Safer journeys for motorcycling on New Zealand roads

NZ TRANSPORT AGENCY
WAKA KOTAHI

Safer Journeys

Road Controlling Authorities Forum
Road Controlling Authorities Forum (New Zealand) Incorporated

Foreword

The disproportionate number of crashes involving motorcycles is one of the reasons why the government's road safety strategy, Safer Journeys, has prioritised motorcycling safety on our roads.

The statistics tell a sobering story about the safety risks associated with motorcycling. Crashes involving motorcycles are highly disproportionate to the number of kilometres driven on our roads by motorcyclists. For example, the risk of a motorcyclist being killed or seriously injured in New Zealand is about 18 times higher than that of a car driver. Clearly there is much more that we can do to improve safety for motorcyclists no matter if they are commuting to work or enjoying a weekend ride.

Safer Journeys guides us to make a shift in how we address safety. This strategy introduced the Safe System approach toward road safety – a fundamental shift in how we think about, and act on, road safety. This approach shifts the mindset around crashes from one in which blame is often placed on the road user to one in which we recognise that human error is inevitable and that the road system needs to protect the road user from death or serious injury.

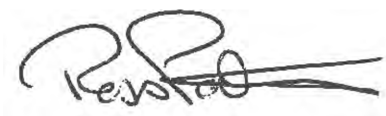
The intent of this document is to help reduce serious injuries and fatalities involving motorcycles on New Zealand roads. This guide has been written for use by a variety of audiences, including road controlling authorities, road designers, maintenance crews, motorcyclists and others in the motorcycling sector, and road users not familiar with motorcycling safety. It represents the holistic approach to safety called for in Safer Journeys, but it emphasises the safe roads and roadsides goal of the Safe System approach. This new approach is being tested 'on the ground' in the Coromandel region, with some great work emerging on improvements to a high-risk motorcycling route in that area.

The guide has been developed with tremendous support and input from many others in the sector, including road controlling authorities, ACC, and Motorcycle Safety Advisory Council (MSAC). The collaboration among all parties has been instrumental in delivering a safety guide that represents the wide range of perspectives needed in order to result in significant safety gains. We value our relationships with the motorcycling sector and are grateful that the active participation from these groups ensures that all points of view are not only considered, but are fundamental in the development of the guide's key recommendations.

We trust this guide will be well used and will help to facilitate a shift over time in how motorcycling safety is approached. Importantly, we intend for the guide to be a dynamic document that is updated over time. Making our roads safer for motorcycling will be an ongoing focus for all of us and we expect that our good relationship with the motorcycling sector will continue as we pursue this journey. We continue to welcome suggestions and comments, including about what's been working well and what hasn't.

In the meantime, I am encouraged by the results of this shared work and look forward to a continued dialogue and further collaboration in making New Zealand's roads safer for motorcycling.

Geoff Dangerfield
Chief Executive
NZ Transport Agency



Ross Paterson
Chair
Road Controlling Authority Forum

Contents

Glossary of terms

Term	Definition
3 Es	Engineering, education and enforcement
AA	New Zealand Automobile Association
ATP markings	Audio-tactile profiled markings
Austroads	Association of Australian and New Zealand road transport and traffic authorities
Casualty	A person who is killed or injured in a crash. There can be more than one casualty in a crash – there can also be no casualties in a crash. A casualty is an individual
Collective risk	Also known as crash density, is a measure of the number of high severity (fatal and serious) crashes, per kilometre of road per year, that have occurred
Crash[1]	A crash is a rare, random, multifactor event preceded by a situation in which one or more persons failed to cope with their environment. A crash is an event in which anyone injured is a casualty
Delineation	Is the pavement markings, edge marker or posts, raised pavement markers and/or signage used on and adjacent to the roadway to safely guide vehicular movements over a specific section of roadway during day, night, dry and wet conditions
DSi	Death and serious injury
Fatal injury	Where death occurs within 30 days as a result of a crash
Favoured motorcycle route	A route identified by motorcycle organisations (such as MSAC) as being a route that motorcyclists frequently choose to ride
Harm minimisation speed	Pre-impact operating speed above which the likelihood of a DSi outcome increases rapidly
Harm reduction speed	A posted speed limit based on using a balance between the current speed limit and a harm minimisation speed
Hazard	An object, feature, and/or condition (whether permanent or temporary) present in the road environment that has the potential to cause harm
High risk motorcycle route	A route where the motorcycle injury crash density is high or medium-high
High-severity crashes	Fatal and serious crashes
HRIG	*High-risk intersections guide*
HRRRG	*High-risk rural roads guide*
Impact speed	The speed of travel of an object (usually a vehicle or a person) immediately before striking another object (for example, a tree, vehicle, or person)
iRAP	International Road Assessment Programme
KAT	KiwiRAP assessment tool
KiwiRAP	The New Zealand joint agency road assessment programme
Minor injuries	Injuries sustained as a result of a crash that are not likely to require a visit to a hospital for treatment, eg cuts, sprains, bruises

[1] Partially taken from: http://www.nzta.govt.nz/resources/guide-to-treatment-of-crash-location/definitions.html

Term	Definition
Moped	Powered two or three wheeled vehicle that has a power output of 2kW or under, and a maximum design speed of 50km/h or under.[2] Note: additional information of vehicle equipment standards and classifications can be sourced at www.nzta.govt.nz
MoT	Ministry of Transport
Motorcycle	Powered two or three wheeled vehicle (with side car) that has a power output of over 2kW or a maximum design speed of over 50km/h Note: additional information of vehicle equipment standards and classifications can be sourced at www.nzta.govt.nz
MSAC	Motorcycle Safety Advisory Council. An organisation established to use the funds gathered from motorcyclists and other riders to make riding safer
NZTA	NZ Transport Agency
OECD	Organisation for Economic Cooperation and Development
Operating speed	The speed at which vehicles travel on a particular section of road. This speed could be greater or less than the posted (legal) speed limit
Personal risk	Also known as crash rate, is a measure of the number of high-severity crashes, per 100 million vehicle kilometres of travel on the road, that have occurred
Posted speed limit	The maximum speed at which a vehicle may legally travel on a particular section of road
Practitioner	A person who is professionally involved in the investigation, design, and/or construction of measures intended to improve the safety of the roading network for riders of motorcycles/mopeds
RAMM	Road Asset Maintenance Management software
RCA	Road controlling authority
RoNS	Road of national significance
RTA	Road Transport Association New Zealand
Rural road	In relation to a road, is one having a posted speed limit of 80km/h or more[3]. It can be a motorway, state highway, expressway, local road or private road. A rural road can have many forms, eg high volume four lane median divided expressway, two lane undivided and a low volume one lane unsealed road (see section 1.3)
Serious injury	Includes injuries (such as broken bones) that are likely to involve a visit to a hospital for treatment
Speed zone	A designated stretch of road where the speed limit has been set for the operating conditions and physical characteristics of the road rather than the standard rural speed limit of 100km/h
TLA	Territorial local authority
Urban road	A road with a speed limit of 70km/h[4] or less

[2] Refer to: http://www.nzta.govt.nz/vehicle/your/motorcycles.html (accessed on 12 June 2012)

[3] Note that, for the purposes of the Guide and any relevant crash analysis, the definition of a rural road is a road with a posted speed limit of 80 km/h or more. This is different to the 'rural' definition contained in some documents, such as the New Zealand *Traffic control devices manual,* where rural is defined as being 70km/h or more and urban as less than 70km/h.

[4] Ibid

1 Introduction and objectives

1.1 Purpose

Safer journeys for motorcycling on New Zealand roads has been prepared by the NZ Transport Agency (NZTA) to provide guidance on the government's Safer Journeys 2020 strategy initiative to focus efforts on increasing the safety of motorcycling. The primary objective of this document is to provide practitioners and policy makers with best practice guidance to identify, target and address key road safety issues on high-risk motorcycle routes, recognising that motorcycles and mopeds are a part of the New Zealand vehicle fleet and their riders are legitimate road users whose safety needs must be more appropriately catered for. It provides links to a number of road safety resources and guidance for planning, funding and evaluating safety projects and programmes. This document focuses on road maintenance and construction practices that have the potential to improve the safety of the roads by motorcyclists. However, this document is also intended to provide:

- details of a Safe System approach for motorcycling, including safe roads and roadsides, safe speeds, safe road use, and safe vehicles
- identification of key crash issues for motorcyclists
- tools to help identify and analyse high-risk motorcycle routes and motorcycling road safety issues
- a range of countermeasures for key crash types occurring in rural and urban environments, to help develop best-value remedial treatments
- guidance for developing, prioritising and funding road safety infrastructure and speed management programmes
- reference to further tools and resources to evaluate implemented countermeasures
- national consistency regarding the identification of motorcycle routes and the application of proven countermeasures.

In addition to this document, the *High-risk rural roads guide* (HRRRG published September 2011) and the *High-risk intersection guide* (HRIG currently under development) could be referenced for more detailed information and recommendations on both high-risk rural routes and high-risk intersections.

1.2 Scope

This document refers and directly links to the Austroads guides and to a number of appropriate policies, standards and guidelines applicable to New Zealand practice.

This document supports and references:

- the New Zealand Ministry of Transport's (MoT) *Safer Journeys: New Zealand's road safety strategy 2010–2020* (March 2010)
- the MoT's cross-agency *Safer Journeys action plan 2011–12* (March 2011)
- the NZTA's Road Safety Strategic Plan (April 2011)
- New Zealand legislation and, in particular, the Land Transport Act 1998 and rules made pursuant to that act, including the Land Transport (Road User) Rule, the Land Transport Rule: Traffic Control Devices, and the Land Transport Rule: Setting of Speed Limits
- general polices contained in Austroads guides (guides to traffic management, road design, road safety) and other Austroads technical guides
- New Zealand and, as appropriate, Australian standards codes of practice and guidelines
- published standards of various organisations and authorities.

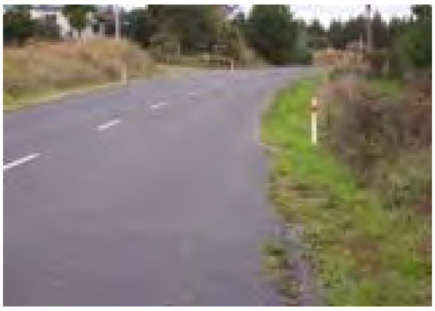
This document provides rules, standards and guidance on measures to improve safety on high-risk motorcycling routes. However, practitioners must always apply sound judgement when identifying and installing any

countermeasures to ensure the best possible safety outcomes. Any departures from recommended practice must be supported by documentation of the principles behind the departures.

1.3 Definitions

For the purposes of using this document:

- a rural road is a road with a speed limit of 80km/h[5] or more. It can be a motorway, state highway, expressway, local road or private road
- a rural road can have many forms ranging from a high volume four-lane median divided expressway to a low volume one-lane unsealed road as illustrated in the photos below

- an urban road is a road with a speed limit of 70km/h or less
- a high-risk motorcycle route[6] is either a:
  - a rural road where the motorcycle injury crash density (collective risk) is high or medium–high compared with other roads, as defined in section 4 or
  - an urban road where the motorcycle injury crash density (collective risk) is high or medium–high compared with other roads. However, it is recognised that further analysis and consistency with the high-risk intersection guide is needed prior to confirming and then describing a high-risk urban intersection or site. (See comment box in section 4.4.1.)

For rural areas a collective crash risk of medium–high or high defines the route as a high-risk motorcycle route (refer to figure 4-1), subject to having two or more motorcycle injury crashes over a five-year period or four or more motorcycle injury crashes over a 10-year period.

1.4 Target audience

The principles presented in this document are relevant to road controlling authorities (RCAs) for both state highway and local roads for both urban and rural road networks. This document is intended to provide guidance to:

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[5] Note that, for the purposes of this document and any relevant crash analysis, the definition of a rural road is a road with a posted speed limit of 80km/h or more. However, in some documents, such as the NZ Transport Agency's *Traffic control devices manual*, this has been defined as being 70km/h or more.

[6] A high-risk motorcycle route identified as high risk through this document may not necessarily meet the requirements for a high strategic fit in the Investment and Revenue Strategy for funding purposes. Refer section 2.5.

- system designers, including, but not limited to:
  - RCAs
  - state highway and local roads engineers
  - planners
  - funders
  - policy makers
  - road system designers
  - road maintenance personnel
- system users, including, but not limited to:
  - all road users, including those unfamiliar with motorcycle/moped use
  - riders of motorcycles/mopeds.

This document may also be useful to other industry practitioners, developers and private landowners seeking to identify road safety risks and develop appropriate risk-reducing measures.

1.5 Structure of the document

This document is divided into seven main sections.

Section 2	Strategic context	Outlines the varying strategies and priorities of the government. It includes descriptions and background information on the Safer Journeys strategy and the Safe System approach.
Section 3	Crash data and comparison of road use	Provides information regarding motorcycling crash data in New Zealand and compares this with crash data for other road users.
Section 4	Identifying routes	Describes the process for identifying high-risk and favoured motorcycle routes.
Section 5	Key issues and treatments	The key issues that affect motorcycling safety are listed and information is provided regarding Safe System countermeasures to address the issues.
Section 6	Understand the issues	An overview of the matters road safety practitioners should consider to assist them to understand the issues associated with motorcycle crashes.
Section 7	Programme implementation, monitoring and evaluation	Describes the processes involved with prioritising and programming works identified as part of the methodology. Provides advice on how best to monitor and evaluate completed countermeasures at high-risk sites and routes.
Section 8	Other information sources	Provides a list of documents and websites containing information that may be useful for practitioners and/or motorcyclists. These include several motorcycle guidance documents that describe relevant treatments and the NZTA's recently developed *High-risk rural roads guide* and *High-risk intersection guide.*

2 Strategic context

2.1 Safer Journeys: New Zealand's road safety strategy 2010–2020

The New Zealand government released its Safer Journeys strategy in March 2010. Safer Journeys is a national strategy to guide improvements in road safety over the period 2010 to 2020. The strategy sets out a long-term vision for New Zealand of 'a safe road system increasingly free of death and serious injury'.[7]

To support the vision, Safer Journeys introduces, for the first time in New Zealand, a Safe System approach to road safety (refer section 2.2 below).

Safer Journeys also lists a number of key initiatives that have been identified as having the greatest impact on reducing road crash trauma. These initiatives will be implemented through a series of action plans relating to the Safe System goal to ultimately achieve safe roads and roadsides, safe speeds, safe road use, and safe vehicles.

'Increasing the safety of motorcycling'[8] is one of the four first actions identified in Safer Journeys. This document is part of achieving that first action.

2.2 Motorcycling and Safer Journeys Action Plan

This guide is one of several motorcycling initiatives designed to increase the safety of motorcycling in New Zealand.

The Safer Journeys Action Plan outlines the actions that need to be advanced to help achieve the Safer Journeys' objectives. The 2011-2012 Safer Journeys Action Plan[9] identifies focus areas to address motorcycling safety; these include:

- implement regulatory changes and improve motorcycle training
- engage motorcyclists
- implement safety treatments on high-risk motorcycle routes.

Sixteen specific actions, related to the focus areas, have been identified for increasing the safety of motorcycling. This guide is primarily intended to address two of the actions, namely:

- Develop policies for the retrofitting of high-risk, popular motorcycling routes with features that improve safety for motorcyclists, and
- Identify high-risk motorcycle routes and develop treatment programmes for these routes.[10]

These actions are intended to help achieve the 2020 goal of New Zealand having a motorcycling fatality rate no worse than that of Victoria, Australia, where there are 7 fatalities per 1 million[11] population, versus the 2009 New Zealand fatality rate of 11 per 1 million[12] population.

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[7] Safer Journeys: New Zealand's Road Safety Strategy 2010-2020, Ministry of Transport, 2010, page 3.

[8] Ibid, page 3.

[9] Safer Journeys Action Plan 2011-2012, National Road Safety Committee, March 2010.

[10] Ibid, page 16.

[11] The action plan incorrectly refers to an annual motorcycling fatality rate for Victoria of 7 fatalities per 100,000 population, whereas, it should refer to 7 fatalities per 1 million population.

[12] The action plan incorrectly refers to an annual motorcycling fatality rate for New Zealand of 11 fatalities per 100,000 population, whereas, it should refer to 11 fatalities per 1 million population.

2.3 Safe System

2.3.1 Safe System principles

The Safe System approach works on the principle that it is not acceptable for a road user to be killed or seriously injured if they are involved in a crash. However, the Safe System approach also acknowledges that road users are fallible and will continue to make mistakes and therefore there should be a shared responsibility to provide a road network that is tolerant of these mistakes.

The traditional 3 Es approach to road safety (engineering, education and enforcement) has helped achieve our current levels of road safety and these elements remain important. However, the 3 Es approach tends to blame and try to correct the road user. Continuing with this approach will not achieve the desired gains in road safety in New Zealand. A Safe System approach recognises the need for system designers and road users to share responsibility, with the ultimate aim of protecting road users from death and serious injury.

The Safe System approach is about acknowledging that:

1. Human beings make mistakes and crashes are inevitable	However, the current consequences of those mistakes and crashes should not be regarded as acceptable. A Safe System aims to reduce the likelihood of death and serious injury (DSi) resulting from a crash, as well as reducing the likelihood and consequences of all crashes.
2. The human body has a limited ability to withstand crash forces	The human body has a limited tolerance to crash forces. A Safe System aims to manage the magnitude of crash forces on the human body to remove the potential for death or serious injury (refer to figure 2-1).
3. System designers and road users must all share responsibility for managing crash forces to a level that does not result in death or serious injury	The aim of the system designer is to deliver to the road user a predictable (self-explaining) road environment that is also forgiving of mistakes. The Safe System relies on the principle of shared responsibility between system designers and road users. System designers include planners, engineers, policy makers, educators, enforcement officers, vehicle importers, suppliers, utility providers and insurers.
4. It will take a whole-of-system approach to implement the Safe System in New Zealand	Everyone plays a part in providing a safe transport system. Road designers will design safe roads and roadsides that will encourage safe behaviour and be forgiving of human error. Vehicle technology (safe vehicles) will vastly improve communication with the road environment to ensure appropriate speeds that respond to real-time conditions (safe speeds). Road users need to understand and play their part in the system (safe road use), including an acceptance of the skills required to get a driver licence as well as maintaining their vehicles to appropriate standards.

2.3.2 Human tolerance to physical force

The fundamental principle of a Safe System is the relationship between road users, vehicles, speeds and road infrastructure, and how much force the human body can withstand when these four elements interact in the event of a crash. The Organisation for Economic Cooperation and Development (OECD)[13] states that 'The human body's tolerance to physical force is at the centre of the Safe System approach'. In addition, the Australian National Road Safety Strategy 2011–2020[14] states that 'The chances of surviving a crash decrease rapidly above certain impact speeds, depending on the nature of the collision'. This is illustrated in figure 2-1, which presents the risk of a fatality occurring as a result of five key crash types. For a motorcyclist, a collision with a car has a survivable impact speed of 30km/h, which is significantly lower than the current typical operating speed for motorcycles and other vehicles

[13] *Towards zero: Ambitious targets and the Safe System approach*, OECD, 2008, page 112.

[14] National Road Safety Strategy 2011–2020, Australian Transport Council, 2011, page 60.

on rural roads. The worst injury severity, in the crashes involving the road user combinations described in figure 2-1, will most often be suffered by the most vulnerable road user; that is, a pedestrian is likely to be more severely injured in a car/pedestrian crash than an occupant of the car.

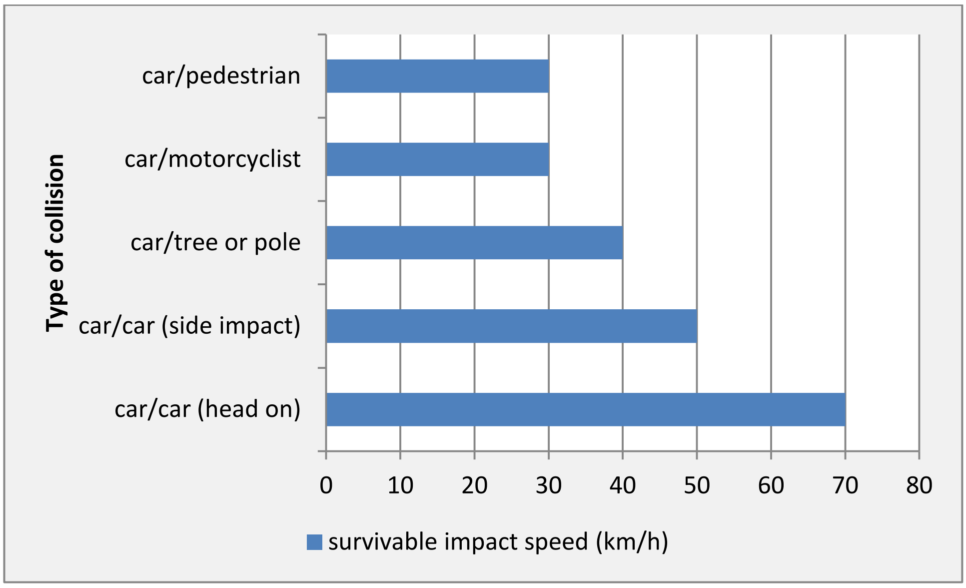

Figure 2-1: Range of survivable impact speeds for different scenarios[15]

Note: The range of impact speeds shown for each crash type is considered to be survivable in most cases.

While the strategy does not include information regarding the survivability of a range of motorcycle crashes, it does note[16] that 'There is evidence that motorcycles are over-represented in speed-related crashes…'

The OECD[17] recognises that, in general, safe speeds will contribute to addressing fatal and serious injury head-on crashes. They note (page 55) that a Safe System approach involves monitoring the proportion of drivers travelling at safe speeds.

The OECD also notes[18] that 'Motorcyclists are highly vulnerable compared with other motorists due to the lack of vehicle crash protection…'

However, achieving operating speeds that are safe speeds (figure 2-1) particularly on rural roads throughout New Zealand, will in some cases adversely affect transport efficiency. Other measures, such as reducing roadside obstacles and protecting all road users from collisions would be needed to reduce crash severity where safe speed thresholds cannot be appropriately provided. The need to balance efficiency desires with safety desires often leads to a harm reduction philosophy being adopted as opposed to a more rigid harm minimisation philosophy.

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[15] National Road Safety Strategy 2011–2020, Australian Transport Council, 2011, page 60.

[16] Ibid, page 61.

[17] *Towards zero: Ambitious targets and the Safe System approach*, OECD, 2008, page 121.

[18] Ibid, page 82.

2.3.3 Safe System elements

Under a Safe System, designers create and operate a transport system where road users who are alert and compliant are protected from death and serious injury. The four elements of a Safe System are illustrated in figure 2-2 and include:

- safe roads and roadsides that are predictable and forgiving of mistakes – their design should encourage appropriate road user behaviour and speeds
- safe speeds that suit the function and level of safety of the road – road users understand and comply with speed limits and drive to the conditions
- safe vehicles that help prevent crashes and protect road users from crash forces that cause death and serious injury
- safe road use that ensures road users are skilled, competent, alert and unimpaired and that people comply with road rules, choose safer vehicles, take steps to improve safety, and demand safety improvements.

Figure 2–2: Safe System elements

2.3.4 Safe System in a motorcycling context

When considering applying a Safe System approach for motorcyclists' high-risk and favoured routes there is some variation from the Safe System approach applied for general road use.

