CRASH MONITORING – PROVEN EFFECTIVE MEASURES PRACTICE PAPER

Author:

Bruno Royce – *BScEng (Civil) (Hons), MBA, CPEng(NZ), IntPE(NZ), TGEng(NZ)*
Director / Principal Traffic Engineer, Traffic Engineering Solutions Ltd (TES)
Email: bruno.royce@tes.net.nz

11 February 2019

ABSTRACT

The government's enhanced focus on road safety should require proposed roading improvements to incorporate crash reduction measures that have a proven record of success, to ensure confidence in performance and economic value. This would result in all roading projects being designed to eliminate Death and Serious Injury (DSI) crashes, as required by the Safe System approach.

Post implementation crash monitoring can identify previously successful measures, which along with an appreciation of site conditions, allows these measures to be applied successfully to new sites, and to be incorporated into larger scale integrated corridor design.

Over several years Traffic Engineering Solutions Ltd (TES) has completed post-implementation crash monitoring of over 50 sites in Auckland.

Based on Safe System principles of road safety design, this conference paper identifies measures that have proved particularly successful in terms of crash reduction, focussed on DSI, while providing value for money.

The types of roading improvements that were particularly successful, include:

- **Traffic Calming**: LATM, roundabouts, raised islands and roadmarking (Sites 1, 4, 7, 11 & 12);
- **Posted Speed Reduction**: Lowering of speeds in urban areas (Site 10);
- **Delineation**: Flush medians and right turn pockets (Sites 5, 6 & 7);
- **Priority control side-roads**: Enhanced signage, delineation and channelisation (Site 1);
- **Rural Road Bend Treatments**: Works to address crashes at bends (Sites 2 & 3);
- **Rural Junction Upgrades**: Resealing, levelling and enhanced road-marking (Sites 5 & 6);
- **Midblock Signals**: Signalised crosswalks for pedestrian safety (Site 8);
- **Traffic signals**: To address a crash problem at a priority controlled junction (Site 9).

This paper succinctly demonstrates the 'before' and 'after' crash and economic data for 12 study cases, allowing road safety practitioners to digest and critique the results.

INTRODUCTION

BACKGROUND

The government's enhanced focus on road safety should require proposed roading improvements to incorporate crash reduction measures that have a proven record of success, to ensure confidence in performance and economic value.

Post implementation crash monitoring can identify previously successful measures, which along with an appreciation of site conditions, allows these measures to be applied successfully to new sites, and to be incorporated into larger scale integrated corridor design.

STUDY SCOPE

Traffic Engineering Solutions Ltd (TES) has completed post-implementation crash monitoring of over 50 sites in Auckland where crash remedial works were installed over the previous decade. These crash monitoring studies have been undertaken over several years, comprising several reports and previously published research.

Based on Safe System principles of road safety design, this conference paper identifies measures that have proved particularly successful in terms of crash reduction, focussed on Death/Serious Injury (DSI) crashes, while providing value for money.

METHODOLOGY

The study methodology was aligned as follows:

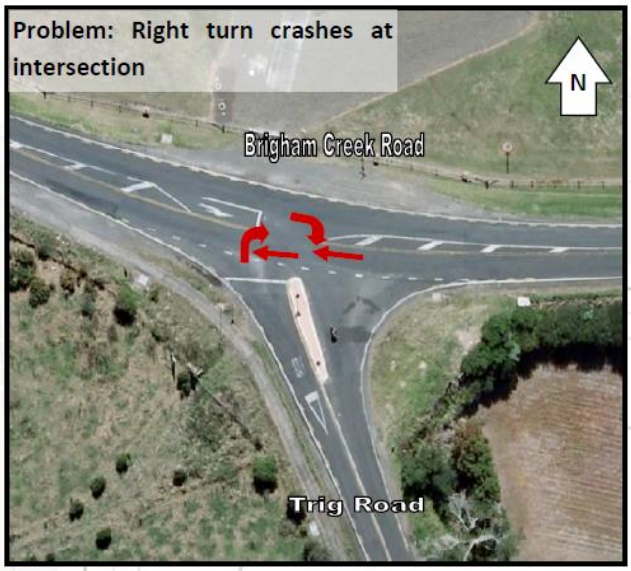
- The original crash monitoring reports were reviewed to identify sites that were representative and particularly effective at crash mitigation;
- Recent CAS crash data was reviewed to update and lengthen the period of analysis, allowing up-to-date 'before' and 'after' crash analysis;
- The costs of the works were based construction costs, which were rounded-up, and reverse-discounted to present worth;
- It is noted that regression to the mean of crash data, crash data analysis methodology, and the selection and application of control group trends, can impact the overall results. The economic results presented should be considered as a guide rather than a precise measure.

