RISA: A case study of the crash reduction potential of RISA on local rural roads in New Zealand

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Abstract

Road Infrastructure Safety Assessment (RISA) is a tool that enables Road Controlling Authorities (RCA) to undertake a Safety Assessment of their Rural Sealed Road Networks to understand the infrastructure risk to road users and therefore enable them to better focus their safety and maintenance funds. RISA was developed by NZTA led by Dr Ian Appleton between 2002 and 2006 and was fully operational between 2007 and 2011. RISA assesses field data collected by the RISA Team using a macro to identify areas for improvement that the local district / council road safety and operational engineers should focus on in order to reduce the risk to road users on their rural roads. The RISA macro was further refined to enable the RCAs to understand the risk reductions that could be gained undertaking various improvements by indicating the changed risk if certain works are undertaken on various road groupings. A case study using two NZ District Councils will be presented to assess the crash reduction potential of RISA. This research examines crash data on rural roads in the respective District Councils. The research will consider the five years of crash data preceding the RISA Team's visit and the available crash data after the RISA Team's visit up to the end of March 2013. The results may indicate the likely effectiveness of RISA as a road safety tool to assist rural district council road safety engineers to best manage their rural roading network within their limited budgets and whether to progress a wider study.

Introduction

RISA is a practical evidence based tool for assessing and predicting the contribution that road infrastructure features make to road safety. It was developed as a network risk assessment tool but can also be used for corridor assessment. To date it has been developed for rural sealed roads only as the infrastructure related risks for unsealed roads vary significantly from time to time, and the crash research completed for rural unsealed roads is limited. Safety risks on urban roads are more complex and are not applicable to this method.

The RISA methodology has been described in previous conference papers, for example Appleton (2009) and will not be described here. RISA was fully operational between 2007 and 2011. The two territorial local authorities selected for further analysis of their before and after RISA crash data are Queenstown Lakes District Council and Dunedin City Council.

Since these RISAs were completed further enhancements were made to the RISA macro to enable interactive discussions to be undertaken by the RISA team with the local engineers during the RISA exit meeting to show the effect of various treatments on the different roads by volume band.

RISA Macro refinements

The RISA macro has been further refined since 2010 to incorporate a dynamic risk tool. The dynamic risk tool allows the Local Authority staff to view in real-time the effect of changes to the Network Risk Number (NRN) when a variety of treatments are implemented; or in the case of a corridor or a group of corridors, the changes in risk. The NRN is produced during the RISA process by combining the risk values collected on a sample of road sections within the roading network, based on the spread of Vehicle Kilometres Travelled (VKT).

The example figures in Figure 1 below show the typical outputs when the dynamic macro is utilised. In these instances the parameters are noted in the figure title with the red line showing the current network risk number and if the selected improvements on the x axis were implemented then the reduction in the NRN is shown by the respective bars within the graph. It is also possible to view this information by selected Annual Average Daily Traffic (AADT) volume band, i.e. in the examples below all volume bands have been selected, however individual bands such as 100 – 500 vehicles per day (vpd) volume band could be selected to assess the effect on the NRN by carrying out the improvements only on roads within the chosen volume band.