F. E. Holgate[19] states that 'In the case of motorcycles, a Safe System could be achieved in three ways:

- Limiting travel to roads where there is segregation from heavier vehicles or where the travel speeds of these vehicles, and motorcyclists is below a survivable limit – probably of the order of 40-50km/h with current protective technologies.

[19] Holgate F. E. *Motorcycling and the safer system: an international perspective.* Vicroads, 2011.

- Improving vehicle protective equipment and roadside performance to increase the speed at which collisions are survivable.
- Improving technology so that rider errors do not result in a crash.'

For all three of these, the gaps between current performance (constrained by technology and community acceptance) are significant – such that for many years, motorcycle safety will need to be focused on risk reduction. The Safe System model provides a means to understand the problem and derive tools to facilitate this risk reduction.'

While all these factors could achieve a Safe System, an appropriate level of practicality or achievability should be considered. Given the road infrastructure in New Zealand it will be difficult to achieve segregation of other vehicles on motorcycle routes. In addition, lowering speed limits to survivable limits (harm minimisation speeds) may not be acceptable to the community, therefore, a balance of less extreme options (such as harm reduction speeds) could be applied.

Holgate states further that:

- '… in the short to medium term, motorcycling will remain an inherently risky activity and that measures should be taken to reduce risk wherever they will be most effective rather than following the pure Safe System approach.' and
- '… that the most significant gains may derive from attention … to error and crash avoidance, rather than mitigating their effects.' and that
- '… strategies should not ignore the opportunities available … such as the promotion of improved protective clothing and equipment.'

2.4 Safer Journeys motorcycling initiatives

2.4.1 Introduction

The recent rise in popularity of motorcycle and moped use is likely to continue. Without a focus on the safety of motorcyclists, this could mean motorcycle injuries continue to increase. 'The risk of a motorcyclist being killed or seriously injured is about 18 times higher than for a car driver'[20]. This is why the Safer Journeys strategy contains a number of actions listed under the four elements, including:

- safe roads and roadsides (refer to section 2.4.2 of this document)
- safe speeds (refer to section 2.4.3 of this document)
- safe vehicles (refer to section 2.4.4 of this document)
- safe road use (refer to section 2.4.5 of this document).

The Safer Journeys objective for motorcycling[21] is that '… there will be an increase (in) the safety of motorcycling … (by reducing) the road fatality rate of motorcycle and moped riders … to that of the best performing Australian state, Victoria, …' The primary aim of this document is to try and make motorcycling safer through the application of best-practice design and maintenance.

2.4.2 Safe roads and roadsides

We know how to make our roads safer. Engineering solutions such as median barriers, skid-resistant surfaces, forgiving roadsides, and intersection improvements have a proven track record.[22] Although these types of measures

[20] Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, 2010, page 27.

[21] Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, 2010, page 13.

[22] Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, 2010, page 14.

are not solely related to reducing the number and severity of motorcycle crashes, they still provide significant overall benefits. Some of the roads and roadsides actions that will assist to improve safety for motorcyclists are[23]:

- targeting high-risk motorcycle routes and high-risk urban intersections
- progress Safe System demonstration projects, and
- design, build and maintain roads of national significance (RoNS).

Significant safety gains on high-risk motorcycle routes are expected to be achieved by focusing on reducing crash frequency, reducing injury outcomes and providing more forgiving roadsides. This approach is also consistent with the Safer Journeys long-term vision of:

'A safe road system increasingly free of death and serious injury.'

A fatal or serious motorcycle crash is equally likely to occur in an urban area as it is in a rural area. However, the types of crashes are somewhat different. For example, in rural areas 42% of high severity crashes involve loss of control type movements, whereas in urban areas 41% of high severity crashes involve one of three specific intersection movements. The three high severity urban intersection movements for motorcycle crashes are (i) right turn off main road, (ii) right turn from a side road and (iii) movements at a crossroads intersection where both vehicles are travelling straight through.

Detailed information on these crash types, for both urban and rural roads, is included in section 3.

The NZTA and local government need to ensure that road safety efforts are primarily focused on the high severity movement types to obtain the greatest benefit from producing safe roads and roadsides. Understanding which movement types result in the most crashes helps to determine the most effective interventions for roads and roadsides.

2.4.3 Safe speeds

The focus detailed in the Safer Journeys Action Plan 2011–2012 is on helping people to drive to the conditions and encouraging them to comply with safe speed limits. Road users need to understand how their decisions about travel speeds affect them and others.[23]

This document provides guidance on the following Safer Journeys safe speed actions 2011/2012 that could assist with reducing motorcycle crashes and severity. These are:

- Public campaigns to achieve acceptance of safe speeds so that road users increasingly understand what driving and riding at safer speeds means, and
- Creating speed limits that reflect a Safe System approach - increasingly speed limits will be intuitive and reflect the use and function of roads, reinforcing a consistent and self explaining look and feel for users across the network.

Safe speeds are closely linked to safe roads and roadsides – especially for rural road and highway networks. This document describes how safe speeds can be achieved to complement safe roads and roadsides (eg implementing safety treatments on high risk motorcycle routes) in order to improve safety for all road users. In addition, appropriate speed management related countermeasures are proposed that relate to the other aspects of the Safe System, ie safe road use (eg improving motorcycle training) and safe vehicles (eg electronic stability control (ESC) which assists riders maintain control if a mistake is made).

The association between driving/riding speed and the risk of (a) being involved in a crash, and (b) being injured in a crash should one occur, is well established within the traffic safety literature[24]. The Safe System brochure includes the above 'S-curves' diagram (refer to figure 2-3) to portray the relationship between fatality risk and collision speed.

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[23] An additional action, that has been in effect since 25 March 2012, involved changes to the give way rule to require traffic turning right to give way to all traffic, including those turning left into the same road.

[24] Monash University *Assessing community attitudes to speed limits: final report*, November 2009

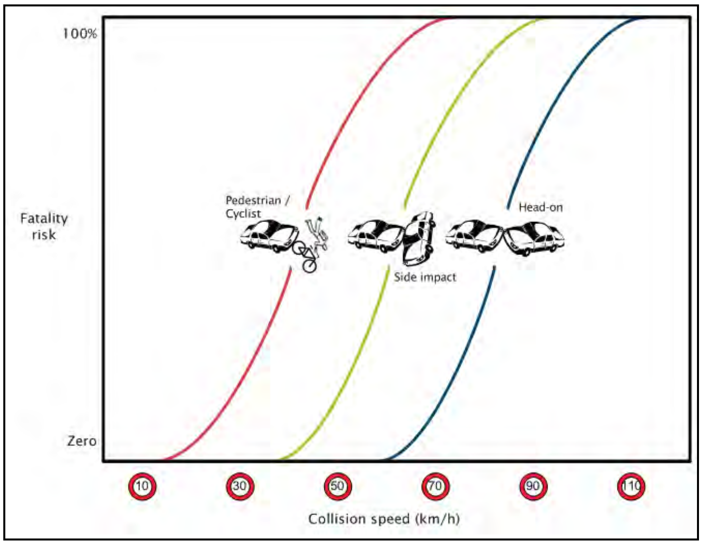
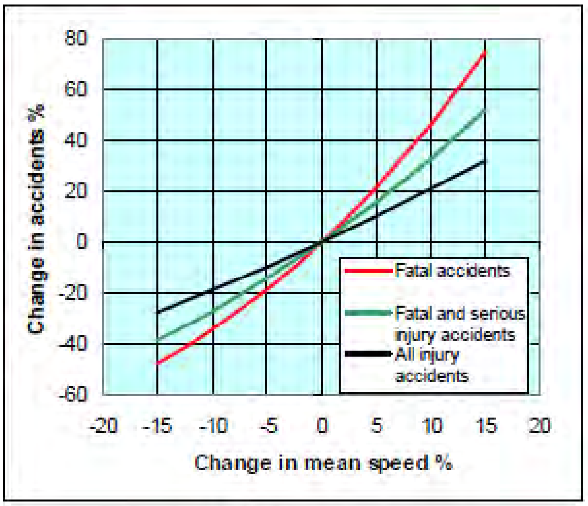


Figure 2–3: Safe Systems brochure S curve diagram

Nilsson's *Power model*[25] (refer to figure 2-4) shows that a 5% increase in average speed leads to approximately a 10% increase in all injury crashes and a 20% increase in fatal crashes, and that a 5% decrease in average speed leads to approximately a 10% decrease in injury crashes and a 20% decrease in fatal crashes. As the model indicates, reducing speed by a few kilometres per hour can greatly reduce the risk of crashes as well as mitigating the consequences of a crash.



Source: Nilsson (2004).

Figure 2-4: Nilsson's power model

The default speed limit on New Zealand open/rural roads is 100km/h and it is generally applied to all rural roads with only limited exceptions at the present time. A more suitable speed limit for many of these roads, for all users, would more closely match the use and function of roads and their present safety features. The NZTA is encouraging the implementation of demonstration safer speed areas[26] for roads on which the default speed limit is inappropriate.

[25] Any model is a simplified representation of reality. The Nilsson model of the relationship between vehicle speed and fatalities and injuries, while founded on a sound scientific base, cannot take into account all the characteristics of the road environment. The actual effects depend on the exact road traffic and characteristics. For example, the effect is considerably larger on urban roads as compared to motorways. (ref OECD Speed Management report.)

[26] Under the Safer Journeys Action Plan 2011-2012, the NZTA and local government are responsible for delivering the following action: 'Ensure the uptake of effective safe speed limits in high-risk rural areas, including implementation of demonstration areas as part of Safe System demonstration projects'. 'Demonstration' rural safer speed areas will help inform how implementing effective safer speed limits can best be accomplished, what problems may occur and how to effectively communicate with road

It must be emphasised that safe speed does not necessarily mean travelling at the posted speed limit – the safe travel speed is determined by the road user based on their competency, the road and weather conditions and the standard of vehicle being driven/ridden.

Harm minimisation and harm reduction speeds to reduce high-severity crashes, used within Safe System approach, are further described within the NZTA's *High-risk rural roads guide*.

2.4.4 Safe vehicles

The action plan for safe vehicles includes a plan to increase public awareness of and demand for safer light vehicles, and promotion of advanced safety features such as collision avoidance technology. While not specifically provided for increasing safety for motorcyclists, these safety features would assist in reducing the overall incidence and severity of crashes. The safe road use action plan also outlines the importance of promoting existing and new technologies such as anti-lock brakes, airbags and advanced protective clothing for motorcyclists.

Note for comment: More information on emerging technology on safe vehicles will be included when it is available

From 1 October 2012, novice riders will only '... be entitled to ride the following:

- A motorcycle with an engine capacity of between 251cc and 660cc and power-to-weight ratio of less than 150 kilowatts per tonne, only if the motorcycle is approved by notice on the NZTA's website.
- A motorcycle with an engine capacity of 250cc or less, unless prohibited by notice on the NZTA's website.'[27]

All motorcycle/moped riders (novice, experienced, returning) are encouraged to purchase their vehicles giving close consideration to the safety features of the motorcycle/moped.

2.4.5 Safe road use

Responsible road use is a key component of the Safe System and particularly relates to motorcyclists. Motorcycle riding requires quite different vehicle control and cognitive skills than those required for driving a car. The potential outcomes of any crash, whether caused by the rider, other road users, the road environment or the vehicle itself, are more severe for motorcyclists.[28.]

This document provides guidance for and an overview of the safe road use plan with a particular focus on:

- implementing regulatory changes and improving motorcycle training
- engaging motorcyclists
- implementing safety treatments on high risk motorcycle routes
- motorcycle focused enforcement.[29]

However, safe road use for motorcyclists requires action to be taken by other road users whose road use can adversely affect the safety of motorcyclists.

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users. Safer speed area demonstration projects will be appropriate to the many areas in New Zealand where it is not possible to economically justify improved infrastructure to enable safe 'high' travel speeds.

[27] http://www.nzta.govt.nz/resources/rules/driver-licensing-amendment-2011-qa.htlm, accessed on 31 March 2012.

[28] Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, 2010, page 27.

[29] Such as periodic campaigns in relation to (for example) helmets and licensing, in a similar manner to periodic campaigns in relation to restraint use in cars.

The Land Transport (Driver Licensing) Amendment Rule 2011 includes the following changes to motorcycle licensing and use requirements:

1. 'Motorcycle-specific training for applicants for restricted and full motorcycle licences.
2. Introduction of a power-to-weight limit for learner and restricted motorcycle riders.
3. Standardisation of the minimum requirements for all novice motorcycle riders at restricted licence stage.
4. Removal of the70km/h speed limit restriction for learner riders.'[30]

The first three items apply from 1 October 2012 and item 4 applies from 1 October 2011.

Safe road use and its effect on motorcycle safety is a matter for action by all road users, not just those who travel on motorcycles/mopeds. However, training for motorcycle/moped users is a critical component of safe road use and it applies to:

- novice riders
- experienced/competent riders
- returning riders who may not have travelled by motorcycle/moped for some time
- pillion riders.

Training information (or links to the information) is available on websites such as:

- www.rideforever.co.nz/returning-to-riding
- www.rideforever.co.nz/resources
- scootersurvival.co.nz/this-is-the-stuff-you-need-to-know-riding-skills/

Motorcycle retailers and hirers also have an important role in ensuring that a motorcycle/moped is suitable for the rider proposing to use the vehicle.

Safe road use also involves:

- wearing appropriate gear for riding a motorcycle/moped. Details of rider safety gear are included in section 5
- having a legal motorcycle/moped and rider, which includes vehicle warrants of fitness (WOF), current registration, and driver's licence applicable to the motorcycle/moped being used.

Urban motorcycling case study

The following fatal crash case study describes a relatively extreme combination of issues associated with each of the Safe System elements. However, it demonstrates the interaction of the Safe System elements and the potential for the severity of a crash to be reduced when the Safe System elements are operating at an appropriate level.

At 3:27am on 3 June 2010 a motorcycle crash occurred in which two males, both aged 20, were killed when the stolen motorcycle they were riding crashed into a power pole as they rounded a right hand bend in an urban area. The road involved is a two-lane, two-way sealed road with widely spaced power poles along both sides. The motorcycle being ridden was unregistered and is of a type designed and intended for off-road use. The crash involved issues associated with each of the Safe System elements as described below. Photo 1 illustrates the motorcycle involved in the crash.

[30] www.nzta.govt.nz/resources/rules/driver-licensing-amendment-2011-qa.html, accessed on 31 March 2012.

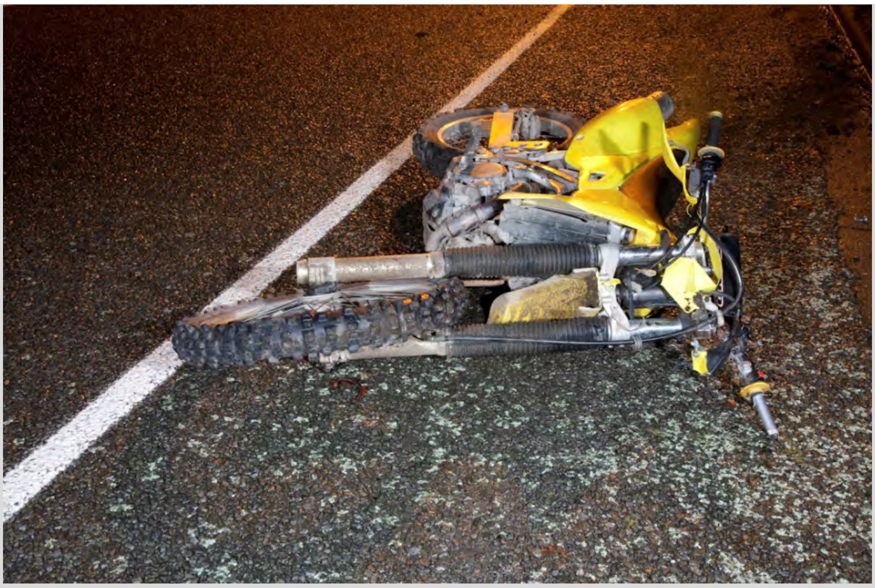


Photo 1: Motorcycle involved in a fatal crash

Safe roads and roadsides issues

- At least one of the riders struck the power pole.
- The road surface was wet and the reporting police described the friction of the surface as 'very low'.
- Although there was a single chevron arrow near the power pole and the road was illuminated by street lighting, the alignment of the curve of the road may not have been delineated well enough. Delineation of the curve would have been difficult due to the intersection immediately prior to the power pole.

Safe speed issues

- The impact speed was not survivable, therefore the speed of travel was not safe.
- Neither the impact speed nor the travel speed are known However, the speed involved in this crash was too fast for the conditions.

Safe vehicle issues

- The rear tyre of the motorcycle was marked 'Not for Highway Use'.
- The motorcycle was unregistered.
- The motorcycle was designed for off-road rather than on road use.
- The motorcycle was not fitted with any safety features such as ABS brakes.
- The motorcycle was not designed to carry a pillion passenger.
- At the time of the crash, the motorcycle headlight was not being used.

Safe road use issues

- Neither of the people on the motorcycle was wearing a helmet or any other motorcycling safety gear.
- The rider held only a learner's car licence and was not licensed for riding a motorcycle.
- The pillion passenger did not have anywhere on the motorcycle they could safely position their feet.
- Based on the point of impact, the line chosen by the rider for traversing the curve was not a safe line for the curve.

2.5 Investment framework

The Government Policy Statement on Land Transport Funding (GPS) 2012, covering the period 2012/13 to 2021/22, has a stronger safety focus than the previous GPS, with its priorities being road safety, value for money and economic growth, and productivity improvement. While no specific safety funding activity class has been created, there is an expectation that the level of safety investment funding will be transparent and the NZTA will be required to report on how the funding has been used to improve road safety. Safety expenditure includes the safety portions of RoNS, safety improvements such as barriers and realignments, minor safety works, safety improvements on high-risk motorcycle routes, high-risk rural roads, high-risk intersections, demonstration projects, road safety education, and a safety component of maintenance and renewals.

The NZTA develops and follows an Investment and Revenue Strategy (IRS) that sets out the NZTA's investment direction and principles for revenue management. The IRS is aligned with the GPS. For the 2012 GPS there is an increased focus on reductions in deaths and serious injuries and the adoption of the Safe System approach in line with Safer Journeys.

The GPS investment focus, combined with this document, is aimed at strongly encouraging RCAs to focus their efforts on the Safer Journeys priorities and actions.

3 Crash data and comparison of road use

There are several types of data available for use when identifying the overall reported issues for motorcyclists. This information can be sourced from the government's crash analysis system (CAS), ACC statistics, motor vehicle registrations, and other national and international research reports.

This section describes the CAS recorded crash data in detail. Further information on understanding the issues can be found in section 6.

3.1 Reported crash data

The CAS includes a total of 13,591 reported crashes involving motorcycles or mopeds from 2001–2010, including 391 fatal, 3489 serious, 6281 minor and 3454 non-injury crashes. Those crashes involved 394 deaths and 3634 serious injuries. Figure 3-1 illustrates that motorcycle and moped crashes have increased by almost 60% from the previous five-year period (2001–2005) to the next (2006–2010). Sixty-six percent of all motorcycle/moped crashes in the 2001–10 period occurred in urban[31] areas. However, in the 2001–10 period, urban areas accounted for only 47% of the fatal and serious injury motorcycle/moped crashes; this indicates that on a crash by crash basis the higher severity crash injuries are a more significant issue on rural roads.

Motorcycle and moped[32] rider injuries accounted for 7% of the total injury crashes in NZ, but 13% of the high severity (fatal and serious injury) crashes from 2001-2010, as shown in Figure 3-2. When comparing this by travel mode (figure 3-3), the proportion of motorcyclist's distance travelled is small compared to drivers and passengers of vehicles that are not motorcycles. However, as illustrated in figure 3-4, the number of motorcyclists killed or seriously injured (per million hours spent travelling) is significantly higher than the injury rate sustained in travel by other modes.

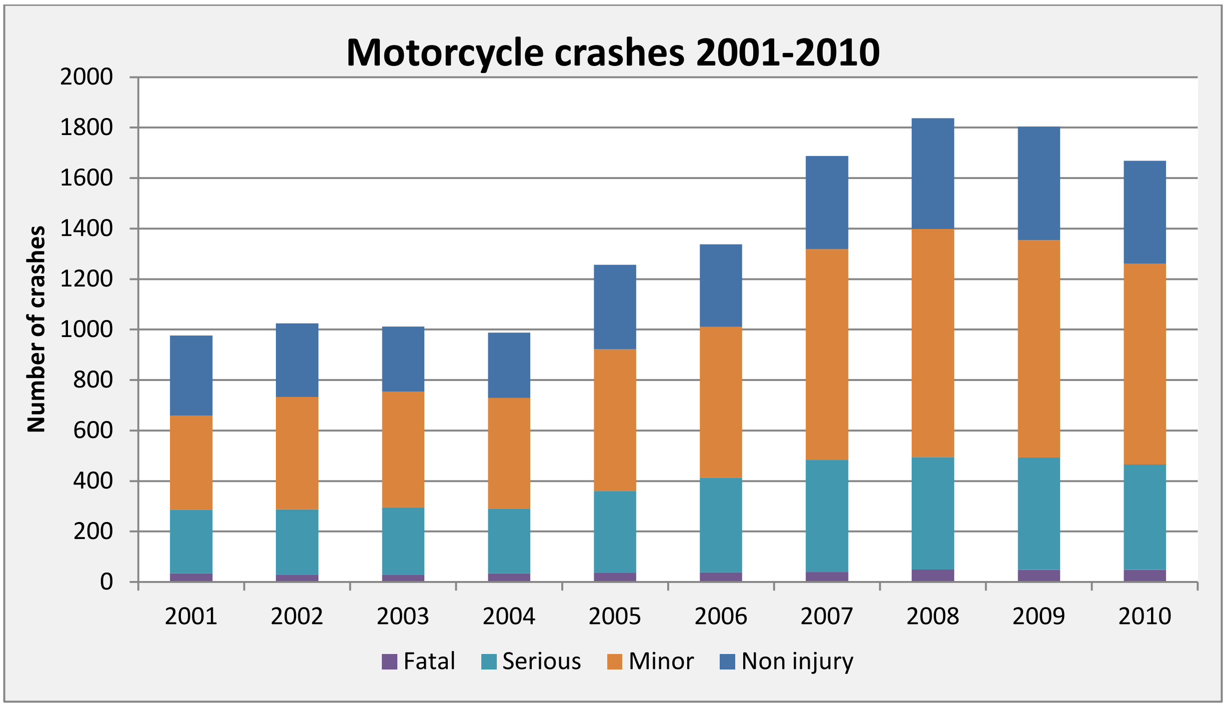


Figure 3-1: Motorcycle crashes by severity (2001–2010). Source: CAS

[31] Urban = the posted speed limit is 70km/h or less.

[32] Note that a moped is defined as a vehicle having a power output of 2kW or under, and a maximum design speed of 50km/h or under.