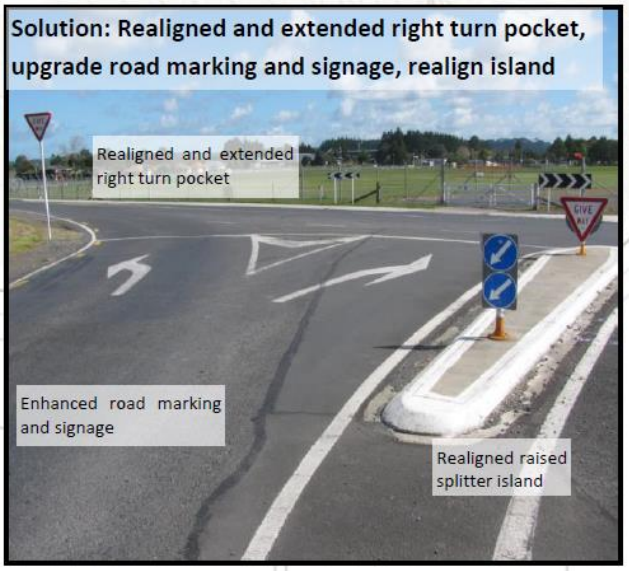
PRESENTATION FORMAT

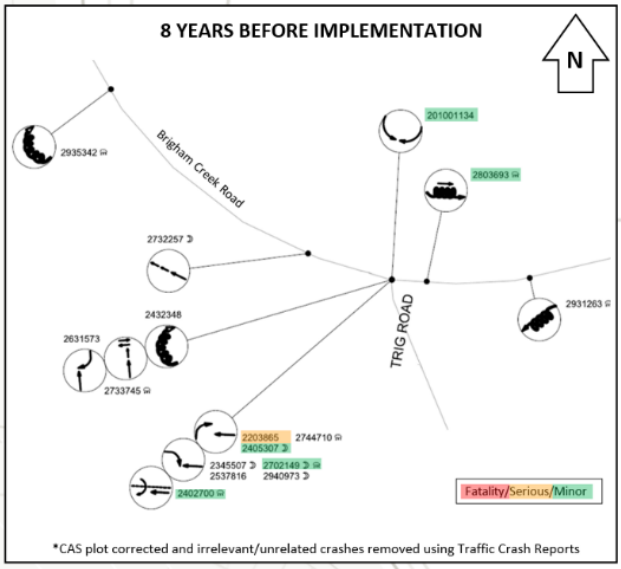
The crash monitoring presentation results include the following:

- Identification of the site and road safety issue;
- Illustrations 'before' and 'after' works;
- CAS crash plots 'before' and 'after' works, with crash savings (including DSI);
- Control group crash saving adjustments (using 'all auckland' as a control group over an equivalent time period 'before' and 'after' for each site);
- Economic benefits related to construction costs.

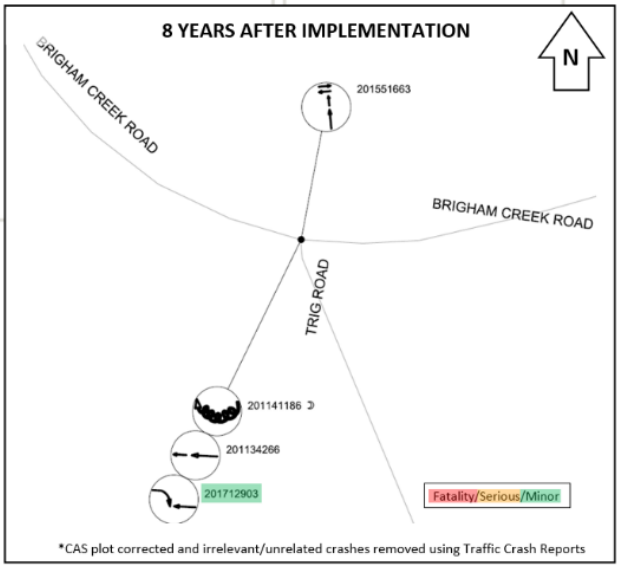
SITE 1: Brigham Creek Road / Trig Road







16 reported crashes (1 serious, 5 minor injury) over 8 years before improvements (mid 2002 – mid 2010)



4 reported crashes (1 minor injury) over 8 years since improvements (mid 2010 – mid 2018)

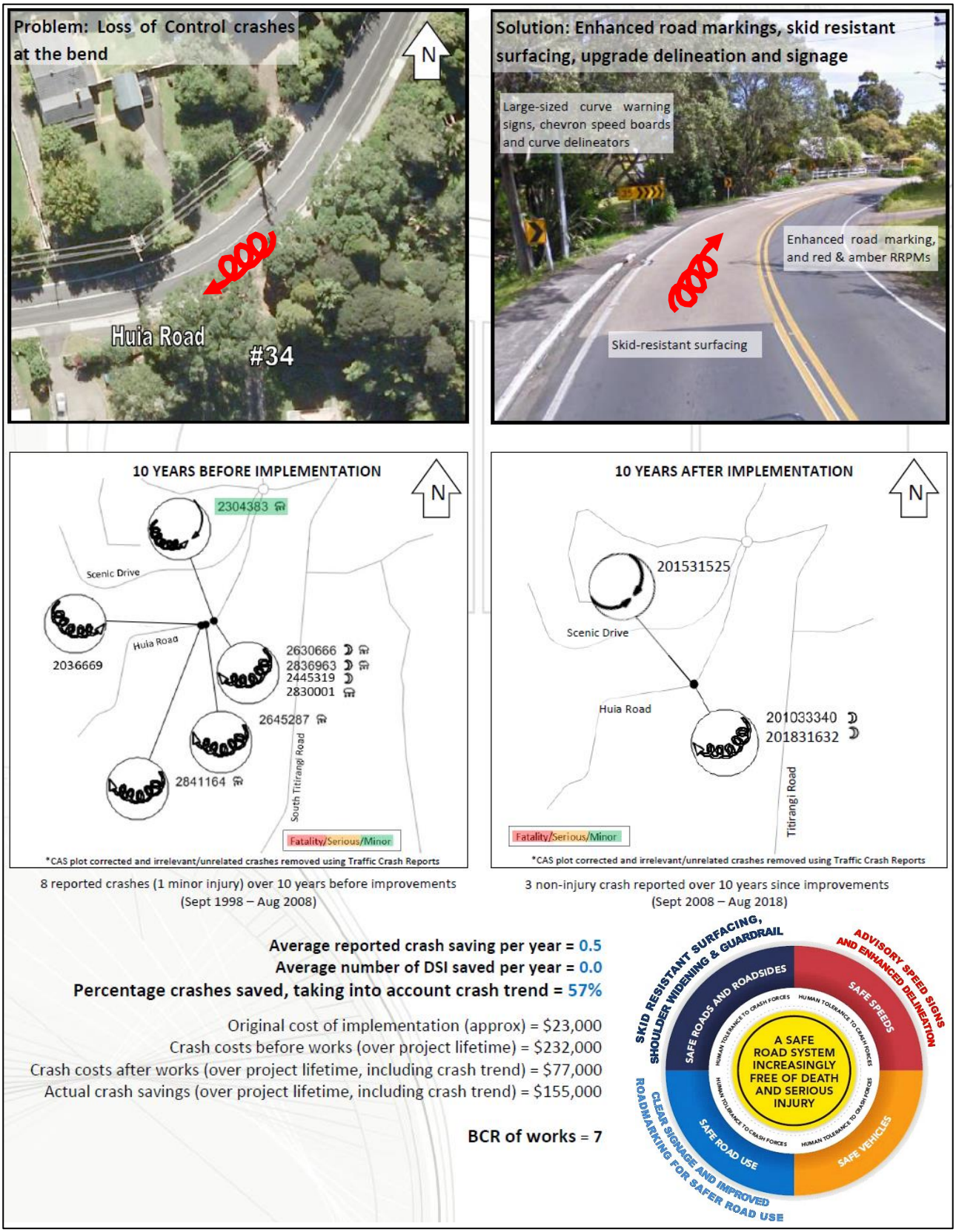
Average reported crash saving per year = 1.5
Average number of DSI saved per year = 0.1
Percentage crashes saved, taking into account crash trend = 71%