Figure 3: Unrestrained Risk Test

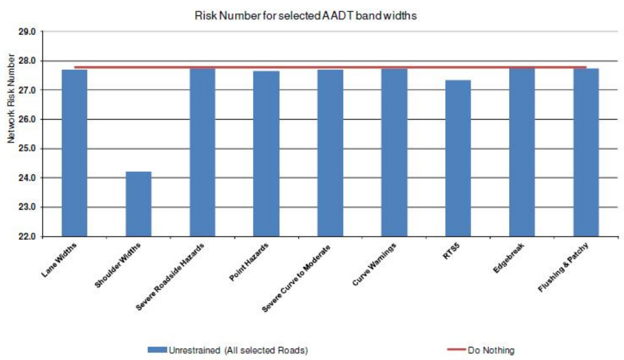

Figure 4: Test 1 – 3 m lanes, 0.25 m – 0.5 m shoulders and RTS 5

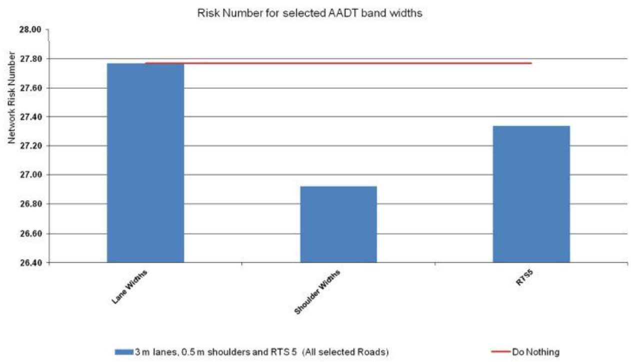

Figure 1. Example figures of dynamic macro outputs

The adaptation of RISA to enable assessment and risk reduction focusing on medium volume corridors has shown that the tool can be used successfully to focus on just the higher volume roads in a rural network and by using the dynamic ability of the tool, infrastructure improvements that focus on low cost but best risk reduction can be determined.

Queenstown Lakes District Council RISA Before and After Crash Assessment

The Queenstown Lakes District Council (QLDC) RISA was undertaken in April 2010 with a RISA Team led by John Hannah. The RISA Team made a number of recommendations as part of their report. From discussions and information received from QLDC, the following improvements identified by the RISA team have been carried out following the RISA:

- When pavement rehabilitation is undertaken the Council is carrying out shoulder widening.
- The standards and setting out and maintenance of Edge Marker Posts (EMPs) have been reviewed and delineation has been improved throughout the district.

- A review of horizontal curves has been undertaken to ensure out of context curves (i.e. those curves where the difference between the approach speed and curve speed exceeded 15 km/h (Koorey and Tate (1997)) are appropriately signed. The curve warning signs have been reviewed in accordance with the Manual of Traffic Signs and Markings (MOTSAM).

- Maintenance practices at intersections have been reviewed to avoid the recurrence of flushing and patchy pavement and loose chip.

Crash Data

The NZ Transport Agency's (NZTA's) CAS database was reviewed for sealed rural road crashes both before and after the RISA which was carried out in April 2010. The following table summarises the injury crashes before and after the RISA. The crash data assessed the five year period between May 2005 and April 2010 for the 'before the RISA' period and the 2 years and 11 months between May 2010 and March 2013 for the 'after the RISA' period.

Table 1. QLDC Injury Crashes Before and After the RISA)

	Fatal	**Serious**	**Minor**	**Fatal + Serious**
Before Crash Numbers	6	47	143	53
Before Crash Rate	1.2	9.4	28.6	10.6
After Crash Numbers	2	17	55	19
After Crash Rate	0.7	5.8	18.9	6.5

This information is represented graphically in the figure below:

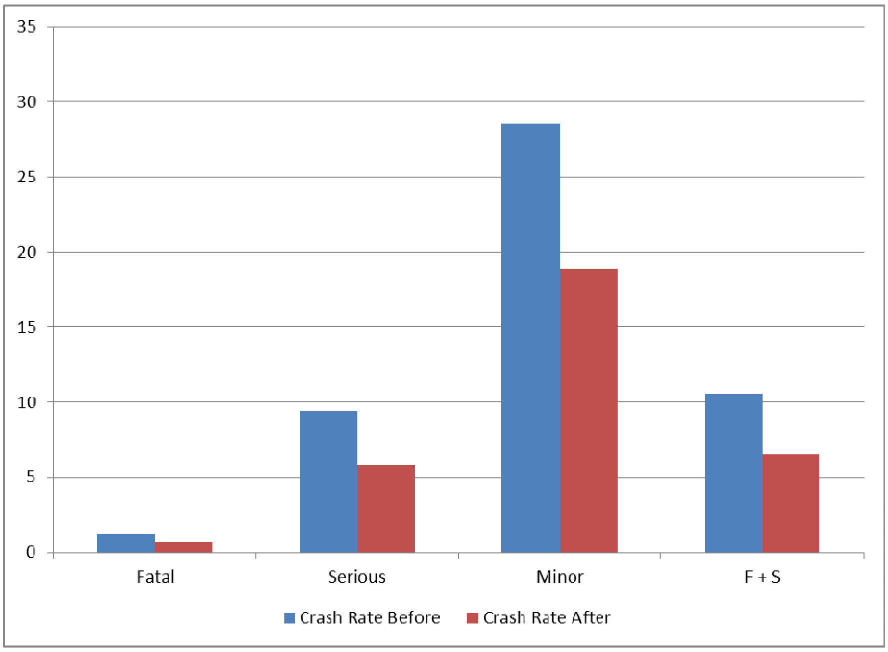

Figure 2. QLDC Injury Crash Rate Before and After RISA

The crash rate data shows that the injury crash rate has decreased after the RISA when compared to the five year period before the RISA.

An assessment was made of the various crash types and the crashes which occurred during the hours of darkness including twilight to assess whether there was any correlation between the recommendations made during the RISA and the change in crash type crash rates.

Table 2. QLDC Injury Crashes Types Before and After the RISA

	Head On (B*)	Lost Control on Straight (C*)	Lost Control on Bend (D*)	Intersections (G*, H*, J*, K*, L*)	Dark and Twilight Crashes
Before Crash Type Numbers	23	23	115	13	61
Before Crash Type Rate	4.6	4.6	23.0	2.6	12.2
After Crash Type Numbers	8	11	46	6	21
After Crash Type Rate	2.7	3.8	15.8	2.1	7.2

This information is represented graphically in the figure below:

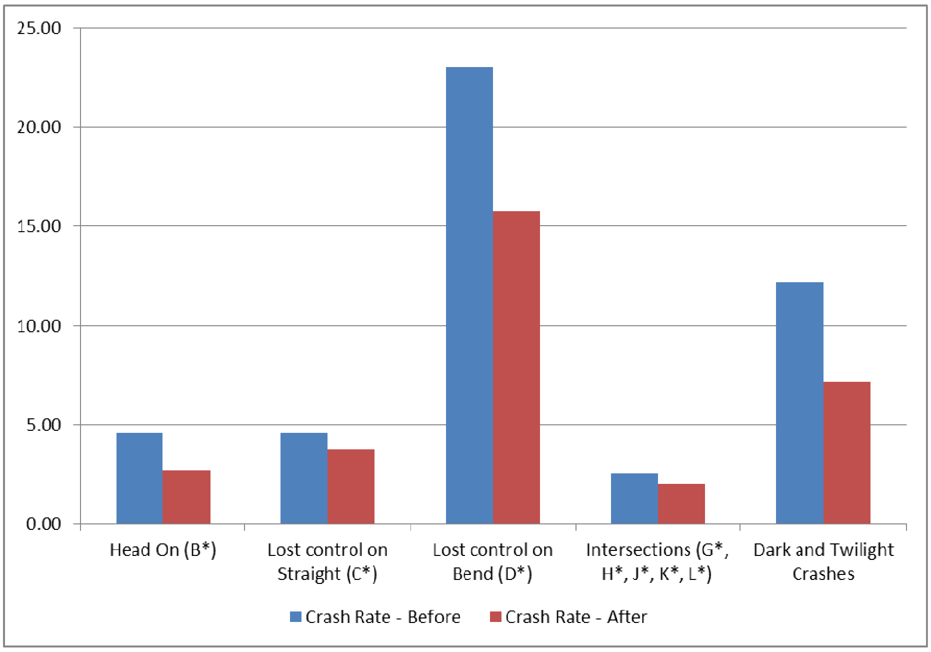

Figure 3. QLDC Injury Crash Type Crash Rate Before and After RISA

The crash type crash rate data shows that the crash rate has decreased for all crash types. The crash rate reduction has been the greatest for both those lost control on bend crashes and those crashes which occur during the hours of darkness and twilight.

