasibility (category PF) – specific works whose specific nature and means of implementation can only be determined after further investigation and analysis by way of a Project Feasibility report.

Transit requires its network consultants to maintain a database to record the key information with regard to each deficiency identified during the course of undertaking the safety inspections and the respective priority treatment. The database must be able to retain outstanding deficiencies from the previous inspection cycle where action has not been completed.

Prioritisation criteria

This is a three step process:

1 The level of hazard probability is identified from a scale of frequent, probable, occasional, remote to improbable.

2 The category of the hazard severity is identified from a scale of catastrophic, critical, major, minor, negligible.

3 The risk level is then determined based on the level of hazard probability and severity on a simple risk matrix, resulting in a range of risk levels – low, medium, high and urgent.

This is not a scientific system but simply a judgement call which may be amended following detailed analysis using benefit cost analysis at a later stage. The benefit/cost ratio is used as a criterion upon which Land Transport NZ confirms funding for an improvement to the highway.

The costs are those affecting the roading authority and the funding organisation and comprise the costs of:

- project design and supervision fees
- property required for the project
- construction of the project
- maintenance of the project (routine and special maintenance).

The benefits are the tangible and intangible cost savings affecting the public, road users and non-road users – vehicle occupants' time, road crashes and operation of vehicles.

This information has been sourced from the Transit NZ SMS document for West Wanganui as developed by Opus, August 2003.

2.2.2 Transit NZ - MWH

Transit NZ will use a safety deficiency database (SDD) to effectively manage the prioritisation and implementation of remedies of safety deficiencies. The SDD is an amalgamation of all safety issues identified through the following sources:

- safety inspections
- crash reports
- analysis of RAMM
- CAS analysis
- black spots, grey spots, hot spots
- crash site monitoring
- stakeholder queries
- corridor management plans
- crash reduction studies.

The SDD contains the following information:

- query number
- state highway
- route station or route position
- physical location
- method and date of identification
- description of safety issue.

Upon entering the above information into the SDD, the following decisions are made:

- safety priority – each safety issue is prioritised according to its potential effect upon the safety of the road users, using the affected length of the state highway
- course of action – each safety issue is assigned an appropriate course of action
- target completion & actual completion dates.

This information has been sourced from the Transit NZ 'Transit Region 9 (Wellington) SMS, 2004', prepared by MWH.

2.2.3 Dunedin City Council

The Dunedin City Council safety deficiency database is an Excel spreadsheet containing the following information on each deficiency:

- category (pedestrian or cycling, etc)
- project description and RAMM location
- status of the deficiency – this year or carried over from the previous year

- the existing problem – a description of the deficiency
- the proposed solution – treatment for the deficiency
- status of the treatment – concept, estimate of cost, draft brief
- reported crashes
- prioritisation process:
  - Level (numerical) of hazard likelihood (L).
  - Level (numerical) of hazard consequence (C).
  - The pre-treatment risk is then calculated (L x C).
  - The treatment costs are estimated.
  - A benefit/cost ratio is calculated.

This information has been sourced from the DCC system SDD currently under development.

2.2.4 North Shore City Council

The North Shore City Council safety deficiency database is an Excel spreadsheet used to prioritise the deficiencies identified, using the following categories and weightings:

- vulnerable road users – scored from none through to school, retirement home or community facility (10 percent)
- vulnerable user crashes - scored from one through to three or more pedestrians per crash (15 percent)
- estimated cost - scored from less than $10,000 through to greater than $100,000 (10 percent)
- five-year crash history - scored from two or less non-injury crashes through to three or more injury crashes (15 percent)
- area of benefit or affected parties - scored from less than 10 households in street through to school, hospital or community facility (10 percent)
- Traffic observations - scored from one through to five or more issues (10 percent)
- exposure - scored from local road with less than 1,000 through to more than 12,000 vehicles per day (10 percent)
- community board - scored from low through to high (5 percent)
- public concerns - scored from low through to citizen action (5 percent)
- NSCC consultation – scored from one through to three or more Divisions within the Council (5 percent)
- Concerns from other agencies (LTNZ, TNZ, Police, etc) - scored from one through to three or more agencies (5 percent).

This information has been sourced from the safety prioritisation matrix used by NSCC.

2.2.5 Central Otago District Council

The Central Otago District Council has a policy for prioritisation of minor safety works as follows:

- all potential projects identified are scored with criteria and a weighting applied to each score
- the criteria is as follows:
  - crash history (30 percent)

  - consistency of standards (25 percent)
  - public approval (25 percent)
  - traffic volume (10 percent)
  - cost (10 percent).
- each criteria has a score of one through to five
- projects are ranked in descending order, where the highest score is the highest priority.

This information has been sourced from the prioritisation of minor safety works projects policy, adopted by the Operations Committee in 2004.

2.3 Consultant products

This information has been sourced from the Safety Deficiency Database Working Group workshop held 26th April 2005, Christchurch.

2.3.1 Opus – SNAP

- The Opus system, 'SNAP', focuses on safety using a central system. The hazard register (safety deficiency database) is one component within the entire SNAP package.
- The system is a standard tool for OPUS and was initially developed by practitioners to manage the Transit NZ network management contracts and is currently being modified for RCA use.
- This is a tool that Opus uses for most of their roading network management contracts.
- The system is used to register all the hazards identified on the network and as such is the key repository of all hazards and deficiencies captured from a range of sources.
- The system makes use of a risk reduction/cost ratio and a benefit/cost ratio. These two ratios are used to help the RCA to determine if they are getting the maximum value from the safety expenditure.
- At present Opus will download CAS data for the database every two months but could proceed into a live environment if required.
- The system is able to store records over time, allowing the user to evaluate their history and monitor past projects when planning for the future.
- The system is able to accept inputs from a range of sources, for example from specific inspections, studies, unreported crash data, Police data, Land Transport NZ data.
- SNAP offers flexible sorting and filtering options to view and output customised reports from the raw database records.
- The hazards are categorised to suit the standard Land Transport NZ roading programme work categories as they are input.
- The database records are colour coded to indicate their status, eg whether managed/unmanaged hazards.

2.3.2 ARRB – RSRM

- The ARRB road safety risk manager system is a database which is used to capture and store safety deficiencies by a number of authorities. The deficiencies and associated treatment options and value of treatment is stored to provide a prioritised works program of all issues on the network, and enable the status of an issue to be tracked. The model and associated database is designed for these safety assessments to be undertaken and varies from more simplified 'issue registers' and similar databases designed for call centre operation.
- The aim of the system is to be able to analyse identified and prioritised safety deficiencies and measure the value (risk reduction cost ratio and soon to be available the benefit cost ratio) of the different treatment options available to manage the deficiency.
- The outcome of the system is improved safety expenditure, by providing the best value for money safety treatment for each hazard identified.

- The heart of the road safety risk manager is the research behind all of the models within the system. This data is based primarily on New Zealand and Australian data, with key parts of the model tailored for New Zealand conditions.
- Austroads (includes NZ and Australian funding) has allocated AUD$ 700,000 per year for the next few years to continue the research and further the development of the models within the system. The programme has been the basis of eight years of research and development, with the pilot software evaluated and tested for a two-year period. The current version of the software has been available in the marketplace for nearly three years. A state-wide roll-out of the software to all local and state road authorities is planned in Queensland this year, with similar smaller activities completed by the state authorities in Western Australia, South Australia and Victoria.

2.3.3 MWH – NM2

- The MWH system has the ability to collect and collate data from a very wide range of sources.
- A new and improved system is currently being developed.
- Generally Transit NZ roads are ribbon roads, ie start and end point, and Local Authority Roads are nodal.
- Inputs collected at speed (with the survey vehicle driven at 80 km/h on the outbound journey and 100 km/h) in a rural environment, using a digital dictaphone which is then emailed and transcribed with the audio file saved to the server.
- The data from the database is capable of then being exported into Excel.
- It was noted that it is vital to record even maintenance deficiencies on such a database as this will allow trends with an underlying cause that is not a maintenance issue.

2.4 International safety deficiency database information

2.4.1 Clackmannanshire Council (CC), Scotland, UK

1 Objectives of the CC strategy to improve transport:

- Improve safety, by focusing attention on areas with child, pedestrian and cyclist casualties.
- Enhance the environment and quality of life, the importance of communities and integrate roads into neighbourhoods as part of scheme.
- Ensure fairness and opportunity for all. A number of smaller schemes could perhaps provide greater benefit than one or two larger ones.
- Encourage healthy travel by making it safe for walkers and cyclists, making it easy for ambulances, accessibility to buses.

2 Traffic management and calming

- Traffic calming – change to road alignments to reduce speed, traffic movement and to promote public transport.
- Traffic management – parking management, pedestrian facilities; speed limits and route hierarchy, traffic signs, road markings.

3 Prioritisation

- To eliminate bias (ie, prioritisation of schemes resulting from those 'who shout the loudest'), objective criteria should be applied to ensure efficiency and maximum benefits.
- Target zones – a single site/street or an area comprising multiple streets.
- Factors for traffic calming prioritization:
  - Accidents – averaged over preceding five years and given a rating based on number of personal injuries per km of road. Accidents involving pedestrians, cyclists and children also taken into account.
  - Traffic speeds – proportion of vehicles exceeding speed limits.
  - Traffic flow – calculating peak hour traffic flows.
  - Road geometry – influences the driver's perception of a route and hence vehicle speed; the road width is factored against the gradient of the road to assign a rating.
  - Frontage residents – the number of people residing in properties that front onto street ie streets more pedestrians will cross.
  - Pedestrian generators – buildings that generate pedestrian activity e.g. schools, hospitals, bus routes, playgrounds, community centres and shops.

This information has been sourced from Clacksweb – Clackmannanshire Council Online, www.clacksweb.org.uk)

2.4.2 Hampshire County Council, England, UK

1 Schemes to be assessed against the following headings:

- Congestion – congestion relief in target areas, congestion saving, contribution to demand management.

- Accessibility – tackling identified accessibility problems; access to work, learning, health, shopping, leisure; improving access to public transport, reducing social exclusion and promoting equality, infrastructure for the disabled, town centre access and access to the countryside.
- Safer roads – contributing to national targets, tackling accident record sites, safety improvements for children and vulnerable road users, speed management, accident saving (ROI).
- Air quality – impact in areas, encouraging low emissions, reducing output of specific air pollutants.
- Economy: Inward investment and retention of existing firms, access to new opportunities, balance of investment and external funding opportunities.
- Environment/quality of life – contribution to national objectives, alternatives to cars, environmental/community impact, landscape impact, neighbourhood renewal, community safety, health improvement, noise reduction, climate change, improving public spaces.
- Integration – contribution to wider network, delivering against passenger transport targets and walking/cycling targets.
- Value for money/added value – best options, consolidating past investment, ongoing cost implications, asset management, financial implications of not implementing scheme, availability of external funding, number of people likely to benefit from the scheme.