Original cost of implementation (approx) = $27,000
Crash costs before works (over project lifetime) = $3,530,000
Crash costs after works (over project lifetime, including crash trend) = $458,000
Actual crash savings (over project lifetime, including crash trend) = $3,072,000

BCR of works = 113

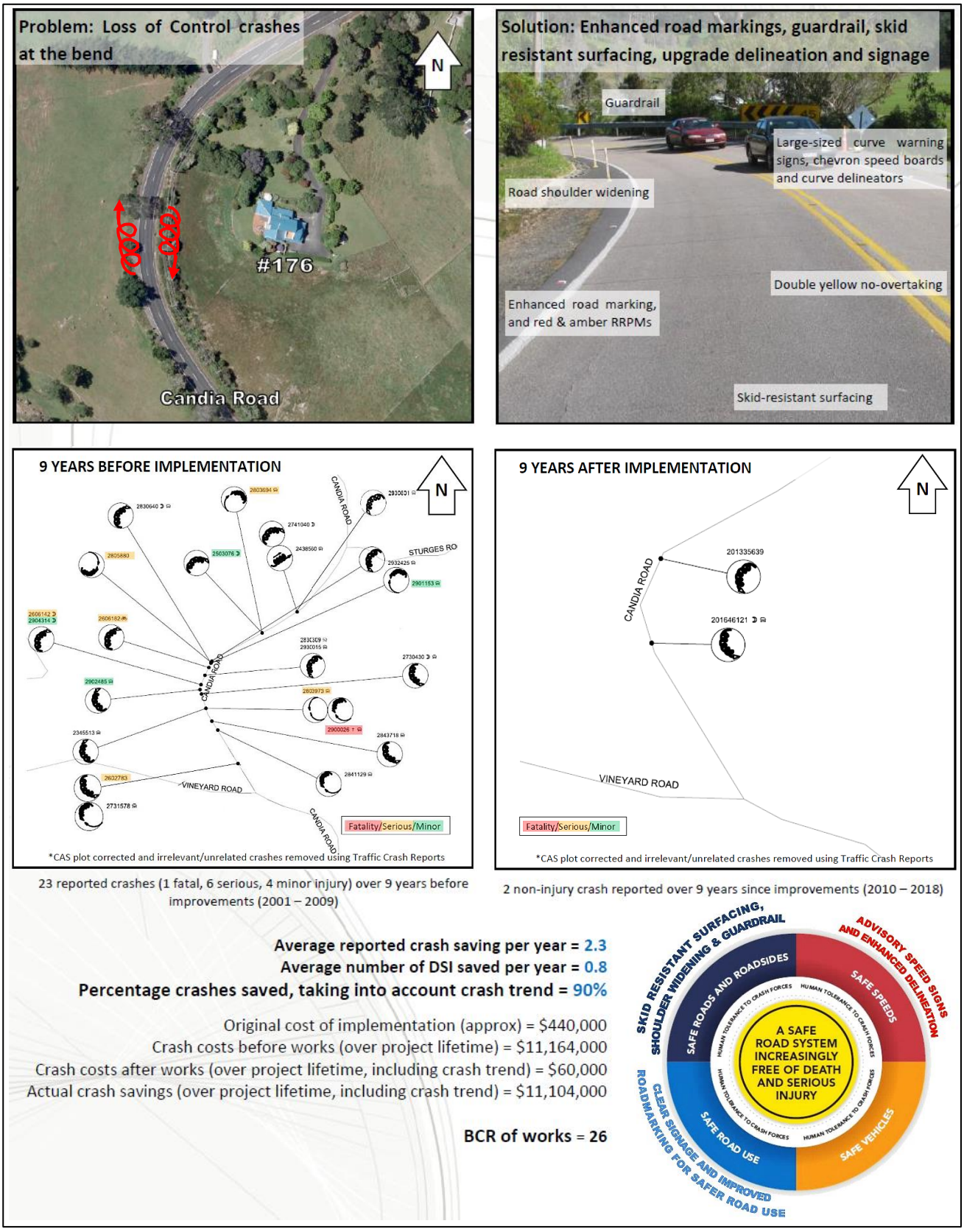
Conclusion: Enhanced signage and delineation at a give-way controlled 'T' junction can be effective at reducing crossing vehicle (CAS code JA) and right-turn against (LB) crashes.

SITE 2: 34 Huia Road



Conclusion: Signage, road-marking and skid resistant road surfacing targeted at loss-of-control crashes in wet conditions can reduce these crashes over the long-term. Friction surfacing can be placed on only one traffic lane to reduce costs. Also, a package of complimentary crash remedial works is more likely to achieve significant results.