Dunedin City Council RISA Before and After Crash Assessment

The Dunedin City Council (DCC) RISA was undertaken in October 2010 with a RISA Team led by Murray Noone. The RISA Team made a number of recommendations as part of their report. From discussions and information received from DCC, the following RISA identified improvements have been carried out following the RISA:

- The installation of edge marker posts
- The identification and programmed installation of guardrail at high risk locations
- The review of when reseals are scheduled
- The reduction of speed limits on some roads
- The review of all warning signage to ensure consistency

- The identification and prioritisation of roadside hazards (with a focus on power poles, trees, drop offs and drainage features (such as headwalls)

Crash Data

The NZTAs CAS database was reviewed for the crashes both before and after the RISA which was carried out in October 2010. The following table summarises the injury crashes before and after the RISA. The crash data assessed the five year period between November 2005 and October 2010 for the 'before the RISA' period and the 2 years and 5 months between November 2010 and March 2013 for the 'after the RISA' period.

Table 3. DCC Injury Crashes Before and After the RISA

	Fatal	Serious	Minor	Fatal + Serious
Before Crash Numbers	4	64	198	68
Before Crash Rate	0.8	12.8	39.6	13.6
After Crash Numbers	4	19	55	23
After Crash Rate	1.7	7.9	22.8	9.5

This information is represented graphically in the figure below:

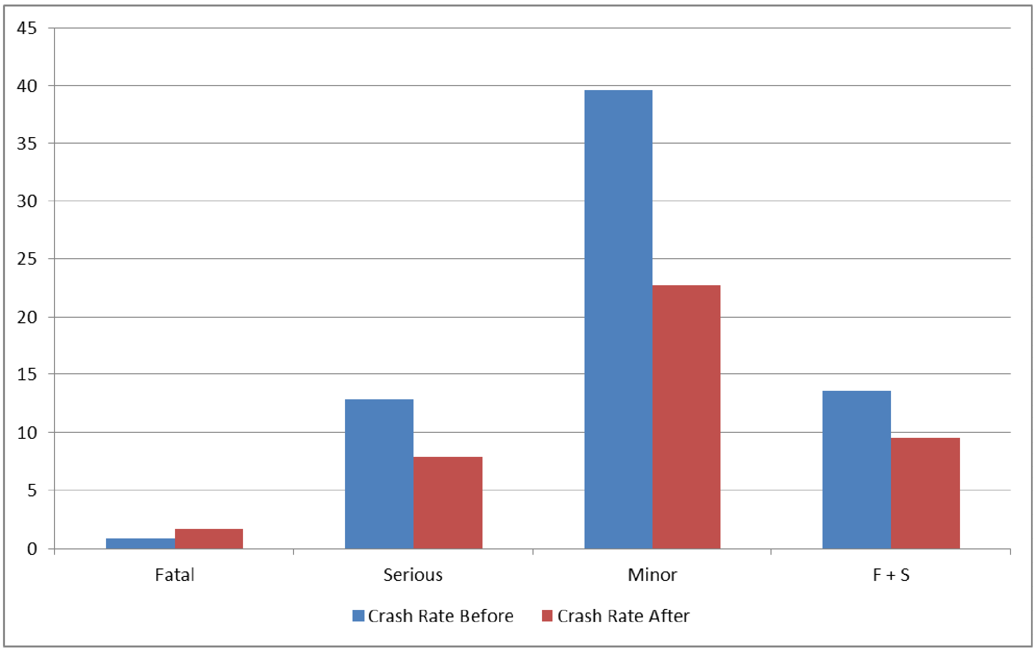

Figure 4. DCC Injury Crash Rate Before and After RISA

The crash rate data shows that the combined Fatal and Serious (F+S) injury crash rate has decreased after the RISA when compared to the five year period before the RISA; whilst noting that the traffic volume and road length have remained roughly the same.

An assessment was made of the various crash types and the crashes which occurred during the hours of darkness including twilight to assess whether there was any correlation between the recommendations made during the RISA and the change in crash type crash rates.