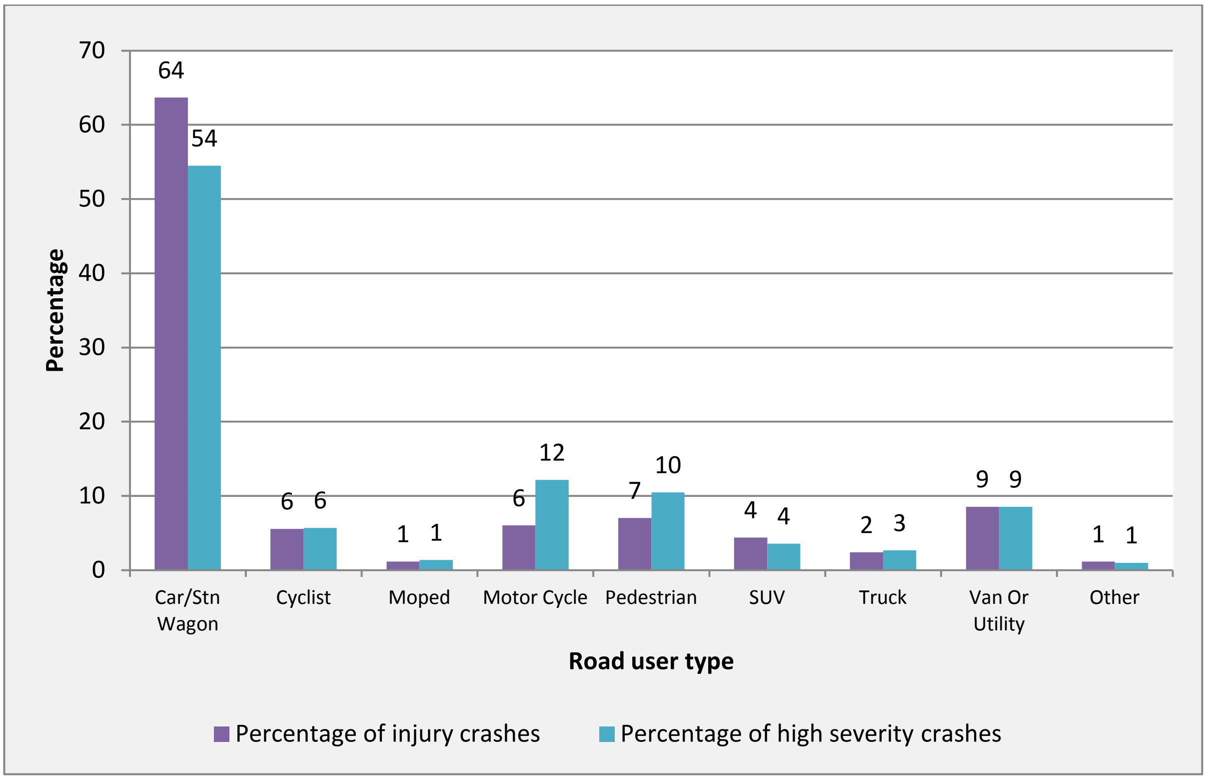


Figure 3-2: Injury crashes and high severity crash percentage by road user type 2001-2010[33]. Source: CAS

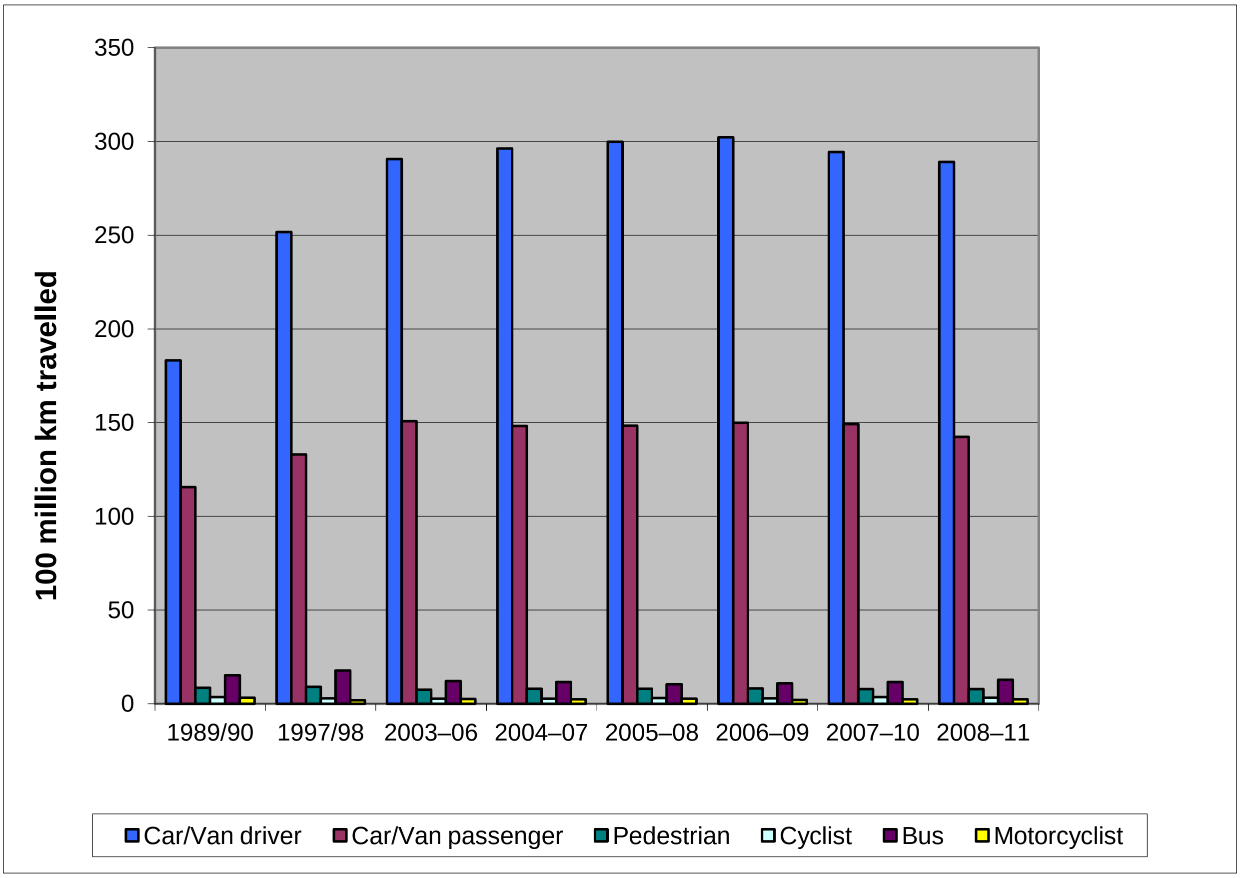


Figure 3-3: 100 million km travelled per year by mode (road-based modes only, ages 5 and over)[34]. Source: MoT[35]

[33] Values shown are rounded to the nearest whole number. However, bars are plotted to the exact height.

[34] This graph visually compresses the time interval between 1989/90, 1997/98 and 2003-2006.

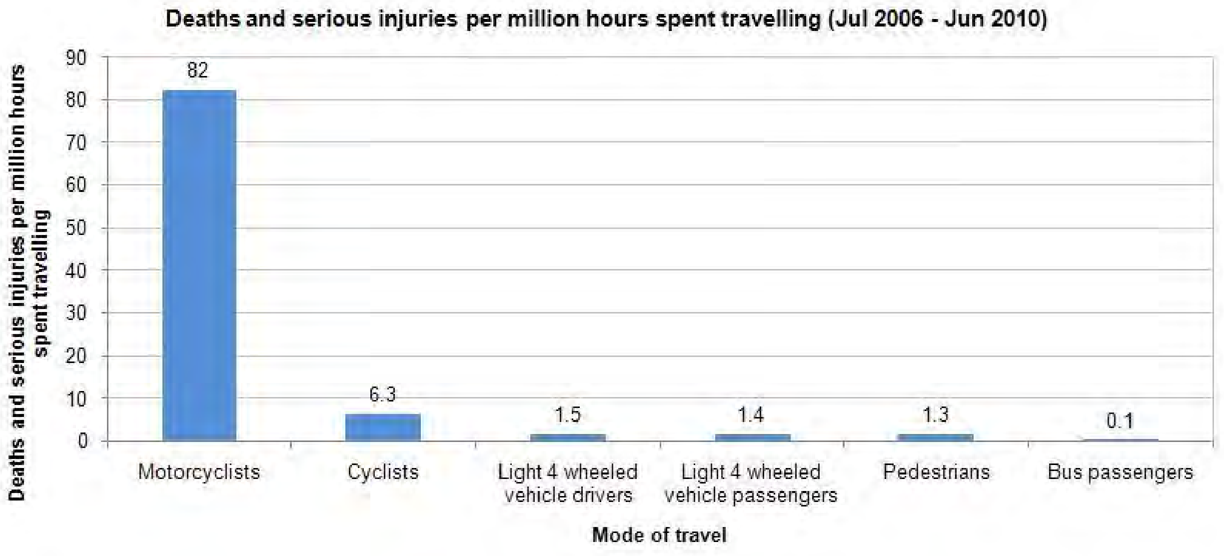
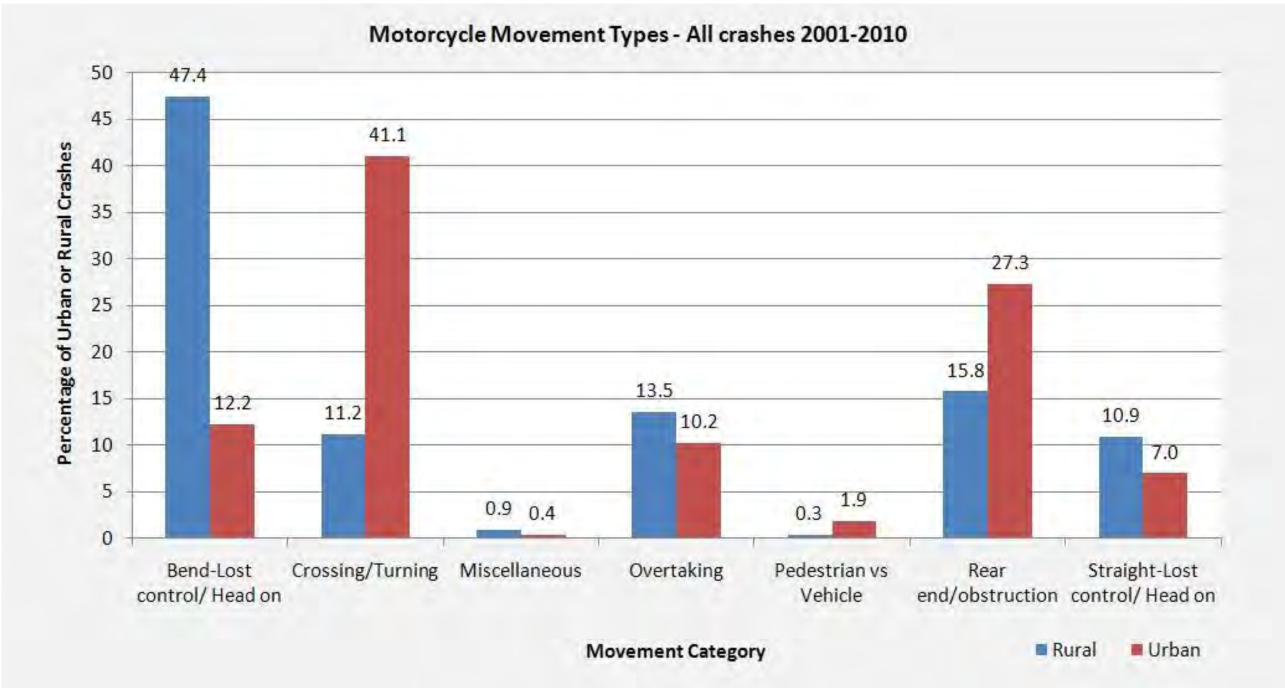


Figure 3–4: People killed or seriously injured in crashes per million hours spent travelling (2006-2010) for all ages. Source: MoT

The most common movement types for crashes involving motorcyclists/mopeds are (Figure 3-5) crossing/turning (intersection type crashes) in urban areas and bend-lost control/head (midblock type crashes) in rural areas. Motorcycle crashes at intersections account for 44% of all motorcycle crashes; of those, 86% occurred in urban areas and the majority of crashes occurred at T-junctions. Midblock crashes account for 56% of all motorcycle crashes and 82% of all rural motorcycle crashes.

Figure 3-6[36] describes the most common movement types for fatal and serious crashes involving motorcyclists. This illustrates that the predominant rural crash type (bend-lost control/head on) and urban crash type (crossing/turning) are also the predominant crash types for fatal and serious crashes.



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[35] Ministry of Transport, 2012, *Comparing travel modes, fact sheet related to New Zealand Household Travel Survey 2008-11*, March 2012, Ministry of Transport, Wellington.

[36] There are minor discrepancies between the data contained in figure 3-6 and that contained in table 3–1.

Figure 3–5: Movement types - all motorcycle crashes 2001-2010. Source: CAS

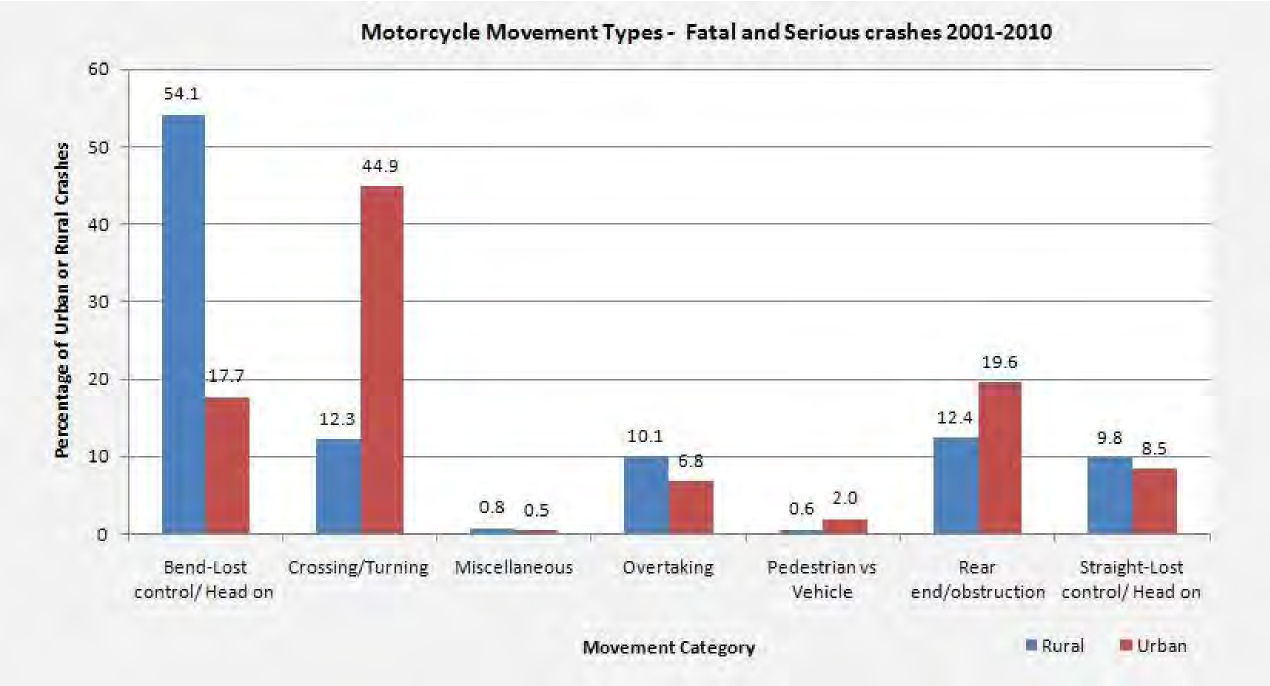


Figure 3–6: Movement types - fatal and serious motorcycle crashes 2001-2010. Source: CAS

Table 3-1 provides an overview of crash severity for the main movement types in urban and rural areas and table 3-2 provides a summary of the distribution of crashes between intersections and midblocks.

Table 3–1: Main movement types of motorcycle/moped crashes. Source: CAS

Area	Crash severity	Main movement/ location	Motorcycle/moped crashes only
Urban	All crashes	Crossing/turning	41%[37]
	High severity	Crossing/turning	44%
Rural	All crashes	Bend (loss of control)	47%[38]
	High severity	Bend (loss of control)	56%

Table 3–2: Distribution of motorcycle/moped crash locations. Source: CAS

Urban	All crashes	Intersection	56%
	All crashes	Midblock	44%
Rural	All crashes	Intersection	18%
	All crashes	Midblock	82%
Both	All crashes	Intersection	44%
	All crashes	Midblock	56%
Both	Urban crashes/ Rural crashes	Intersection	86%/14%
	Urban crashes/ Rural crashes	Midblock	53%/47%

A look at driver fault causes shows that motorcyclists were attributed to be at either prime or part fault for 49% of urban crashes and 79% of rural crashes[39]. However, it is recognised that there are a lot more single vehicle crashes in rural areas (approximately 2.6 times more) and operating speeds are significantly higher. Therefore, it is not unexpected that the at-fault value is generally higher in rural areas than in urban areas.

The most common contributing factor for injury crashes where motorcyclists are at fault (including prime fault and part fault) is poor handling, which was recorded for 25.7% of all crashes in urban areas and 37.2% in rural areas. A further breakdown of at-fault motorcycle/moped contributing factors, in order of frequency is shown in table 3-3. The numbers in the table represent the percentage of injury crashes in which each of these factors was identified[40].

[37] 15% of all urban motorcycle/moped crashes involved a vehicle making a right turn in front of straight through traffic.

[38] 23% of all rural motorcycle/moped crashes involved a vehicle losing control turning right.

[39] 'At-fault' is a data factor obtained from the CAS. However, assigning fault to a particular road user does not preclude that there may have been other factors (for example, loose gravel on the road surface) that contributed to the crash.

[40] It is important to note that there can be more than one factor in a crash, therefore, the total percentage of factors can be more than 100%.

Table 3–3: Percentages where motorcycle/moped riders were at fault[41]

Urban (percentage of crashes)	Rural (percentage of crashes)
Poor handling (25.7%)	Poor handling (37.2%)
Poor observation (22.8%)	Too fast for the conditions (23.6%)
Poor judgement (19.4%)	Poor observation (18.1%)
Too fast for the conditions (17.0%)	Poor judgement (15.7%)
Alcohol (15.4%)	Road factors (15.6%)

Road factors for motorcycle injury crashes were identified as a factor in 8.5% of urban crashes and 14.6% of rural crashes. The main road factors identified are described in Table 3-4. The numbers in the table are the percentage of crashes in which each of these factors was identified.

Table 3–4: Percentages for motorcycle/moped crashes in New Zealand (2001-2010)

Urban (percentage of crashes)	Rural (percentage of crashes)
Road slippery (including general and rain) (5.8%)	Road slippery (including general and rain) (6.7%)
Road slippery (loose material on seal) (1.6%)	Road slippery (loose material on seal) (6.1%)
Road slippery (oil/diesel/fuel) (1.1%)	Road slippery (oil/diesel/fuel) (1.8%)

3.2 Mopeds versus motorcycles

The crash data in this document generally refers to crash data for all motorcycles/mopeds. However, moped use differs from motorcycle use in that moped riders need only hold car licences and mopeds are generally only used in urban conditions.

Mopeds are involved in 26% of urban motorcycle/moped crashes, and 2.6% of rural motorcycle/moped crashes. The proportionally higher use of mopeds in urban areas (when compared with rural areas) contributes to the difference in at-fault contributing factors in crashes when factors for moped crashes are compared with those for motorcycles (table 3-5).

[41] Crash factors are determined based on the information provided by the police staff that complete traffic crash reports.

Table 3-5: Key at-fault contributing factors for mopeds versus motorcycles[42]

Poor observation	Poor handling
Poor judgement	Too fast for the conditions
Poor handling	Poor observation
Failed to give way/stop	Poor judgement

Source: www.yamaha-motor.co.nz

Source: www.honda-motorcycles.co.nz

In general, motorcycle/moped crashes in both urban and rural areas (excluding rural moped crashes) have shown an increase over the past 10 years (figure 3-7).

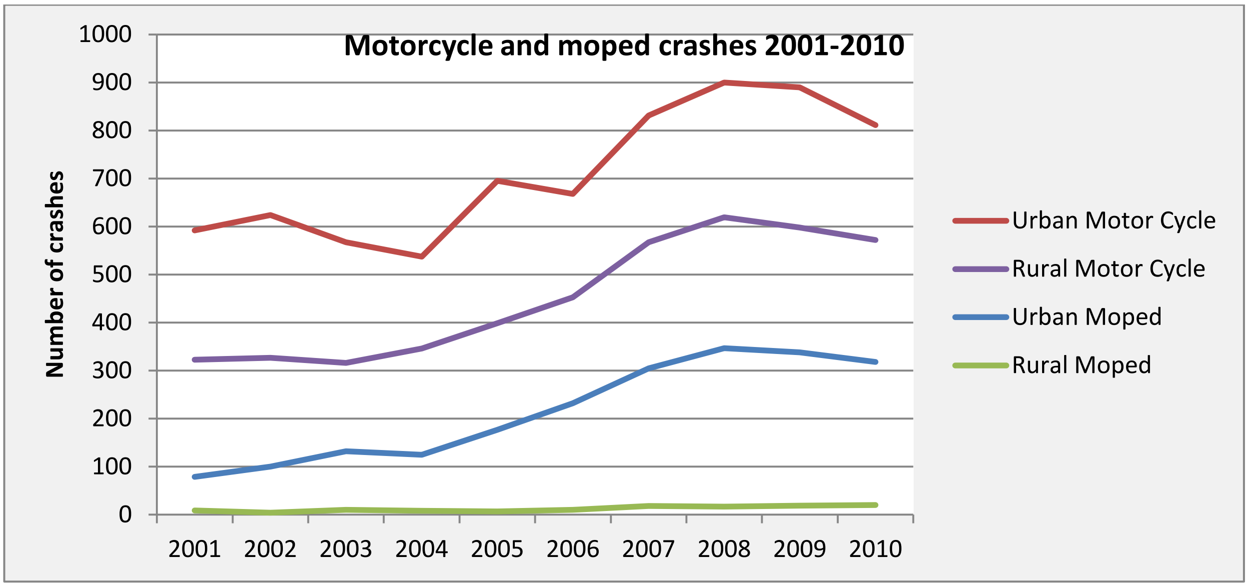


Figure 3-7: Moped versus motorcycle crashes 2001-2010 (Source: CAS)

The predominant movement types for urban and rural motorcycle and moped crashes are described in the following tables. Table 3-6 describes the movement types for all motorcycle/moped crashes while table 3-7 describes the movement types for injury only motorcycle/moped crashes.

[42] Listed in decreasing order of occurrence.

Table 3–6: Predominant movement types for all moped and motorcycle crashes

	Mopeds	Motorcycles
Urban	• Crossing/turning (42.5%) • Rear end/obstruction (28.1%) • Overtaking (9.8%)	• Crossing/turning (40.6%) • Rear end/obstruction (27.9%) • Bend-lost control/Head on (13.1%)
Rural	• Straight-lost control/head on (25.4%) • Bend-lost control/head on (24.6%) • Crossing/turning (21.3%)	• Bend-lost control/head on (48.0%) • Rear end/obstruction (15.8%) • Overtaking (13.5%)

Table 3–7: Predominant movement types for injury moped and motorcycle crashes

	Mopeds	Motorcycles
Urban	• Crossing/turning (44.1%) • Rear end/obstruction (24.5%) • Bend-lost control/head on (9.9%)	• Crossing/turning (42.5%) • Rear end/obstruction (22.4%) • Bend-lost control/Head on (15.5%)
Rural	• Bend-lost control/head on (26.9%) • Straight-lost control/head on (25.0%) • Crossing/turning (20.1%)	• Bend-lost control/head on (50.5%) • Rear end/obstruction (14.1%) • Overtaking (12.2%)

4 Identifying high-risk and favoured motorcycle routes

The safety performance of a road is a function of:

- the likelihood of each user travelling on the road being involved in a crash of any severity
- the exposure to risk (based on the number of vehicles using the road (that is, the traffic volume))
- the severity outcome of any crashes that occur.