SITE 3: 176 Candia Road

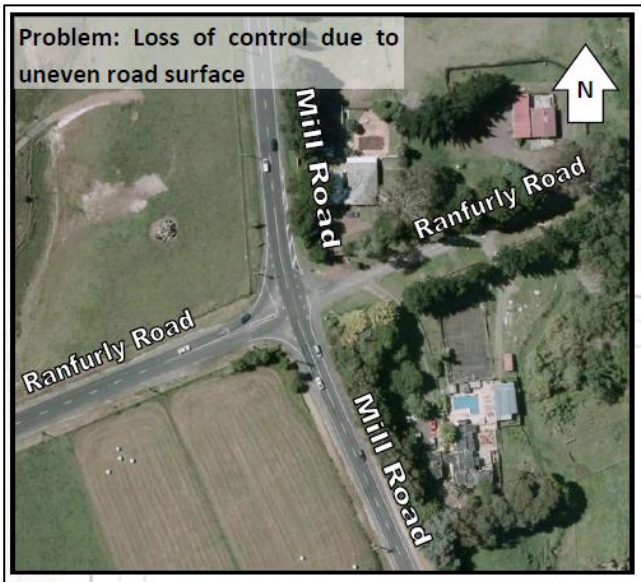


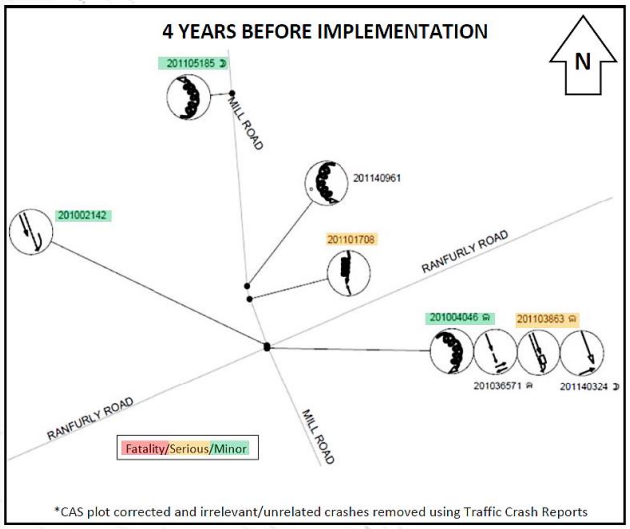
Conclusion: A complimentary package of rural road bend treatment works can generate substantial crash savings over the long-term, without crash migration.

SITE 4: Terry Street

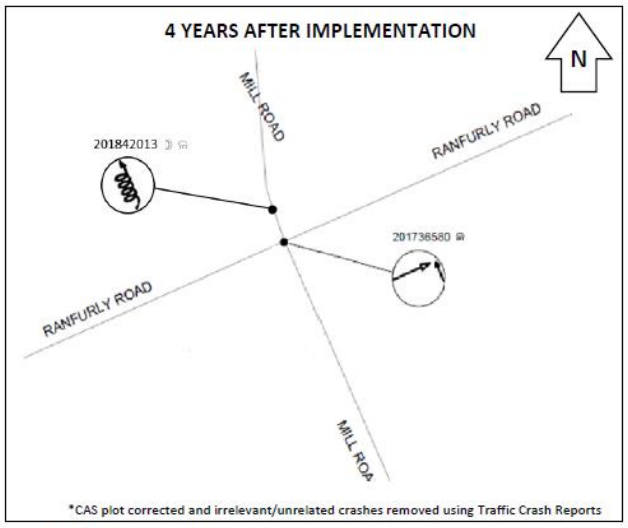
Conclusion: Speed hump traffic calming is very likely to considerably address the severity and frequency of most types of reported crashes relating to speed.

SITE 5: Mill Road / Ranfurly Road





8 reported crashes (2 serious, 3 minor injury) over 4 years before improvements (2009 – 2012)



2 non-injury crash reported over 4 years since improvements (2015 – 2018)

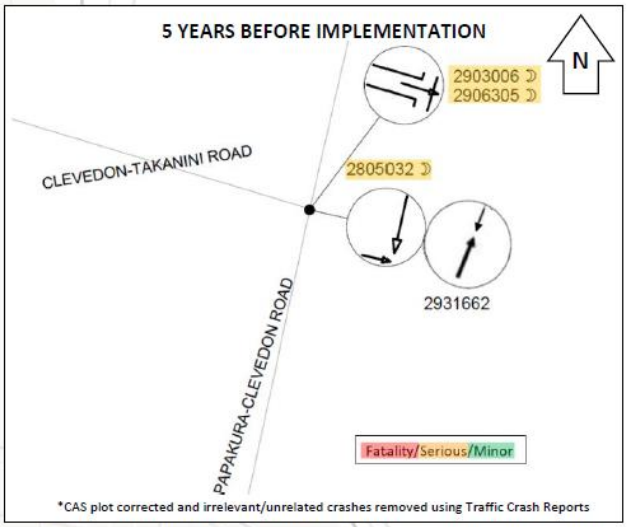
Average reported crash saving per year = 1.5
Average number of DSI saved per year = 0.5
Percentage crashes saved, taking into account crash trend = 76%

Estimated original cost of implementation (approx) = $265,000
Crash costs before works (over project lifetime) = $9,232,000
Crash costs after works (over project lifetime, including crash trend) = $308,000
Actual crash savings (over project lifetime, including crash trend) = $8,924,000

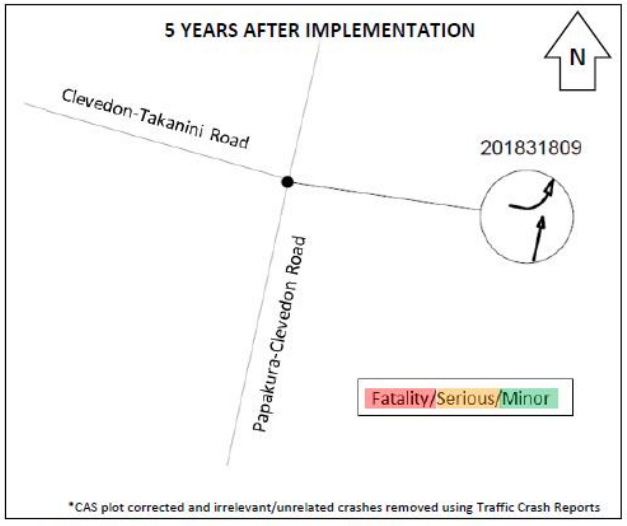
BCR of works = 34

Conclusion: Resealing can be effective at addressing loss-of-control crashes, and a right turn pocket effective at addressing rear-end crashes. Also, at sites with DSI crashes, road works involving significant cost (road surface milling/resealing) can be highly economical.