Table 4. DCC Injury Crashes Types Before and After the RISA

	Head On (B*)	Lost Control on Straight (C*)	Lost Control on Bend (D*)	Intersections (G*, H*, J*, K*, L*)	Dark and Twilight Crashes
Before Crash Type Numbers	17	32	112	21	67
Before Crash Type Rate	3.4	6.4	22.4	4.2	13.4
After Crash Type Numbers	3	4	39	2	23
After Crash Type Rate	1.2	1.7	16.1	0.8	9.5

This information is represented graphically in the figure below:

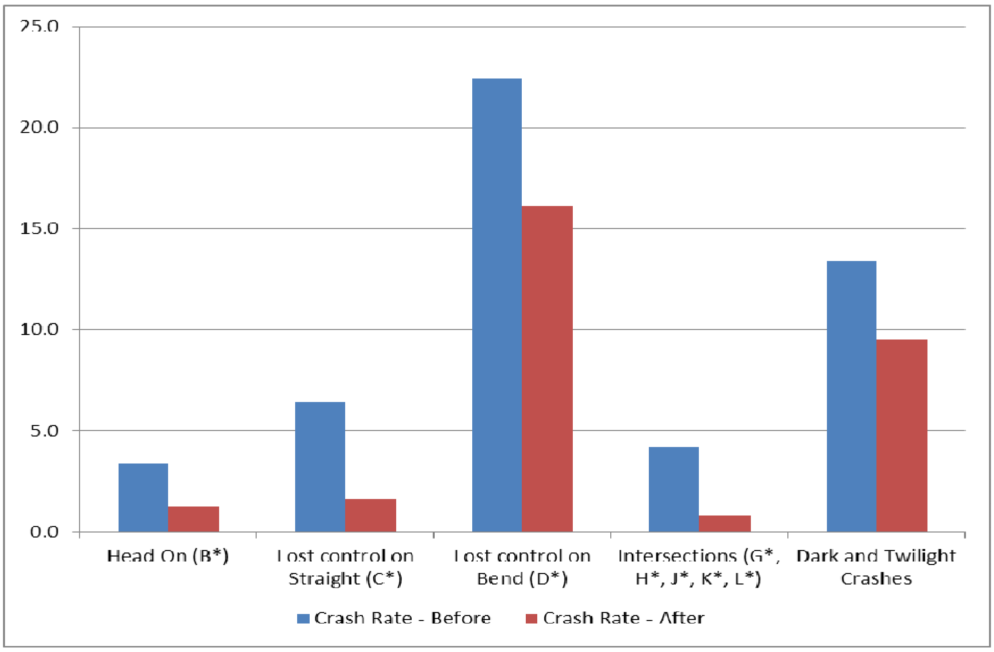

Figure 5. DCC Injury Crash Type Crash Rate Before and After RISA

The crash type crash rate data shows that the crash rate has decreased for all crash types. The crash rate reduction has been the greatest for both those lost control on bend crashes and those crashes which occur during the hours of darkness and twilight.

An assessment was also made of the objects struck, in particular drop offs, power poles, trees and drainage features.

Table 5. DCC Objects Struck Injury Crashes Before and After the RISA

	Over Edge of Bank (E*)	Utility Pole (P*)	Trees (T*)	Ditch (V*)	All crashes (E*, P*, T*, V*)
Before Crash Type Numbers	24	10	20	26	76
Before Crash Type Rate	4.8	2.0	4.0	5.2	15.2
After Crash Type Numbers	6	5	3	4	17
After Crash Type Rate	2.5	2.1	1.2	1.7	7.0

This information is represented graphically in the figure below:

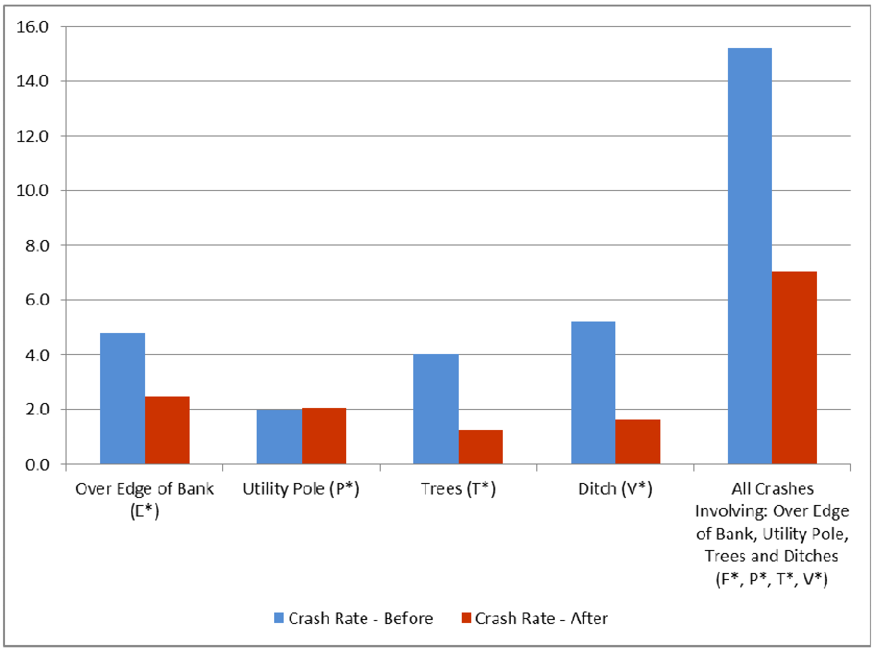

Figure 6. DCC Objects Struck Injury Crashes Crash Rate Before and After RISA

As is the norm for many lower volume rural roads, there is a risk from road side hazards and these are often expensive to mitigate, therefore the RCA's assessed have not undertaken any significant road side hazard protection work. However, excepting the utility poles, there has been a reduction in the DCC crash rate where there has been an object struck (E*, T* or V*).

Conclusions

This research paper assessed the likely effectiveness of RISA as a road safety tool to assist rural district council road safety and operational engineers to best manage their rural roading network within their limited budgets by reviewing the before and after crash data available on two local authority rural roading networks that had RISAs undertaken during 2010.

The crash data from both the Queenstown Lakes District and the Dunedin City rural roads indicated that the crash rates had dropped for all crash types, combined fatal and serious (F+S) crashes and crashes occurring during the hours of darkness and twilight.

Whilst the crash data for the two RCAs shows a reduction, it is important to note that the after data is limited to between 2 and 3 years due to the timing of this paper and therefore the crash reductions may be due to other causes.

It is recommended that further analysis of other local authorities should be undertaken and the use of a longer after period since the respective RISAs were undertaken to confirm the validity of this data against a wider study group.

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Appendices

Appendix A – RISA Report Recommendations for QLDC

RISA Recommendations (taken from RISA Report, July 2010)

Based on the features measured we recommend that Queenstown Lakes District Council consider the following:

Recommendation 1
We suggest that Council continue its programme of shoulder widening as part of pavement rehabilitation.

Recommendation 2
Review the standards of setting out and maintenance of EMPs.

Recommendation 3
Review all curve warning signage to ensure consistency with the signs and markings manual (MOTSAM) ensuring that appropriate speed advisory values are implemented. Review the curves to ensure out of context curves are appropriately signed. When undertaking rehabilitation, consider the opportunity to improve the geometric design of curves, if this can be undertaken at acceptable costs.

Recommendation 4
Reconsider the installation of raised reflective pavement markers (RRPMs) on high volume roads which have night time use.

Recommendation 5
Review intersections for;
1. Flag Lighting.
2. Maintenance practices at intersections to reduce;
    - Flushing / Patchy pavement
    - Loose chip / Detritus which will reduce paint wear and improve skid resistance.

With the recommendations, the team emphasises a strategic approach that prioritises any proposed works by hierarchy and traffic volume, possibly combined with other factors that identify the frequency and/or severity of crashes.

RISA Assessment Conclusions (taken from RISA Report, July 2010)

The following conclusions are made from the assessment results:

- There were few roadside hazards such as power poles and trees, over which the Council has some levels of control, but there were locations where newly installed power poles were recorded and these could have been located outside the clear zone. There were also a few locations where self-sown trees were noticed and these should be removed before they become a hazard.