2 Deliverability

- Take account of scheme development, consultation, legislative, public inquiry etc requirements.
- General level of local support for scheme.

3 Proposed methodology

- Each scheme scored against above headings, given an individual mark and a cumulative score for every scheme – simple scoring to aid transparency of the process.
- 'Weighting' scores under particular headings, incorporating a 'multiplier' to certain headings to give higher priority to those which are considered more important, will need to be considered.
- The final decision on the scheme selection will rest with Exec taking into account the advice of the Panels.

This information has been sourced from 'Hantsweb', Hampshire County Council website, www.hants.gov.uk)

2.4.3 Mackay City Council, Australia

1 Difficulty faced by many authorities is the ability to determine the value of a potential remedial treatment when there is not an existing crash history at the location. The public will ask: do we have to wait until a crash occurs before something is done?

2 Investigation details – info on site, assessor and other project details.

  - Exposure – number of vehicles exposed to the hazard and associated treatment.
  - Likelihood – selection of the typical road environment at the location (eg, intersection or mid-block), assessment of how bad the particular problem at the site is (and how the treatment will rectify the situation), an assessment of the degree to which other factors (eg, weather, skid resistance) influence the risk at the site.
  - Severity – the severity of a crash if it does occur taking into account speed and crash type.
  - Risk reduction cost ratio – the initial and ongoing costs associated with the treatment, automatic calculation of the risk reduction cost ratio of the treatment.

- Action taken – details on the status of the issue (eg, pending, completed, no further action), actual works planned or undertaken.
- Reporting and budget analysis – a budget analysis tool to assess changes in treatment order, different reporting and ranking options suitable for technical review through to management summaries.
- Exporting and importing – the ability to transfer records between users for overall program management.

This information has been sourced from the paper 'Risk assessment for road networks and bridges', presented at the IPWEAQ Conference 2003.

2.4.4 The DUMAS (Developing urban management and safety) project, commissioned by the European Commission

The objective of DUMAS was to produce a framework for design and evaluation of urban safety initiatives, based on identifying key issues, defining framework for looking at effect on safety (eg, cost, affect on speeds, crashes, conflicts, road capacity), so that different issues can be compared.

This information has been sourced from the 'The DUMAS project – developing urban management and safety', www.trl.co.uk/dumas.

2.5 Areas of commonality identified in sections 2.2 to 2.4

Commonality was assessed in three distinct subsets of responses as follows.

2.5.1 New Zealand RCAs

The SDD systems used by RCAs in New Zealand utilise simple spreadsheets as the database and reasonably well developed criteria and calculations to assess and then prioritise the deficiencies.

The database function of the SDD is usually a spreadsheet used to capture key information about the deficiencies and issues identified on their network. All systems reviewed captured the following information on each deficiency:

- the physical location of the deficiency
- type or category or seriousness of deficiency
- a short description of the deficiency or issue
- any historic information about the particular 'segment' of road (number, type and seriousness of crashes, etc.)
- proposed treatment to address the deficiency and the cost of treatment.

There were two different approaches to the prioritisation process function of the RCA's SDD system.

- One approach is the use of a number of (weighted) criteria, each of which is scored, producing a final score (often a percentage). The priority of the deficiency is determined based on the final score and often is deemed to be high, medium or low. The criteria selected are often based on the key factors that the RCA feels are critical to determine the value of their safety expenditure.
- The second approach is the use of a risk calculation, where the risk is calculated by multiplying the exposure (or probability or likelihood) by severity (or consequence) for each deficiency. The priority of the deficiency is determined based on the final risk value.

Regardless of the approach followed to prioritise the deficiencies identified, the objective of each RCA's system was to provide the RCA's roading team with an ability to determine how to best manage deficiencies on their roads by being able to ensure they get as high a safety return as possible for every dollar spent.

2.5.2 Consultant products

The three systems reviewed – SNAP (Opus), NM2 (MWH) and Road Safety Risk Manager (ARRB) – have a number of features in common, though there are a few key points of difference between SNAP and NM2 and Road Safety Risk Manager.

SNAP and NM2 have the following similarities:

- Both systems have reasonably sophisticated database features, especially in comparison to the systems used by the RCAs. These databases are able to capture a very wide range of information about each deficiency identified, allowing for a greater ability to manage, manipulate, utilise and report this information.
- The two systems utilise a variation on the risk calculation (risk = exposure x severity) to calculate a risk score. The risk calculation is used to determine a pre-treatment risk score, which is then used to prioritise all the deficiencies captured within the database.

- Both systems require treatment options to be developed by use of engineering judgement. The cost for each treatment option is then determined and a post-treatment risk (the resulting reduction in the risk once the treatment has been implemented) is then calculated.

The ARRB Road Safety Risk Manager does have the capability to act as a database and is able to prioritise the deficiencies in terms of the pre-treatment risk, but its real strength is in its ability to determine the 'safety return per dollar spent' for each treatment option developed for a deficiency. This feature is based on the level of sophistication of the risk calculation utilised and the quality and quantity of data used by the system to develop the post-treatment risk calculation.

2.5.3 International practice

Information obtained on systems used in other countries did not contain detail about the database capability but tended to focus on the criteria that should be used by local authorities when looking at how they address safety issues on their roads. Some systems used criteria that could be best described as traditional roading criteria such as crashes, traffic flow, road geometry and frontage residents, and others used a much wider focus with criteria such as air quality, economy impact and quality of life.

Once again, as with RCA systems in New Zealand, the focus was on being able to ensure the best safety return for each dollar spent on treatments to the identified deficiency.

2.6 Deficiency database and prioritisation process checklist

2.6.1 Methodology used

A safety deficiency database is comprised of two key parts – a deficiency database and a prioritisation process.

1 The deficiency database is a system used to capture, store, manipulate and manage information on deficiencies on the road network collected from a range of data sources.

2 The prioritisation process is a risk assessment model that can be applied to the data collected and stored within the database, to produce a range of responses that the user will use when deciding which deficiencies need to be treated and the value of the treatments (ie, the safety return gained by the use of the treatments).

A potential safety deficiency database checklist was developed following a literature review of systems used by RCAs and consultants in New Zealand and systems developed by local authorities around the world. The working group was required to determine which of the characteristics noted in the potential safety deficiency database checklist were essential or added value:

- **Essential** for such a system to function and deliver value to the RCA's SMS.
- **Added value** over the essential elements, to provide further functionality.

A potential process an RCA might use to capture, assess and prioritise deficiencies identified on an RCA's network is as follows:

1 The deficiency is noted on the RCA's network and recorded in the RCA's safety deficiency database (SDD) system. Information on each deficiency is captured and recorded in the system eg, location and type of deficiency, method of identification, person or group responsible for identifying the deficiency.

2 The deficiency is assessed to determine its significance. The deficiency is assessed by analysing the following three aspects:
   - Likelihood of the deficiency – the chance or probability that a road user will be effected or impacted by the deficiency. This data might be based on CAS data.
   - Exposure of the deficiency – the potential for a road user to be exposed to the deficiency. This measure might be based on AADT data.
   - Severity of the potential – the 'damage' the deficiency might cause. This data might be based on CAS data and experience.

3 Once frequency, severity and exposure are noted in the SDD system, a risk score is calculated for each deficiency.

4 The risk score is then used to prioritise all the deficiencies recorded in the SDD system. This prioritised list then allows the RCA to determine the priority for the development of treatment options to address the list of the deficiencies.

5 Engineering judgement is then used by the RCA, to develop the most appropriate treatment (and cost) for each deficiency.

6 Once treatment has been developed and costed, the post-treatment risk is then calculated to determine the safety return for each deficiency treated.
   - The post-treatment risk is calculated via the use of engineering judgement to determine the new values of likelihood, exposure and severity following the implementation of the treatment.

- The post-treatment risk calculation is a measure that allows the RCA to track safety spending to ensure the highest priority risks are treated with a fixed budget.

The following tables provide:

1 The potential characteristics a safety deficiency database might have.

2 The responses from the consultants within the working group as to which characteristics were determined to be essential for a safety deficiency database to function and deliver value to the RCA's SMS.

3 The responses from the RCAs within the working group as to which characteristics were determined to be essential for a safety deficiency database to function and deliver value to the RCA's SMS.

4 The essential characteristics for a safety deficiency database to function and deliver value to the RCA's SMS.

The working group results were determined as follows:

- Only three RCAs within the working group were able to provide their responses for the deficiency database and prioritisation process checklist.
- Three of the consultants were able to provide their responses for the deficiency database and prioritisation process checklist.
- The working group total is a summation of the responses from the three RCAs and the three consultants.
- The essential characteristics are the deficiency database and prioritisation process characteristics selected by more than 50 percent of the RCAs and consultants.

2.6.2 Working group feedback

2.6.2.1 Results- inputs

Data characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Deficiency location				
Use RAMM method of identification	100	100	100	®
Use RCAs own method of identification	100	0	50	
Key information required				
• Road name	100	100	100	®
• Section of road	100	67	83	®
• District, ward	100	67	83	®
• Physical location	100	100	100	®
• Side of road	67	67	67	®
• Type of road (rural, city, etc)	0	100	50	
• Direction of travel	33	100	67	®
• Speed of road	33	67	50	
• GPS location of deficiency	33	67	50	
• Comments (plain text)	33	67	50	
GIS display to locate deficiency	0	33	17	

Data characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Deficiency information				
Deficiency number	100	100	100	®
Date identified	100	100	100	®
Method of identification	33	67	50	
When deficiency was caused	0	33	17	
New or existing deficiency	0	33	17	
Data sources				
• Safety inspections	100	100	100	®
• Crash reports	100	67	83	®
• Analysis of RAMM	67	67	67	®
• CAS analysis	67	67	67	®
• Black-spots, grey-spots, hot-spots	100	67	83	®
• Crash site monitoring	67	67	67	®
• Stakeholder queries	100	67	83	®
• Public queries	100	67	83	®
• Crash reduction studies	100	67	83	®
• Corridor management plans	67	67	67	®
• Safety studies	67	67	67	®
• Safety audits	100	67	83	®
• Contractor information	100	67	83	®
Identified by who	100	100	100	®
Description of deficiency				
• Type of deficiency	100	100	100	®
• Size of deficiency	67	100	83	®
Cause of deficiency	0	0	0	
Crash data recorded				
• Number of crashes	100	67	83	®
• Type of crashes	100	67	83	®
• Seriousness of crashes	100	67	83	®
Comments (text)	67	67	67	®
AADT for road	33	67	50	