SITE 6: Papakura-Clevedon Road / Takanini Road



4 reported crashes (3 serious injuries) over 5 years before improvements (2007 – 2011)



1 non-injury crash reported over 5 years since improvements (2014 – 2018)

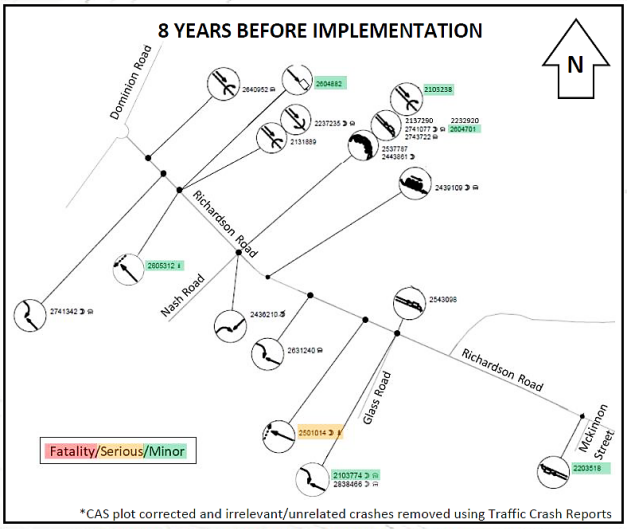
Average reported crash saving per year = 0.6
Average number of DSI saved per year = 0.6
Percentage crashes saved, taking into account crash trend = 79%

Original cost of implementation (approx) = $305,000
Crash costs before works (over project lifetime) = $9,733,000
Crash costs after works (over project lifetime, including crash trend) = $143,000
Actual crash savings (over project lifetime, including crash trend) = $9,590,000

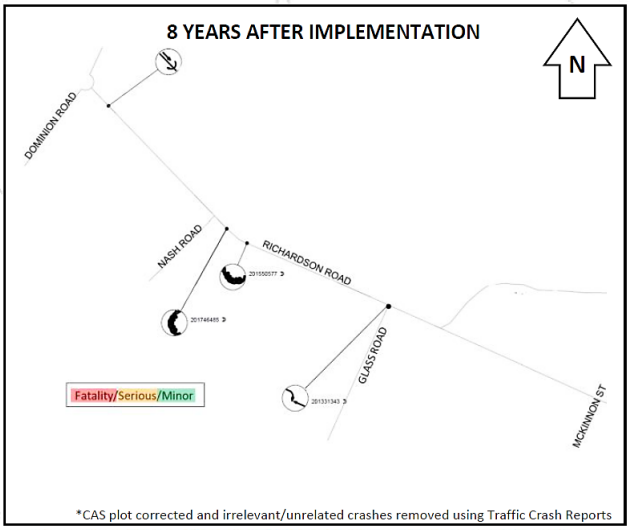
BCR of works = 31

Conclusion: Missed intersection and turning crashes can be substantially addressed with a right turn pocket, chevron sight board, and upgraded street lighting.

SITE 7: Richardson Road (Between Dominion Road & McKinnon Street)



22 reported crashes (1 serious, 6 minor injury) over 8 years before improvements (2001 – 2008)



4 reported non-injury crash over 8 years since improvements (2011 – 2018)

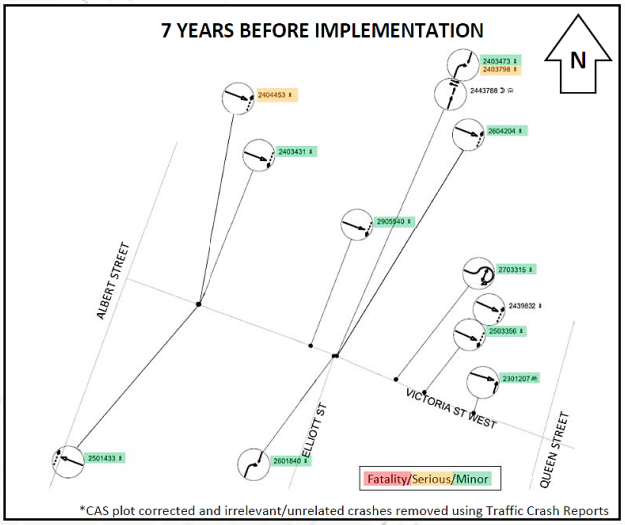
Average reported crash saving per year = 2.3
Average number of DSI saved per year = 0.1
Percentage crashes saved, taking into account crash trend = 78%

Original cost of implementation (approx) = $13,000
Crash costs before works (over project lifetime) = $2,722,000
Crash costs after works (over project lifetime, including crash trend) = $139,000
Actual crash savings (over project lifetime, including crash trend) = $2,583,000

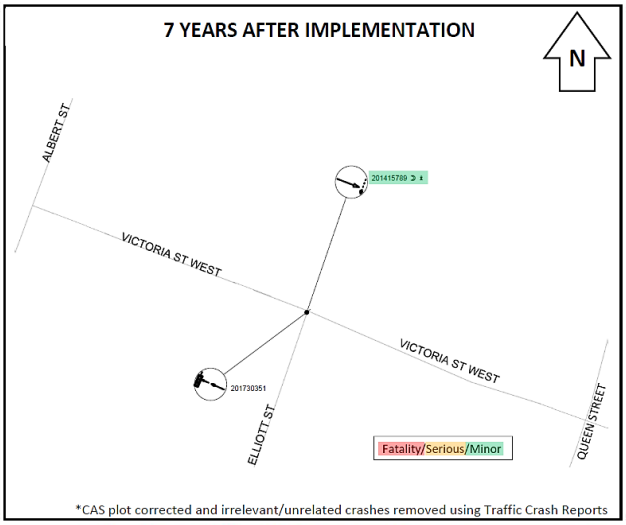
BCR of works = 196

Conclusion: Improved delineation with a flush median, parking edgelines and NSAAT, appears to have considerably reduced rear-end (GD), right-turn against (LB), and U-turn crashes.