With regard to safety performance of a road for motorcycling there are two types of route that can be identified:

- High-risk routes – which essentially lengths of road with a higher than average crash risk, and by implication are roads where targeted safety improvements are most likely to reduce trauma.
- Favoured routes – are those routes that have been identified by either motorcycling agencies, (eg MSAC), rider groups, communities, RCAs or any other key stakeholder as being a preferred route for motorcycling.

High-risk motorcycle routes are where the greatest reduction in severe casualties is likely to be achieved. There are also likely to be benefits from improving roads with moderate risks or riskier spot locations (such as crash clusters/blackspots) on road lengths not formally classified as high-risk. Cost-effective solutions may be available for such sites and it is not the intention of this document to stop blackspot studies and treatments, but rather to focus most attention on high-risk routes.

This section defines what constitutes a high-risk motorcycling route for both urban and rural areas and outlines how those can be identified. However, as the NZTA develops other safe system guides, such as the *High-risk intersection guide*, further work will be undertaken to define high risk motorcycling routes to ensure there is consistency between the safe system guides (see also comment box in section 4.4.1).

The identification of favoured routes is relatively subjective, therefore, there are difficulties associated with defining route within the context of this document. Further information can be obtained from motorcycling industry and community groups (section 7.3). This section focuses on how to identify high-risk routes.

4.1 High-risk rural motorcycling routes definitions

The manner in which this document describes the definition of high-risk rural motorcycling routes is a work in progress, therefore:

- the methodology described below is the current (but not necessarily the final) method
- for now, the methodology is limited to rural high risk motorcycle routes
- it is acknowledged that there are limitations in the methodology
- further steps are required to obtain better data and improve the methodology. These include undertaking an Auckland based pilot project, and finalisation of the *High-risk intersection guide*.
- the communities at risk register (www.nzta.govt.nz/resources/communities-at-risk-register/register.html) has been developed by the NZTA to identify communities that are over-represented in terms of road safety risk
- crash analysis trend reports provide the latest five-year trends across a number of key road safety themes. These cover the 13 areas of concern outlined in Safer Journeys for all local bodies grouped by road safety regions across New Zealand. The reports include trends for death and serious injury for motorcycle/moped riders (www.nzta.govt.nz/resources/crash-analysis-reports/docs/trends/trends-motorcyclists-2012.xls).

A high-risk motorcycle route for a rural area is defined as:

- a road where the injury crash density (collective risk) is classified as high or medium-high compared with other roads (section 4.4.1 and figure 4-1).

We have not defined a minimum road length. Instead, we have specified a minimum threshold level based on the number of injuries (for rural roads) and high severity crashes (for urban roads). For rural areas, medium-high and high collective crash risk define the route as a high-risk motorcycle route, subject to having at least two or more motorcycle injury crashes over the most recent five-year period or four or more motorcycle injury crashes over the most recent 10-year period. This criteria is different from that in the *High-risk rural roads guide*,[43], which limits the evaluation criteria for a high-risk route to consideration of fatal and serious injury crashes only. However, because fatal and serious injury motorcycle crashes on rural roads are generally widely distributed, including all injury crashes provides a better picture of the location and length of roads with motorcycle crash issues.

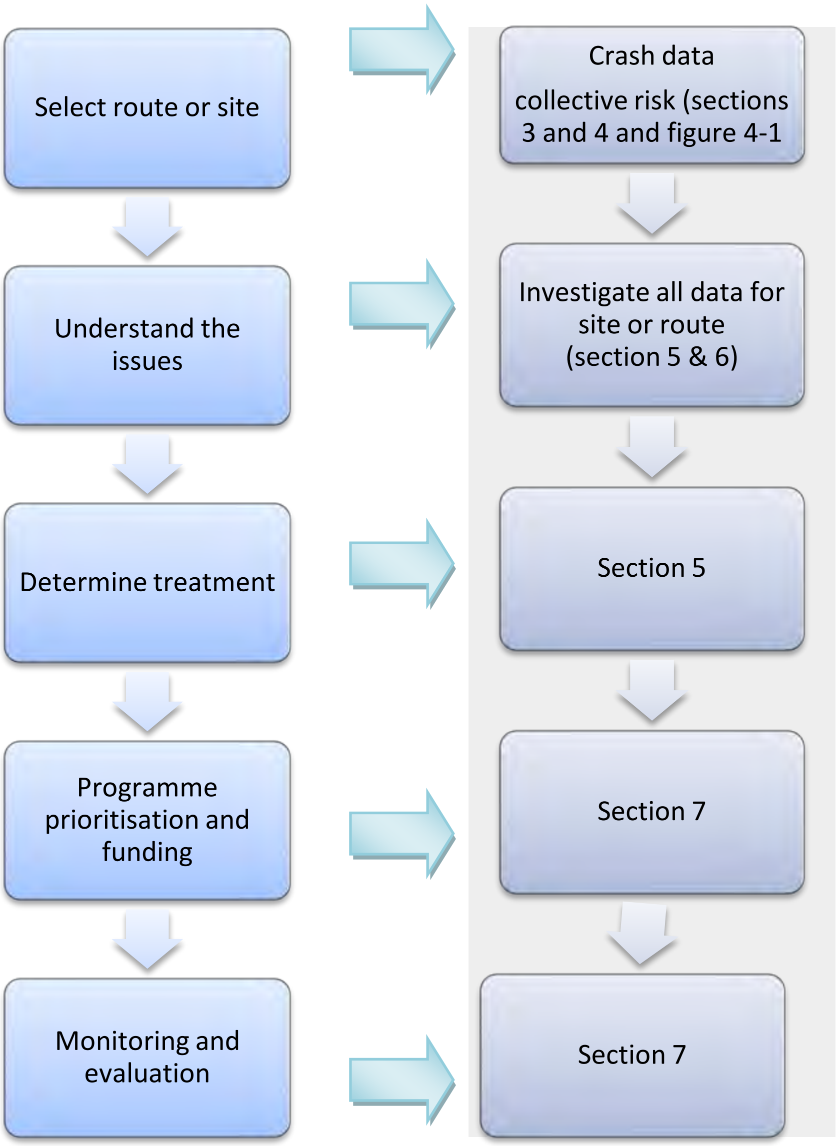
Ideally, lengths of road being considered should be corridors (maybe 10km or longer) or adjoining road sections with similar characteristics, traffic volumes, environment and road-use purpose. However, shorter lengths can be considered. At the extremes, a very short section of road with two or more injury crashes will be a blackspot with a high crash density, while a very long section may have a low crash density (collective risk) and may only justify relatively low cost improvements (eg delineation). In either case the process and treatments outlined in this document are relevant.

4.2 Summary of process

The process of identifying high-risk motorcycle routes and sites on road networks should be completed at least every three years to provide information to support maintenance and renewal works proposed for inclusion in the three-year National Land Transport Programme (NLTP). Table 4-1 shows the total process (from selection of the route to monitoring and evaluation).

[43] NZTA, 2011, *High-risk rural roads guide.*

Table 4-1: General summary process to determine, manage, implement and monitor high-risk motorcycle routes



4.3 Using crash and RAMM data

We can use crash data to determine the crash density (collective risk). Practitioners' software tools (that are not available to the general public) such as CAS and RAMM should be used to determine crash density. CAS should be used to map crashes on an identified section of road and the measurement tool in CAS applied to obtain the length of the road section. This approach works well when looking at predefined links, but is cumbersome when seeking to screen a network. RAMM (road asset maintenance management software) data is better suited to network screening.

RAMM is an alternative to CAS for calculating collective risk and is more appropriate for network-wide screening. Using the traffic crash data held in the databases operated by RCAs, an annual report from CAS can be created and exported. This is linked to the RAMM road_ID. Appendix A of the *High risk rural roads guide* describes how to perform this calculation; the calculation information is replicated in appendix Y of this motorcycling document.

One of the key issues with this approach is the proliferation of relatively short links in many RAMM databases. Once plotted in RAMM map or another GIS system, it is generally necessary to join up sections of road to define a known route.

4.4 Process to calculate collective risk

Collective risk (also known as crash density) is a measure of the number of injury crashes (for rural routes) that have happened per kilometre of road per year.

Calculations to determine this risk are provided in section 4.4. Urban crash risk calculation methods are yet to be determined. See comment box in section 4.4.1.

4.4.1 Collective risk (crash density) calculations

Having identified lengths of interest, the collective risk needs to be calculated using data from CAS and/or RAMM. The following paragraphs discuss the definition and the calculation of collective risk.

Collective risk in this context is simply the number of either motorcycle injury crashes (for rural) or motorcycle high-severity crashes (for urban areas) divided by the length of road under consideration.

$$\text{Rural collective risk} = \frac{\text{Motorcycle injury crashes / number of years of data}}{\text{Length of road section}}$$

As noted previously, this calculation differs from the collective risk calculation in the *High-risk rural roads guide*. In this document, all motorcycle injury crashes are considered, whereas in the *High-risk rural roads guide*, only fatal and serious crashes are considered.

Note for comment: No definitions have yet been given for collective risk on urban routes as further work is being completed in conjunction with preparation of this document. It is likely that the definition of an urban site or route will be defined by the number of motorcycle injury crashes over a time period. This definition will be clarified with the publication of the draft high risk intersection guide, which is due for completion by December 2012.

Having calculated the collective risk, plot this value against the total section length on Figure 4-1. The risk scores can then be compared with a number of other rural roads risk scores (Figure 4-1) to determine the relative risk of a road section, that is, does it rate as a low-risk or high-risk relative to others[44].

Note that to be defined as a high-risk motorcycle rural route or site in terms of collective risk it must be:

- medium-high or high as shown in figure 4-1 subject to having at least two or more motorcycle injury crashes in five years or four motorcycle injury crashes in 10 years in rural areas.

Further information on how collective risk is quantified, and discussion regarding relationships between crash data and specific infrastructure figures, can be referenced from the *High-risk rural roads guide*. The colour scheme for each risk description used in figure 4-1 has been adopted from the KiwiRAP and similar programmes.

[44] Note that the risk comparison is based on the state highway rural network, as this network has relatively complete traffic volume coverage. However, the figures can be used for all roads.

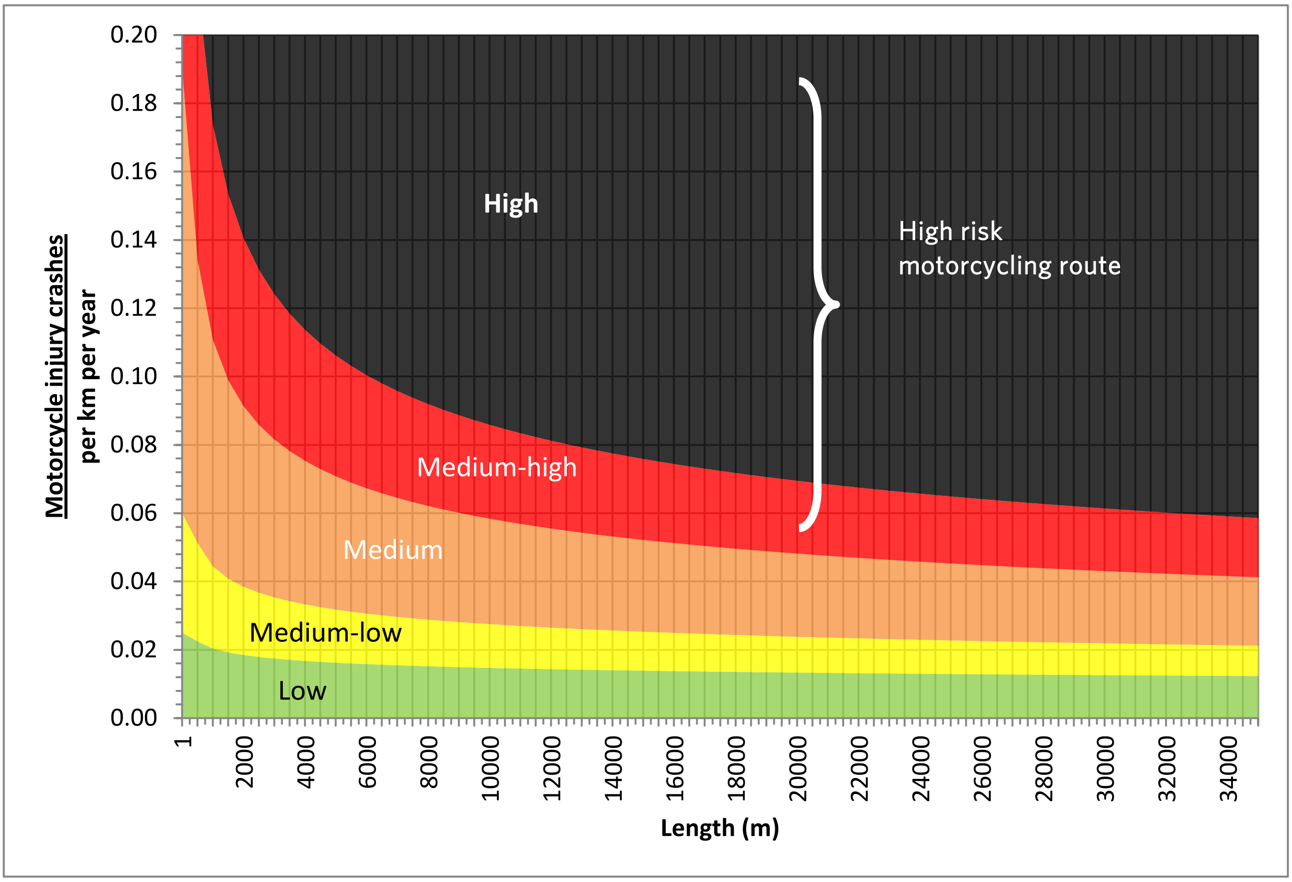


Figure 4-1: Collective injury crash risk (crash density) – rural areas

4.5 Corridor treatment of high-risk motorcycle routes

This section provides guidance on how to use the above risk metrics to determine an appropriate treatment strategy, together with some examples of the process.

4.5.1 Process

The first step is to determine what type of safety problem exists – whether the current crash patterns have either geographical or thematic commonality, whether they are clustered (black or grey spots) or whether there is a common theme, (eg lost control on curve in dark). Although there may not be specific black or grey spots, subsections of the route may appear to have more crashes than other sections.

Guidance for understanding the safety issues is given in section 5 and 6. Further analysis and treatments of crash clusters (or blackspots) can also be found in the *New Zealand guide to the treatment of crash locations.* It is important to analyse motorcycling routes from a motorcyclist's perspective, therefore, methods of analysis and treatment are not necessarily limited to those described in documents such as the *New Zealand guide to the treatment of crash locations*. Analysis of motorcycling routes may involve the application of techniques that are new for practitioners, such as the use of instrumented motorcycles (refer to the case study box following section 7.3.2).

4.5.2 Interim safety treatments

It is recognised that where larger infrastructure works have been identified as the most appropriate treatment strategy, such strategies are likely to require relatively involved investigation and implementation phases given the higher cost of infrastructure-type treatments. Therefore, consideration should be given to providing interim safety treatments where these are cost effective, that is, the interim treatment should deliver economically viable benefits

but not create difficulty or increase costs significantly when programming for larger infrastructure works in the future.

For example, if you determine that the long-term treatment for motorcyclists for a particular route is to provide roads to a high standard with median barriers and high skid resistance surfacings, then the interim safety treatments could include providing wide centreline treatments, localised widening on curves and then along straights, and a prioritised pavement repair programme to produce a consistent surface.

4.6 Treatment of non high-risk or favoured routes

If a site or route has been defined as a favoured route (section 4) it may not necessarily be high risk but has the potential to become high risk due to the number of motorcyclists using the route. Consideration needs to be given to treating known road safety issues such as those identified in sections 5 and 6. The priorities for implementing these treatments need to be considered in conjunction with those routes or sites that have been identified as high risk (section 4.1).

5 Key issues and treatments

5.1 Key issues

Austroads Part 15; *Guide to traffic engineering practice – motorcycle safety* describes the safety needs of motorcyclists. In summary, motorcyclists need to:

- stay in control and upright on the vehicle and stay on the carriageway
  - motorcycles are less stable than other vehicles as they only have two wheels and can easily become unstable and topple if braking, accelerating or when on a slippery or unstable road surface
  - motorcycles tend to have much higher power to weight ratios than cars and an increasing number of motorcycles are capable of very high speeds and acceleration
  - the potential for motorcyclists to lose control can be reduced through improved surface conditions, improved delineation, pavement markings, geometry and alignment, surface conditions, safe vehicles and speeds, road user experience, training and education
- avoid collisions with other road users
  - the visibility of motorcycles to other traffic – motorcyclists are often obscured from the vision of other road users, particularly in congested traffic
  - rider's visibility can be impacted (particularly peripheral vision) due to their helmet and/or goggles
  - can be addressed through improvements to intersections and sight distance, safe vehicles and speeds, road user experience, training and education
- avoid collisions with roadside objects and survive (minimise injury) if fallen from a motorcycle
  - motorcyclists are extremely vulnerable to high severity injuries
  - can be addressed through protecting, removing or mitigating road and roadside hazards, safe speeds and improved rider safety gear.

Notwithstanding the need for motorcyclists to be safe road users there is clearly a need for safe road use by all road users. This requires road users not on motorcycles or mopeds to recognise the presence of motorcycles and mopeds and to allow for them accordingly.

A summary of the key issues is provided in table 5-1. More detailed information on these key issues and possible treatments is provided in sections 5.2 to 5.7.

Table 5-1: Summary of key issues that if resolved have the potential to reduce the incidence, severity, and/or consequences of motorcycle crashes

Roads and roadsides	• Surface conditions • Pavement markings • Delineation • Hazards/roadside furniture • Geometry and alignment • Intersections
Road users	• Training and education • Rider experience, speed, route knowledge and risk taking • Alcohol and drug use • Fatigue • Rider safety gear

	• Group riding • Rider position on the road
Vehicle	• Maintenance • Power to weight ratios • Safety features • Headlight performance
Speeds	• Rider behaviour (too fast for the conditions) • Rider behaviour (following distances) • Posted speed limits
Injury treatment	• Proximity of helicopter landing area • Available mobile phone coverage • Personal responsibility • Use of personal locator beacons that could be activated to summon assistance if an incident occurs; particularly for use in remote areas where mobile phone coverage may be poor

The key types of general treatments relating to a Safe System, those relating to safe roads and roadside, safe vehicles, safe road users, safe speeds, targeting key crash types and others are described in the following sections. Clearly, prevention of crashes is better than treatment for them, therefore, resolving the key issues will significantly reduce the potential for motorcycle crashes. However, because crashes will occur, addressing the key issues will assist to reduce the severity of any injuries sustained in those crashes.

5.2 Safe road environment

A safe road environment should provide:

- no surprises in road design or traffic control
- a controlled release of relevant information (the design matches information processing abilities)
- repeated information where necessary to emphasise risk.

Austroads Part 15; *Guide to traffic engineering practice – motorcycle safety*[45] describes a safe road environment and what it should provide to all road users. In summary:

A safe road environment should:

- WARN the driver or rider of any substandard or unusual features
- INFORM the driver or rider of conditions to be encountered
- GUIDE the driver or rider through unusual road sections
- CONTROL the driver or rider's passage through conflict points or conflict sections
- FORGIVE the driver or rider's errant or inappropriate behaviour.

The last point is aligned to the Safer Journeys goal[46] '... to make roads forgiving, so that they help to reduce the consequences of those crashes that do occur.'

[45] Austroads, 1999, *Guide to traffic engineering practice, part 15-motorcycle safety*, page 10.

[46] Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, 2010, page 14.

5.3 Key countermeasures

5.3.1 General Safe System treatments

There are five key treatment philosophies that have been developed for high-risk rural roads, the principles of which could also be applied (to a greater or lesser extent) to high-risk motorcycling routes (whether urban or rural). Further information such as application, issues, cost, crash reduction benefits and treatment life for each treatment type can be found in the *High-risk rural roads guide*.

Table 5-2: Summary of the key treatment philosophies[47]

Treatment philosophy	Description
Safety maintenance	Maintaining roads to an appropriate standard in accordance with specified standard criteria. Example measures include maintaining skid resistance to current specified levels.
Safety management	Measures aimed at optimising safety levels through maintenance of the existing road network such as skid resistance. Generally, high personal risk roads with low traffic volumes will not warrant significant infrastructure investment. It will therefore be important to consider supplementing safety management on these routes with additional speed management (curve warning signs) education and enforcement measures.
Safe corridors	Infrastructure and speed management measures that improve safety, though to a lesser extent and generally at a lower cost compared to Safe System transformation works. Example measures include delineation, speed activated warning signs, seal widening, and audio tactile profiled (ATP) markings.
Safe System transformation works	Measures that eliminate or significantly reduce the potential for fatal and serious injury crashes. These include infrastructure measures that physically separate road users and/or speed management measures that reduce impact speeds to survivable human tolerance limits. Example infrastructure measures include median barriers, roadside barriers, clear zones and roundabouts. However, unless there are issues along a route that very significantly relate to motorcycle crashes, it is unlikely that transformation works[48] would be undertaken to solely address motorcycle crashes.
Site-specific treatments	These measures are used where you have crash clusters (blackspots) along a route or at just one site. Depending on where the crash cluster is located, and to be consistent with other measures along the route, the types of treatments can be from a range of measures covering Safe System transformation works, safer corridors, safety management and safety maintenance.

As these are general treatment philosophies that affect all road users, further consideration needs to be given to providing appropriate treatments for motorcyclists on high-risk routes or sites. This is explained further in sections 5.3.2, and 5.4 to 5.7.

In many cases, the maintenance and construction measures that will improve the safety of roads and roadsides for motorcyclists are measures that should already be actioned as part of normal best practice and complying with contractual obligations; for example, sweeping debris and loose gravel at intersections. While many existing maintenance and construction practices benefit motorcyclists (and all road users) it is important for practitioners with road maintenance and construction responsibilities to have a greater focus on, and awareness of, motorcycle specific interventions, which in turn can make the roads even safer for other road users as well.

[47] Source: NZTA *High-risk rural roads guide.*

[48] For example, the provision of special vehicle lanes for motorcycles only, which are not currently permitted.

5.3.2 Treatments based on key crash types for motorcyclists

As discussed in section 3 of this document, the key crash types for motorcyclists are:

- rural road - loss of control on bends (run off road/head-on)
- urban areas - crossing or turning, that is, at intersections.

A description of how to address these key crash types with Safe System, safety management and safer corridor treatments is provided in this section, a summary of which is shown in table 5.3.