Data characteristic	Consultants responses	RCAs responses	Working group	Essential characteristics
Deficiency category				
Category of treatment				
• Scheduled maintenance	100	100	100	®
• Unscheduled maintenance				
− Urgent	100	100	100	®
− Non-urgent	100	100	100	®
• Minor safety	100	100	100	®
• Capital project (Project feasibility study)	67	67	67	®
Deficiency programming				
Is the deficiency to be assessed	67	100	83	®
If the deficiency is not to be assessed, why not	33	33	33	
Date deficiency will be assessed	0	100	50	
Date deficiency was assessed	33	67	50	
Has assessment been deferred	0	67	33	
Why has assessment been deferred	0	33	17	
Risk of deferring the deficiency assessment	0	67	33	
Cost of deferring the deficiency assessment	0	67	33	
Is the deficiency to be treated	100	100	100	®
If the deficiency is not to be treated, why not	67	33	50	
Date treatment will be proposed	0	67	33	
Date treatment was proposed	0	33	17	
Date treatment will be implemented	33	67	50	
Date treatment was implemented	67	67	67	®
Outcome if deficiency not treated				
• Potential crash or increase	0	67	33	
• Seriousness of crashes	0	67	33	
• Degradation of asset	0	67	33	
• Minimum consequence	0	0	0	
Treatment solution to address deficiency	67	100	83	®
Person responsible for developing solution	33	100	67	®

Data characteristic	Consultants responses	RCAs responses	Working group	Essential characteristics
Deficiency programming, continued				
Person responsible for implementing solution	67	100	83	®
Status of solution implementation	67	100	83	®
Cost to develop solution				
• Estimate/provisional sum	67	100	83	®
• Quote provided	33	33	33	
Cost to implement solution				
• Estimate/provisional sum	67	67	67	®
• Quote provided	33	33	33	
Funding source				
• RCA & Transit NZ amounts	67	67	67	®
• RCA accounting code(s)	67	67	67	®

2.6.2.2 System characteristics

System characteristic	Consultants responses	RCAs responses	Working group	Essential characteristics
Systems use				
Frequency of data entry				
• Daily	100	33	67	®
• Weekly	100	67	83	®
• Monthly	100	67	83	®
• Periodically	100	33	67	®
Skill required for those entering data				
• Admin – unskilled in use of system	0	0	0	
• Admin – skilled in use of system	100	100	100	®
• Technician – unskilled in use of system	0	0	0	
• Technician – skilled in use of system	67	67	67	®
• Engineer – unskilled in use of system	0	0	0	
• Engineer – skilled in use of system	100	67	83	®
Entry method				
• Manual data	100	100	100	®
• Importing electronic data	67	100	83	®

System characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Information storage				
Years				
• 1–2	0	67	33	
• 2–3	0	33	17	
• 3–4	0	33	17	
• 4–5	0	67	33	
• > 5	100	33	67	®
Track deficiency treatments over time	100	67	83	®
System to be able to store attachments	33	67	50	
System 'familiarity'				
Systems to use common software features	100	100	100	®
Systems to use uncommon software features	0	0	0	
System terminology				
Terminology to be RCA focused	67	33	50	
Terminology to be common NZ-wide	67	100	83	®

2.6.2.3 Process characteristics

Data characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Criteria used to assess risks				
Factors considered for treatment				
3 Cost	100	100	100	®
4 Risk				
– Frequency	67	100	83	®
– Severity	67	100	83	®
– Exposure	67	100	83	®
• Benefits	67	100	83	®
• Location	67	100	83	®
• Extent of problem	67	100	83	®
• If future works are programmed at site	100	67	83	®
Parties impacted by deficiency	0	67	33	

Data characteristic	Consultants responses	RCAs responses	Working group	Essential characteristics
Criteria used to assess risks, continued				
Crashes				
• History	67	67	67	®
• Seriousness	67	67	67	®
Vulnerable road users	67	67	67	®
Vulnerable road user crashes	67	67	67	®
Political concern	33	67	50	
Community board concern	0	100	50	
Police concern	33	100	67	®
Public concern	100	100	100	®
Other agencies concern – Land Transport NZ, Transit NZ, etc.	67	67	67	®
Is it a key item in Road Safety Strategy	67	100	83	®
Traffic volume	100	100	100	®
Risk assessment				
Risk before treatment				
• Likelihood value	67	100	83	®
• Exposure value	67	100	83	®
• Severity value	67	100	83	®
• Result in a risk score	67	100	83	®
Risk after treatment				
• Likelihood value	67	100	83	®
• Exposure value	67	100	83	®
• Severity	67	100	83	®
• Result in a risk score	67	100	83	®
Risk reduction of treatment				
• Risk reduction score/percentage	100	100	100	®
• Cost-benefit score/percentage	100	100	100	®
Ability to evaluate multiple treatment solutions	67	67	67	®
Date assessment carried out	67	100	83	®

Data characteristic	Consultants responses	RCAs responses	Working group	Essential characteristics
Decision making capability				
Analysis of individual deficiencies	67	100	83	®
Analysis of treatments for each deficiency	67	67	67	®
System location				
Hosted internally by RCA	100	33	67	®
Hosted externally by consultant	33	33	33	
Web-based system	0	100	50	
Accessible by consultants	67	67	67	®
Accessible by contractors	67	33	50	
System size				
Must be able to store 100s of deficiencies	0	33	17	
Must be able to store 1000s of deficiencies	33	67	50	
Must be able to store 10,000s of deficiencies	33	67	50	
Must be able to store 100,000s of deficiencies	67	0	33	

2.6.2.4 Output characteristics

Data characteristic	Consultants responses	RCAs responses	Working group	Essential characteristics
Course of action				
Deficiency assigned appropriate action	67	100	83	®
Deficiency assigned to right person	67	100	83	®
Note if further investigation is required	100	67	83	®
Mode of treatment				
• Safety works programme	100	100	100	®
• Existing maintenance contract	67	67	67	®
• New maintenance contract	67	67	67	®
Dates of action				
• Date action proposed-solution confirmed	0	67	33	
• Date action to commence	33	67	50	
• Date action has commenced	33	67	50	
• Date action to be completed	0	67	33	
• Date action has been completed	67	67	67	®

Data characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Output media				
Hard copy	100	100	100	®
Export				
• MS Word	100	67	83	®
• MS Excel	100	100	100	®
• LTP on-line	0	0	0	
Report format				
• Text	100	100	100	®
• Graphical	33	67	50	
• Pictorial	33	0	17	
Reports produced				
Sort by				
• Date deficiency entered	67	100	83	®
• Date deficiency assessed	67	67	67	®
• Date deficiency treated	67	67	67	®
• Status of treatments	67	67	67	®
• Deficiency ranking/priority	67	67	67	®
• Risk ranking pre-treatment	67	67	67	®
• Risk ranking post-treatment	67	67	67	®
• Amount risk reduced	67	67	67	®
• Treatment cost	67	67	67	®
• Benefit/Cost ratio	67	67	67	®
• Deficiencies treated	100	67	83	®
• Deficiencies to be treated	100	67	83	®
• Deficiencies per maintenance area	100	33	67	®
• Deficiencies per maintenance contract	100	33	67	®
• Deficiencies per contractor	100	33	67	®
• Contractor per maintenance area	100	33	67	®
• Type of deficiency per network	100	67	83	®
• Type of deficiency per part of network	67	33	50	
• All deficiencies per network	67	67	67	®
• All deficiencies per part of network	67	33	50	
• Type of treatment options	67	67	67	®
• Type of treatment solutions	67	67	67	®
Provide clear line for auditing	100	100	100	®

Data characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Users of reports (system outputs)				
RCA engineers	100	100	100	®
RCA politicians	67	67	67	®
RCA management	100	67	83	®
Land Transport NZ	67	67	67	®

2.6.2.5 Outcome characteristics

System characteristic	**Consultants responses**	**RCAs responses**	**Working group**	**Essential characteristics**
Value of system to RCA				
System to capture deficiencies				
• All deficiencies on network	67	67	67	®
• Key deficiencies on network	33	100	50	
• New deficiencies on network	67	67	67	®
• Existing deficiencies on network	100	67	83	®
Formal system				
• To prioritise or rank deficiencies	100	100	100	®
• To prioritise minor safety projects	67	100	83	®
Decision making tool to assist RCA				
• To prioritise or rank deficiencies	100	100	100	®
• To prioritise minor safety projects	67	100	83	®
Reason for use of system				
• Decision making tool	100	100	100	®
• Provide formal process	100	67	83	®
• Provide ‘hard facts’	100	33	67	®
• Provide solutions to deficiencies	67	67	67	®
Holistic approach to managing safety issues	67	100	83	®
More proactive response to safety projects	100	100	100	®
Enhanced strategic knowledge of RCA’s assets	100	100	100	®
More focused efforts to achieve 2010 targets	100	100	100	®
Greater value for safety expenditure	100	100	100	®
Provide legal protection	100	100	100	®

2.6.3 Overview of the feedback summarising significant differences between consultant and RCA responses

There are very few differences (ie, ratio of two to one differences [eg, 66 percent : 33 percent], about 30 differences from 200+ characteristics) and there is no readily identifiable pattern.

The one characteristic type that does have about 10 differences is the deficiency programming characteristic. One possible reason for this is that the consultant systems are inherently more complex than the RCA systems and allow additional analysis of data.

2.6.4 Deficiency database and prioritisation process checklist

Based on the responses received above, a checklist of recommended characteristics for a deficiency database and prioritisation process has been prepared and is attached in Appendix G.

3 Stage 3 Develop preferred system, undertake trials and report

3.1 Introduction

The third stage of the deficiency database and prioritisation process project involved the trial and evaluation of a range of existing safety deficiency database systems used within New Zealand. A total of four systems were evaluated – SNAP (Opus), Risk manager (ARRB), Dunedin City Council's system and a simple risk matrix developed in Excel by the project consultant.

Each member of the working group was provided with an evaluation pack, containing the following information:

1 A set of test instructions detailing the aims and process to be followed during this evaluation stage. The instructions also contained a simple questionnaire to be completed by members of the working group (refer to Appendix B for the responses to the questionnaire).

2 Methodology detailing the process that was used to capture and record the test case data.

3 A spreadsheet (refer to Appendix C) with the test data for the case study, the test case pick-up form, indicating which columns were filled out during the physical inspection and which columns were filled out in the office.

4 A very simple risk matrix (refer to Appendix D) has been developed for use by smaller RCAs or RCAs who wish to trial a simple system before committing to developing their own or purchasing a proprietary package.

The purpose of this test is to evaluate five things:

(a) The baseline requirement for input data to provide effective storage and identification of a deficiency in a system and the subsequent prioritisation of those. In short, how much information is needed to input and rank deficiencies and does the data provided meet the minimum requirement to enable entry and prioritisation.

(b) How well the existing systems allow input, storage and prioritisation of the deficiencies.

(c) Whether or not the simple evaluation matrix provided with the test provides a method which allows a usable, coarse ranking of the deficiencies.

(d) Whether the system checklist contains any gaps, not yet identified.

(e) Determine whether a consistent result (in terms of ranking) could be produced from the calculation in the simple risk matrix (refer to Appendix D), as the person entering the data will need to make a subjective evaluation (preferably based on engineering judgement) as to whether the crash frequency, crash severity or exposure will reduce as a result of the treatment and by how much.