SITE 8: Victoria Street (Between Albert Street & Queen Street)



13 reported crashes (2 serious, 9 minor injury) over 7 years before signals (2003 – 2009)



2 reported crashes (1 minor-injury) over 7 years since improvements (2012 – 2018)

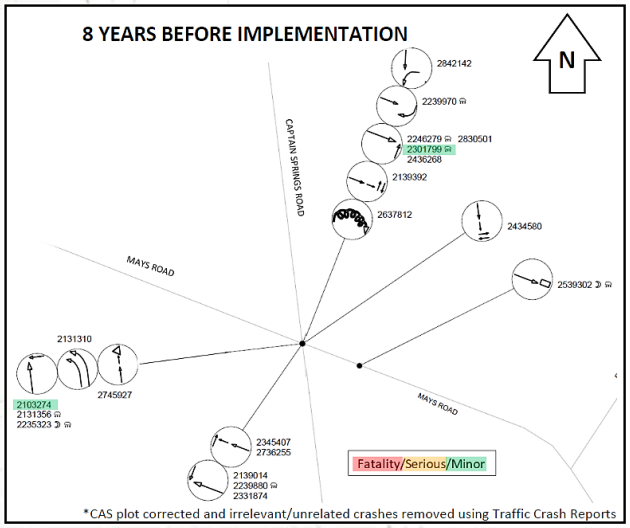
Average reported crash saving per year = 1.6
Average number of DSI saved per year = 0.3
Percentage crashes saved, taking into account crash trend = 83%

Original cost of implementation (approx) = $125,000
Crash costs before works (over project lifetime) = $5,017,000
Crash costs after works (over project lifetime, including crash trend) = $167,000
Actual crash savings (over project lifetime, including crash trend) = $4,850,000

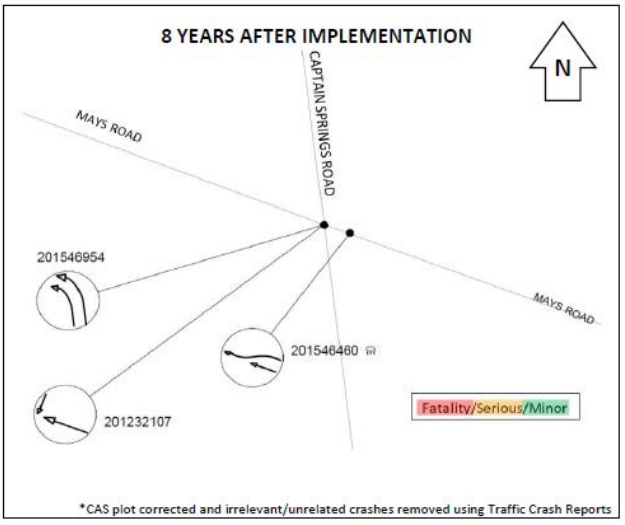
BCR of works = 39

Conclusion: Mid-block pedestrian traffic signals can be easily justified if reported crashes include serious injury pedestrian crashes, and if the crosswalk can be installed on the pedestrian desire line.

SITE 9: Captain Springs Road / Mays Road



20 reported crashes (2 minor injury) over 8 years before improvements (2001- 2008)



3 reported non-injury crash over 8 years since improvements (2011 – 2018)

Average reported crash saving per year = 2.1
Average number of DSI saved per year = 0
Percentage crashes saved, taking into account crash trend = 81%

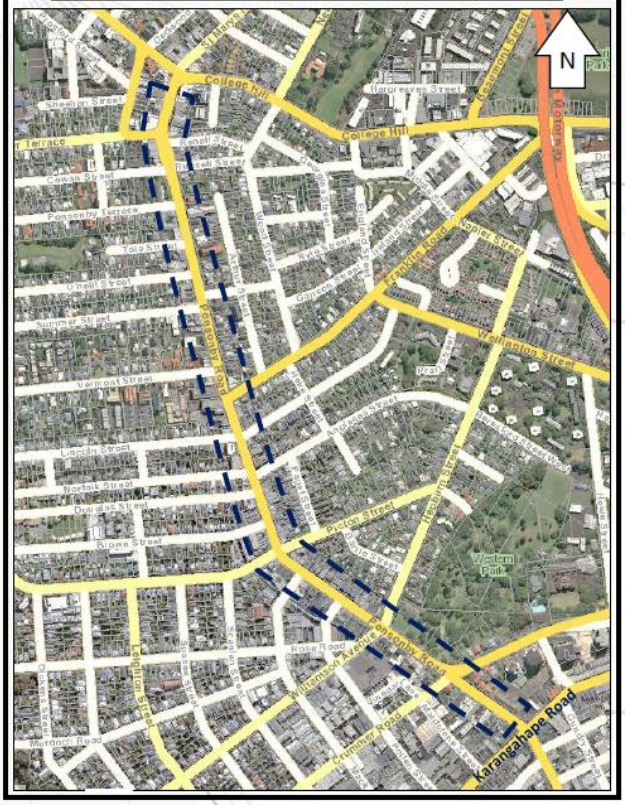
Original cost of implementation (approx) = $220,000
Crash costs before works (over project lifetime) = $685,000
Crash costs after works (over project lifetime, including crash trend) = $105,000
Actual crash savings (over project lifetime, including crash trend) = $580,000

BCR of works = 2.6

Conclusion: Various vehicle related reported crashes at a problematic 'Stop' controlled X-junction can be addressed by installation of traffic signals.