Table 5-3: Summary of key crash types and best value treatments for motorcycles

Key crash type	Recommended Safe System treatments[49]	Recommended safe corridor treatments[50]	Recommended safety management treatments[51]
Run off road	Roadside barriers Clear zones Safe System speeds	Wider shoulders Improved delineation Harm reduction speeds	Increased intervention levels Skid resistance Planting policies Hazard removal
Head-on	Median barriers (solid/ semi-rigid and flexible) Safe System speeds. That is, speed management measures to encourage motorcyclists to travel at speeds commensurate with safe system speeds	Marked median treatments ATP markings, improved delineation (signs and markings) Vehicle activated signs. However, it may be difficult to produce vehicle activated signs that only activate for motorcycles Harm reduction speeds	Increased intervention levels Skid resistance Hazard removal
Crossing or turning at intersections	Grade-separated interchanges or overpasses Roundabouts Safe System speeds	Wider shoulders and separated turning facilities Improved delineation Active signs Harm reduction speeds	Intervention levels Skid resistance Improved sight distance through various treatments

5.4 Issues and treatments for roads and roadsides

Based on the results of a search of national and international literature, and discussions with motorcycle groups in New Zealand, the key issues for motorcyclists, with regard to roads and roadside, are those described in sections 5.4.1 to 5.4.6. In some cases, the solutions required to produce safe road and roadsides for motorcyclists may simply involve road maintenance activities being completed to a higher standard than they are at present.

Maintenance issues will generally be identified by those people or organisations engaged by the road controlling authority to identify and address maintenance issues. However, the potential exists for road users to contribute to safe roads and roadsides by advising RCAs of maintenance issues. Provision of simple and direct methods (for

[49] See definitions of Safe System, safe corridor, and safety management treatments in table 5-2.

[50] Ibid

[51] Ibid

example free calling phone numbers or email addresses) to allow road users to contact RCAs could assist with making roads safer for motorcyclists (and all road users).

5.4.1 Surface conditions

From a road maintenance perspective, this section of this document is very important. As discussed in section 3, loss of control due to road conditions was one of the most common causes of crashes for motorcycles.

Surface conditions including changes to surface texture, skid resistance and loose material on the road surface are critical due to the potential for a motorcycle tyre to have inadequate or inconsistent friction with the road surface. More specifically, inadequate surface conditions on curves are hazardous as motorcycles only have two points of contact with the road surface and are therefore more at risk than other vehicles. Consistent and suitable surfaces (that can otherwise be affected by a range of issues) are important in all situations, however, they are critical in areas where motorcyclists are braking and in other situations (such as on curves) where the friction demand is increased. Issues and possible treatments related to surface conditions are described in table 5-4.

Table 5-4: Issues and possible treatments for surface conditions

Issue	Possible treatments
Slippery conditions (eg rain, frost, diesel spills and bleeding (photo 2)), and surfaces with inadequate skid resistance can cause sudden and unexpected changes to surface texture and lead to loss of control. As for all vehicles, motorcycles also need more distance to stop in wet weather.	Provide appropriate warning signage. Provide adequate surface drainage to prevent water/loose material washing onto the pavement. Ensure minimum levels of friction on curves and straight are met and consider improvements to skid resistance investigatory levels for high risk or favoured routes, particularly on approach to curves, bridges, intersections or other hazards with high speed approaches. Improve maintenance response times. Consider increased frequency of routine inspections to identify any issues. Ensure consistent and appropriate standard of skid resistance on road surfaces.
Surface obstacles (manholes, steel plates, speed humps/judder bars, rail crossing, bridge expansion joints and connection to roads) create sudden changes in available surface friction and can cause loss of traction (photo 3).	Ensure obstacles located within the road surface (such as manhole covers and steel plates) are flush with respect to the surrounding road surface. Provide skid resistant drain covers/metal road plates. Position manholes away from braking area or corner apex where practicable. Provide standard warning signs for obstacles or road features (such as speed humps) that may create loss of control for riders. Install skid resistant surfacing on steel bridge expansion joints.
Surface debris (eg gravel and other debris, unsealed intersections and driveway accesses) create sudden changes in available friction and can cause loss of traction (photo 4).	Provide regular sweeping of surfaces and checking after road works have been completed. Sealing of intersections where gravel side roads intersect with sealed roads. Repair and define shoulders – particularly on curves.
Uneven surface conditions (eg corrugations, rutting, flushing, delamination, potholes) can cause	Create suitable and consistent road surfaces free of rutting

motorcycles to temporarily lose contact with the road surface.	and uneven surfaces. Ensure minimum levels of friction on curves and straight are met and consider improvements to skid resistance investigatory levels for high risk or favoured routes particularly on approach to curves, bridges, intersections or other hazards with high speed approaches. Improve maintenance standards for prompt identification and repair of road surface (eg potholes/utility skid resistance improvements, broken road edges and consistency of surface levels). Provide appropriate temporary warning signage if surface defects will not be remedied in the short term.
Surfacing transitions, inconsistent frictional properties across road width, surface joins, multiple seal types (photo 5, crack sealing, patchwork repair (photo 6), and treatments (pot holes and edge drop-offs).	Resurface to provide consistency. Ensure that when programming resurfacing the joints are not placed in lean zones, approach to and middle of curves or other locations where the there is possibility of a rider losing control. Maintain shoulder levels and provide a smooth transition.
Roadwork sites (eg loose aggregate, inappropriately placed signs) can create reduced levels of skid resistance and inadequate messages.	Provide appropriate temporary traffic management layout and warning signage at road worksites. Ensure road is back to acceptable condition before temporary signs are removed.
Parallel grooving is commonly used to restore surface friction. Motorcycle tyres can get trapped along parallel grooving resulting in loss of stability.	Avoid parallel grooving. Apply transverse grooving if necessary.
Removal or masking of obsolete line markings can lead to the old markings showing through (Photo 7)	Markings can appear more noticeable in wet road conditions if they have not been removed properly. For all roads, but particularly on high risk routes, use techniques (such as water cutting or sand blasting) that remove road markings permanently, rather than masking the old markings with black paint, which wears through and creates a hazard in itself.
Lack of consideration in roading design and maintenance regarding specific needs of motorcycle/moped users.	Design and maintenance practitioners should familiarise themselves with section 5 and in particular section 5.5.7.

The *Guidelines for the management of road network skid resistance* (AP-G83/05, Jan 2005) describe issues for motorcycles which require specific consideration by maintenance practitioners and designers.

Photo 2: Flushed or slippery section located within wheel track. Source: Yvonne Forrest (MSAC)

Photo 3: Bridge deck expansion joint. Source: NZTA presentation 2011

Photo 4: Gravel migration located on a curve

Photo 5: Seal change located in brake zone. Source: Yvonne Forrest (MSAC)

Photo 6: Patchwork repair zone located on corner

Photo 7: Removal of obsolete road markings rather than painting over or doing nothing. Source: Robert Swears (Opus)

5.4.2 Pavement marking

The general issues with pavement marking relate to providing consistent, well located and skid resistant applications. When considering the effect of pavement marking on motorcyclists, one rule of thumb is 'if it's not black, it's bad'; that is, motorcyclists want pavement markings minimised. Issues and possible treatments related to pavement markings are outlined in table 5-5.

Table 5-5: Issues and possible treatments for pavement marking

Issue	Possible treatments
Absence of pavement markings.	Apply road markings to current standards where required.
Slippery pavement markings located in the centre of a lane or on curves (eg large head directional arrows, speed control markings, other mid lane markings) can lead to low levels of skid resistance.	Apply road markings to current standards. Restrict markings in the centre of lanes or on curves where not necessary.
The placement of audio tactile or raised markings within lane or centrelines has the potential to cause motorcycles to temporarily lose contact with the road surface.	Possible restriction of audio tactile profiled (ATP) markings to edgelines only (not lane or centrelines). However a recommendation not to provide these should take into consideration the overall safety issues along a route. That is, if there is a high fatal and serious crash rate for other road users for overtaking/head-on type crashes then centreline ATP treatment may be installed to improve the overall safety of the route.
Transverse markings	These types of markings are not standard and have only recently been trialled (photo 9). Where transverse markings are proposed, the needs of motorcyclists should be accommodated. This may involve providing space between markings, within the lane, and not installing transverse markings through curves or at hazards where stopping and deceleration is likely to occur (refer photo 8).
Faded road markings	Increase remarking frequency. New chip seal sites need to have a remark shortly after the initial marking to provide additional build-up of paint.

Pavement marking includes audio tactile profiled (ATP) road markings, reflectorised raised pavement markers (RRPMs), and raised pavement markers (RPMs); the situations in which these are used are described in the NZTA *Traffic control devices (TCD) manual*. Before installing any raised pavement markings, the effect of these on all road users (including motorcycle/moped riders) needs to be evaluated and a decision made as to whether the devices will improve safety for all road users (when considered as a whole).

For example, if there is a choice between ATP and RPM, the ATP will create fewer issues for motorcyclists than the RPM.

Photo 8: Transverse road markings located across the lane in braking zone should be avoided

Photo 9: Transverse markings on approach to hazard with space available in middle of lane to accommodate motorcyclists. Source: Andrew Martindale, Cherie Urlich (Opus)

5.4.3 Delineation

Delineation is particularly important for motorcycles. In particular, it is more critical at high-risk locations such as curves, on approaches to hazards, and in any case, its effectiveness at night may be reduced for motorcyclists due to the relatively limited range of motorcycle headlights. Issues and possible treatments related to delineation are described in table 5-6.

Table 5-6: Issues and possible treatments for delineation

Issue	Possible treatments
Inconsistencies (including absence of) route delineation and signage (eg advance warning signs, chevrons and guideposts/edge marker posts) can make it more difficult for motorcyclists to 'read' the route. Limited range of motorcycle headlights	Apply consistent road and edge delineation and appropriate warning signs, (eg edge and centrelines, edge marker posts and curve advisory speeds; refer to photo 10). Keep route layouts simple, clearly defining vehicle paths. Consider installing appropriate and/or improved lighting standards on high risk routes and sites (photo 11).
Inconsistent curve advisory signage	Using ball bank gauge, check curves for need for and consistency of advisory signage.

Photo 10: Delineation treatment, SH 2 Waioeka Gorge
Source: Opus International Consultants

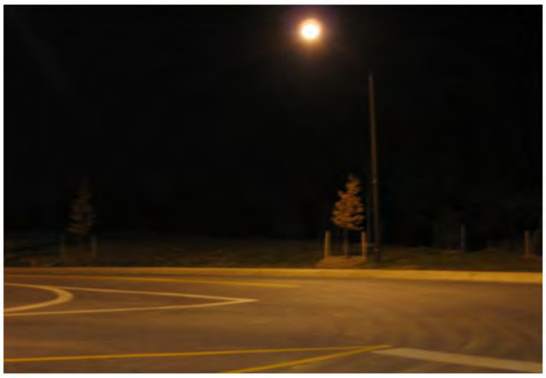


Photo 11: Flag lighting at an intersection
Source: safety.fhwa.dot.gov/

5.4.4 Hazards/roadside furniture

5.4.4.1 Roadside objects

A search of the CAS database for all motorcycle/moped crashes in which objects were struck, for both urban and rural areas shows that the most common objects struck by motorcycles/mopeds in urban areas for the 10-year period 2001-2010 were parked vehicles, kerbs and fences. In rural areas, ditches, fences and cliffs/banks were the most common objects struck.

As illustrated in figure 5-1, for crashes involving death and serious injury, the objects struck most often were:

- fence (rural and urban)
- ditch (rural)
- cliff/bank (rural)
- parked vehicle (urban)
- post or pole (urban).

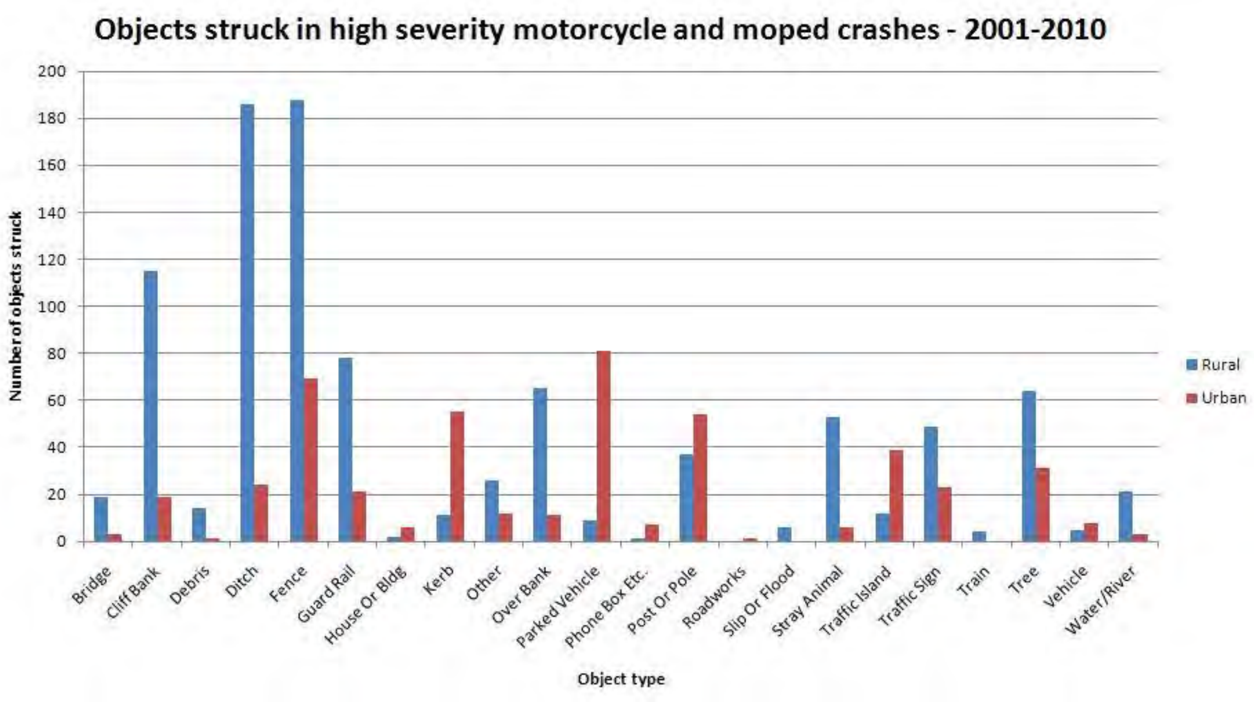


Figure 5-1: Objects struck in fatal and serious motorcycle crashes – 2001-2010 (Source: CAS)

For all injury crashes (which includes those involving death and serious injury); figure 5-2 illustrates that the objects struck were similar to those associated with fatal and serious crashes. The objects struck most often were:

- ditch (rural)
- fence (rural and urban)
- cliff/bank (rural)
- parked vehicle (urban)
- kerb (urban).

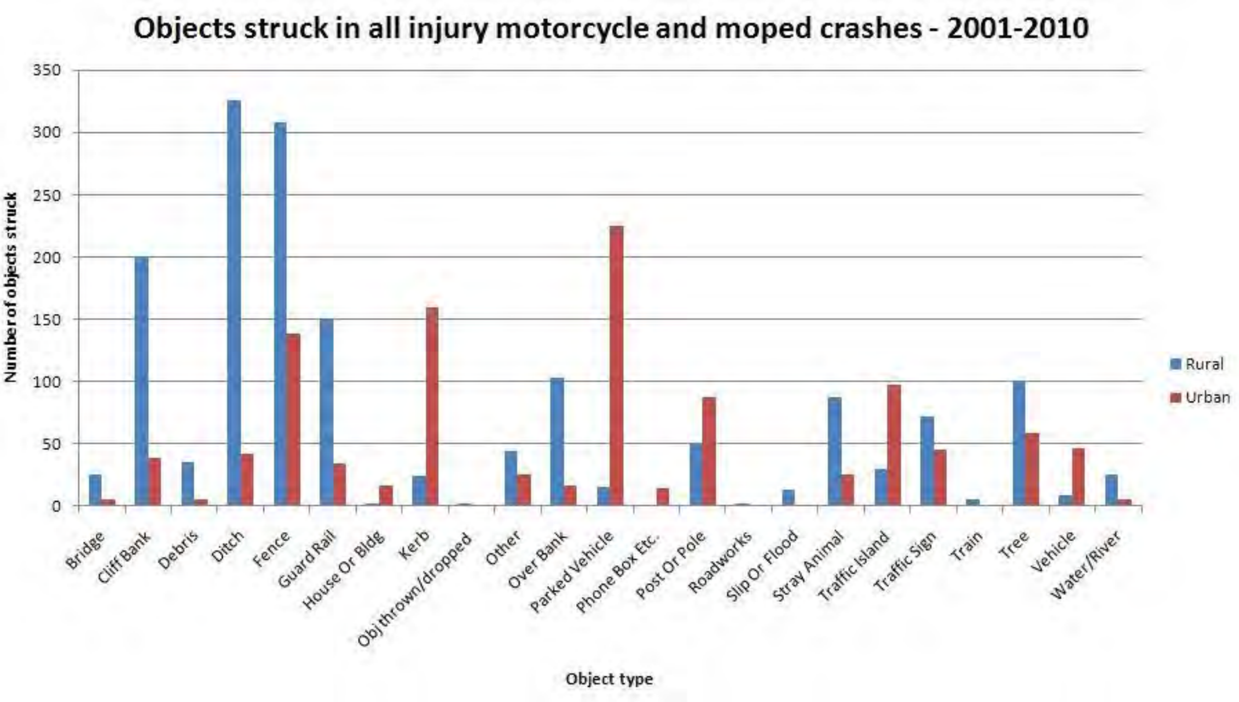


Figure 5-2: Objects struck in injury motorcycle crashes – 2001-2010 (Source: CAS)

Current research[52] predicts 'that … in about 9 cases out of 10, a motorcyclist travelling less than about 55km/h (sic) will survive a collision with a fixed object'. As illustrated in figure 5-3, the fatality risk for motorcyclists as a function of travel speed compared with the type of fixed object, increases significantly as you reach speeds greater than 55km/h. The fatality risk for a motorcyclist hitting a point hazard (such as a tree) is higher than for other objects struck (figure 5-3).

While figure 5-3 (which relates to probability of a fatality) appears to contradict figure 2-1, (which relates to survivable impact speeds) it is important to note that the plotted values in the former rise above zero at about 30km/h. Figure 2-1 illustrates that for speeds up to 30km/h a collision between a car and a motorcycle is typically survivable. While figure 5-3 does not describe the same type of impact, it does illustrate that when an object is struck in a motorcycle crash the probability of a fatality is approximately zero if the travel speed is less than 30km/h; that is, the crash is survivable. As speeds increase above 30km/h, the probability of a motorcyclist being fatally injured if they strike an object increases, as illustrated in figure 5-3. Therefore, the figure 2-1 and figure 5-3 graphs are correlated because above 30km/h a motorcycle crash is less likely to be survivable and becomes even less survivable as impact speeds increase.

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[52] M.R. Bambach, R.H. Grzebieta, J. Oliver & A.S. McIntosh (2011). *Fatality risk for motorcyclists in fixed object collisions*, Journal of Transportation Safety & Security, 3:3, 222-235, page 231.

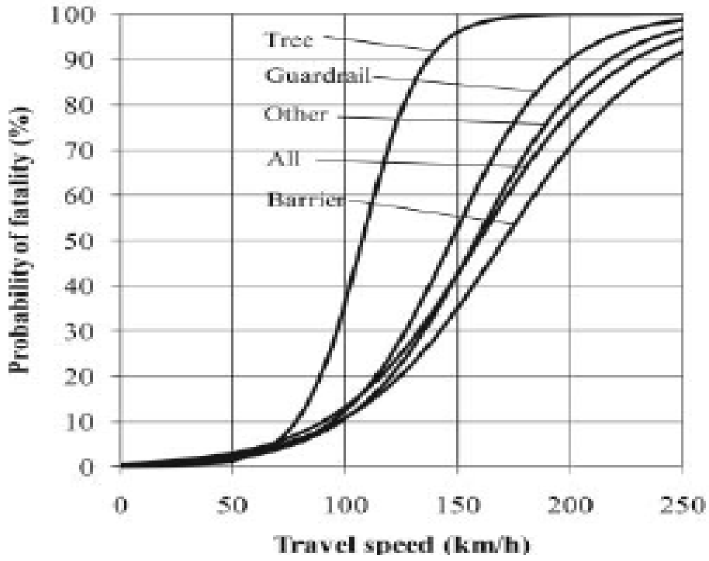

Figure 5-3: Probability of fatality for motorcyclists striking a fixed object as a function of travel speed[53]

Issues and possible treatments related to roadside objects are described in Table 5-7

Table 5-7: Issues and possible treatments for roadside objects

Issue	Possible treatments
Roadside objects (eg culverts, culvert end walls, poles, signs, steep shoulders/deep drains, trees and vegetation) in clear zones. (photo 12 and photo 13)	Provide a forgiving roadside environment in which roadside hazards are removed or relocated (that is, provide clear zones adjacent to the road; these are unobstructed, relatively flat areas beyond the edge of the road that allow a road user to stop safely or regain control of a vehicle that leaves the road). Where roadside hazards cannot be removed or relocated, or otherwise treated to reduce the associated risk to an acceptable level, install appropriate barriers, flexible signage and poles. However, barriers are warranted '… where the risk with the device installed is significantly less than the risk without the …' barrier.[54] The frangibility of a sign support is important and consideration should be given to providing frangible sign supports where signs are located close to the road and the risk of an errant vehicle colliding with a post or pole is a factor. Information relating to impact performance, frangibility and breakaway designs can be found in the NZTA's *Traffic control devices manual* part 1,[55] NZTA's *Performance based specification for traffic signs,* the *State highway geometric design manual*, the RSMA *Compliance standard for traffic signs* and the Austroads *Guide to traffic management* part 10. Consider sealing currently unsealed shoulders to assist in recovery

[53] M.R. Bambach, R.H. Grzebieta, J. Oliver & A.S. McIntosh (2011): *Fatality risk for motorcyclists in fixed object collisions*, Journal of Transportation Safety & Security, 3:3, 222-235, page 231.

[54] Findings of Coroner Katharine Greig, 28 September 2010.

[55] NZTA *Traffic control devices manual* – part 1: General guidance.

Issue	Possible treatments
	and/or avoidance manoeuvres.
Presence of crash barriers (eg concrete, W-beam and wire ropes – see section 5.4.4.2) can be hazardous with the posts presenting the greatest potential for injury for motorcyclists. With wire rope barriers, there is a risk of motorcyclists striking the posts and/or the wire cable.	Crash barrier types should take into account vehicle types and location characteristics. A motorcyclist is usually separated from their motorcycle before they hit a crash barrier and it is usually the crash barrier posts that can cause most injury. Barrier surfaces needs to be as smooth as possible avoiding obstructions and indentations to reduce risk of snagging. Wire rope barriers should desirably be installed well away from traffic lanes, however, standards must be adhered to for maximum performance for all road users. Repairs to barriers must be carried out promptly to protect motorcyclists and other road users.
Collisions with animals such as wandering stock.	Installation of appropriate hazard warning signs.  A programme implementation strategy could be developed for construction of stock underpasses on high volume motorcycle routes. Revision of stock droving bylaws.
Motorcyclist sight distance can be restricted and can be more easily reduced by parked vehicles than for other road users.	Restrict and manage parking where it can obstruct sight distances.

Care is needed to ensure that when signage is used to mitigate a hazard, the sign itself does not become a hazard.

Photo 12: Poles located within clear zones

Photo 13: Steep slopes and open drains located within clear zones

5.4.4.2 Barriers

Quite simply, roadside and median barriers protect all road users (including motorcyclists) from hazards alongside roads and from the potential for opposing vehicles to cross the centreline of the road. However, crashes into road safety barriers (both roadside and median) are a significant concern to motorcyclists. Their use and type of installation has been researched and discussed on a number of different levels and it is important to put the use of these barriers into both the rider and a Safe System perspective.