3.2 Methodology for data capture

Data capture for the test evaluation was undertaken[5] using a simple hard copy of the test case pick-up form (refer to Appendix B). This limited the number of fields to those that were collected on-site, additional data was added back at the DCC council offices. The data was collected using a two-person team in a drive over at operating speed in both directions, taking:

- around one and a half hours door to door to collect the field data
- an hour was required for field data input into the spreadsheet
- two hours required to input additional data including rough order costing of treatments.

Maintenance items were also collected in this list and while these still require to be logged in the systems under evaluation they would not require to be prioritised for this test.

The treatments proposed were not selected from a number of suitable treatments at each site as there were concerns about the amount of input this would require of the working group, they were simply agreed (by engineering judgement) practical solutions to the identified deficiency.

For some deficiencies more than one treatment option had been supplied, with the expectation that the respondents would prioritise both in the system they used for the test evaluation.

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[5] With the assistance of Ron Minnema from Dunedin City Council, Transportation Planning Department.

3.3 Simple test matrix

A very simple risk matrix (refer to Appendix C) was developed for use by smaller RCAs or those wanting to trial a simple system before committing to developing their own or purchasing a proprietary package. This system had the following sections:

- Information about each deficiency identified and recorded noting the location, description and treatment options for the deficiency.
- The pre-treatment risk rating, using risk = exposure x severity x frequency, where:
  - exposure is the AADT for the road
  - severity is the seriousness of crash
  - frequency is the number of crashes per year.
- Pre-treatment priority (based on the above pre-treatment risk calculation).
- Treatment costs – both individual costs and cumulative costs for all the deficiencies.
- The post-treatment risk rating, using risk = exposure x severity x frequency, where one (or potentially more than one) of the risk components would be decreased due to the implementation of the risk treatment. It is at this point that the use of engineering judgement comes into play with this test evaluation.
- Post-treatment risk reduction, noting the following:
  - reduction ratio (pre-treatment risk rating over post-treatment risk rating)
  - priority (based on the ranking of the reduction ratio)
  - the cumulative cost, based on the reduction ratio priority ranking.
- Value of safety expenditure, noting the following:
  - reduction per $1,000 spent (reduction ratio over cumulative cost)
  - priority (based on the ranking of the reduction per $1,000 spent).

3.4 Outcomes of test evaluation

3.4.1 Baseline requirement for input data

In general, the working group members noted that the fields used in the test case pick-up form were suitable for a basic level safety deficiency database, as these were the essential items of information required. In order to provide further value, the following further sources of data for input into a safety deficiency database were suggested:

- images of the location/hazards would be useful, particularly if the assessor doesn't have good local knowledge of the area
- indication of speed limit / advisory speed would be useful
- approach speed of traffic
- always need the length of hazard to be provided
- where relevant, indication of proportion of commercial vehicles would be good as RSRM allows for this for certain road types
- note characteristics of site such as lane width, shoulder width (sealed and unsealed), available clear zone, hazard severity, type of terrain, horizontal alignment, delineation, overtaking provision, left and right turn provision, sight distance, intersection or road section type
- indication of ongoing treatment costs and treatment life
- street address, side of street

Thus, the agreed baseline (essential) fields for data input into a deficiency database system are as follows:

- deficiency number recorded in the system
- road name
- direction of travel
- side of road
- RAMM RP of side road
- distance from side road
- left or right on road
- type of hazard
- operating speed at hazard
- comments (ie, text)
- AADT
- proposed treatment
- treatment cost

3.4.2 Capability of existing systems

A total of four systems were evaluated – SNAP (Opus), Risk manager (ARRB), Dunedin City Council's system and a simple risk matrix developed in Excel, by the project consultant.

In section two of this report a safety deficiency database comprised of two key parts – a deficiency database and a prioritisation process.

1 The deficiency database is a system to be used to capture, store, manipulate and manage information on deficiencies on the road network, collected from a range of data sources.

2 The prioritisation process is a risk assessment model that can be applied to the data collected and stored within the database, to produce a range of responses that the user will use when deciding which deficiencies need to be treated and the value of the treatments (ie, the safety return gained by the use of the treatments).

The two consultant systems, SNAP and Road safety risk manager, offer the two key functions - a deficiency database and a prioritisation process. The Dunedin City Council system and the simple risk matrix evaluated are both simple Excel based spreadsheets, used to capture essential information about the deficiencies and use a very simple risk calculation (risk = severity x frequency).

The simple risk system was a very basic approach to a deficiency database and prioritisation process. It was developed for use by smaller RCAs or RCAs wanting to trial a simple system before committing to developing their own or purchasing a proprietary package. This simple system has a number of weighted criteria, which led to a number of working group members questioning whether the criteria selected were weighted appropriately.

The two consultant systems were very sophisticated products and as such had a considerable amount of capability with both the database function and the prioritisation process. The risk calculations for both the consultant systems were quite complex in comparison to the simple risk matrix and as such were able to be fine-tuned.

3.4.3 The value of the simple risk matrix

The key issues noted with the simple risk matrix are as follows:

- There were a number of data entry issues where incorrect data was entered into the wrong fields, or the wrong values were selected.
- The amount of time spent using the system – from entering the data (from the test case pick-up form into the simple risk matrix) through to using the calculations in the matrix – ranged from 30 minutes through to four hours. Those taking less time were able to use administrative staff within their organisations to input data into the matrix and then just focus on the prioritisation steps.
- A number of the working group were not comfortable with the weightings provided for the three elements of the risk calculations (exposure, severity and frequency) and as such a number of suggestions were provided.
- The resulting priorities (pre-treatment, post-treatment, risk reduction) were noted as being easy to interpret and were deemed to be of value to the members as a potential tool to assist RCAs with the safety expenditure decision making process.
- There was general agreement that the use of engineering judgement would be best applied during the prioritisation process of the matrix and not at the stage where data is entered into the system.
- There did seem to be some confusion or potential lack of comfort by a couple of respondents of basic risk management theory. This was apparent with some of the post-treatment risk calculations where there did not seem to be a sound appreciation of the elements of risk (severity, exposure and frequency) and the relationship between these elements.

3.4.4 Identify gaps in the SDD checklist

The general response from the working group members was that the systems they used met the essential requirements of the SDD checklist. As expected, the two consultant systems (Risk manager and SNAP) were able to provide superior functionality over the Dunedin City Council system and the simple risk matrix.

3.4.5 Requirement to apply a first sieve to the data

The evaluation data deliberately included some deficiencies that would be typically dealt with by cyclic maintenance. The response in the evaluation to this data was mixed, with some respondents ignoring that it was a maintenance item, and therefore not needing to be prioritised.

Any deficiency database should be able to record all deficiencies and then be able to sieve/filter out those deficiencies that are maintenance items so that they can be dealt with under maintenance (either scheduled or unscheduled).

4 Conclusions

4.1 Summary

A representative group of the customers of a safety deficiency database, the RCAs, have determined that a safety deficiency database is comprised of two key parts – a deficiency database'and a prioritisation process. The deficiency database is a system used to capture, store, manipulate and manage information on deficiencies on the road network, collected from a range of data sources. The prioritisation process is a risk assessment model that can be applied to the data collected and stored within the database to produce a range of responses. It helps the user decide which deficiencies need to be treated and the value of the treatments (ie, the safety return gained by the use of the treatments).

In order for a safety deficiency database to assist an RCA in delivering its SMS, it must have these two functions to allow it to capture required information about a range of deficiencies identified on their network and then be able to analyse and assess these deficiencies.

A literature review of safety deficiency database systems available in New Zealand from consultants both here and in Australia and used by RCAs and local bodies in a number of other countries, resulted in the creation of a set of essential characteristics for an optimum safety deficiency database.

The set of essential characteristics is the minimum requirement (as determined by a set of working group representatives) for the safety deficiency database to allow the RCA to meet its SMS obligations. These characteristics will allow the RCA to record and track the progress of all their identified deficiencies and enable the RCA to assess and value the safety significance of these deficiencies. The assessment and subsequent prioritisation of the recorded deficiencies will allow the RCAs to get a maximum safety return from their safety spending.

A key set of essential characteristics is the information collected and recorded within the safety deficiency database. It is vital to capture a basic amount of information about each deficiency identified on the RCA's network, as this information is required to locate any deficiency in the future and to assess and then prioritise that deficiency.

Finally, if an RCA is currently working through the process of selecting or developing a safety deficiency database, it should review the simple risk matrix developed as part of this project to ensure it is able to identify the key aspects required of a safety deficiency database.

4.2 Recommendations and suggestions for the next step for Land Transport NZ and the Ministry of Transport

It is important to get feedback on this report from a wider group of RCAs[6] in order to determine their needs before any further research is done in this area.

Wider feedback on the weightings used in the simple risk matrix would be of value in ensuring they are reasonably robust and if applied nationally would provide a measure of consistency in outputs.

To get the information contained in this report out to the wider RCA group, we suggest the following:

- Ensure all Land Transport NZ regional engineers are familiar with this report so they can provide support to their RCAs.
- Develop a simple brochure, similar to the initial SMS brochure, providing an initial summary of this report. It should be distributed firstly to Land Transport NZ engineers and then to the RCAs. The brochure should include a flowchart showing the process steps required to develop a deficiency database and prioritisation process.
- Land Transport NZ local engineers will then distribute the report to the RCAs, so they can work through the RCA issues. The Traffic Management Liaison Group meetings may also be a suitable forum for this information.
- Land Transport NZ engineers and the RCAs then devise a plan based on:
  - what are the RCA's needs ie, RCAs need to conduct a simple gap analysis
    - determine what their (the RCAs) needs are with respect to a SDD, eg
      - how do they do this now?
      - what will they need to do to deliver their SDD?
    - review the report to get a feel of what an SDD can do and decide
    - what information from the report can they take to further understand the needs and come up with potential solutions
    - compare this to their needs
    - determine what the best path forward should be for them and what support they need.

Most of the smaller RCAs could commence with a simple spreadsheet to capture information (ie, the deficiencies) and then work (possibly with a consultant) to get these reviewed and prioritised periodically throughout the year.

It is important to sell the entire value of the SDD and give the RCAs information and assistance (through Land Transport NZ engineers) to develop and implement the right solution for each RCA.

In order to achieve a level of national consistency in how such systems are developed and operated, it is important that a peer review of the weightings and risk scoring in any prioritisation process used is undertaken. It seems logical that as Land Transport NZ will have a key role in funding any outcomes from the systems eg, minor safety works, capital improvements, they should take a lead in peer reviewing weightings and risk scoring methods used in the systems.

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[6] The project working group was made up of a small number of RCAs, and due to time constraints, didn't have the opportunity to fully take in all of the information and data being discussed and feedback sought in realising this report.

Additional note

(a) The issue of data capture needs to be discussed and further work undertaken on providing advice to RCAs on how they can undertake this within their existing work programmes. The mechanics of data capture are, however, outside the scope of this project and thus will not be discussed further in this document.