SITE 10: Ponsonby Road

Problem: Road Safety along Ponsonby Road



Solution: Lower Posted Speed Limit to 40km/h

Site No: 10 Ponsonby Road Lowering of Speed Limit	Fatality	Serious	Minor	Non-injury	Total
(2001 – 2008) Actual crashes before over 8 years =	2	14	73	301	390
Expected crashes after (accounting for trend & assuming no works) =	1.4	14	71	229	315
(2011 – 2018) Actual crashes after over 8 years =	0	6	66	225	297
% Crash Reduction (expected crashes compared to actual crashes) =	100%	57%	7%	2%	6%

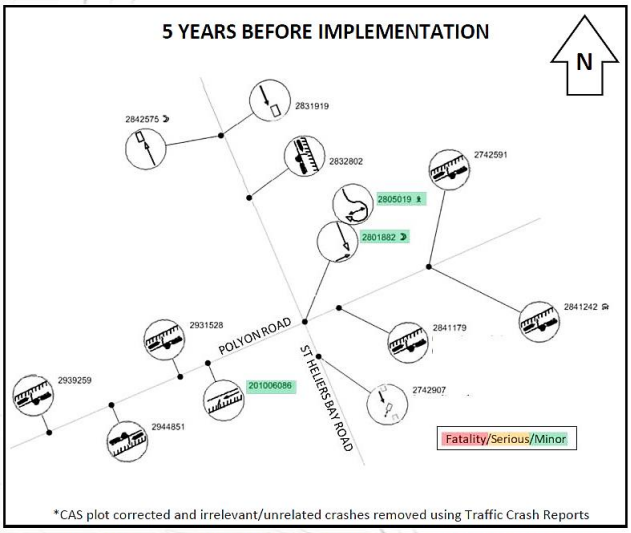
Average reported crash saving per year = 12
Average number of DSI saved per year = 1.3
Percentage crashes saved, taking into account crash trend = 6%

Original cost of implementation (approx) = $187,000
Crash costs before works (over project lifetime) = $42,779,000
rash costs after works (over project lifetime, including crash trend) = $20,592,000
Actual crash savings (over project lifetime, including crash trend) = $22,187,000

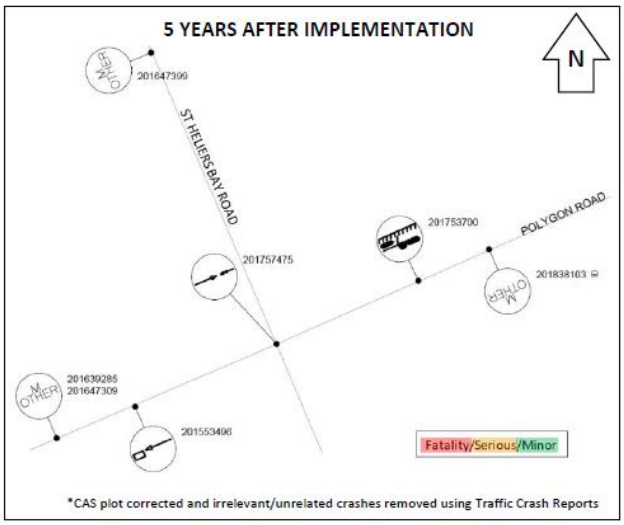
BCR of works = 119

Conclusion: Lowering the posted speed at an appropriate location using highly visible gateway treatments can be very effective at reducing DSI crashes.

SITE 11: St Heliers Bay Road / Polygon Road



13 reported crashes (3 minor injury) over 5 years before improvements (2007 – 2011)



7 reported non-injury crashes over 5 years since improvements (2014 – 2018)

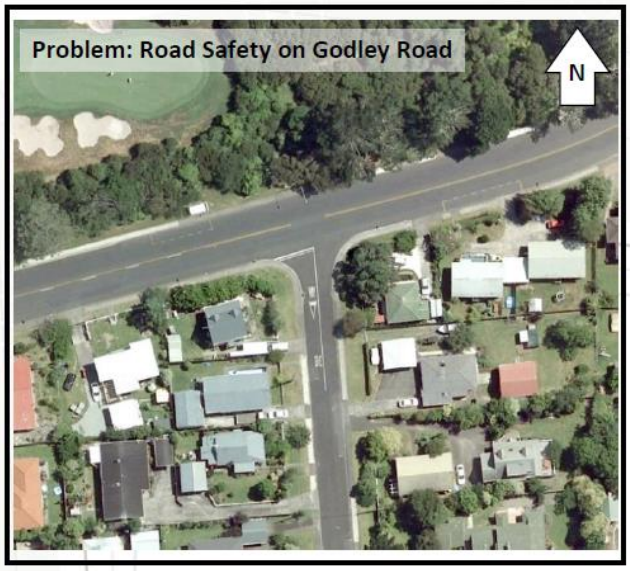
Average reported crash saving per year = 1.2
Average number of DSI saved per year = 0
Percentage crashes saved, taking into account crash trend = 38%

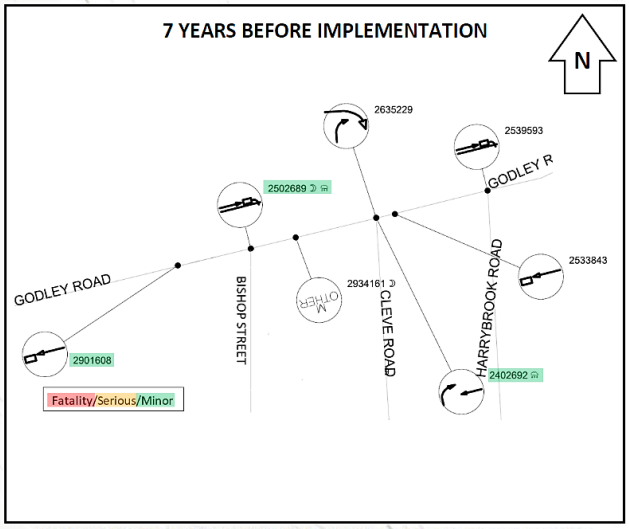
Original cost of implementation (approx) = $202,000
Crash costs before works (over project lifetime) = $924,000
Crash costs after works (over project lifetime, including crash trend) = $334,000
Actual crash savings (over project lifetime, including crash trend) = $580,000