Three main types of barriers are used in various locations nationally. These are:

- Concrete barriers, which have no flexibility and tend to be used in medians for high speed locations such as motorways (photo 14).

- W-beam barriers are considered to be semi-rigid and are used both in the median and roadside locations, (photo 15).
- Wire rope barriers are considered flexible and are also used in both median and roadside locations, photo 16 and photo 17).

The main concern for motorcyclists relating to barrier installation is the severity of a crash when colliding with a safety barrier.

Another important focus is from a Safe System perspective. As previously discussed in section 2.2, one of the key goals of a Safe System is that 'roads and roadsides are predictable and forgiving of mistakes'. Barriers are generally installed to protect road users from collision with hazards (such as oncoming traffic, roadside poles, trees and slopes) that may result in a fatal or serious injury outcome. Consideration needs to be given to the risks to all road users due to the installation of a barrier; conversely the risks associated with not installing a barrier at a particular location also need to be considered.

Photo 14: Concrete barriers

Photo 15: W-beam or steel barriers

Photo 16: Wire rope barriers used in median

Photo 17: Wire rope barriers used on roadside

There is a significant research available regarding barriers and the implications for motorcyclists – the following documents provide further information.

- *Motorcycle crashes into roadside barriers* stage 1 and stage 2 reports, 2010, University of New South Wales.
- Berg, F. A., Rucker, P., Gartner, M., Konig, J., Grzebieta, R., & Zou, R. (2005). *Motorcycle impact into roadside barrier- real-world accidents studies, crash tests and simulations carried out in Germany and Australia.* In Proceedings of the 19th International Conference on the ESV, Washington, USA. pp.1–13
- *Evaluation of the safety impact of centre-of-the-road wire rope barrier (WRB) on undivided rural roads.* (Austroads Project No. STT1344, Austroads Publication No. AP-T135/09).

While there '... has been a significant concern raised by motorcycle organisations in Australia and overseas regarding the use of wire rope barriers ... recent evidence from Sweden suggests that median wire rope barriers may produce sizeable reductions ... in fatalities and serious injuries for motorcyclists ...'.[56]

It is important to note that:

- a motorcyclist that hits a barrier (or any other roadside or median object) is at risk of injury or death, regardless of the type of barrier they hit
- road controlling authorities have a number of factors to weigh up when determining whether or not to install a barrier and the type of barrier to be installed
- road controlling authorities must consider options to improve road safety for all road users. With regard to barriers, these considerations must include evaluation of the type of barrier that is most appropriate to improve safety for all road users and take into account the specific needs of vulnerable road users including motorcyclists.

5.4.5 Geometry and alignment

According to Berg et al (2005)[57], motorcycles and mopeds are especially vulnerable to collisions on bends and curves, where acceleration or deceleration occurs, or where the stability of the motorcycle/moped is compromised and loss of control is more likely. A disproportionately high number of impacts happen on slip roads (ie roads with a tight radius) and on roundabouts (Williams et al., unpublished). These are precisely the areas where barriers are installed and where attention to detail is needed to ensure that adequate protection is provided. Issues and possible treatments related to geometry and alignment are described in table 5–8.

Table 5-8: Issues and possible treatments for geometry and alignment

Issue	Possible treatments
Changes in alignment (vertical, horizontal, variable radius curves). The vulnerability of motorcyclists on bends and curves where there is a higher risk of loss of control.	Design new roads and realignments to ensure consistent and appropriate design standards are adopted for road alignment on approach to and through curves. Ensure delineation is provided where there are unpredictable changes in alignment.
Lack of sightlines (eg through intersections, roundabouts, splitter islands) and visibility through curves in rural areas.	Ensure clear sight lines through intersections for all road users and design for route consistency and predictability. Ensure visibility through curves where possible so that full curve can be 'read' by approaching motorcyclist.
Adverse camber (superelevation)	Provide superelevation improvements/cross section consistency commensurate with design speed of road and radius of curve.

5.4.6 Intersections

Motorcycle crashes at intersections account for 44% of all motorcycle crashes; of those, 86% occurred in urban areas and the majority of crashes occurred at T-junctions. The main contributing factors (attributable to the parties involved in the crashes; not just the motorcyclists) for both urban and rural intersection crashes were 'failing to give way or stop' and 'did not look or see another party until too late'. Issues and possible treatments related to intersections are described in table 5-9.

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[56] Grzebieta, R., et al (2010). *Motorcycle crashes into roadside barriers*-Stage 1. University of New South Wales, pages 6 and 8.

[57] Berg, F. A., Rucker, P., Gartner, M., Konig, J., Grzebieta, R., & Zou, R. (2005). *Motorcycle impact into roadside barriers: real-world accidents studies, crash tests and simulations carried out in Germany and Australia.* In Proceedings of the 19th International Conference on the ESV, Washington, USA. pp. 1 – 13

Table 5-9: Issues and possible treatments for intersections

Issue	Possible treatments
Inadequate quality and/or quantity of lighting at intersections.	Install and/or improve existing lighting at high risk or high volume intersections.
Lack of sight distance.	Improve sight distance through intersections for all road users, whether through redesign or through removal or relocation of obstacles that restrict vertical and/or horizontal sight lines and approach visibility (such as vegetation (photo 18 and photo 20) parking, and roadside commercial activity).
Obstacles in lean zones on curves. Motorcycles overhang their wheel track by about 0.5 m on each side.[58]	Remove or relocate hazards in lean zones; specifically those close to the kerb or edge of seal. The designer should allow for angles of lean of 45 degrees (photo 21).
Form of intersection, ie roundabout/T-junction/crossroads.	Restrict some movements to reduce conflict where necessary (photo 19).

Photo 18: Sightlines obstructed at intersection Source: Opus International Consultants

Photo 19: Intersection with the right turn out movement restricted to limit conflict. Source; Google maps: pro licence

Photo 20: Sightlines through a roundabout obstructed by vegetation. Source: Austroads Part 15

Photo 21: Hazards located in lean zones. Source: NZTA presentation: Bullick, R. 2011

Improvements to intersections that improve safety for all road users will generally be of benefit to motorcycle/moped users. Therefore, reference should also be made to the *High-risk intersection guide*.[59]

[58] Vicroads. Motorcycle notes no. 6.

[59] NZTA, 2012, *High-risk intersection guide*, consultation draft, March 2012.

5.5 Issues and treatments for road users (motorcyclists)

Motorcycles are different to four (or more) wheeled vehicles and motorcyclists require different skills to other road users in relation to braking, cornering[60] and swerving (crash avoidance); they also need a highly developed sense of balance. A safe road user operating within a Safe System is skilled and knowledgeable, alert and compliant, and in the case of motorcycle/moped riders, is wearing appropriate safety gear.

How motorcyclists can achieve these skills are described in more detail in sections 5.5.1 to 5.5.7.

5.5.1 Training and education

In Victoria's Road Safety and Transport Strategic Action Plan for Two Wheelers, it was reported that in 10% of all fatalities the rider did not have a valid licence, while 10% were riding an unregistered motorcycle. In New Zealand (using CAS data) this is similar, with 10% of fatalities and 6% of all injury crashes involving riders who were either never licensed or were disqualified or had an expired licence. Unregistered statistics cannot be easily obtained for crash data in New Zealand. However, it is interesting to note that 23% of fatal motorcycle/moped crashes in rural areas and 32% of fatal motorcycle/moped crashes in urban areas involved motorcycles/mopeds with no warrant of fitness. While the legality of a motorcycle/moped for use on the road is an enforcement issue, it is important that riders are educated regarding the importance of safe vehicles as well as safe road use.

Training and education is a necessary component of ensuring motorcyclists have developed the necessary skills and have equipment appropriate for their level of experience. Issues and possible treatments related to training and education of motorcyclists are described in table 5-10.

Table 5-10: Issues and possible treatments for training and education

Issue	Possible treatments
The current motorcycle theory test is predominantly focused on general road rules (25 of the 35 questions).	The theory test should be redeveloped to place more emphasis on motorcycle specific requirements.
The practical riding assessment standards for novice riders do not adequately test the rider ability.	The NZTA is introducing a tougher basic handling skills test and competency-based training and assessment courses for novice riders.
An increase in motorcycle use recreationally, particularly in the riders over the age of 25 years.	Motorcycle awareness campaigns targeting older recreational motorcyclists. Refresher training for returning riders.[61]
Currently, holders of learner and restricted motorcycle licenses are restricted to riding motorcycles of 250cc or less. However, recent advances in technology have limited the effectiveness of the restriction.	Motorcycle awareness campaigns to encourage motorcyclists to choose motorcycles appropriate for their level of experience and advanced safety features. Introduction of legislation (effective from 1 October 2012) to replace a simple engine capacity restriction with a scheme that is based on a maximum capacity of 660cc and a power to weight ratio of less than 150kW per tonne.

[60] Refer to www.rideforever.co.nz/skills-and-technique/cornering/.

[61] Refer to www.rideforever.co.nz/returning-to-riding/.

Issue	Possible treatments
An increase in crashes involving mopeds. Moped riders are only required to hold a car driver licence and are not required to pass any handling skills test before they can legally ride a moped on the road.	Awareness campaigns targeting moped users.[62] Motorcycle dealers encouraged to provide information to moped riders regarding suitable safety gear and to stock suitable safety gear.
Understanding of general road rules (all road users).	Education/motorcycle awareness campaigns targeted at all road users.
Understanding specific motorcycle issues (all road users).	Campaigns developed that outline/focus on specific motorcycle issues such as lean zones, leaning across the centreline, visibility of motorcyclists by drivers, rider fatigue, user responsibility for maintenance (tyre pressure etc), overloading (especially for mopeds).

Many local councils are providing motorcycle skills training and some have developed regional motorcycle strategies that focus on the motorcyclist and their skills.

5.5.2 Rider experience, speed, route knowledge and risk taking

Table 5-11 describes issues and possible treatments related to rider experience, speed, route knowledge and risk taking.

Table 5-11: Issues and possible treatments for rider experience, speed, route knowledge and risk taking

Issue	Possible treatments
Inexperienced riders.	Rider education and licensing improvements. Incentives to attend rider training courses. Note: Changes in the Land Transport Amendment Rule 2011 include removing the 70km/h speed limit restriction for learner motorcycle license holders so they can get more appropriate experience on rural roads.
Speed choice of rider.	Install speed management and perceptual countermeasures (eg speed advisory signage, chevron indicators, edge marker posts), where there are identified high risk or favoured routes and/or sites. Setting appropriate speed limits and consider Safe System speeds along high risk or favoured routes. Enforcement and education.
Lack of route knowledge and new route locations.	Education on route knowledge and event based promotion. Provide a consistent environment for all road users including good delineation and identification of hazards; a no surprises forgiving environment.

[62] Refer to: scootersurvival.co.nz/.

Lack of knowledge of route conditions.	Provide and promote information regarding current conditions on routes through websites such as: maps.aa.co.nz/traffic/roadwatch and www.nzta.govt.nz/traffic/current-conditions/highway-info/index.html.
Risk taking (seeking a thrill and riding beyond their capabilities).	Provide targeted enforcement along high risk and favoured routes and develop education campaigns.

Safe road use can also include road users making RCAs aware of hazards on the roads so that the RCA is able to address matters that otherwise affect the provision of safe roads and roadsides.

5.5.3 Alcohol and drug use

The use of alcohol is a significant factor in motorcycle crashes, particular in urban areas where it is the most common contributing factor for injury crashes from 2001-2010. Issues and possible treatments related to rider alcohol and drug use are described in table 5–12.

Table 5-12: Issues and possible treatments for alcohol and drug use

Issue	Possible treatments
Alcohol and drug use.	Blood alcohol/drug content testing Random breath testing Drug impairment tests (CIT[63]) Post crash breath testing Education Alcolocks

Motorcyclists are subject to the same compulsory breath test requirements (as illustrated in photo 22 and photo 23) as other road users. Testing for alcohol content includes testing for blood alcohol content (BAC), which can arise from a random stop or may be carried out following a crash.

Photo 22: Compulsory breath testing activity is supported by booze buses. Source: Opus International Consultants: Swears, R.

Photo 23: All road users, including motorcyclists, are subject to compulsory breath testing. Source: Opus International Consultants: Swears, R.

While police enforcement of road use by motorcyclists is generally conducted in the same manner as enforcement of other road users, some motorcycle specific enforcement activities are undertaken such as (for example) special operations in relation to outlaw motorcycle gangs.

[63] CIT = compulsory impairment test.

5.5.4 Fatigue[64]

The Safer Journeys strategy notes that reducing the impact of distraction and fatigue is a further possible action that could assist with addressing New Zealand's road crash problem.

Measures can be applied across all four elements of the Safe System to reduce the adverse impact of fatigue on road safety. However, in relation to the safe road users' element, it is important to make New Zealanders' management of road user distraction and fatigue a habitual part of what it is to be a safe and competent driver. Rider fatigue occurs when people are riding while they are tired, drowsy or sleepy. Fatigue can affect a rider's reaction time, their ability to concentrate and their understanding of the road and traffic around them.

Until recently, efforts to reduce road user fatigue have focused on commercial drivers. However, to reduce fatigue related crashes we need to extend the focus to all road users; including motorcycle/moped riders.

5.5.5 Rider safety gear

Wearing protective gear while motorcycling assists in providing safety improvements, specifically enhancing visibility of motorcyclists to other road users and reducing injuries. In addition, suitable safety gear provides protection from the elements and reduces the potential for riders to suffer from exposure related conditions such as hypothermia.

Research completed in New Zealand[65] identified that 'Low conspicuity may increase the risk of motorcycle crash related injury. Increasing the use of reflective or fluorescent clothing, white or light coloured helmets, and daytime headlights are simple, cheap interventions that could considerably reduce motorcycle crash related injury and death.' In summary the research noted that:

- 'drivers wearing reflective or fluorescent clothing had a 37% lower risk than those who were not wearing such materials...'
- 'compared with wearing a black helmet, use of a white helmet was associated with a 24% lower risk...'
- 'self reported light coloured helmet versus dark coloured helmet was associated with a 19% lower risk'
- 'three quarters of motorcycle riders had their headlights turned on during the day, and this was associated with a 27% lower risk ...'.

It is important to recognise that the improved safety associated with more conspicuous clothing may also be a function of the safety attitude of the motorcyclist wearing the clothing.

Issues and possible treatments related to rider safety gear are described in table 5-13. The responsibility for addressing these treatments lies with a range of organisations and agencies including the NZTA, MOTO, ACC, and other agencies and motorcycle groups with an interest in improving safety for motorcyclists.

Table 5-13: Issues and possible treatments for rider safety gear

Issue	Possible treatments
Use of protective clothing.	Promotion and education of the importance of protective clothing (figure 5-5 and figure 5-6).
Promotion of new technology (eg air bag technology, neck protection).	Promotion and education of new technology to both sellers and buyers.
Use and quality of helmet design (eg age, size, fit, and type).	Promotion and education of the importance of appropriate equipment to both sellers and buyers. Refer to www.rideforever.co.nz/gear/safety-approved-gear/.

[64] Material in this section is predominantly taken from the Safer Journeys strategy.

[65] British Medical Journal April 2004, 328:857. *Motorcycle rider conspicuity and crash related injury: case-control study.*

Figure 5-4: Protective gear for motorcyclists: Source: NZTA The official NZ road code for motorcyclists

Examples of education campaigns for motorcycle/moped road users are illustrated in figure 5-5 and figure 5-6 below:

Figure 5-5: Education campaign to wear protective clothing; Source: www.scootersurvival.co.nz

Figure 5-6: Successful rider training Source: www.reducetherisk.co.nz/

Also refer to:

- www.rideforever.co.nz/gear/
- www.infrastructure.gov.au/roads/safety/publications/2009/good_gear_guide.aspx

While motorcycle/moped riders have the primary responsibility for ensuring they are safely equipped, motorcycle retailers and hirers have an obligation to ensure they have appropriate protective gear for motorcycle/moped riders. This includes making available:

- a range of helmets
- a range of protective clothing, including a much wider range of coloured clothing to balance the predominant availability of black clothing
- a range of boots
- information regarding the need for stocking a range of suitable protective clothing.

5.5.6 Group riding

Many recreational motorcyclists enjoy the social opportunities associated with group riding. However, it can have its own set of issues as outlined in Table 5-14. Additional information on group riding can be found at:

- Scooter Survival (Accident Compensation Corporation, www.scootersurvival.co.nz).
- Ride Forever (Accident Compensation Corporation, www.rideforever.co.nz).
- *The official New Zealand road code for motorcyclists* (NZ Transport Agency, www.nzta.govt.nz).

Table 5-14: Issues and possible treatments for group riding

Issue	Possible treatments
In group riding situations there can be perceived or actual peer pressure for motorcyclists to ride above their abilities to keep up with the bunch.	Education should be provided as part of training packages and other campaigns. Talk to tour group facilitators.
Lack of communication between riders.	Each riding group should have a set of basic hand signals so they can communicate with each other.
Keeping the group together (stopping and leaving intersections, passing vehicles etc).	Group leader takes responsibility. If you are at the front of the group leave enough room for others to join.
Inexperienced riders failing to keep up with the rest of the group may lead to them feeling pressured to ride with the group and therefore ride outside of their comfort zone and experience.	Provide designated stopping or meeting places. Allow inexperienced riders to set the pace in group rides.
Inappropriate riding formation can reduce safety for all road users.	Riders should ride in a staggered formation (photo 24 and photo 25), with less experienced riders in the left hand wheel track of the lane. Lead rider should take responsibility. Single file formation should be considered in locations where it may be safer than staggered formation; such as when the group are turning, using off-ramps, passing slower vehicles, riding in areas of narrow lane widths or areas with parked cars.[66]

[66] www.motorcyclebasics.com/group-riding.html

Photo 24: Group riding Source: www.rideforever.co.nz

Photo 25: Staggered formation, Source: The official NZ road code for motorcyclists

5.5.7 Rider position on the road

As vulnerable road users, motorcyclists need to position themselves where they can be seen by other road users and see the road ahead of them. Along straight sections of the road, the rider will generally position themselves in the right hand wheel track so they can be seen by other road users and see the road ahead of them. At curves, for a right hand curve the rider will initially position themselves in the left hand wheel track and on a left hand curve, initially in the right hand wheel track. That is, riders will often enter a curve wide so that they can get a view around the curve, then when they can see it is clear, they will ride across towards the apex of the curve.[67 68] Issues and possible treatments related to rider position on the road are described in table 5–15.

[67] www.scootersurvival.co.nz/videos/how-to-ride/

[68] www.rideforever.co.nz/skills-and-technique/cornering/cornering-lines/

Table 5-15: Issues and possible treatment for rider position on the road

Issue	Possible treatments
Motorcyclists tend to position themselves in the vehicle wheel track. At curves, this can be potentially hazardous as the wheel tracks will be the higher loaded areas of the road (especially by trucks) and therefore likely to have more damage to the road surface and pavement.	Provide wider shoulders where needed such as on approach to out of context curves on high risk or favoured routes (photo 26). Apply appropriate speed management treatments and consider perceptual countermeasures (photo 27 and photo 28). Reduce head-on risk where exposure is high through appropriate treatments such as wide centrelines (photo 29) and median barriers. Rider education. Carry out appropriate maintenance to ensure motorcyclist riding lines are in good condition. This requires recognition that on curves motorcyclists may cross from one wheel track to the other.

Photo 26: Shoulder widening

Photo 27: Perceptual countermeasures to slow speeds on approach to an urban area (dragon's teeth), Charlton and Bass, (2006)

Photo 28: Speed threshold treatment on approach to Hamilton

Photo 29: Wide centreline. Source: Yvonne Forrest (MSAC)

Riders need to position themselves on the road so they can follow safe paths (for example, do not ride a motorcycle/moped in the gutter)[69] and they are visible to other road users. It is also important for riders to choose a riding path that avoids hazards where possible. This includes markings on the road surface and features such as manhole covers.

[69] www.scooter-survival.co.nz/videos/how-to-ride

Those who design, build and maintain roads can assist motorcycle/moped riders through carefully considering the impact of temporary and permanent features in the road environment on the ability of motorcycle/moped riders to select a safe riding line.

5.6 Issue and treatments for vehicles (the motorcycle)

Safe vehicle technology for motorcycles/mopeds is developing and in the future there will be improvements to the safety features available on motorcycles/mopeds. As new information comes to hand, this section of the guide will be updated.

5.6.1 Maintenance

Table 5–16 describes issues and possible treatments related to maintenance of motorcycles.

Table 5–16: Issues and possible treatments for maintenance of motorcycles

Issue	Possible treatments
Poor vehicle maintenance (eg inadequate tyre tread and pressure, bearings, lights, brakes).	Education and information campaigns to educate riders about importance of vehicle maintenance. Vehicle inspections on popular motorcycle routes.

5.6.2 Power-to-weight ratios

'A higher proportion of crashes involving large motorcycles (500cc or larger) result in death rather than injury – riders of large motorcycles make up 41% of all casualties but 60% of deaths.[70] This is partly a result of riding patterns.' [71] Issues and possible treatments related to power-to-weight ratios of motorcycles are described in Table 5-17.

Table 5-17: Issues and possible treatments for motorcycle power-to-weight ratios

Issue	Possible treatments
Limited capabilities in handling more powerful vehicles than experienced or trained in.	Changes to legislation and licensing. Note: recent legislation outlined in the Land Transport (Driver Licensing) Amendment Rule 2011 will include introducing a power-to-weight restriction for novice motorcycle riders. This replaces the current cc limit for novices. Learner motorcycle licence holders will only be able to ride motorcycles which do not exceed a power-to-weight ratio of 150 kilowatts per tonne. (Refer to section 2.4.4). Training and education for riders regarding their choice and use of a motorcycle/moped that is suitable for their level of capability.

5.6.3 Motorcycle conspicuity

With regard to lighting on motorcycles/mopeds it is well known that the relative lack of motorcycle/moped conspicuity, when compared to cars is one of the most important factors associated with motorcycle/moped crashes. However, the conspicuity advantage obtained through the use of headlights (for daytime and night-time)

[70] As a percentage of all casualties and deaths for motorcycle/moped riders.

[71] Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, 2010, page 27.

on motorcycles/mopeds has been threatened through the increased daytime use of headlights by other road users.[72] The results of a study into four light configurations for motorcycles found that:[73]

- a triangular lighting configuration on a motorcycle was not significantly more detectable than a standard lighting configuration
- motorcycles, where the standard headlight and a helmet mounted light were used were '… globally better detected … than PTWs[74] equipped with the standard headlights …'
- motorcycles equipped with a yellow headlight '… were globally better detected…than with a standard one …'.

While some of the differences in detection described above were not statistically significant, when compared with the detection rate for standard lighting, other research has confirmed that non-standard lighting configurations on motorcycles/mopeds can improve the recognisability of motorcycles/mopeds in a traffic stream. Results[75] indicate that motorcycles/mopeds with a T light configuration (across the handlebars and down the front forks) are identified significantly faster than motorcycle/mopeds with a conventional front headlight only.

'Enhancement of motorcycles' conspicuously might make a critical contribution to the safety of …' motorcycles/mopeds[76].

5.6.4 Features

Issues and possible treatments related to motorcycle features are described in Table 5-18.

Table 5-18: Issues and possible treatments for motorcycle features

Issue	Possible treatments
Ability to be installed and availability of safety technology (eg presence of ABS, stability control, linked brakes, traction control and airbags).	Promotion of new safety technology. Enhance rules regarding safety features required on imported motorcycles in New Zealand.
Lack of conspicuity associated with motorcycles.	Daytime headlights. As required by law.[77] Additional running lights.
Buyers and importers knowledge of safety features.	Provide access to information for buyers and importers on what safety features they should be looking for such as anti lock brakes and stability control features.