Appendix A Consultant systems/products: a summary of features (as presented)

MWH – NM2

- The MWH system has the ability to collect and collate data from a very wide range of sources.
- A new and improved system is currently being developed.
- Generally, Transit NZ roads are ribbon roads, ie start and end point, and local authority roads are nodal.
- Inputs are done at speed 80 km/h out and 100 km/h in a rural environment using a digital dictaphone which is then emailed and transcribed with the audio file saved to the server.
- The data from the database is capable of then being exported into Excel.
- It is vital to record even maintenance deficiencies on such a database as this will allow trends with an underlying cause that is not a maintenance issue to become apparent.

Opus – SNAP

- The Opus system, SNAP is focused on safety using a central system. The hazard register (safety deficiency database) is one component within the entire SNAP package.
- The system is a standard tool for OPUS and was initially developed by practitioners to manage the Transit NZ network management contracts and is currently being modified for RCA use.
- This is a tool that Opus uses for most of their roading network management contracts.
- The system is used to register all the hazards identified on the network and is the key repository of all hazards and deficiencies captured from a range of sources.
- The system makes use of a risk reduction/cost ratio and a benefit/cost ratio. These two ratios are used to help the RCA determine if they are getting the maximum value from the safety expenditure.
- At present Opus will download CAS data for the database every two months but could proceed into a live environment if required.
- The system is able to store records, over time allowing the user to evaluate their history and monitor past projects when planning for the future.
- The system is able to accept inputs from a range of sources, for example, from specific inspections, studies, unreported crash data, police data, Land Transport NZ data.
- SNAP offers flexible sorting and filtering options to view and output customised reports from the raw database records.
- The hazards are categorised to suit the standard Land Transport NZ roading programme work categories as they are input.
- The database records are colour-coded to indicate whether they are managed or unmanaged hazards

ARRB – Risk manager

- The ARRB road safety risk manager system is a database. The database is used to capture and store safety deficiencies by a number of authorities. The deficiencies and associated treatment options and value of treatment is stored to provide a prioritised works programme of all issues on the network, and enable the status of an issue to be tracked. The model and associated database is designed for these safety assessments to be undertaken and varies from more simplified issue Registers and similar databases designed for call centre operation.
- The aim of the system is to analyse identified and prioritised safety deficiencies and measure the value (risk reduction cost ratio and soon to be available the benefit cost ratio) of the different treatment options available to manage the deficiency.
- The outcome of the system is improved safety expenditure, by providing the best value for money safety treatment for each hazard identified.
- The heart of the system is the research behind all of the models within the system. This data is primarily based on New Zealand and Australian data with key parts of the model tailored for New Zealand conditions.
- Austroads (includes New Zealand and Australian funding) has allocated AUD$700,000 per year for the next few years to continue the research and further the development of the models within the system. The programme has been the basis of eight years of research and development. The pilot software was evaluated and tested for a two-year period and the current version has been available in the marketplace for nearly three years. A statewide rollout of the software to all local and state road authorities is planned in Queensland this year, with similar smaller activities completed by the state authorities in WA, SA and Victoria.

Appendix B Working group questionnaire responses

(Total responses received = 8)

1 If you were going to capture data while out in the field, would you use different or additional fields?

- *Images of the location/hazards would be useful, particularly if the assessor doesn't have good local knowledge of the area.*
- *Indication of speed limit/advisory speed would be useful.*
- *Approach speed of traffic.*
- *Always need the length of hazard to be provided.*
- *Where relevant, indication of proportion of commercial vehicles would be good as RSRM allows for this for certain road types.*
- *Note characteristics of site such as lane width, shoulder width (sealed and unsealed), available clear zone, hazard severity, type of terrain, horizontal alignment, delineation, overtaking provision, left & right turn provision, sight distance, intersection or road section type. However, as mentioned images and/or local knowledge would assist with this greatly, and for most assessments this works very well.*
- *Indication of ongoing treatment costs and treatment life.*
- *Street address, side of street.*
- *A separate column for estimated maximum crash severity. The input into this new column would be numbers 1 to 4 to match the categories on the calculation sheet.*

2 For data captured out in the field, would your preference be hard copy, dictaphone, personal digital assistant (PDA) or other (please list)?

- *Since the Road safety risk manager software can be easily used by road safety professionals (ie, engineers, technical officers), data format can be captured as suits individual using the programme. Use of a laptop in the field is also an option although most users undertake assessments based on an image taken and assessed in the office.*
- *Dictaphone in the field recorded in order for data entry, thereby allowing the observer to concentrate on deficiencies.*
- *Safety inspections/mode inspections would use dictaphone as you are at/or near road speed.*
- *Theme inspections may use dictaphone/notepad/sheets/PDA/digital tablet.*

3 Did the process your SDD followed meet the SDD checklist requirements?

- *The assumptions field associated with the RSRM also provides a method to document any non-standard issues identified.*
- *The general response was that the SDD used did meet the SDD checklist requirements.*

4 Having worked through this evaluation, is there anything missing from the SDD checklist that has come to your attention as a result of going through this process?

- *Crash results should be separated from general comments and be entered into own column.*

- Possibly some cross-referencing checks to ensure incorrect data is disallowed eg, incorrect RAMM AADT information.
- *Also maximise automation to minimise inputting required eg, crash frequency, severity (if using numbers as suggested above) and exposure for the pre-treatment could all be calculated and input from the raw input data without manual reference to calculation sheet. For the post-treatment the same can normally happen for the exposure unless a road/lane is closed so the ability to manually override would be needed. Even crash severity and frequency figures should both transfer automatically to the post-treatment columns, as only one of these is likely to change. These figures could be colour-coded to highlight that they are default figures and could change colour if manually changed.*

5 How long did it take you to process the data – input data through to development of outputs?

- *Approximately 10 to 15 minutes per investigation (hazard and treatment) scenario. If images had been supplied and we were more familiar with the location (as would be the case for real assessments) this time would be quicker. Time taken also depends on level of detail required in assumptions etc. For these assessments completed remotely detailed assumptions were required.*
- *A total of 30 minutes, including some construction of the worksheet.*
- *About an hour.*
- *Two hours.*
- *Four hours.*
- *One hour.*

6 Is the length of time taken to input the data into your SDD acceptable?

- *Yes – the RSRM is quick and easy for practitioners to use. For issues with a similar hazard type, scenarios (hazards and treatments) may be evaluated even quicker through using the duplicate hazard functionality of the software. For very small/cheap issues that do not require prioritisation, a simple hazard register as part of an asset management system would suffice, as opposed to the safety deficiency database.*
- *Three other respondents noted Yes and one noted No.*

7 Is there something about the process that is to onerous and do you believe it could be acceptably shortened?

- **If so what is it?**
- **Why is it?**
- **How would you shorten it?**

- *ARRB have developed a network level risk assessment tool that will be used throughout Queensland and can be easily applied in New Zealand. Discussions are taking place with Southland to run such a project. The outcome would see the proactive identification of road safety hotspots based on engineering features. This could be used to set up a road safety hierarchy on the network from which intervention or response policies can be formulated for quick and easy response. For higher cost items or hazard and treatment prioritisation the RSRM can be used.*
- *Best input by skilled typist.*

- *Also someone experienced with SDD form/process.*
- *Maximise opportunities for automation of process as long as safeguards, and where appropriate, ability to override available.*

8 Was the risk matrix we provided you to use clear, easy to use and did you feel comfortable while using it?

- *Did not use in detail. In our research and trials we have found these models are so broad that variation between users is significant, and that the sensitivity of the factors and their influence on the score magnitude often do not translate well into practice and expected outcomes. Relaying these models down to an individual specific hazard is often not appropriate when considering the true causal factors of a crash and issues that influence crash outcomes.*
- *Had to do some fine-tuning to allow category sorting and category definition*
- *Could use an example to start.*
- *Yes.*

9 Do you agree with the weightings used in the risk matrix we provided you? If not, why not and what do you feel the weightings should be?

- *Uncomfortable with many of the weightings. Difficult to relate the impacts of treatment (many different options) to the factors used.*
- *They are linear which is not strictly correct for crash prediction, however it must be emphasised that the system DCC used is for administrative purposes to address in general the highest risk sites taking into account council strategies for which no specific funding is provided.*
- *I generally agree and especially with the RCA setting the tolerance levels. The tolerance levels suggested would be far too low as they are.*
- *The point rating for serious injury should be between 35 and 45 instead of 18.8. There should be another crash severity criteria called medium injury between fatal and serious injury crash and its rating point may be considered 18-22.*

10 Were the results of your SDD easy to interpret?

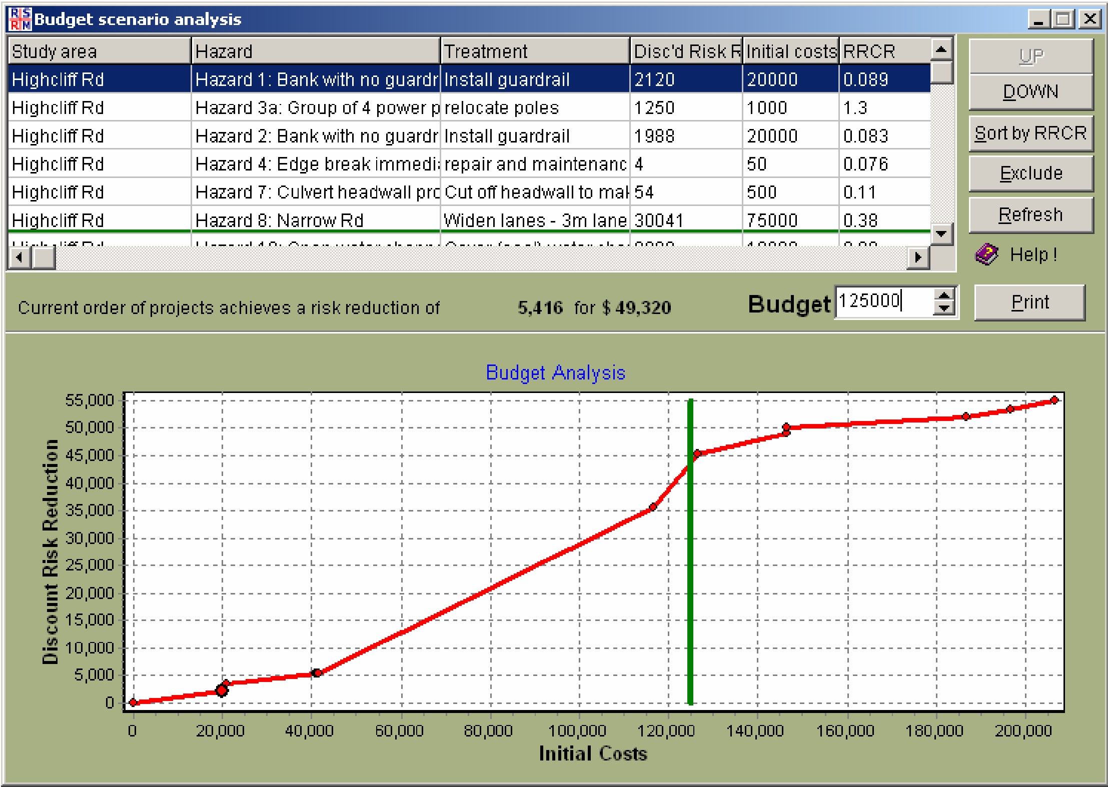
- *Yes. Each assessment ends with a risk reduction cost ratio at the end of the process. The projects may then be compared and sorted according to those that deliver the best road safety <u>benefit per dollar spent</u>. The new version of RSRM due later this year will have BCR as an output.*
- *Could possibly include a running priority.*