BCR of works = 2.9

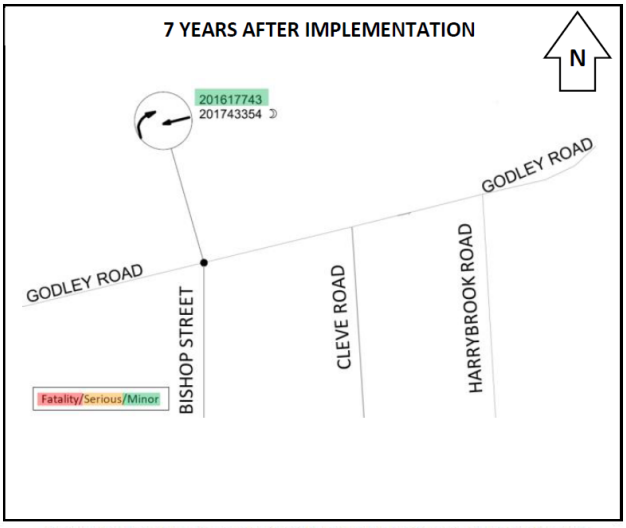
Conclusion: The traffic calming benefits of installing a roundabout at a cross-roads junction can reach beyond the immediate confines of the junction, even if the roundabout design is low standard.

SITE 12: Godley Road (Bishop Street to Harrybrook Road)





7 reported crashes (3 minor injury) over 7 years before improvements (2003 – 2009)



2 reported crashes (1 minor injury) over 7 years since improvements (2012 -2018)

Average reported crash saving per year = 0.7
Average number of DSI saved per year = 0
Percentage crashes saved, taking into account crash trend = 66%

Original cost of implementation (approx) = $36,000
Crash costs before works (over project lifetime) = $478,000
Crash costs after works (over project lifetime, including crash trend) = $171,000
Actual crash savings (over project lifetime, including crash trend) = $307,000

BCR of works = 8.4

Conclusion: Relatively simple delineation improvements and traffic calming (flush median, road-marking, raised islands, NSAAT) can have a beneficial effect on reducing various types of crashes, particularly parked vehicle crashes (EA) and rear-end crashes (GD).

CONCLUSIONS

The following key conclusions have been reached:

- As part of a national government Safe System strategy to address DSI crashes, emphasis should be placed on implementing crash remedial works that have a proven record of success at similar sites, to ensure confidence in performance and economic value;

- Local council's should consider establishing crash monitoring programmes to clearly identify local crash remedial works proven to be successful;

- Crash savings results are greater if crash remedial works are implemented at sites with a reported crash problem, rather than a perceived road safety problem. It is noted that regression to the mean can contribute to apparent success at sites with adverse crashes over a short period of time. However, the potential impact of regression to the mean can be minimised by establishing clear crash patterns, 'cause' and 'effect' analysis, and by reviewing reported crashes over an extended time period;

- DSI crash severity and frequency have a significant impact on economic value, and can justify substantial remedial works;

- Significant DSI crash savings can be achieved by clearly identifying reported crash patterns, and targeting these patterns using relevant crash remedial works;

- When reviewing 'before' and 'after' crashes, it is important to 'cleanse' the data and remove reported crashes unrelated to the proposed works, particularly with small data samples. A small quantity of unrelated crashes can confuse the key results. However, to avoid analysis bias, data 'cleansing' should be objective, documented, substantiated, and fairly applied to 'before' and 'after' crashes;

- Crash trends can have a significant effect on the final crash results, hence its important to calculate the crash trend for a control group for each relevant site/study period;

- Some study sites achieved statistical significance, but due to the small number of reported crashes at most of the sites reviewed, most of the analysis results are not statistically significant individually. However, the results overall are considered useful as a guide to the types of crash remedial works that are likely to be effective.

REFERENCES

Royce, B. (2014). Crash Location Monitoring - 'Before' and 'After' Study of 14 Sites – Minor Safety Works Programme 2009/2010. Study for Auckland Transport. Auckland, New Zealand.

Royce, B. (2015). Crash Location Monitoring - 'Before' and 'After' Study of 14 Sites – Minor Safety Works Programme 2010/2011. Study for Auckland Transport. Auckland, New Zealand.

Royce, B., Jones C. (2017). Crash Location Monitoring - 'Before' and 'After' Study of 14 Sites – Minor Safety Works Programme 2012/2013. Study for Auckland Transport. Auckland, New Zealand.

Royce, B., Rajkotwala B. (2018). Crash Location Monitoring - 'Before' and 'After' Study of 14 Sites – Minor Safety Works Programme 2013/2014. Study for Auckland Transport. Auckland, New Zealand.

NZTA (2016). Economic evaluation manual. Available at <https://www.nzta.govt.nz/resources/economic-evaluation-manual>

NZTA. *CAS Database,* referenced October 2018, <https://securecas.nzta.govt.nz/Citrix/AccessPlatform/auth/login.aspx>

Safer Journeys (2010), *The Safe System approach*, viewed 2018, <http://www.saferjourneys.govt.nz/about-safer-journeys/the-safe-system-approach/>

ACKNOWLEDGEMENTS

I would like to thank Irene Tse (*Team Leader, Road Safety Engineering (Urban) – Auckland Transport*) and Marina Palalagi (*Senior Road Safety Analyst – Auckland Transport*), for actively supporting crash monitoring and commissioning several studies, from which some of the study sites were derived. Also, I thank Burhan Rajkotwala for providing technical assistance during preparation of the latest crash monitoring study and the conference paper.