- The general standard of intersections assessed was good but could be improved with improved standards and locations of road and street name blades and their sizes, removal of loose gravel and the provision of flag lighting on the higher trafficked roads.

Appendix B – RISA Report Recommendations for DCC

RISA Recommendations (taken from RISA Report – December 2010)

Based on the features measured we recommend that Dunedin City Council consider the following:

Recommendation 1
Review the standard of implementation of EMPs with specific reference to MOTSAM and Road Traffic Standard 5 – Guidelines for Rural Road Marking and Delineation (RTS 5).

Recommendation 2
Review the application of curve warning and advisory speed signage with specific reference to MOTSAM, to ensure out of context curves are appropriately signed and appropriate speed advisory values are implemented.

Recommendation 3
Consider a programme of hazard removal or protection for:
1. Power Poles
2. Trees
3. Drop offs
4. Drainage features (such as headwalls)

Recommendation 4
Review the road network hierarchy and the level of service being delivered on each road type within the hierarchy.

Recommendation 5
Review intersections for:
1. Improved vegetation control that would improve sight distance
2. Use of flag lighting at intersections, particularly on routes at the high end of the road hierarchy.
3. Appropriate road marking on the approach to and through the intersection.

With the recommendations the team emphasises a strategic approach that prioritises any proposed works by hierarchy and traffic volume, possibly combined with other factors that identify the frequency and/or severity of crashes.

RISA Assessment Conclusions (taken from RISA Report, December 2010)

- A large proportion of Council's rural roads did not have Edge Marker Posts (EMPs), however the team did find that many of the roads assessed had RRPMs along the centreline and many had red RRPMs on the edge line. The team found that the installation of EMPs was inconsistent across the road network and where installed they were generally not set out to comply with current standards. The team considered that a medium-term programme to get all delineation, including EMPs, to improve to the MOTSAM and RTS 5 standards would be prudent.

- The team noted numerous out-of-context curves where advanced warning and better advisory speed signage could have reduced the risk of drivers leaving the roadway. The team acknowledges the high cost of realigning severe curves and recommends that the Council take the opportunity, when practical, to ease curves when undertaking pavement rehabilitation.

- Overall, the team noted the need for improved consistency and accuracy of Traffic Services. It was obvious to the assessment team that some delineation was not being installed by appropriately trained contractors or that those installers were not being well directed by supervising staff or advisors. Training is desirable.

- Approximately 17% of the roadside assessed was influenced by point hazards. This means that the consequences for an errant vehicle straying off the road are serious. Many of the hazards are power poles and the team acknowledge the difficulty in having these relocated but there are many other point hazards such as trees, drainage features and fencing which are within the road reserve and over which the Council has some control. The team felt that the Council should consider a programme of hazard removal or protection for Power Poles, Trees, Drop offs and Drainage features (such as headwalls).

- The team identified that a number of low volume roads had delineation and maintenance standards that appeared higher than other more heavily trafficked routes. This appeared to indicate that the level of service was unrelated to the road hierarchy or traffic volume. The team considers it necessary to review the road network hierarchy and the level of service being delivered on each road type within the hierarchy, with a view to increasing consistency and reducing costs.

- 50% of intersections had inadequate sight distance, this is a poor result. While many of the sight distance issues related to topography and are therefore difficult to address, a number could be mitigated through improved control of vegetation.

- Only a few intersections had flag lighting (36%). Flag lighting at rural intersections assists the identification of these intersections at night and could reduce unexpected and last minute decisions by road users. This is particularly important at intersections with traffic islands. The team acknowledges that the majority of roads assessed are low volume and therefore lighting is not warranted, however the use of flag lighting at intersections, particularly on routes at the high end of the road hierarchy is prudent.

- At a number of low volume intersections, there was no appropriate approach roadmarking to indicate the presence of the intersection; this can be easily addressed in the next roadmarking cycle. This includes use of solid white centrelines and consideration should be given to more widespread use of edgelines to define the edge of seal for turning vehicles.