11 Was additional information needed to ensure your SDD was able to provide a basic level of output?

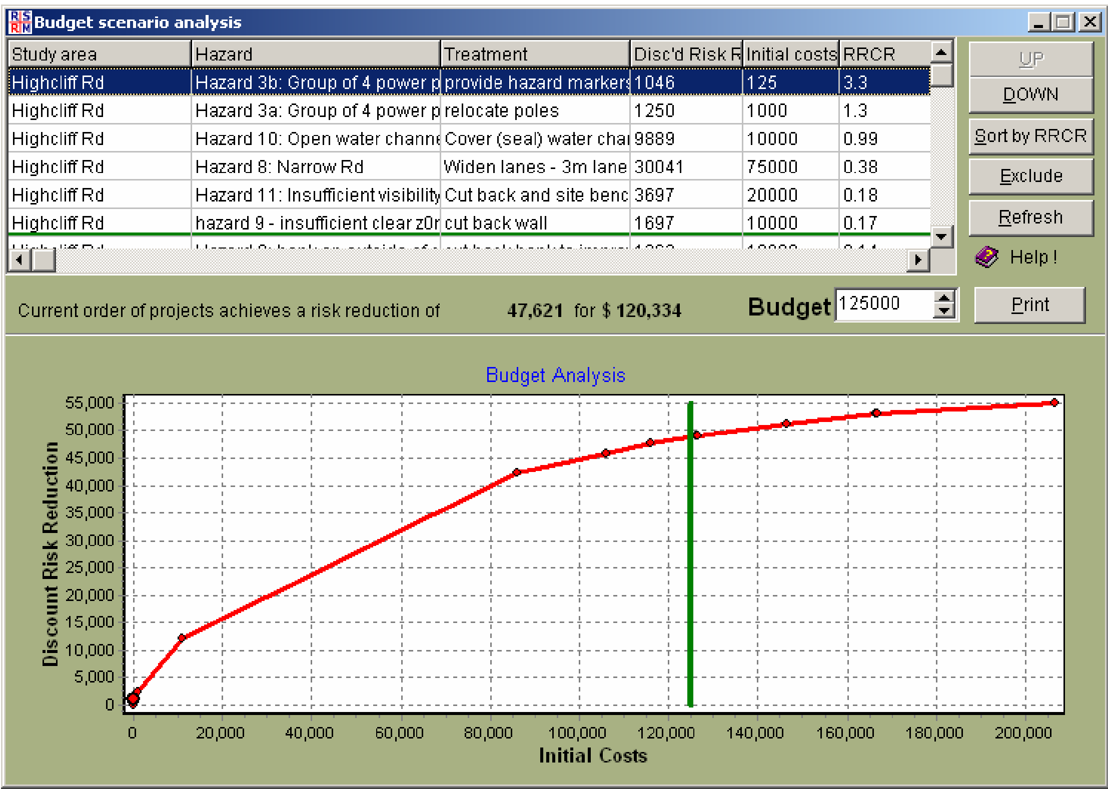
- *All respondents noted No*

12 Did the output attained by your SDD seem reasonable?

- *Yes, because (as seen in graphs on the next page) the lower cost higher safety benefit projects were recommended to be completed first, resulting in a higher safety benefit to be achieved for a limited budget.*
- *The graph on the next page shows a works programme for a budget of $125 000. The projects that are able to be completed under the current programme ($125 000) achieve a risk reduction of 5,416 points (this is arbitrary value as used by RSRM). The current projects are sorted according to how they were entered into the system.*



- *The following graph shows the same works programme as above. Once the projects are sorted according to risk reduction cost ratio, a risk reduction of 47 621 points is achieved for the same budget (this is arbitrary value as used by RSRM).*



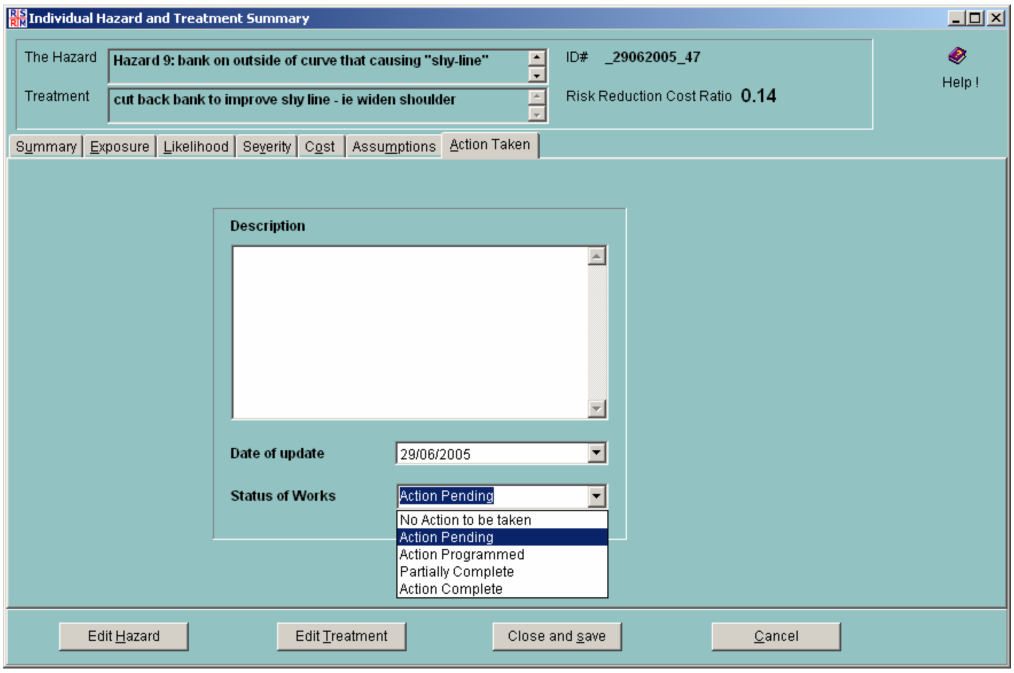
- *All other respondents noted Yes.*

13 Do you feel, using engineering judgement, that the prioritisation order of the deficiencies produced by your SDD is appropriate?

- *All respondents noted Yes.*

14 Any other comments you might have.

- *The Road safety risk manager allows a great range of flexibility in its use. It may be used to determine a capital works programme, minor works programmes and even manage complaints/suggestions received from the general public regarding road safety issues (given a hazard and appropriate treatment is identified). It provides the benefits of seven years of research and development and an ongoing heavy investment by Austroads (via programme managed by Bill Frith) to ensure the detailed knowledge of the impact some 70 different deficiency types have on road safety outcomes. With a risk approach, TLAs can use the RSRM to assess issues that may or may not have direct crash histories associated with them – which is often the case on lower volume roads. In addition, it allows the status projects to be tracked through the life of the project via an action taken tab.*



- *The DCC's system attempts to prioritise deficiencies based on need and does not take into account the capital cost. It is purely a system for prioritising the sites with the highest need for investigation thereby avoiding the need to investigate low priority sites.*
- *Traffic volume should carry through spreadsheet automatically.*
- *The crash data order changed to reflect calculation sheet ie, frequency first and severity, etc.*
- *Should have running total of risk information.*

Appendix C Evaluation case pick-up form

FIELD SHEETS											OFFICE								
Manual input											Automatic					Manual input			
No.	Road name	Direction of travel		Side road	RAMM RP of side road	Dist from side rd (m)		Left or right on road	Type of hazard	Operating speed at hazard (km/h)	Comments	No.	Road name	Road RAMM ID	RAMM RP of hazard		AADT	Proposed treatment	Treatment cost
		Incr RP	Dec RP			Start	End	Incr. RP							Start	End			
1	Highcliff Rd	Incr.	-	Hilton Rd	2375	450	450	L	Bank with no guardrail	70	> right hand bend, no guardrail > fence only > steep drop-off > estimated severity SERIOUS-FATAL > 50m long	1	Highcliff Rd	878	2825	2825	700	Install guardrail	$20,000
2	Highcliff Rd	Incr.	-	Hilton Rd	2375	4200	4200	R	Bank with no guardrail	45	>left hand bend > out of context with operating speed > chevron 45km/h on bend > estimated severity SERIOUS >50m long	2	Highcliff Rd	878	6575	6575	700	Install guardrail	$20,000
3	Highcliff Rd	Incr.	-	Hilton Rd	2375	5300	5300	L	Power pole	70	> power pole x 4 @ 70m spacing offset from edgeline 1.5m > non hazard markers > estimated severity SERIOUS to FATAL	3	Highcliff Rd	878	7675	7675	700	Option 1 relocate poles > Option 2 install hazard markers	Option 1 $1,000 per pole total cost $4,000 > Option 2 $125 per pole TOTAL cost $500
4	Highcliff Rd	Incr.	-	Hilton Rd	2375	7000	7000	R	Edge break	30-40km/h	> edge break immediately adjacent to edgeline on the inside of LH bend above culvert. If wheel caught driver would lose control. > estimated severity MINOR to SERIOUS> 10m	4	Highcliff Rd	878	9375	9375	300	Repair - maintenance @$5/m	$50
5	Highcliff Rd	Incr.	-	Hilton Rd	2375	7000	7400	L	Overhanging trees	70km/h	>branches on large overhanging caracara could fall on road or vehicle> estimated severity MINOR to SERIOUS	5	Highcliff Rd	878	9375	9775	300	Investigate for treatment if required	-
6	Highcliff Rd	Incr.	-	Hilton Rd	2375	7700	7700	L	Solid wall	60km/h	> left hand bend > wall approximately 0.5m from edgeline > estimated severity MINOR to SERIOUS> could bounce off and drive off RHS of road over bank.	6	Highcliff Rd	878	10075	10075	300	Improve delineation on approach, cut back wall, rebuild- still with clear zone so install guardrail.	$40,000