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[72] Pinto, M, and Cavallo, V *Influence of headlight design on sensory conspicuity of powered two wheelers, proceedings of the sixth international driving symposium on human factors in driver assessment training and vehicle design,* 2011, page 373.

[73] Ibid, page 377.

[74] PTWs = powered two wheelers, ie motorcycles/mopeds.

[75] Rössger L, Hagen K, Krzywinski J, Schlag B *Recognisability of different configurations of front lights on motorcycles*, Accident Analysis and Prevention 44 (2012) 82-87.

[76] Ibid, page 86.

[77] It is a legal requirement to turn on either your moped or motorcycle's headlight or daytime running lights during daylight hours if your motorcycle or moped was manufactured on or after 1 January 1980. Refer to www.nzta.govt.nz/resources/roadcode/motorcycle-road-code/about-riding/night-riding.html.

5.7 Issues and treatments for speeds

Safe speeds are a fundamental issue with regard to motorcycling and all road user safety. Travelling at safe speeds for the conditions reduces the risk of losing control of your vehicle. If a collision occurs, the speed at which you were travelling prior to that collision affects the severity of the injury.

There are a number of other treatments, relating to speed management in other parts of a Safe System that can be applied to promote safe speeds and therefore reduce injury severity when crashes occur. These treatments include vehicle technology (see sections 2.4.4 and 5.6), rider safety gear (see section 5.5.5) and issues for riders in general such as risk taking.

Issues and possible treatments related to speeds are described in table 5–19.

Table 5–19: Issues and possible treatments for speeds

Issue	Possible treatments
Travelling too fast for the conditions.	Self explaining roads (refer to section 7.2.3): appropriate signs and markings for certain hazards, that is, curve signs and edge marker posts to highlight design of curves (particularly those that are out of context). Visible (targeted automated and non-automated) enforcement.
Speeding (that is over the speed limit).	Visible (targeted automated and non-automated) enforcement.
Posted speed limits that do not match the environment or risk.	Consider harm reduction and harm minimisation speeds.
Following distances.	Enforcement and education.
Lack of rider awareness of speed limit.	Provide additional repeater speed limit signage, particularly in areas subject to speed zoning and/or where speed limits may not be obvious under principles of self-explaining roads.

Speed management measures, which are fully described in Appendix E6 of the *High-risk rural roads guide* (replicated in appendix Z of this document), include:

- speed activated warning signs (SAWS)
- speed thresholds
- lowering the posted and operating speed.

Speed management involves encouraging road users to travel at speeds that are safe for the conditions – recognising that some conditions vary due to a variety of factors (such as light, weather, road surface, state of rider, standard of vehicle) and therefore cannot be managed by the RCA alone.

5.8 Issue and treatments for injuries

As noted in section 2, motorcyclists are about 18 times more prone to being killed or seriously injured than other road users. It is important that motorcyclists (and other road users) are aware of general crash scene and first aid procedures.

Immediate first aid for riders injured in crashes on rural roads can reduce the severity of the outcome. Although more motorcycle crashes occur on urban roads than on rural roads, the majority of motorcyclist fatalities and serious injuries occur on rural roads where speed limits are generally higher. For example, in the 2006–10 five-year period, about two-thirds of motorcycle injury crashes occurred on urban roads, but nearly three-quarters of fatal

crashes were on rural roads[78]. ACC claims for rural road motorcycle crashes are approximately twice as expensive as those on urban roads[79].

Appropriate gear reduces the severity of motorcyclists' injuries and in some cases can prevent injury. For example a heavy jacket (leather, Kevlar, etc) would reduce the severity of injuries in 92% of motorcycle crashes, whereas a light or medium weight one (cotton, denim, etc) would do this in only 69% of crashes; light footwear reduces the severity of injuries in 46% of crashes, whereas motorcycle boots achieve this in 93% of crashes[80].

Legs are the area of the body that is most often seriously injured in motorcycle crashes, but arms get fractured more frequently than legs. In the 2007–10 four-year period nearly 5000 people had ACC claims for broken limbs that resulted from motorcycle crashes[81].

Information on choosing the right gear for riding a motorcycle/moped can be found on the ACC 'Ride Forever' website (www.rideforever.co.nz).

A summary of the issues and possible treatments related to motorcyclist injuries are described in table 5-20.

Table 5-20: Issues and possible treatments for injuries

Issue	Possible treatments
Personal responsibility.	Knowledge of first aid and general crash scene procedures.
Proximity of helicopter landing area.	First responder needs (golden hour).
Available mobile phone coverage.	Increased coverage in lower population areas. Use of personal locator beacons that could be activated to summon assistance if an incident occurs, particularly for use in remote areas where mobile phone coverage may be poor.
Inadequate safety gear.	Wearing suitable safety gear to reduce the potential for injury if a crash occurs.

5.9 General crash reduction results

While this document does not go into detail about specific crash reduction percentages, a summary of the effectiveness of some treatments to reduce the potential motorcycle casualties has been developed by iRAP (International Road Assessment Programme)[82] – examples of these treatments, their relative costs and potential for casualty reduction are described in Table 5-21. Further information and detailed crash reduction percentages for all road users can be found in the NZTA *High-risk rural roads guide* and the NZTA *High-risk intersection guide*.

Table 5-21: Possible casualty reduction for motorcycle crash treatments

Treatment (cost)	Casualty[83] reduction percentage	Treatment (cost)	Casualty reduction percentage
Delineation (L[84])	10-25	Intersection-delineation (L)	10-25

[78] NZ Ministry of Transport, *Motorcyclists crash factsheet*, 2011. www.transport.govt.nz/research/Documents/Motorcyclist-crash-statistics-2011-(1).pdf

[79] Accident Compensation Corporation.

[80] ACEM, European Motorcycle Industry, www.acem.eu/cms/ppe.php.

[81] Accident Compensation Corporation.

[82] www.toolkit.irap.org/default.asp?page=roaduser&id=6

[83] As defined in the glossary, a casualty is a person who is killed or injured in a crash. There can be more than one casualty in a crash, there can also be no casualties in a crash. A casualty is an individual.

Treatment (cost)	Casualty[83] reduction percentage	Treatment (cost)	Casualty reduction percentage
Central turning lane full length (L)	10-25	Intersection-turn lanes (signalised) (L-M)	10-25
Roadside safety - hazard removal (L-M)	25-40	Intersection - turn lanes (unsignalised) (L-M)	10-25
Parking improvements (L-M)	10-25	Motorcycle lanes[85] (M)	25-40
Shoulder sealing (M)	25-40	Intersection-signalise (M)	25-40
Road surface upgrades (M)	25-40	One way network (M)	25-40
Speed reducing treatments (M)	25-40	Restrict/combine direct access points (M-H)	25-40
Traffic calming (M-H)	25-40	Realignment - horizontal (H)	25-40
Intersection - grade separation (H)	25-40	Realignment - vertical (H)	10-25

[84] L = low estimated cost, M = medium estimated cost, H = high estimated cost.

[85] *The official New Zealand Road Code* (www.nzta.govt.nz/resources/roadcode/about-driving/using-lanes-correctly.html) does not describe motorcycle only lanes, but notes that in some cases, motorcycles/mopeds can use bus lanes.

6 Understand the issues

As discussed in section 4, we determine where high-risk motorcycle routes/sites are by determining collective risk from crash data. This process works predominantly on the basis of using high-severity crashes (that is fatal and serious injury crashes in urban areas and all injury crashes in rural areas) to determine our highest-risk routes or sites. It is important to provide further analysis on all crash data and other factors to better determine the safety problem and the most appropriate countermeasures to be adopted for the treatment strategy.

6.1 Analysing the data

Crash analysis is essential before choosing countermeasures. Using all the crash data rather than just data for the high-severity crashes provides a larger sample size to enable practitioners to identify the risk issues and make more informed decisions on what type of countermeasures may be appropriate for any given route/site.

Risk analysis uses the crash prediction tools that identify the factors that may be contributing to crash risk. This may help supplement any detailed crash analysis

In these investigations the road safety practitioner should seek to understand:

- crash patterns for both:
  - high-severity crashes, that is, those resulting in death or serious injury, as they may differ from lower-severity crashes
  - all crashes (the inclusion of minor and non-injury crashes will better highlight spatial, temporal and crash movement commonalities or factor patterns)
- the spatial location of crashes – whether they are clustered or distributed
- key risk factors such as lengths, proximity to other road users and to hazardous roadsides
- consistency of expectation and provision of road features and roadside infrastructure.

In addition to this section, it is recommended that the NZTA's *New Zealand guide to the treatment of crash locations* and Austroads: Part 8 *Treatment of crash locations* are referenced for additional details on diagnosing crash problems.

Other data that could help develop treatments includes consideration of changes to development/residential/commercial growth in the area, traffic volumes, and key stakeholder and community concerns. Techniques such as the use of instrumented motorcycles (refer to the case study box following section 7.3.2) and obtaining feedback directly from riders (for example through the MSAC) are methods for obtaining road user information.

Where pedestrians, cyclists and equestrians are present, the NZTA's draft non-motorised user review procedures should be consulted to assist in defining the issues.

6.2 Detailed crash analysis

To help understand the safety problems, a detailed analysis of the crash data is required. Although the CAS plain English and coded reports will assist, it is strongly recommended that the original traffic crash reports are reviewed and analysed, as these provide information not available in the summary reports. In some cases, discussing a specific crash with the police officer involved may help an analyst to better understand the details of the crash.

The **general factors** that need to be understood are crash movement types, midblock versus intersections, direction of travel, temporal factors (day of week, time of day, month of year) and ambient light (day or night).

The specific **roads and roadside factors** that need to be understood are straights versus curves, wet or dry road conditions, objects struck, and other road factors (such as surface material, sight distance, roadside features).

Issues to consider in addressing these include consistency and readability of the alignment, signage and delineation, carriageway width, skid resistance, median treatments, and hazard removal, protection or mitigation.

The specific **speed factors** that will need to be understood include drivers travelling too fast for the conditions versus speeding (that is, exceeding the posted speed limit), and time of day and traffic conditions for speed-related crashes.

The specific **road user factors** that may need to be taken into consideration include (but are not limited to) driver/rider age, sex, licence status, recent motorcycling experience on actual motorcycle that was crashed, and if alcohol, speed, fatigue or inattention was involved.

The specific **vehicle factors** that need to be understood are the age, type and condition of the vehicle.

When developing solutions, crash data and road user information is needed so that the analyst can understand the level of use and road issues associated with motorcyclists both along and across the road corridor.

If crash analysis or community and key stakeholder feedback has identified that a significant number of motorcyclists use a route, then considering appropriate facilities for these types of road users is important when developing any treatment.

Motorcyclists have well-defined main crash types, with a distinct pattern (see section 3 for detailed crash types and issues for motorcyclists).

Further information and analysis on environmental factors (for example, wet and dark crashes) and other vulnerable road users (pedestrian and cyclists) can be found within the NZTA *High-risk rural roads guide*, NZTA's *Pedestrian planning and design guide,* NZTA's website (www.nzta.govt.nz), and cycling aspects of Austroads guidelines.

While use of a route by a significant number of motorcyclists does not necessarily equate with a safety issue, high levels of motorcycle usage demonstrate a greater need for RCAs (and their consultants and contractors) to ensure that construction and maintenance practices are appropriate for all road users.

7 Programme implementation, monitoring and evaluation

Monitoring targets for motorcyclists are currently included in the Safer Journeys strategy and are to reduce:

- fatal and serious injury crashes involving motorcycles and moped riders per 1 million population (from 11 per 1 million to no more than 7 per 1 million)
- the number of motorcycle and moped riders on learner or restricted licences that are at fault in fatal and serious injury crashes
- the number people killed or injured in motorcycle crashes per million hours spent travelling.

With the development of this document, additional monitoring targets were defined by analysis of motorcyclist crashes nationally, which identified these as high risk. These targets include a reduction in all injury crashes involving motorcyclist/mopeds in rural areas[86].

7.1 Introduction

The focus of this document is to assist practitioners to identify high-risk motorcycle routes and sites, and develop countermeasures to reduce the incidence of crashes along a route or at a site. While this document focuses on addressing fatal and serious crashes, the countermeasures described are also likely to address some minor injury and non-injury crashes. Once countermeasures have been determined for high-risk routes and sites, a suitable programme of implementation is important, along with a system to monitor the effectiveness of these countermeasures.

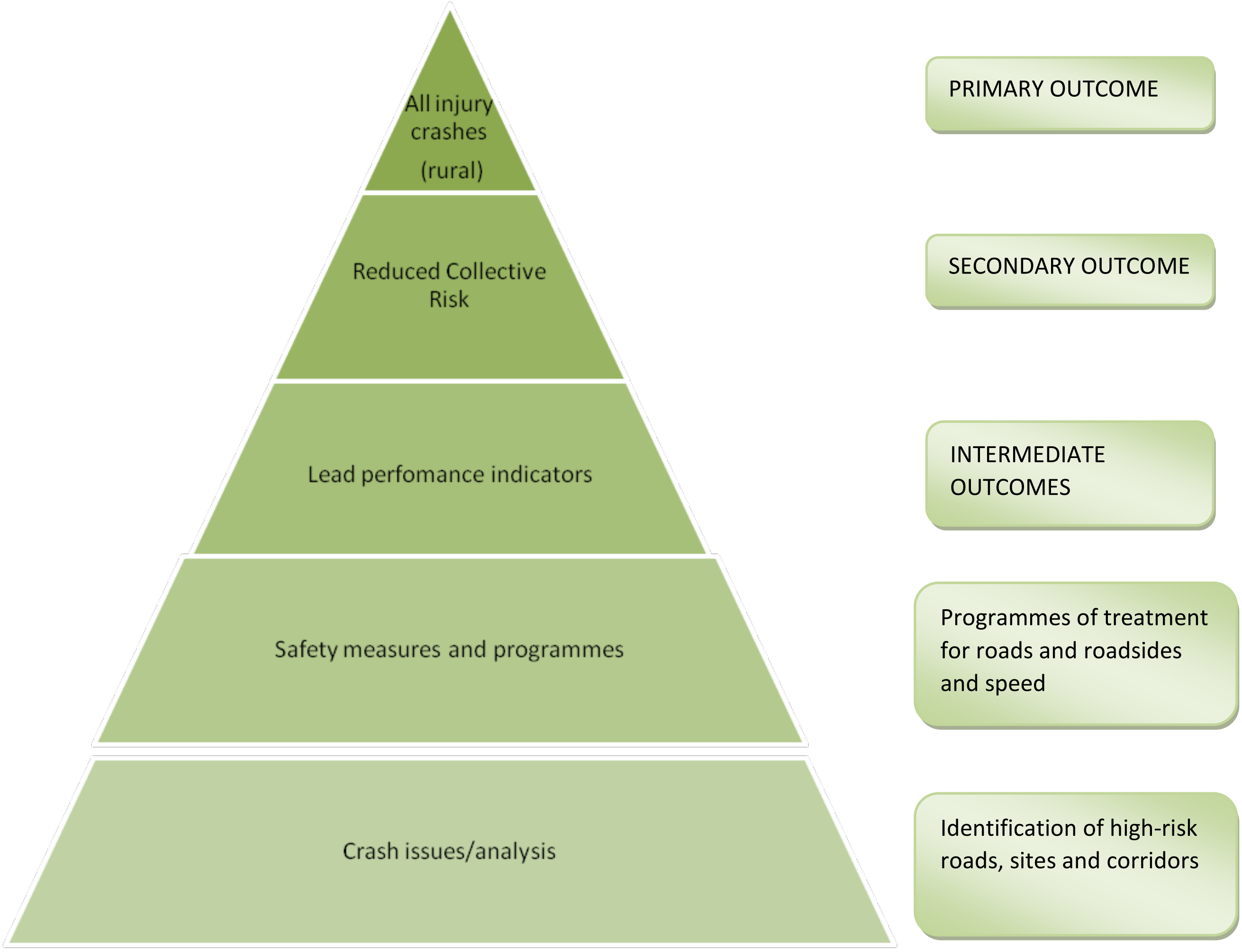
This section looks at issues associated with developing programmes for treating high-risk motorcycle routes and sites and then monitoring the effectiveness of those programmes to:

1. identify the benefits and the effectiveness of the various treatments
2. identify the most effective packages of treatments
3. assess the levels of investment that may be required to achieve various levels of crash reduction
4. prove that funding has been invested wisely.

Figure 7-1 is a modified version of the safety management triangle. Working from the base up, the foundation of this triangle is the identification and analysis of crash issues, which would include the means of identifying high-risk motorcycle routes, corridors or sites (see section 4).

[86] As previously stated urban targets are yet to be developed. These will be confirmed with the analysis completed and subsequent publication of the NZTA *High-risk intersection guide* (see comment box in section 4.4.1).

Figure 7-1: Road safety management triangle



As previously stated, urban targets are yet to be developed. These will be confirmed once the analysis is completed and the NZTA have published the *High-risk intersection guide* (see comment box in section 4.4.1).

Having described the method to identify sites/routes and clarify the safety concerns associated with these, this document now discusses some possible treatments or strategies that could be used to improve the safety of high-risk rural motorcycle routes, and reduce the risk of injury crashes, that is, the primary outcome.

In an ideal world, the analysis of the effectiveness of each treatment or programme item would be assessed by applying only one specific treatment to a range of sites and monitoring the performance of the treatment over time, before applying the next treatment. However, in New Zealand, the number of people killed or seriously injured in any one location is too small, while the risk of doing nothing could be too severe. Therefore, because of the delays associated with the post-implementation data collection and the immorality of 'playing with people's lives', this precludes such a purist approach. In order to facilitate the necessary analysis, the road safety management triangle introduces the concept of intermediate and secondary outcomes.

In this section we begin by describing the development of a programme of treatments, and how to establish the appropriate intermediate measures. We then describe monitoring the site-specific secondary and primary measures.

7.2 Programme development

It is important to remember that even though Safe System transformation works[87] (refer also to sections 4.5.2 and 6.2.1 of the HRRRG) can produce significant safety benefits, low-cost safety management treatments are still relevant for many situations and are potentially more appropriate on high-risk motorcycling routes.

The assessment of rural road risks in section 4 identifies the longer-term plan for a particular road/route. In some regions there will be no rural road sections that have long term larger infrastructure or corridor improvements planned, therefore, a programme of ongoing safety improvements should be considered and tailored to fit the desired outcome. Analysing the data and understanding the issues are important and are discussed in more detail in sections 5 and 6.

For more information on programme prioritisation, programme implementation and challenges to implementation, refer to the NZTA *High-risk rural roads guide.*

7.2.1 Focus on incremental improvements across networks

The focus for a programme of works should be on incremental improvements across networks to help achieve larger overall benefit–cost ratios. So what are incremental improvements?

Having identified that larger infrastructure/capital projects may be planned for a route to produce a Safe System transformation (table 5-2), the end result has to some degree been confirmed. However, given the limited funding and associated priorities, together with the lead time associated with getting major infrastructure projects to construction (as a result of RoNS, Safe System, high-risk rural roads and other safety projects), doing nothing until that project eventuates continues to place motorcyclists at risk of death or injury.

Responsible road safety practitioners and network managers need to consider this risk. Incremental improvements are viable if they:

- contribute to a reduction in the cost of the final project, that is providing incremental benefit and costs, or
- return an economic road safety benefit over the intervening period, that is between now and the realistic date for delivery of the major project.

If, however, the final solution involves a completely new alignment, any proposed works will have a reduced economic life and should be analysed over the pre-implementation period.

7.2.2 Consistency and road classification

The road environment should provide the road user with strong indications of what to expect, how to behave and safe operating speeds. The consistency of road environment messages along the road corridor is important. These messages are delivered through the carriageway width, alignment, access management, signs and markings standards and other traffic control devices.

Service levels for travel time and safety are determined based on the road hierarchy, or, for the state highway network, the recently published road classification.[88] Hence, in developing road safety programmes, the road hierarchy needs to be considered and safety measures applied that are appropriate for, and consistent with, the road function and the traffic volumes it carries.

As well as determining the appropriateness of the safety measures, the road classification is likely to be a determinant in prioritisation for funding.

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[87] Safe System transformation works are likely to be the most effective in producing a significant step change in the safety profile for a section of road. Safe System transformation works are generally the higher cost infrastructure countermeasures and are developed and implemented over a long term.

[88] NZTA, 2012, *State highway classification*, refer to www.nzta.govt.nz/planning/process/state-highway.html.

7.2.3 Driver awareness measures/self-explaining roads

Driver awareness measures for self-explaining roads provide clear direction and unambiguous information to all road users which drivers can use to make decisions and modify their behaviour depending on the design and function of a road and the associated risks. These measures are more likely on routes where there are higher levels of personal risk but low to medium levels of collective risk.

7.3 Key stakeholder engagement

7.3.1 Risk management, communication and engagement

The objective of this document is to reduce serious and fatal motorcycle crashes on New Zealand roads as defined by the Safer Journeys strategy. The term 'high-risk motorcycle route' takes into account both consequence and likelihood of crashes occurring.

In defining a high-risk or favoured motorcycling route, this document provides a mixture of information (section 4) including sources from which favoured motorcycle routes can be identified and the methodology to assist RCAs in risk identification on those routes (such as those calculations and charts provided for local roads to determine high-risk routes).

Communication, consultation and engagement are some of the most important components of risk management and should be considered at all stages of the process. For example, risk identification may be through local and national motorcycling groups/organisations, public feedback, Road Transport Association (RTA), high volume road users, Automobile Association (AA) and emergency services. By using feedback from stakeholders we can determine whether their level of perceived risk matches the actual or potential risk as determined from crash and road data. Once high-risk routes or sites have been determined, RCAs can undertake further consultation with the community and road user groups to better understand the risks and the best methods of addressing these.

Users of this document should record the identification, analysis, treatment and monitoring process for high-risk motorcycle routes. This record provides the right level of information for decision makers and the people responsible for taking action.

Further information on risk management, communication and consultation, and recording the risk management process can be sourced from AS/NZA ISO31000: *2009 Risk management: Principles and guidelines* and chapters 3 and 9 of SAA/SNZ HB 436:2004 *Risk management guidelines.*

7.3.2 General consultation and engagement

It is vital to engage with key stakeholders (community, affected and interested parties) when developing projects in order to create a common sense of purpose, draw on and learn from other's perspectives, make better decisions, align mutual interests, identify and mitigate risks, and find shared solutions to challenges.

Good relationships are important for effective engagement. However, many of the hallmarks of good relationships – trust, mutual respect and understanding – are intangibles that develop and evolve over time. Early engagement provides a valuable opportunity to set a positive tone with stakeholders from the outset of a project. The absence of established relationships and communication channels can put your project at an immediate disadvantage.

Establishing and maintaining good relationships requires a long-term view. Organisations that take this approach see the value obtained by consistently following through on their commitments to stakeholders. They take grievances seriously and deal with them in a reliable and timely manner. They continually invest in communicating about their work in a way that makes sense to their stakeholders. Effective engagement and communication will ultimately ensure the project's success.

As stated within the Austroads research report[89]:

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[89] Austroads, 2006, *Community consultation process and methods for quantifying community expectations on the levels of service for road networks*, AP-R290-06, page 2.