FIELD SHEETS												OFFICE							
Manual input												Automatic					Manual input		
7	Highcliff Rd	Incr.	-	Hilton Rd	2375	7800	7800	L	Culvert headwall	60km/h	>culvert headwall protruding 200mm above road level > would cause sudden deceleration> estimated severity MINOR to SERIOUS	7	Highcliff Rd	878	10175	10175	300	Cut-off headwall to make flush or no more than 100mm above road surface	$500
8	Highcliff Rd	Incr.	-	Hilton Rd	2375	8200	9200	L/R	Narrow road	40km/h	> too narrow to mark centreline > Edge line's marked > potential collision with wide vehicle > estimated severity MINOR	8	Highcliff Rd	878	10575	11575	300	Widen seal to provide for 2-lanes	$75,000
9	Highcliff Rd	Incr.	-	Hilton Rd	2375	9000	9000	L	Bank	40-50km/h	>left hand bend > bank on apex of curve (suspect rock) > estimated severity MINOR	9	Highcliff Rd	878	11375	11375	300	Cut back bank to improve shy-line	$10,000
10	Highcliff Rd	Incr.	-	Hilton Rd	2375	9000	9500	L	Bend	40-50km/h	>ditch parallel to road immediately adjacent to edgeline could get a wheel caught given the narrow width > estimated severity MINOR (single vehicle) SERIOUS (multi-veh)	10	Highcliff Rd	878	11375	11875	300	Form sealed water channel	$10,000
11	Highcliff Rd	Incr.	-	Hilton Rd	2375	9700	9700	L/R	Bend	40-50km/h	>limited visibility around bend > insufficient width to cater for a car or truck travelling in opposite	11	Highcliff Rd	878	12075	12075	300	Cut back and site bench plus seal widen on bend	$20,000
12	Highcliff Rd	-	Dec.	Seaton Rd	14466	300	400	R	Overhanging trees	40-50km/h	> risk of falling branches > shade to carriageway contibutes to ice	12	Highcliff Rd	878	14166	14066	300	Investigate for treatment if required	
13	Highcliff Rd	-	Dec.	Seaton Rd	14466	1200	1200	R	Carriageway defect	40-50km/h	> 20m > reverse super> surface breaking -up> estimated severity MINOR	13	Highcliff Rd	878	13266	13266	300	Maintenance issue	

FIELD SHEETS												OFFICE							
Manual input												Automatic					Manual input		
14	Highcliff Rd	-	Dec.	Seaton Rd	14466	1400	1500	R	Rock fall	40-50km/h	> unstable bank > could have rock fall> estimated severity MINOR	14	Highcliff Rd	878	13066	12966	300	Option 1 sign for rock fall > option 2 bench and stabilise	Option 1 two signs at $250 each = total $500 > Option 2 $100,000
15	Highcliff Rd	-	Dec.	Seaton Rd	14466	1700	1900	R	Potholes	40-50km/h	> if hit at speed, risk of losing control > estimated severity MINOR (single veh) SERIOUS (multi head-on)	15	Highcliff Rd	878	12766	12566	300	Maintenance item	
16	Highcliff Rd	-	Dec.	Seaton Rd	14466	2000	2000	R	Access to walking track	40-50km/h	> no parking provision > parking provision exists within 100m > no signage	16	Highcliff Rd	878	12466	12466	300	Install signs indicating parking area location	$500
17	Highcliff Rd	-	Dec.	Seaton Rd	14466	2500	2500	L/R	Blind bend	30km/h	>insufficient width for car/truck travelling in opposite directions to pass each other > estimated severity SERIOUS	17	Highcliff Rd	878	11966	11966	300	Cut back and site bench plus seal widen on bend	$20,000
18	Highcliff Rd	-	Dec.	Seaton Rd	14466	2700	2700	R	Pothole	50-60km/h	>pothole immediately adjacent to edgeline, no room for error > strike lose control> estimated severity MINOR (single veh)	18	Highcliff Rd	878	11766	11766	300	Maintenance issue	
19	Highcliff Rd	-	Dec.	Seaton Rd	14466	2800	2800	R	Shoving / heaving	50-60km/h	> large uneven section of road, 30m² > very soft> estimated severity MINOR (single veh)	19	Highcliff Rd	878	11666	11666	300	Maintenance issue	
20	Highcliff Rd	-	Dec.	Seaton Rd	14466	2900	2900	R	Shoulder failure shoulder slump	50-60km/h	> potential for road to slip> estimated severity SERIOUS> ie crater forms/??, sudden stop	20	Highcliff Rd	878	11566	11566	300	Maintenance issue	
21	Highcliff Rd	-	Dec.	Seaton Rd	14466	3200	3200	R	Lack of shoulder	50-60km/h	> 20m > left hand bend> motorist straight-lines Will get wheel lock and lose control > estimated severity SERIOUS (single veh)	21	Highcliff Rd	878	11266	11266	300	Seal widening	$15,000

FIELD SHEETS												OFFICE							
Manual input												Automatic					Manual input		
22	Highcliff Rd	-	Dec.	Seaton Rd	14466	3500	3500	R	Post strainer	30-40km/h	>post strainer within 3m of road edge > estimated severity MINOR	22	Highcliff Rd	878	10966	10966	300	Option 1 install hazard` markers, or Option 2 remove and rebuild in safe location	Option 1 $250, Option 2 $700
23	Highcliff Rd	-	Dec.	Seaton Rd	14466	3700	3700	R	Power pole	30-40km/h	> pole on outside of left-hand bend within 3m of road edge> estimated severity SERIOUS	23	Highcliff Rd	878	10766	10766	300	Relocate pole	$1,000
24	Highcliff Rd	-	Dec.	Seaton Rd	14466	4000	4000	R	Drop-off	40-50km/h	>steep drop-off on inside of bend presently highlighted with sight rail.> estimated severity SERIOUS/FATAL	24	Highcliff Rd	878	10466	10466	300	Replace existing sight rail with 50m of guardrail and delineation	$20,000
25	Highcliff Rd	-	Dec.	Seal point Rd	9463	0	0	on side road	Lack of visibility to north from side road	50-60km/h	> install stop controls > estimated severity SERIOUS > HA haz	25	Highcliff Rd	878	9463	9463	300	Install signs and markings	$600
26	Highcliff Rd	-	Dec.	Seal point Rd	9463	1000	1000	Camp Rd	Lack of visibility to north from side road	50-60km/h	> install stop controls > estimated severity SERIOUS > HA haz	26	Highcliff Rd	878	8463	8463	300	Install signs and markings	$600
27	Highcliff Rd	-	Dec.	Seal point Rd	9463	900	1200	L/R	Footpath	60-70km/h	> lack of footpaths for pedestrians> estimated severity SERIOUS	27	Highcliff Rd	878	8563	8263	300	Install safety footpath (gravel) one side	$3,000
28	Highcliff Rd	-	Dec.	Seal point Rd	9463	2500	2500	R	Guard rail end treatment	60-70km/h	> no hazard marker on terminal > estimated severity SERIOUS	28	Highcliff Rd	878	6963	6963	300	Install end treatment	$7,500

FIELD SHEETS												OFFICE							
Manual input												Automatic						Manual input	
29	Highcliff Rd	-	Dec.	Seal point Rd	9463	3300	3300	R	Gravel migration	70km/h	> gravel migrating onto road from driveway> could cause a LOC > estimated severity MINOR (Sveh) SERIOUS (M ve)	29	Highcliff Rd	878	6163	6163	700	Seal back onto driveway 15msq	$512
30	Highcliff Rd	-	Dec.	Seal point Rd	9463	4200	4800	R	Deep ditch	70km/h	> ditch adjacent to carriageway beside edgeline> get wheel caught LOC> estimated severity MINOR single veh, SERIOUS multi veh	30	Highcliff Rd	878	5263	4663	700	Form sealed water channel	$12,000
31	Highcliff Rd	-	Dec.	Seal point Rd	9463	5100	5100	R	Pull-off area	70km/h	> informal pull-off, stock pile area> poor visibility> estimated severity SERIOUS (multi)	31	Highcliff Rd	878	4363	4363	700	Close off area for public access, fence	$1,000
32	Highcliff Rd	-	Dec.	Seal point Rd	9463	5800	7000	R	Deep ditch	70km/h	> ditch adjacent to carriageway beside edgeline> get wheel caught LOC> estimated severity MINOR single veh, SERIOUS multi veh	32	Highcliff Rd	878	3663	2463	700	Form sealed water channel	$24,000

Appendix D Evaluation example instructions and risk matrix

Instructions for use of SDD

Enter hazard or deficiency location on worksheet tab, risk prioritisation matrix:

- Road name.
- Location RP and/or description.

Calculation sheet to determine the following for each hazard or deficiency identified:

- Crash frequency.
- Crash severity.
- Exposure.

Note: CAS data should be used for crash frequency and crash severity, (see test case pick-up form.xls last column for five year CAS data).

Once frequency, severity and exposure are noted in the risk prioritisation matrix, a risk rating is calculated for each hazard or deficiency.

The hazards or deficiencies can be prioritised in terms of relative risk rating. This will allow you to determine the priority for the development of treatments to address the list of identified hazards or deficiencies.

Treatment options are then developed by RCA engineers - engineering judgement is used here. Note options have been supplied in test case pick-up form.xls.

Once treatment options and costs have been developed, it is possible to calculate the cumulative costs for treating the hazards or deficiencies. This allows the RCA to track safety spending, to ensure the highest priority risks are treated with a fixed budget. Note: treatment costs have been calculated in the supplied test case pick-up form.xls.

The post-treatment risk is then calculated for each hazard or deficiency, via use of the frequency, severity and exposure measures – engineering judgement is used here.

Post-treatment risk reduction is then calculated, as follows:

- pre-treatment risk rating divided by the post-treatment risk rating
- the hazards or deficiencies are then prioritised with respect to the greatest risk reduction
- the cumulative spending as per risk reduction can then be calculated, providing the RCA with yet another measure of the safety spending, to ensure maximum safety return within a fixed budget.

Evaluation risk matrix

Criteria	Description	Point rating	Example score	Comment
Crash Frequency	HIGH Crashes occur more than 3 times per annum.	**100**	100	Enter crash frequency for section of road - information should be provided by CAS data.
	MEDIUM Crashes occur more than 1-2 times per annum.	**50**		
	LOW Crashes occur more than 1-5 times in past 5 years.	**30**		
	VERY LOW No crashes recorded.	**10**		
Crash Severity	Fatal crash	**100**	18.8	Enter crash severity for section of road - information should be provided by CAS data.
	Serious injury crash	**18.8**		
	Minor injury crash	**2.2**		
	Non-injury crash	**0.5**		
Exposure	10,000 +	**100**	75	AADT information should be provided by RCA.
	5,000–10,000	**75**		
	2,500–5,000	**37.5**		
	1,000–2,500	**17.5**		
	500–1,000	**7.5**		
	250–500	**3.8**		
	100–250	**1.8**		
	< 100	**1**		
Crash Risk Category	**A - INTOLERABLE (> 350,000)**		144100	This figure that is calculated by multiplying frequency, severity and exposure scores.
	B - UNDESIRABLE (150,000 <= 350,000)			
	C - TOLERABLE (15,000 <= 150,000)			
	D - ACCEPTABLE (<= 15,000)			

This figure allocates the risk category to A, B, C, or D. Projects with scores of A, B, or C are also ranked in risk category ie prioritised for treatment assessment and subsequent funding. (see note below).

Note: each RCA or other user of the system will be required to set the tolerance levels above. These will need to be fine-tuned perhaps in conjunction with the RCA maintenance contractors, safety intervention plan. Thus the levels (ie A, B, C and D) specified here are for information only with respect to this evaluation. The prioritisation process used with this example is based on amount of risk associated with the deficiency and subsequent prioritisation based on risk reduction achieved per $ spent.

Appendix E Evaluation example data input sheet

Minor safety improvements prioritisation list

				Pre-treatment risk calculations				Pre-treatment	Treatment costs		Post-treatment risk calculations				Post-treatment risk reduction			Value of safety expenditure		
Road name	Location RP	Deficiency description	Treatment description	Crash Severity	Crash Frequency	Exposure	Risk Rate	Priority	Estimate	Cumulative Cost	Crash Severity	Crash Frequency	Exposure	Risk Rate	Reduction	Priority	Cumulative	Reduction / $1,000	Priority	Cumulative
Rangiriri	450m north of Jacks Road	Entrance visibility deficient	6	18.8	30	75	42,300	**3**	$5,000	$5,000	2.2	30	75	4950	9	**3**	$5,000	1.71	**1**	$5,000
Jesmond	300m south Alan Terrace	Poor driver visibility of existing ped crossing	Relocate existing pedestrian crossing eastward from SH1.	18.8	100	37.5	70,500	**2**	$10,000	$15,000	18.8	10	37.5	7050	10	**2**	$15,000	0.67	**3**	$15,000
Tauwhare Road	150m south Johns Road	High speed at entry points to village	Install speed thresholds and Tauwhare village and tauwhare marae. Improve signage, ref: CRS Remedial List	18.8	100	17.5	32,900	**4**	$17,000	$32,000	18.8	50	17.5	16450	2	**5**	$32,000	0.06	**5**	$32,000
Kay Road	Int River Road	Poor sight distance at intersection	Improving sight line at River Road/Kay Road intersection; ref: CRS Remedial Work list	100	100	7.5	75,000	**1**	$10,000	$42,000	18.8	100	7.5	14100	5	**4**	$42,000	0.13	**4**	$42,000
Falls	D/way 173	Poor signt-distance at private property driveway	Improve sight lines from private property at 173 Falls Road.	18.8	10	100	18,800	**5**	$10,000	$52,000	0.5	10	100	500	38	**1**	$52,000	0.72	**2**	$52,000
COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	Column contains formula!	Column contains formula! using RANK function	COLUMN REQUIRES DATA INPUT	Column contains formula!	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	COLUMN REQUIRES DATA INPUT	Column contains formula!	formula used = pre-treatment risk rate divided by post-treatment risk rate	Column contains formula! using RANK function	Column contains formula!	formula used = reduction/ treatment cost est x 1000	Column contains formula! using RANK function	Column contains formula!

Appendix F Overview of the road infrastructure safety assessment and road side hazard management projects

Road infrastructure safety assessment (RISA) project

Project Manager: Ian Appleton, Land Transport NZ

The project's objectives are:

- to determine the appropriateness of the road infrastructure to provide a safe passage for users, taking account of both the road terrain and traffic volume
- to ensure that measures to eliminate or reduce the identified problems are considered fully by the road controlling authority (RCA)
- to seek consistency across the nation's total network and to influence policy weaknesses.

A RISA will:

- identify the risk and severity that may be attributed to the existing road conditions
- optimise whole-of-life maintenance and operation benefits for the road network from a safety perspective
- improve awareness of safe maintenance practices
- help Land Transport NZ determine the effectiveness of its resource allocation for the provision of a safe and efficient roading network, and
- provide an overall (network) risk score for an RCA
- allow comparison with other similar RCAs
- demonstrate where the largest risk reduction can be achieved by mass action type treatments.

At the time of writing, RISA has obtained best consistency in rural mid-block sections, although it is planned to incorporate urban mid-block and both urban and rural type intersections in the assessment.

Road side hazard management project

Project Manager: Lyndon Hammond, Land Transport NZ

This project seeks to alleviate the consequences of driver error through the provision of a forgiving roadside environment, or crash barriers, to reduce the presence of roadside hazards.

The project will be undertaken in four stages:

- Stage 1 – compile a literature review and review current New Zealand practice.
- Stage 2 – develop and draft guidelines for identification and treatment of roadside hazards.
- Stage 3 – adapt findings of the road side hazard assessment project, to develop a draft strategic approach to roadside hazard management.
- Stage 4 – conduct a trial to refine the approach, including a further review of existing roadside hazard management practices in RCAs, and adapting the results of Land Transport NZ's RISA project.

Appendix G Safety deficiency database and prioritisation process checklist

Input characteristics

Data characteristic	**Essential characteristics**
Deficiency location	Tick ✓
Use RAAM method of identification Key information required • Road name • Section of road • District, ward • Physical location • Side of road • Direction of travel	
Deficiency information	Tick ✓
Deficiency number Date identified Data sources • Safety inspections • Crash reports • Analysis of RAMM • CAS analysis • Black-spots, Grey-spots, Hot-spots • Crash site monitoring • Stakeholder queries • Public queries • Crash reduction studies • Corridor management plans • Safety studies • Safety audits • Contractor information Identified by who	

Input characteristics, continued

Data characteristic	Essential characteristics
Deficiency information, continued	Tick ✓
Description of deficiency • Type of deficiency • 'Size' of deficiency Crash data recorded • Number of crashes • Type of crashes • Seriousness of crashes Comments (text)	
Deficiency category	Tick ✓

Category of treatment
• Scheduled maintenance
• Un-scheduled maintenance
  − Urgent
  − Non-urgent
 	
Minor safety
• Capital project (Project Feasibility Study)
 	
Who is responsible for deficiency	

Deficiency programming	Tick ✓
Is the deficiency to be assessed Is the deficiency to be treated Date treatment was implemented Treatment solution to address deficiency Person responsible for developing solution Person responsible for implementing solution Status of solution implementation Cost to develop solution • Estimate/provisional sum Cost to implement solution • Estimate/provisional sum Funding source • RCA & Transit NZ amounts • RCA accounting code(s)	

System characteristics

System characteristic	**Essential characteristics**
System use	Tick ✓
Frequency of data entry • Daily • Weekly • Monthly • Periodically Skill required for those entering data • Admin – skilled in use of system • Technician – skilled in use of system • Engineer – skilled in use of system Entry method • Manual data • Importing electronic data	
Information 'storage'	Tick ✓
Years • 1 – 2 • 2 – 3 • 3 – 4 • 4 – 5 • > 5 Track deficiency treatments over time	
System 'familiarity'	Tick ✓
Systems to use 'common' software features	
System 'terminology'	Tick ✓
Terminology to be common NZ-wide	

Process characteristics

Data characteristic	Essential characteristics
Criteria used to assess risks	Tick ✓

Factors considered for treatment
• Cost
• Risk
  − Frequency
  − Severity
  − Exposure
• Benefits
• Location
• Extent of problem
• If future works are programmed at site
 	
Crashes
• History
• Seriousness
 	
Vulnerable road users
 	
Vulnerable road user crashes
Police concern
Public concern
Other agencies concern – Land Transport NZ, Transit NZ, etc.
Is it a key item in Road Safety Strategy
Traffic volume (AADT)	

Risk assessment	Tick ✓
Risk before treatment • Likelihood value • Exposure value • Severity value • Result in a risk score Risk reduction of treatment • Risk reduction score/percentage • Cost-benefit score/percentage Ability to evaluate multiple treatment solutions Date assessment carried out	

Process characteristics, continued

Data characteristic	**Essential characteristics**
Prioritisation process	Tick ✓
Criteria • Pre-treatment risk • Risk reduction ratio • Treatment cost • Benefit/Cost ratio Complexity of risk model • Simple assessment – qualitative • Simple assessment – crash data Process response time • Short time – 2 to 4 mins	
Use of engineering judgement	Tick ✓
When data is entered into system When risks are prioritised by system • Analyse the likelihood • Analyse the consequences • Calculate the risk (score) When risks treatments are identified When risks treatments are proposed When impact of treatment is assessed When output is reviewed by engineer	
Treatment development	Tick ✓
Developed by RCA engineer Treatments developed one-at-a-time	
Decision making capability	Tick ✓
Analysis of individual deficiencies Analysis of treatments for each deficiency	
System location	Tick ✓
Hosted internally by RCA Accessible by consultants	

Output characteristics

Data characteristic	**Essential characteristics**
Course of action	Tick ✓
Deficiency assigned appropriate action Deficiency assigned to right person Note if further investigation is required Mode of treatment • Safety works programme • Existing maintenance contract • New maintenance contract Dates of action • Date action has been completed	
Output media	Tick ✓
Hard copy Export • MS Word • MS Excel Report format • Text	
Reports produced	Tick ✓
Sort by • Date deficiency entered • Date deficiency assessed • Date deficiency treated • Status of treatments • Deficiency ranking/priority • Risk ranking pre-treatment • Risk ranking post-treatment • Amount risk reduced • Treatment cost • Benefit/Cost ratio • Deficiencies treated • Deficiencies to be treated • Deficiencies per maintenance area	

Output characteristics, continued

<table>
<tr><th>Data characteristic</th><th>Essential characteristics</th></tr>
<tr><td>Reports produced, continued</td><td>Tick ✓</td></tr>
<tr><td>• Deficiencies per maintenance contract
• Deficiencies per contractor
• Contractor per maintenance area
• Type of deficiency per network
• All deficiencies per network
• Type of treatment options
• Type of treatment solutions

Provide clear line for auditing</td><td></td></tr>
<tr><td>Users of reports (system outputs)</td><td>Tick ✓</td></tr>
<tr><td>RCA engineers
RCA politicians
RCA management
Land Transport NZ</td><td></td></tr>
<tr><td>Value of system to RCA</td><td>Tick ✓</td></tr>
<tr><td>System to capture deficiencies
• All deficiencies on network
• New deficiencies on network
• Existing deficiencies on network

Formal system
• To prioritise or rank deficiencies
• To prioritise minor safety projects

Decision making tool to assist RCA
• To prioritise or rank deficiencies
• To prioritise minor safety projects

Reason for use of system
• Decision making tool
• Provide formal process
• Provide ‘hard facts’
• Provide solutions to deficiencies</td><td></td></tr>
</table>

Output characteristics, continued

System characteristic	**Essential characteristics**
Value of system to RCA, continued	Tick ✓
Holistic approach to managing safety issues More proactive response to safety projects Enhanced strategic knowledge of RCA's assets More focused efforts to achieve 2010 targets Greater value for safety expenditure Provide legal protection	