- 'An ideal consultation with road users and other stakeholders is one that:
    - consists of a number of clearly defined stages, each with their own specific objectives
    - includes both external stages (ie those that include road users and stakeholders) and internal stages (ie that include employees of the road agency only)
    - is iterative in nature, that is, is part of an ongoing and iterative cycle of learning, refinement and improvement embedded within the LOS development process rather than an 'isolated event' that takes place externally to it.'
- 'The development of levels of service and intervention criteria for maintenance and improvement activities through community consultation is complex and requires careful planning. The process consists of several iterative stages: listen, communicate, reflect and plan, implement, monitor and measure. The process alternates stages that involve the community with stages that require internal agency assessment and evaluation. Each stage is conducted in a structured manner and requires specific techniques and specialised skills.'[90]
- 'The process begins with a two-way communication ('listen' and 'communicate') between the road agency and the community with the purpose of gaining a common understanding of community concerns, priorities, current road classification system and levels of service as well as agency issues, priorities and budget limitations. This part of the process also helps the development of a common language and the identification of the most effective channels for further communication of road maintenance issues. The two way communication establishes the foundation for a transparent and strong relationship between the road agency and the community.'[91]

Case study: Coromandel loop pilot and motorcycle safety demonstration projects

A joint motorcycle pilot project with ACC and NZTA was recently undertaken within the Coromandel area. The purpose of the Thames-Coromandel pilot project was to determine and implement suitable interventions and road safety improvements for motorcyclists. The project was founded on the safe roads and roadsides element of the Safe System approach, with the intent of enhancing road safety and minimising motorcycle crash risk. This pilot route is a 130km loop of state highways popular among recreational motorcyclists. This includes SH 25A Kopu to Hikuai, SH 25 Hikuai to Waihi, SH 2 Waihi to Paeroa and SH26 Paeroa to Kopu (figure 7-2).

The 2001–10 motorcycle crash history for the route includes 5 fatal, 21 serious injury, and 20 minor injury crashes. 34 of the 50 crashes (including 4 non-injury) occurred on bends and 10 at intersections. There are concentrations of crashes around the loop, therefore, any works proposed to address motorcycle crashes will initially be focused in the locations with the most motorcycle crashes.

Figure 7-2: Motorcycle pilot project route. Source: www.nzta.govt.nz

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[90] Ibid, page 60.

[91] Ibid, page 60.

As part of that project the NZTA, MSAC and ACC commenced consultation with motorcycle groups both regionally and nationally who were encouraged to join a ride over of the route and provide input to the project. An instrumented motorcycle was used to record features of the route from a motorcyclist's perspective. In addition to the key stakeholders, maintenance teams, local road safety coordinators and a number of international motorcycling experts from VicRoads and Monash University were invited to join and help to identify safety issues and recommend suitable interventions. As a result of that ride over, a list of issues and possible solutions was raised. Further work is being undertaken to define the exact nature of the solutions and prioritisation of the associated works. However, the possible countermeasures identified to date include; speed management, signage and delineation, motorcycle specific signs, flexible signs and posts, and improvements to construction and maintenance practices.

The process of engagement with the community and motorcycle groups was a vital part of this project. Further encouragement and opportunity was provided by the project team for motorcyclists to provide feedback on their ride over or general comments regarding the route via an information centre set up on the day or by adding comments to project specific web pages managed by ACC and MSAC.

7.4 Road safety action planning

Road safety action planning is a world best-practice process for planning and implementing road safety interventions by road safety partners. Continued and enhanced road safety action planning is one of the essential platforms for delivering the Safer Journeys road safety strategy.

Effective road safety action planning requires a collaborative approach from participating partners to provide focus, commitment and urgency in order to address and mitigate road safety risks, especially in terms of the Safer Journeys high priority road safety issues (speed, alcohol and drugs, motorcycling, young drivers, and roads and roadsides) for the local area.

Participating partners include regional and local authorities, the NZTA, the NZ Police, the Accident Compensation Corporation (ACC), and other road safety stakeholders according to local enthusiasm. The partners agree on regional and/or local road safety risks, identify objectives, set targets, undertake road safety actions, and monitor and review progress towards road safety targets.

This document is mostly focused on engineering treatments for roads and roadsides, however, the practitioner also needs to consider a range of treatments across safe speeds, safe users and safe vehicles to address the safety issues and concerns of key stakeholders.

Road safety action planning is the primary way to coordinate a Safe System approach to road safety problems at sub-regional levels and could be a key opportunity for all road safety partners to identify their motorcycle improvement projects. These plans can be referenced for any additional information on agreed measures at sites or routes of interest or updated as a result of Safe System investigations.

7.5 Monitoring and evaluation

Monitoring and evaluation of Safe System treatments is important in gauging the effectiveness of different treatments. This is also important when developing types of countermeasures for specific issues and implementation procedures for future programmes. Specifically:

- **Monitoring** involves an assessment of progress and collecting information through the course of a project, this can be before, during and after implementation to gather results from which to do an evaluation (see section 7.5.1).
- An **evaluation** analyses the results of monitoring and determines the results and effectiveness of the types of treatments used (see section 7.5.2).

7.5.1 Monitoring

Monitoring and collection of data for evaluation will help to identify if road safety has been improved. 'Systematic recording of data and analysis of trends from which the performance measures can be calculated allows the most

recent values of measures and their trends to be compared with target levels.'[92] The NZTA website (www.nzta.govt.nz/resources/road-safety-outcomes/) contains quarterly outcome reports that indicate actual road safety progress compared with the Safer Journeys areas of concern. These reports provide an overall picture of road safety from a national, regional, and police district perspective.

7.5.2 Evaluation

The role of evaluation is to:

- ensure that recently delivered programmes are effective and enable remedial action if they are not
- build up a reliable knowledge base about the effectiveness of different interventions, which will allow more effective programmes to be developed in the future.

There are effectively two levels of monitoring and evaluation:

- Strategic monitoring and then evaluating the effectiveness of the overall programme or strategy, which is made up of various projects or initiatives.
- Individual monitoring and evaluating of specific projects or initiatives that combined make up the overall programme or strategy.

While good monitoring and evaluation will support future road safety improvement programmes, the monitoring and evaluation effort should not consume excessive amounts of staff time or other resources that could be used to undertake more road safety initiatives. As a general observation, many people and organisations undertake little or no monitoring, while others seek to monitor an extraordinary number of items, arguing that the various measures do not take account of every minute impact.

In the following sections the monitoring and evaluation of individual initiatives or projects are described, followed by the monitoring of the overall strategy.

For further information of evaluation of treatments, evaluation methods refer to the NZTA *High-risk rural roads guide*.

7.5.2.1 CAS monitoring, data requirements

The key to effective evaluation of specific works is to ensure the data required for evaluation of individual projects, treatments or initiatives is collected over the course of the programme and staff are not faced with the arduous task of trawling back through project files to identify when and which works have been completed.

The best way of addressing this issue is to ensure the project monitoring established at the start of a project and, as discussed above, the entering of monitoring data forms part of the contract, in-house service agreement or task plan for the works. Monitoring is best done using the Crash Analysis System (CAS).

CAS has the ability to record three types of site:

- **Sites of interest** (figure 7-3) – these are simply locations that users can identify spatially and for which crash data can be recalled. Once data is recalled the user can analyse the effects of a programme of works. Recording works as sites of interest relies on recording key data about the works undertaken elsewhere, so sites of interest may be useful when monitoring areas to determine ongoing trends and whether these are related to improvement programmes or not.
- **Safety improvement projects or crash reduction monitoring sites** (figure 7-4 and figure 7-5) – these two types of site are essentially the same in terms of the inputs required. The first data entry screen (figure 7-4) allows the user to input site description data (the sites are spatially defined later in the process).

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[92] Austroads, 2006, *Guide to road safety part 2: Road safety strategy and evaluation*, AGRS02/06, page 30.

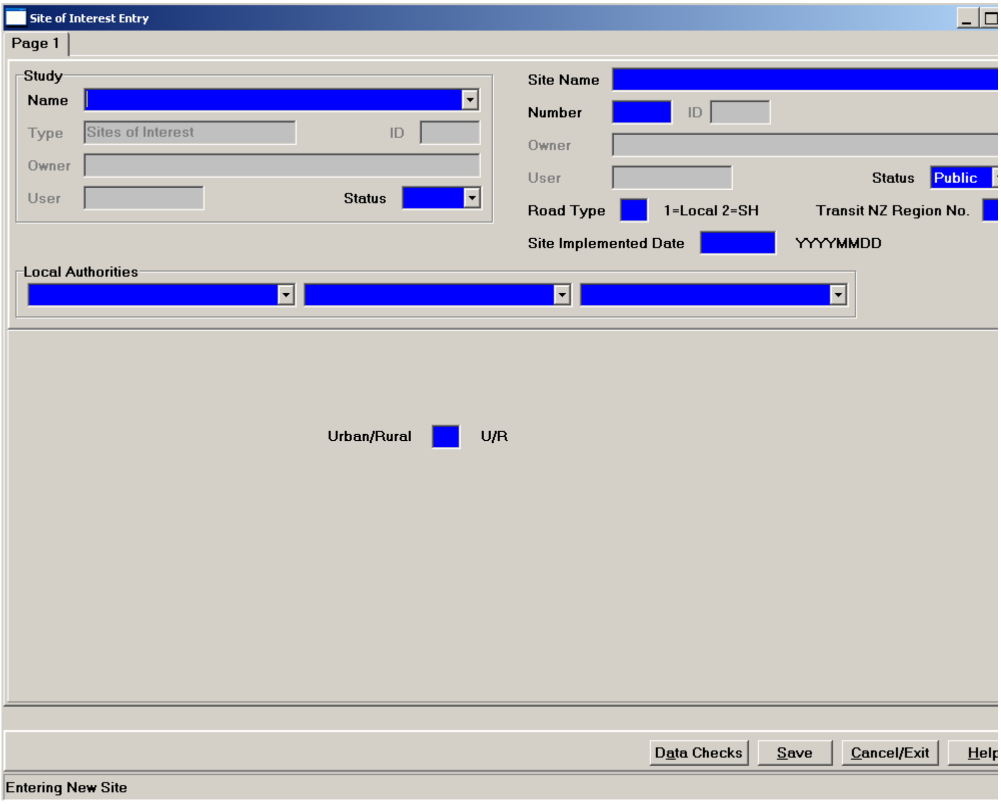

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Figure 7-3: CAS sites of interest

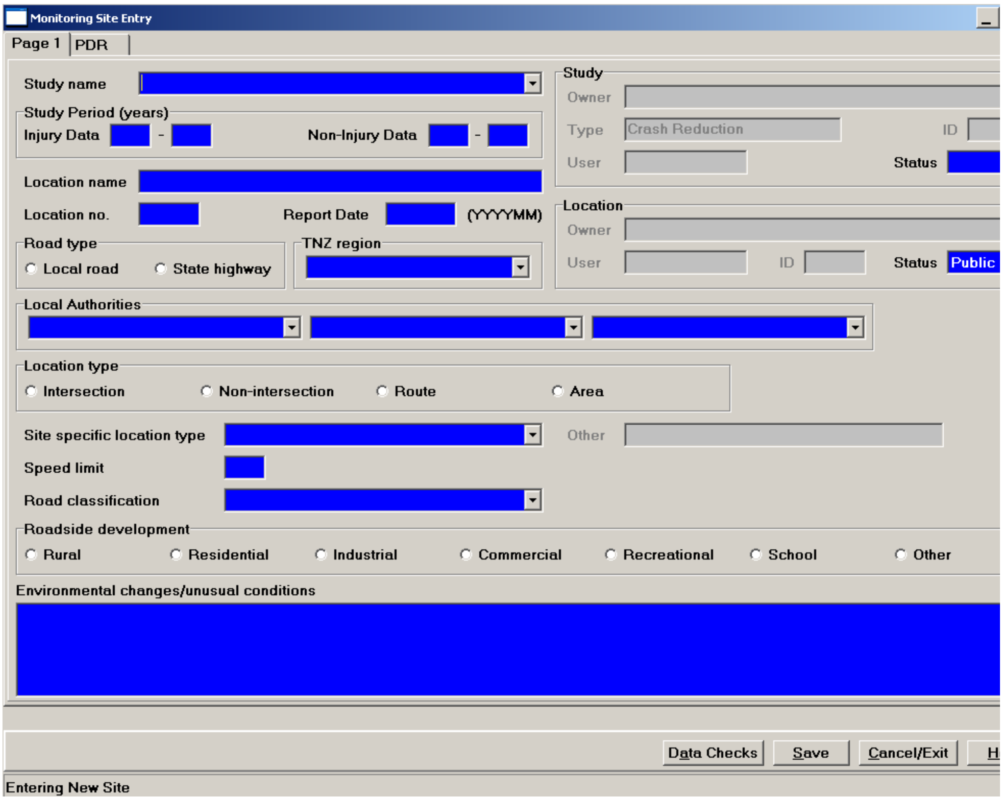

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Figure 7-4: Monitoring site data entry screen 1

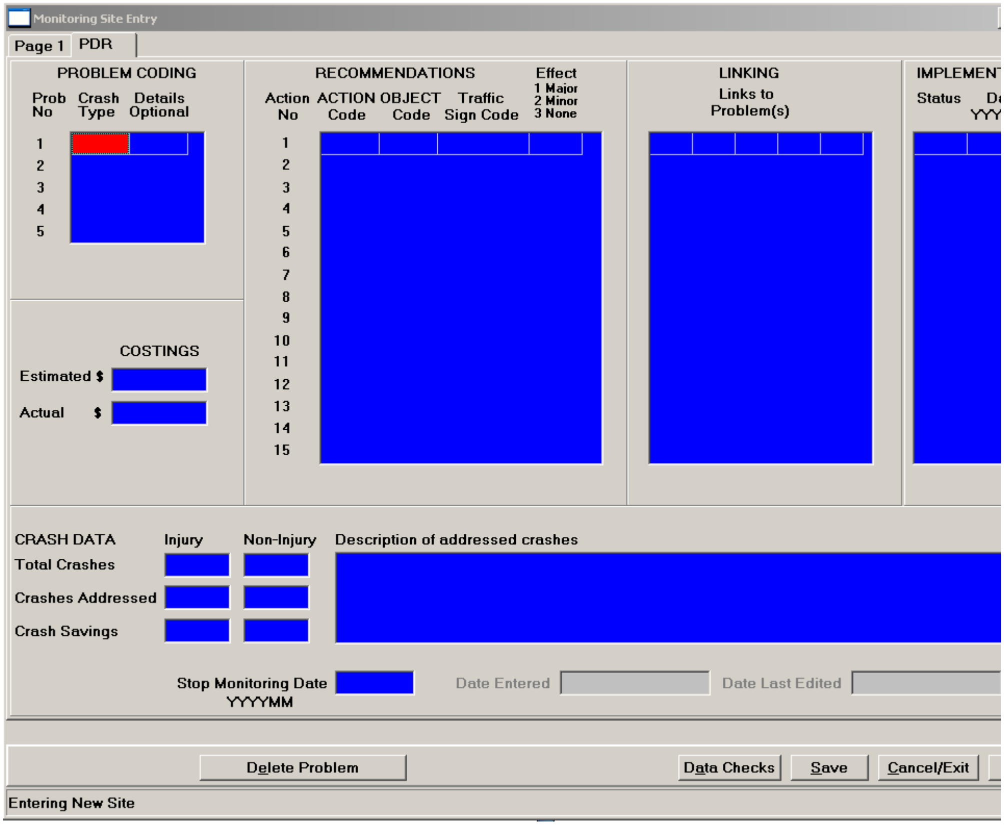

Figure 7-5: Monitoring site data entry screen 2

The second screen (figure 7-5) is used to identify the crash issues at the site and explicitly links the proposed solutions to the problems and the expected crash savings. While entering projects as safety improvement projects or monitoring sites involves detailed data, monitoring site performance data automatically adjusts for potential regression to the mean impacts.

It is, however, important to recognise that, under the Safe System approach, we are looking toward more proactive treatment, (rather than waiting for crash histories to develop), and implementing synergetic corridor treatments to increase consistency. It is therefore quite likely that in some situations works will be undertaken with a view to decreasing risk, rather than to treat a documented crash history.

In such situations crash performance monitoring may well be invalid because of a lack of a ‘before’ crash risk. In these situations we need to monitor and evaluate our programme as a whole, or develop some other key performance measures.

7.5.3 Monitoring and evaluation performance measures

Referring back to figure 7-1, three types of road safety measures are available for monitoring and evaluation:

- **Primary outcomes** – for example, the reduction in the number of motorcyclists injured in rural areas as a result of road crash trauma.
- **Secondary performance measures**, such as reductions in the collective risk. These can be measured in terms of reported crash numbers and patterns of crash types and factors.
- **Lead performance indicators** or intermediate measures describing the improvements to the road, road environment, speed or other features that have a known impact on road safety; for example, increasing skid resistance investigatory levels to reduce loss of control crashes. These output measures are known to directly impact safety outcomes.

The intermediate measures are particularly important as stated in the OECD report.[93]

'Within a Safe System approach there is a need to switch from injury based data (final outcomes) to performance data (intermediate outcomes). Some countries such as Sweden have already started to develop systems which give them an opportunity to address road safety problems within the road transport system without needing to wait to measure final outcomes in terms of fatalities and injuries. Focusing on this intermediate data and its measurement builds awareness that, for a Safe System, 100% achievement of safety performance in various sub-target areas is required.'

7.5.3.1 Primary outcomes

The primary outcome target is the **reduction in deaths and serious injuries in rural areas**[94] over the highest-risk routes and intersections that contribute most to the total across the network.

7.5.3.2 Secondary performance measures

Secondary performance measures (refer to table 7-1) relate to reducing the crash risks on the network and on each high-risk rural route or intersection. Indicators could be reductions in all recorded crash types or particular subgroups:

Table 7-1: Key secondary performance measures

Key secondary performance measures based on actual risk (crash data) could include a reduction in:	Key secondary performance measures based on predictive risk analysis may include a reduction in:
overall collective risk	the length of route (through realignment)
number and severity of loss of control crashes	
number and severity of intersection crashes	
number and proportion of crashes in the wet	
injuries to motorcyclists	

7.5.3.3 Lead performance indicators

The best and most relevant lead performance indicators will relate most directly to the change in collective crash risk that is associated with improvements in the feature being assessed. Key lead performance indicators (refer to table 7-2) to benefit motorcyclists may include:

Table 7-2: Key lead performance indicators

Key lead performance indicators
Proportion of highway (or travel on highways) with roadside barriers or hazard reduction
Proportion of highway (or travel on highways) with sealed shoulder widths of at least 1m
The length of routes subject to speed zoning below the default limit or under active speed management.
The change in network mean and/or 85th percentile speed (measured by the MoT)
The change in centre line or edge line encroachments

[93] OECD, 2008, *The Safe System approach: Towards zero ambitious road safety targets and the safe system.* OECD International Transport Forum, Transport Research Centre, 2008, page 12.

[94] As previously stated urban targets are yet to be developed. These will be confirmed with the analysis completed and subsequent publication of the NZTA high-risk intersection guide (see comment box in section 4.1).

7.5.4 Goals and targets

The goals for the primary outcomes all relate back to the nationally reported targets for motorcycling road safety. The targets involve reducing the following metrics:

- ACC entitlement claims from motorcyclists.
- Motorcycle/moped riders killed per 100,000 population per year.[95]
- The percentage of motorcycle/mopeds with a non-current warrant of fitness (WOF) involved in crashes.
- Motorcycle/mopeds riders hospitalised for more than one day per 100,000 population per year.

In addition to the nationally reported targets, and depending on which lead performance indicators are being used to monitor the effectiveness of the ongoing programme of safety improvements, goals can be set for one or more lead indicators. However, in all cases the goals should pertain to:

- crash patterns for both:
  - high-severity crashes, that is, those resulting in death or serious injury, as they may differ from lower-severity crashes
  - all crashes (the inclusion of minor and non-injury crashes will better highlight spatial, temporal and crash movement commonalities or factor patterns)
- the spatial location of crashes – whether they are clustered or distributed
- key risk factors such as length, proximity to road users, and severity of hazardous roadsides
- consistency of expectation and provision of road features and roadside infrastructure.

7.5.5 Responsibilities for monitoring and evaluation

The responsibility for monitoring and evaluation at the highest level lies with the Ministry of Transport, which monitors the national trends in the numbers of road users killed or seriously injured – the primary outcomes. However, the various RCAs should also be monitoring these primary outcomes for their respective networks. Where large networks, (for example the state highway network or Auckland City), have been divided into sub-networks, the roading manager should also monitor the primary outcomes.

RCAs should also be monitoring the secondary outcomes, related to collective and personal risk, patterns of crash types and factors, and changes in the risk profile of the routes and intersections being targeted.

RCAs should also focus on lead performance indicators as the measure of the work they are performing towards Safe System goals.

[95] The nationally reported targets are described in terms of per 100,000 population per year. This is different from the Safer Journeys targets which are in terms of per 1 million population per year, however, as noted previously, the targets described in Safer Journeys incorrectly refer to per 100,000 population per year.

8 Other information sources

Document/reference	Website information (if any)
Safer Journeys: New Zealand's road safety strategy 2010–2020. Ministry of Transport, March 2010.	www.transport.govt.nz/saferjourneys/Pages/default.aspx
Traffic control devices manual. NZ Transport Agency.	www.nzta.govt.nz/resources/traffic-control-devices-manual/index.html
Traffic Control Devices Rule and Traffic note. NZ Transport Agency.	www.nzta.govt.nz/resources/results.html?catid=2
Kiwi Road Assessment Programme (KiwiRAP). New Zealand Joint Agency.	www.kiwirap.co.nz
The handbook of road safety measures. Elvik, 2004.	http://books.google.com/books/about/The_handbook_of_road_safety_measures.html?id=f4NUAAAAMAAJ
Towards zero: Ambitious targets and safe system approach. OECD, 2008.	www.internationaltransportforum.org/jtrc/safety/targets/08TargetsSummary.pdf
Motorcycle crashes into roadside barriers stage 1 and stage 2 reports. (Monash University Study).	
Berg, FA, Rucker, P, Gartner, M, Konig, J, Grzebieta, R, & Zou, R. (2005). *Motorcycle impact into roadside barrier- real-world accidents studies, crash tests and simulations carried out in Germany and Australia* in Proceedings of the 19th International Conference on the ESV, Washington: USA. pp.1–13.	
Evaluation of the safety impact of centre-of-the-road wire rope barrier (WRB) on undivided rural roads. (Austroads AP-T135/09).	
Scooter survival (Accident Compensation Corporation).	www. scootersurvival.co.nz
Ride forever (Accident Compensation Corporation).	www.rideforever.co.nz
The official New Zealand road code for motorcyclists. NZ Transport Agency.	www.nzta.govt.nz
Motor vehicle crashes in New Zealand, 2010. Ministry of Transport.	www.transport.govt.nz/research/Pages/MotorVehicleCrashesinNewZealand2010.aspx

9 Appendix Y: RAMM SQL for calculating personal and collective risk

The material contained in this appendix is taken from the September 2011 version of the NZTA *High-risk rural roads guide*. Practitioners using the methodology contained in this appendix are encouraged to confirm that they are using the most recent version of this methodology.

10 Appendix Z: Speed management

The material contained in this appendix is taken from the September 2011 version of the NZTA *High-risk rural roads guide*. Practitioners using the material contained in this appendix are encouraged to confirm that they are using the most recent version of this material.